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 ATLANTIC FLEET TRAINING AND TESTING STUDY AREA

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UPDATE NOTES

This August 04, 2017 update contains technical clarifications and corrections to the original 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 Atlantic Fleet Training and Testing Study Area, which was submitted to NMFS on June 15, 2017. For clarity and understanding of the changes included in this update, substantive revisions have been made in track changes and are summarized below:

- Changes in Section 1 include updates to activity numbers for both training and testing in Table 1.5-1, Table 1.5-2 and Table 1.5-3.
- Changes in Section 1 include updates to acoustic stressor hours and counts for both training and testing in Table 1.5-5 and Table 1.5-8.
- Changes in Section 3 include updates to Table 3.1-1 based on the 2016 Stock Assessment Reports published in June 2017.
- Changes in Section 4 include updates to select species “Population Trends” sections based on the 2016 Stock Assessment Report.
- Changes in Section 5 include updates to estimated impacts from training and testing activities in Table 5.1-5 through Table 5.1-5.
- Changes in Section 6 include updates to impact graphics and tables, as well as associated text.
- The Ship Shock box located in the VACAPES Range Complex has been revised. All applicable figures now show the correct boundaries.

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Request for Regulations and LOA for the Incidental Taking of Marine Mammals Resulting from U.S. Navy Training and Testing Activities in the Atlantic Fleet Training and Testing Study Area

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ABBREVIATIONS AND ACRONYMS

Acronym	Definition
µg/g	microgram(s) per gram
AFTT	Atlantic Fleet Training and Testing
ASW	Anti-Submarine Warfare
ASUW	Anti-Surface Warfare
CFR	Code of Federal Regulations
CV	coefficient of variation
dB	decibel(s)
DS	Doppler Sonars
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FA	Fathometers
FLS	Forward Looking Sonars
ft.	foot/feet
GI	Gastrointestinal
GOMEX	Gulf of Mexico
HF	High-Frequency
HHS	Handheld Sonars
IEER	Improved Extended Echo Ranging
IMS	Imaging Sonars
in.	Inch
JAX	Jacksonville
kg	kilogram(s)
kHz	kilohertz
LF	low-frequency
LOA	Letter of Authorization
m	meter(s)
M	Acoustic Modems
MF	mid-frequency

Acronym	Definition
MMPA	Marine Mammal Protection Act
NAEMO	Navy Acoustic Effects Model
NAVAIR	Naval Air Systems Command
NEW	Net Explosive Weight
NM	nautical mile(s)
NMFS	National Marine Fisheries Service
NRL	Naval Research Laboratory
OEIS	Overseas Environmental Impact Statement
ONR	Office of Naval Research
OPAREA	operating area
P	Pingers
psi	pound(s) per square inch
PTS	permanent threshold shift
R	acoustic release
rms	root mean square
SAS	Synthetic Aperture Sonars
SDS	Swimmer Defense Sonars
SEL	sound exposure level
SPL	Sound Pressure Level
SSS	Side Scan Sonars
SUS	Signal Underwater Sound
TNT	Trinitrotoluene
TORP	Torpedo
TTS	Temporary Threshold Shift
VACAPES	Virginia Capes
VHF	Very-High Frequency
U.S.C.	United States Code

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1 DESCRIPTION OF SPECIFIED ACTIVITY

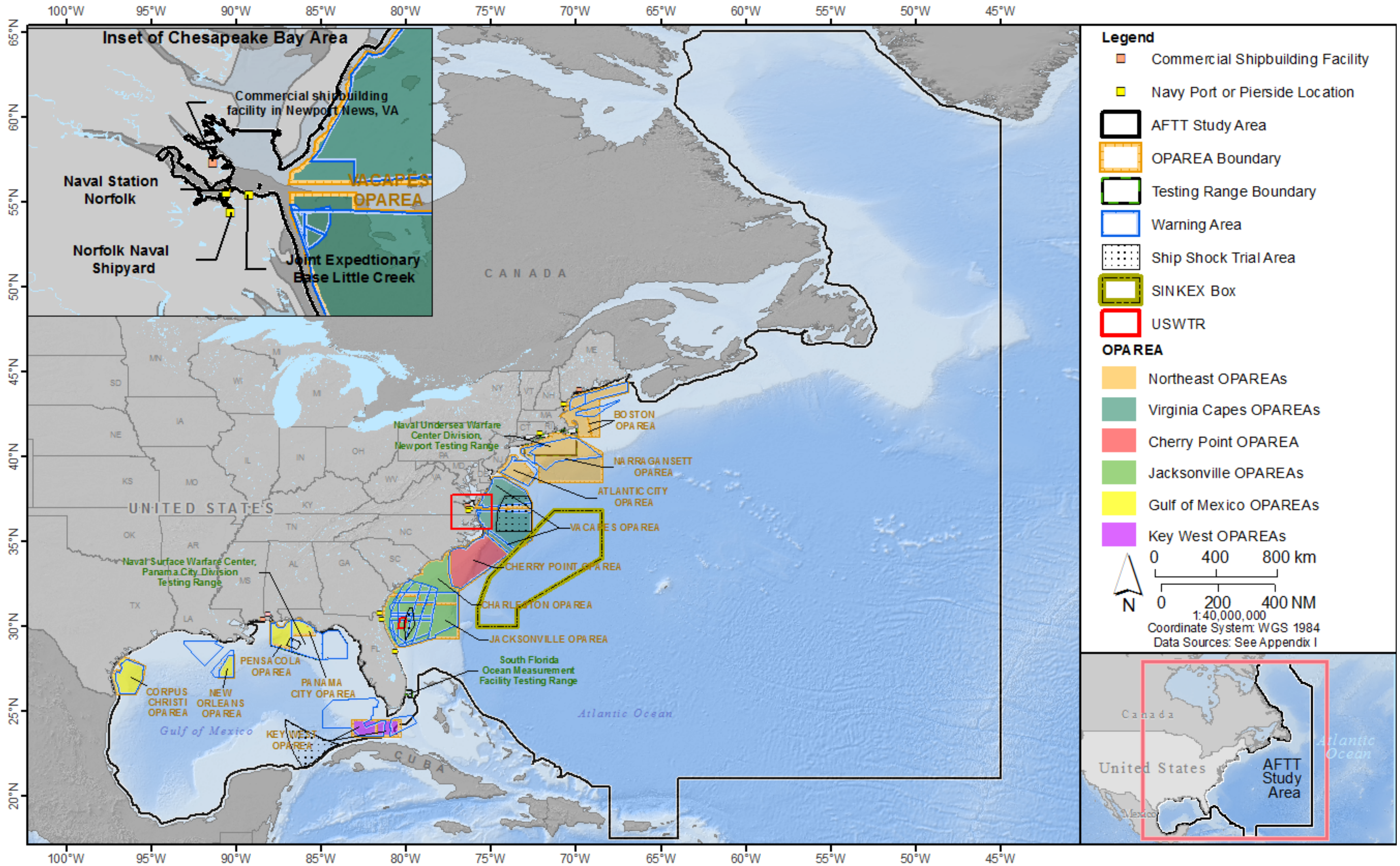
1.1 INTRODUCTION

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 Take Authorization Requested) of marine mammals during the conduct of training and testing activities within the Atlantic Fleet Training and Testing (AFTT) Study Area. This application supports the request for a 5-year LOA for training activities and a 5-year LOA for testing activities from 2018-2023.

The Marine Mammal Protection Act (MMPA) of 1972, as amended (16 United States Code [U.S.C.] Section [§] 1371(a)(5)), authorizes the issuance of regulations for the incidental, but not intentional, taking of marine mammals by a specified activity for a period of not more than 5 years. The issuance occurs when the Secretary of Commerce, after notice has been published in the Federal Register and opportunity for comment has been provided, finds that such taking will have a negligible impact on the species and stocks of marine mammals and will not have an unmitigable adverse impact on their availability 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 AFTT Study Area to evaluate all components of the proposed training and testing activities. A description of the AFTT Study Area (Figure 1.1-1) 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 AFTT Draft EIS/OEIS), referred to in this document as the Proposed Action.

This document has been prepared in accordance with the applicable regulations and the MMPA, as amended by the National Defense Authorization Act for Fiscal Year 2004 (Public Law [PL] 108-136) and its implementing regulations. This request for Letters of Authorization is based on: (1) the analysis of spatial and temporal distributions of protected marine mammals in the AFTT Study Area (hereafter referred to as the Study Area), (2) the review of training and testing activities 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 could result in Level B harassment, Level A harassment, or mortality under the MMPA. Of the Navy activities analyzed in the AFTT EIS/OEIS, the Navy has determined that only the use of sonar and other transducers, in-water detonations, air guns, impact pile driving/vibratory extraction have the potential to affect marine mammals in a manner which rise to the level of take. 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.



Notes: AFTT = Atlantic Fleet Training and Testing; km=kilometers; NM = nautical mile; OPAREA = Operating Area

Figure 1.1-1. AFTT Study Area

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 U.S.C. § 5062), which ensures the readiness of the naval forces of the United States.[1] The Navy accomplishes 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 AFTT EIS/OEIS, and NMFS is a cooperating agency pursuant to 40 CFR §§ 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.

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 addressed in the AFTT EIS/OEIS 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 listed as "other activities." Each warfare community (surface, subsurface, aviation, and special warfare) may train in 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.

[1] Title 10, Section 5062 of the U.S.C. 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."

The Navy describes and analyzes the impacts of its training and testing activities within the AFTT Draft EIS/OEIS. In its assessment, the Navy concluded that sonar and other transducers, in-water detonations, air guns, and pile driving/extraction were the stressors that would result in impacts on marine mammals that could rise to the level of harassment or injury as defined in the MMPA. Therefore, this request for LOAs 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. In terms of Navy warfare areas, this includes:

- amphibious warfare (in-water detonations)
- anti-submarine warfare (sonar and other transducers, in-water detonations)
- expeditionary warfare (in-water detonations)
- surface warfare (in-water detonations)
- mine warfare (sonar and other transducers, in-water detonations)
- other (sonar and other transducers, impact pile driving/vibratory extraction, air guns)

The Navy's training and testing activities in air warfare and electronic warfare do not involve sonar or other transducers, in-water detonations, pile driving/extraction, air guns 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 application, but are analyzed fully in the Navy's AFTT 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 classifying 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 Expeditionary Warfare

The mission of expeditionary warfare is to provide security and surveillance in the littoral (at the shoreline), riparian (along a river), or coastal environments. Expeditionary warfare is wide ranging and includes defense of harbors, operation of remotely operated vehicles, defense against swimmers, and boarding/seizure operations.

Expeditionary warfare training activities include underwater construction team training, dive and salvage operations, diver propulsion device training and testing, and parachute insertion.

1.3.1.4 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 neutralization 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.

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. 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 to evaluate the effectiveness of tracking devices, countermeasure and neutralization systems, and general purpose bombs to neutralize mine threats. Most neutralization tests use mine shapes, or non-explosive practice mines, to evaluate a new or enhanced capability. 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 tests require the use of high-explosive mines to evaluate and confirm the ability of the system 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.

1.3.1.5 Surface Warfare

The mission of surface warfare is to obtain control of sea space from which naval forces may operate, and entails offensive action against other surface, subsurface, and air targets while also defending against enemy forces. In surface warfare, aircraft use cannons, air-launched cruise missiles, or other precision-guided munitions; ships employ torpedoes, 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 and missile exercises, and 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 ordnance 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 AFTT 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 AFTT 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.[2]

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

[2] 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.

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 1.3-1 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.

Table 1.3-1: 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 Exercise	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	JAX RC Navy Cherry Point RC VACAPES RC	COMPTUEX	>500 hours
Major Training Exercise	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	JAX RC Navy Cherry Point RC VACAPES RC	FLEETEX/ SUSTEX	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	JAX RC Navy Cherry Point RC VACAPES RC	SWATT, NUWTAC	50-100 hours
Integrated/ Coordinated Training	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	JAX RC Navy Cherry Point RC VACAPES RC	TACDEVEX	Less than 100 hours
Integrated/ Coordinated Training	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	JAX RC Navy Cherry Point RC VACAPES RC	ARG/MEU, Group Sail	Less than 50 hours

Notes: ASW: anti-submarine warfare; JAX: Jacksonville; RC: Range Complex; VACAPES: Virginia Capes; FLEETEX/SUSTEX: Fleet Exercise/Sustainment Exercise; SWATT: Surface Warfare Advanced Tactical Training Exercise; NUWTAC: Navy Undersea Warfare Training Assessment Course; TACDEVEX: Tactical Development Exercise; ARG/MEU: Amphibious Ready Group/Marine Expeditionary Unit

The training activities that are part of the Proposed Action for this LOA request are described in Table 1.3-1, 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 AFTT DEIS/OEIS provide more detailed descriptions of the activities.

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 AFTT 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 AFTT EIS/OEIS are Naval Air Systems Command, Naval Sea Systems Command, and the Office of Naval Research.

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 or testing it to ensure 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, launch systems, 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.

One ship of each new class (or major upgrade) of combat ships constructed for the Navy typically undergoes an at-sea ship shock trial. A ship shock trial consists of a series of underwater detonations that send shock waves through the ship's hull to simulate near misses during combat. A shock trial allows the Navy to assess the survivability of the hull and ship's systems in a combat environment as well as the capability of the ship to protect the crew.

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 AFTT Study Area includes acoustic and oceanographic research, large displacement unmanned underwater vehicle (innovative naval prototype) research, and emerging mine countermeasure technology research.

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 request based on public comment received during scoping, previous NEPA analyses, previous consultation documents, and opinions of subject matter experts. Stressor/resource interactions that were determined to have negligible or no impacts (i.e., vessel, aircraft, or weapons noise) were not carried forward for analysis in this LOA request.

1.4.1 Acoustic Stressors

This section describes the characteristics of sounds produced during naval training and testing and the relative magnitude of these sound-producing activities. 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 request are in Appendix D (Acoustic and Explosive Concepts) of the AFTT 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 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 conservative 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 AFTT 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 LOA request are described in Appendix A (Navy Activity Descriptions) of the AFTT 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-ranging 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 12 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 or testing 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 of use. Classes are further sorted by 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 1.4-1. While general parameters or source characteristics are shown in the table, actual source parameters are classified.

Table 1.4-1: 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
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)

Source Class Category	*Bin*	*Description*
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 various offshore areas in the AFTT Study Area, as well as near shore at Newport, RI.

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 SEL per shot.

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 Joint Expeditionary Base Little Creek-Fort Story in the Virginia Capes Range Complex or Marine Corps Base Camp Lejeune in the Navy Cherry Point 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 (Reinhall & Dahl, 2011) (note this shock wave has very low peak pressure compared to a shock wave from an explosive). 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 1.4-2.

Table 1.4-2: 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 µPa^{2}s SEL (single strike)
24-in. Steel Pipe Pile	Vibratory[2]	146 dB re 1 µPa SPL rms 145 dB re 1 µPa^{2}s SEL (per second of duration)

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

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, 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 – 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.

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).

1.4.2 Explosive Stressors

This section describes the characteristics of explosions during naval training and testing. The activities analyzed in this LOA request that use explosives are described in Appendix D (Acoustic and Explosive Concepts) of the AFTT EIS/OEIS. Explanations of the terminology and metrics used when describing explosives in this LOA request are in Appendix D (Acoustic and Explosive Concepts) of the AFTT 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 AFTT 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 near 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 1.4-3.

Table 1.4-3: 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
E14	> 1,741 – 3,625	Line charge
E16[2]	> 7,250 – 14,500	Littoral Combat Ship full ship shock trial
E17	> 14,500 – 58,000	Aircraft carrier full ship shock trial

[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] E14 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.

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) in the 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 AFTT Study Area. The Navy has been conducting military readiness activities in the Study Area for well over a century and with active sonar for over 70 years. The tempo and types of training and testing activities have fluctuated because of the introduction of new technologies, the evolving nature of international events, advances in warfighting doctrine and procedures, and changes in force structure (organization of ships, weapons, and personnel). Such developments influenced the frequency, duration, intensity, and location of required training and testing activities. This LOA request reflects the most up to date compilation of training and testing activities deemed necessary to accomplish military readiness requirements. The types and numbers of activities included in the Proposed Action accounts for fluctuations in training and testing in order to meet evolving or emergent military readiness requirements.

1.5.1 Training Activities

The training activities that the Navy proposes to conduct in the Study Area are described in Table 1.5-1. The table is organized according to primary mission areas and includes the activity name, associated stressors applicable to this LOA request, number of proposed activities and locations of those activities in the AFTT Study Area. For further information regarding the primary platform used (e.g., ship or aircraft type), and duration of activity see Appendix A (Navy Activity Descriptions) of the AFTT 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 application, 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 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 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location[2]*
Major Training Exercise – Large Integrated ASW						
Acoustic	Composite Training Unit Exercise	Aircraft carrier and its associated aircraft integrate with surface and submarine units in a challenging multi-threat operational environment in order to certify them for deployment.	ASW1, ASW2, ASW3, ASW4, ASW5, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	2–3[1]	12	VACAPES RC Navy Cherry Point RC JAX RC
Major Training Exercises – Medium Integrated Anti-Submarine Warefare						
Acoustic	Fleet Exercises/Sustainment Exercise	Aircraft carrier and its associated aircraft integrates with surface and submarine units in a challenging multi-threat operational environment in order to maintain their ability to deploy.	ASW1, ASW2, ASW3, ASW4, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	4	20	JAX RC
				2	10	VACAPES RC
Integrated/Coordinated Training – Small Integrated Anti-Submarine Warfare Training						
Acoustic	Naval Undersea Warfare Training Assessment Course	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.	ASW1, ASW3, ASW4, HF1, LF6, MF1, MF3, MF4, MF5, MF12	6	30	JAX RC
				3	15	Navy Cherry Point RC
				3	15	VACAPES RC
Integrated/Coordinated Training – Medium Coordinated Anti-Submarine Warfare Training						
Acoustic	Anti-Submarine Warfare Tactical Development Exercise	Surface ships, aircraft, and submarines coordinate to search for, detect, and track submarines.	ASW1, ASW3, ASW4, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	2	10	JAX RC
				1	5	Navy Cherry Point RC
				1	5	VACAPES RC
Integrated/Coordinated Training – Small Coordinated Anti-Submarine Warfare Training						
Acoustic	Group Sail	Surface ships and helicopters search for, detect, and track threat submarines.	ASW2, ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, MF11, MF12	4	20	JAX RC
				4	20	Navy Cherry Point RC
				5	25	VACAPES RC
Amphibious Warfare						
Explosive	Naval Surface Fire	Surface ship crews use large-caliber guns	ES	4	20	GOMXEX RC

Table 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location*[2]
	Support Exercise – At Sea	to support forces ashore; however, the land target is simulated at sea. Rounds are scored by passive acoustic buoys located at or near the target area.		12	60	JAX RC
				2	10	Navy Cherry Point RC
				38	190	VACAPES RC
Anti-Submarine Warfare						
Acoustic	Anti-submarine Warfare Torpedo Exercise – Helicopter	Helicopter aircrews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF4, MF5, TORP1	14	70	JAX RC
				4	20	VACAPES RC
Acoustic	Anti-submarine Warfare Torpedo Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft aircrews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF5, TORP1	14	70	JAX RC
				4	20	VACAPES RC
Acoustic	Anti-Submarine Warfare Torpedo Exercise –Ship	Surface ship crews search for, track, and detect submarines. Exercise torpedoes are used.	ASW3, MF1, TORP1	16	80	JAX RC
				5	25	VACAPES RC
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Submarine	Submarine crews search for, track, and detect submarines. Exercise torpedoes are used.	ASW4, HF1, MF3, TORP2	12	60	JAX RC
				6	30	Northeast RC
				2	10	VACAPES RC
Acoustic	Anti-Submarine Warfare Tracking Exercise – Helicopter	Helicopter aircrews search for, track, and detect submarines.	MF4, MF5	24	120	Other AFTT Areas
				370	1,850	JAX RC
				12	60	Navy Chery Point RC
				8	40	VACAPES RC
Acoustic	Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft aircrews search for, track, and detect submarines.	ASW2, MF5	90	450	Northeast RC
				176	880	VACAPES RC
				525	2,625	JAX RC
				46	230	Navy Cherry Point RC

Table 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location*[2]
Acoustic	Anti-Submarine Warfare Tracking Exercise – Ship	Surface ship crews search for, track, and detect submarines.	ASW1, ASW3, MF1, MF11, MF12	5*	25*	Northeast RC
				110*	550*	Other AFTT Areas
				5*	25*	GOMEX RC
				440*	2,200*	JAX RC
				55*	275*	Navy Cherry Point RC
				220*	1,100*	VACAPES RC
Acoustic	Anti-Submarine Warfare Tracking Exercise – Submarine	Submarine crews search for, track, and detect submarines.	ASW4, HF1, MF3	44	220	Other AFTT Areas
				13	65	JAX RC
				1	5	Navy Cherry Point RC
				18	90	Northeast RC
				6	30	VACAPES RC
Expeditionary Warfare						
Explosive	Maritime Security Operations – Anti-Swimmer Grenades	Small boat crews engage in force protection activities by using anti-swimmer grenades to defend against hostile divers.	E2	2	10	GOMEX RC
				2	10	JAX RC
				2	10	Navy Cherry Point RC
				4	20	Northeast RC
				5	25	VACAPES RC
Mine Warfare						
Acoustic	Airborne Mine Countermeasure - Mine Detection	Helicopter aircrews detect mines using towed or laser mine detection systems.	HF4	66	330	GOMEX RC
				317	1,585	JAX RC
				371	1,855	Navy Cherry Point RC
				244	1,220	NSWC Panama City

Table 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location*[2]
				1,540	7,700	VACAPES RC
Acoustic, Explosive	Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercise	Maritime security personnel train to protect civilian ports against enemy efforts to interfere with access to those ports.	HF4, SAS2 E2, E4	1	3	Beaumont, TX; Boston, MA; Corpus Christi, TX; Delaware Bay, DE; Earle, NJ; GOMEX RC; Hampton Roads, VA; JAX RC; Kings Bay, GA; NS Mayport; Morehead City, NC; Port Canaveral, FL; Savannah, GA; Tampa Bay, FL; VACAPES RC; Wilmington, DE
Acoustic	Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercise	A detachment of helicopter aircrews train as a unit in the use of airborne mine countermeasures, such as towed mine detection and neutralization systems.	HF4	2	10	GOMEX RC
				2	10	JAX RC
				2	10	Navy Cherry Point RC
				2	10	VACAPES RC
Acoustic, Explosive	Mine	Ship, small boat, and helicopter crews	HF4, E4	132	660	GOMEX RC

Table 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location[2]*
	Countermeasures – Mine Neutralization – Remotely Operated Vehicle	locate and disable mines using remotely operated underwater vehicles.		71	355	JAX RC
				71	355	Navy Cherry Point RC
				630	3,150	VACAPES RC
Acoustic	Mine Countermeasures – Ship Sonar	Ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.	HF4	22	110	GOMEX RC
				53	265	JAX RC
				53	265	VACAPES RC
Explosive	Mine Neutralization – Explosive Ordnance Disposal	Personnel disable threat mines using explosive charges.	E4, E5, E6, E7	6	30	Lower Chesapeake Bay
				16	80	GOMEX RC
				20	100	JAX RC
				17	85	Key West RC
				16	80	Navy Cherry Point RC
				524	2,620	VACAPES RC
Surface Warfare						
Explosive	Bombing Exercise Air-to-Surface	Fixed-wing aircrews deliver bombs against surface targets.	E9, E10, E12	67	335	GOMEX RC
				434	2,170	JAX RC
				108	540	Navy Cherry Point RC
				329	1,645	VACAPES RC
Explosive	Gunnery Exercise Surface-to-Surface Boat Medium-Caliber	Small boat crews fire medium-caliber guns at surface targets.	E1	6	30	GOMEX RC
				26	130	JAX RC
				128	640	Navy Cherry Point RC
				2	10	Northeast RC
				260	1,300	VACAPES RC
Explosive	Gunnery Exercise Surface-to-Surface Ship Large-Caliber	Surface ship crews fire large-caliber guns at surface targets.	E3,E5	10	50	Other AFTT Areas
				9	45	GOMEX RC

Table 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location*[2]
				51	255	JAX RC
				35	175	Navy Cherry Point RC
				75	375	VACAPES RC
Explosive	Gunnery Exercise Surface-to-Surface Ship Medium-Caliber	Surface ship crews fire medium-caliber guns at surface targets.	E1	41	195	Other AFTT Areas
				33	165	GOMEX RC
				161	806	JAX RC
				72	360	Navy Cherry Point RC
				321	1,605	VACAPES RC
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	2	10	VACAPES RC
				2	10	JAX RC
Explosive	Missile Exercise Air-to-Surface	Fixed-wing and helicopter aircrews fire air-to-surface missiles at surface targets.	E6, E8, E10	102	510	JAX RC
				52	260	Navy Cherry Point RC
				88	440	VACAPES RC
Explosive	Missile Exercise Air-to-Surface – Rocket	Helicopter aircrews fire both precision-guided and unguided rockets at surface targets.	E3	10	50	GOMEX RC
				102	510	JAX RC
				10	50	Navy Cherry Point RC
				92	460	VACAPES RC
Explosive	Missile Exercise Surface-to-Surface	Surface ship crews defend against surface threats (ships or small boats) and engage them with missiles.	E6, E10	16	80	JAX RC
				12	60	VACAPES RC

Table 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location*[2]
Acoustic, Explosive	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, E8, E9, E10, E11	1	5	SINKEX Box
Other Training Activities						
Acoustic	Elevated Causeway System	A temporary pier is constructed off the beach. Supporting pilings are driven into the sand and then later removed.	Impact hammer or vibratory extractor	1	5	Lower Chesapeake Bay
				1	5	Navy Cherry Point RC
Acoustic	Submarine Navigation	Submarine crews operate sonar for navigation and object detection while transiting into and out of port during reduced visibility.	HF1, MF3	169	845	NSB New London
				3	15	NSB Kings Bay
				3	15	NS Mayport
				84	420	NS Norfolk
				23	115	Port Canaveral, FL
Acoustic	Submarine Sonar Maintenance	Maintenance of submarine sonar systems is conducted pierside or at sea.	MF3	12	60	Other AFTT Areas
				66	330	NSB New London
				9	45	JAX RC
				2	10	NSB Kings Bay
				34	170	NS Norfolk
				86	430	Northeast RC

Table 1.5-1: Proposed Training Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Annual # of Activities*	*5-Year # of Activities*	*Location*[2]
				2	10	Port Canaveral, FL
				13	63	Navy Cherry Point RC
				47	233	VACAPES RC
Acoustic	Submarine Under Ice Certification	Submarine crews train to operate under ice. Ice conditions are simulated during training and certification events.	HF1	3	15	JAX RC
				3	15	Navy Cherry Point RC
				9	45	Northeast RC
				9	45	VACAPES RC
Acoustic	Surface Ship Object Detection	Surface ship crews operate sonar for navigation and object detection while transiting in and out of port during reduced visibility.	HF8, MF1K	76	380	NS Mayport
				162	810	NS Norfolk
Acoustic	Surface Ship sonar Maintenance	Maintenance of surface ship sonar systems is conducted pierside or at sea.	HF8, MF1	50	250	JAX RC
				50	250	NS Mayport
				120	600	Navy Cherry Point RC
				235	1,175	NS Norfolk
				120	600	VACAPES RC

[1] For activities where the maximum number of events could vary between years, the information is presented as 'representative-maximum' number of events per year. For activities where no variation is anticipated, only the maximum number of events within a single year is provided.

[2] Locations given are areas where activities typically occur. However, activities could be conducted in other locations within the Study Area. Where multiple locations are provided within a single cell, the number of activities could occur in any of the locations, not in each of the locations.

* For anti-submarine warfare tracking exercise – Ship, the Proposed Action, 50 percent of requirements are met through synthetic training or other training exercises

Notes: GOMEX: Gulf of Mexico; JAX: Jacksonville; NS: Naval Station; NSB: Naval Submarine Base; NSWC: Naval Surface Warfare Center; RC: Range Complex; VACAPES: Virginia Capes

1.5.2 Testing Activities

Testing activities covered in this LOA request are described in Table 1.5-2 through **Table 1.5-5**. The Proposed Action entails a level of testing activities to be conducted into the reasonably foreseeable future, with adjustments that account for changes in the types and tempo (increases or decreases) of testing activities to meet current and future military readiness requirements. The Proposed Action includes the testing of new platforms, systems, and related equipment that will be introduced after November 2018. The majority of testing activities that would be conducted under the Proposed Action are the same as or similar as those conducted currently or in the past. The Proposed Action includes the testing of some new systems using new technologies and takes into account inherent uncertainties in this type of testing.

Under the Proposed Action, the Navy proposes an annual level of testing that reflects the fluctuations in testing programs by recognizing that the maximum level of testing will not be conducted each year. The Proposed Action contains a more realistic annual representation of activities, but includes years of a higher maximum amount of testing to account for these fluctuations.

1.5.2.1 Naval Air Systems Command

Table 1.5-2: Proposed Naval Air Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities*[1]	*5-Year # of Activities*	*Location*[2]
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 (e.g., helicopter) and fixed-wing aircraft and the ability to search for, detect, classify, localize, track, and attack a submarine or similar target.	MF5, TORP1	20–43	146	JAX RC
				40–121	362	VACAPES RC
Acoustic, Explosive	Anti-Submarine Warfare Tracking Test – Helicopter	This event is similar to the training event anti-submarine warfare 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 system perform to specifications.	MF4, MF5, E3	4–6	24	GOMEX RC
				0–12	24	JAX RC
				3–27	39	Key West RC
				28–110	304	Northeast RC
				137–280	951	VACAPES RC
Acoustic, Explosive	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, E1, E3, MF5, MF6	10–15	60	GOMEX RC
				19	95	JAX RC
				10–12	54	Key West RC
				14–15	72	Navy Chery Point RC
				36–45	198	Northeast Point RC
				25	125	VACAPES RC

Table 1.5-2: Proposed Naval Air Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities*[1]	*5-Year # of Activities*	*Location*[2]
Acoustic	Kilo Dip	Functional check of a helicopter deployed dipping sonar system prior to conducting a testing or training event using the dipping sonar system.	MF4	2–6	14	GOMEX RC
				0–6	6	JAX RC
				0–6	6	Key West RC
				0–4	8	Northeast RC
				20–40	140	VACAPES RC
Acoustic, Explosive	Sonobuoy Lot Acceptance Test	Sonobuoys are deployed from surface vessels and aircraft to verify the integrity and performance of a production 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	160	800	Key West RC
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	16-32	96	NSWC Panama City
				6-18	42	VACAPES RC
Explosive	Airborne Mine Neutralization System Test	A test of the airborne mine neutralization system evaluates the system's ability to detect and destroy mines from an airborne mine countermeasures capable helicopter. 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	20-27	107	NSWC Panama City
				25-45	145	VACAPES RC

Acoustic	Airborne Sonobuoy Minehunting Test	A mine-hunting system made up of a field of sonobuoys deployed by a helicopter. A field of sonobuoys, using high-frequency sonar, is used to detect and classify bottom and moored mines.	HF6	52	260	NSWC Panama City
				24	120	VACAPES RC
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	20	100	VACAPES RC
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 guns, gun ammunition, or associated systems meet required specifications or to train aircrews in the operation of a new or enhanced weapon system.	E1	25–55	215	JAX RC
				110–140	640	VACAPES RC
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 weapon system or as part of another system's integration test.	E6, E9, E10	0–10	20	GOMEX RC
				29–38	167	JAX RC
				117–148	663	VACAPES RC
Explosive	Rocket Test	Rocket tests evaluate the integration, accuracy, performance, and safe separation of guided and unguided 2.75-inch rockets fired from a hovering or forward-flying helicopter.	E3	15–19	87	JAX RC
				31–35	167	VACAPES RC
Other Testing Activities						

Acoustic	Undersea Range System Test	Following installation of a Navy underwater warfare training and testing range, tests of the nodes (components of the range) will be conducted to include node surveys and testing of node transmission functionality.	MF9	4–20	42	JAX RC

[1] For activities where the maximum number of events could vary between years, the information is presented as 'representative-maximum' number of events per year. For activities where no variation is anticipated, only the maximum number of events within a single year is provided.

[2] Locations given are areas where activities typically occur. However, activities could be conducted in other locations within the Study Area.

Notes: GOMEX: Gulf of Mexico; JAX: Jacksonville; NSWC: Naval Surface Warfare Center; RC: Range Complex; VACAPES: Virginia Capes

1.5.2.2 Naval Sea Systems Command

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	Activity Name	Activity Description	Source Bin	Annual # of Activities[1]	5-Year # of Activities	Location[2]
Anti-Submarine Warfare						
Acoustic	Anti-Submarine Warfare Mission Package Testing	Ships and their supporting platforms (e.g., helicopters, unmanned aerial systems) detect, localize, and attack submarines.	ASW1, ASW2, ASW3, ASW5, MF1, MF4, MF5, MF12, TORP1	42	210	JAX RC
				4	20	Newport, RI
				4	20	NUWC Newport
				26	130	VACAPES RC
Acoustic	At-Sea Sonar Testing	At-sea testing to ensure systems are fully functional in an open ocean environment.	ASW3, ASW4, HF1, LF5, M3, MF1, MF1K, MF3, MF5, MF9, MF11, TORP2	2	10	JAX RC Navy Cherry Point RC Northeast RC VACAPES RC
				1	5	JAX RC Navy Cherry Point RC VACAPES RC
				2	10	offshore Fort Pierce, FL GOMEX RC JAX RC SFOMF Northeast RC VACAPES RC
				4	20	JAX RC
				2	10	Navy Cherry Point RC
				8	40	NUWC Newport
				12	60	VACAPES RC

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities*[1]	*5-Year # of Activities*	*Location*[2]
Acoustic	Pierside Sonar Testing	Pierside testing to ensure systems are fully functional in a controlled pierside environment prior to at-sea test activities.	ASW3, HF1, HF3, HF8, M3, MF1, MF1K, MF3, MF9, MF10	1	5	NSB New London NS Norfolk Port Canaveral, FL
				11	55	Bath, ME
				5	25	NSB New London
				4	20	NSB Kings By
				8	40	Newport, RI
				13	65	NS Norfolk
				2	10	Pascagoula, MS
				3	15	Port Canaveral, FL
				2	10	PNS
Acoustic	Submarine Sonar Testing/Maintenance	Pierside testing of submarine systems occurs periodically following major maintenance periods and for routine maintenance.	HF1, HF3, M3, MF3	16	80	Norfolk, VA
				24	120	PNS
Acoustic	Surface Ship Sonar Testing/Maintenance	Pierside and at-sea testing of ship systems occur periodically following major maintenance periods and for routine maintenance.	ASW3, MF1, MF1K, MF9, MF10	1	5	JAX RC
				1	5	NS Mayport
				3	15	NS Norfolk
				3	15	VACAPES RC
Acoustic, Explosive	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	4	20	GOMEX RC offshore Fort Pierce, FL Key West RC Navy Cherry Point RC Northeast RC VACAPES RC

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities*[1]	*5-Year # of Activities*	*Location*[2]
				2	10	GOMEX RC JAX RC Northeast RC VACAPES RC
Acoustic	Torpedo (Non-Explosive) Testing	Air, surface, or submarine crews employ non-explosive torpedoes against submarines or surface vessels. When performed on a testing range, these torpedoes may be launched from a range craft or fixed structures and may use artificial targets.	ASW3, ASW4, HF1, HF6, MF1, MF3, MF4, MF5, MF6, TORP1, TORP2, TORP 3	7	35	GOMEX RC
				11	55	offshore Fort Pierce, FL
				2	8	JAX RC
				7	35	Navy Cherry Point RC
				8	38	Northeast RC
				30	150	NUWC Newport
				11	55	VACAPES RC
Acoustic	Countermeasure Testing	Countermeasure testing involves the testing of systems that will detect, localize, track, and attack incoming weapons including marine vessel targets. Testing includes surface ship torpedo defense systems and marine vessel stopping payloads.	ASW3, HF5, TORP1, TORP2	5	25	GOMEX RC JAX RC NUWC Newport VACAPES RC Key West RC
				2-4	14	GOMEX RC JAX RC Northeast RC VACAPES RC
Mine Warfare						
Acoustic, Explosive	Mine Countermeasure and Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines and mine-like objects.	E4, E11	13	65	NSWC Panama City
				6	30	VACAPES RC
Acoustic, Explosive	Mine Countermeasure Mission Package Testing	Vessels and associated aircraft conduct mine countermeasure operations.	HF4, SAS2, E4	19	95	GOMEX RC
				10	50	JAX RC

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities[1]*	*5-Year # of Activities*	*Location[2]*
				11	55	NSWC Panama City
				2	10	SFOMF
				5	25	VACAPES RC
Acoustic	Mine Detection and Classification Testing	Air, surface, and subsurface vessels and systems detect, classify, and avoid mines and mine-like objects. Vessels also assess their potential susceptibility to mines and mine-like objects.	HF1,HF4, HF8, MF1, MF1K, MF9	6	30	GOMEX RC
				10	50	Navy Cherry Point RC
				47-55	250	NSWC Panama City
				7-12	43	Riviera Beach, FL
				4	20	SFOMF
				3	15	VACAPES RC
Surface Warfare						
Explosive	Gun Testing – Large Caliber	Crews defend against targets with large-caliber guns.	E3, E5	12	60	GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
				1	5	GOMEX RC
				1	5	JAX RC
				1	5	Key West RC
				1	5	Navy Cherry Point RC
				1	5	Northeast RC
				33	165	NSWC Panama City
				5	25	VACAPES RC

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities[1]*	*5-Year # of Activities*	*Location[2]*
Explosive	Gun Testing – Medium-Caliber	Airborne and surface crews defend against targets with medium-caliber guns.	E1	12	60	GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
				102	510	NSWC Panama City
				5	24	VACAPES RC
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, E10	13	65	GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
				1	5	GOMEX RC
				2	10	JAX RC
				5	25	Northeast RC
				22	110	VACAPES RC
Unmanned Systems						
Acoustic, Explosive	Unmanned Underwater Vehicle Testing	Testing involves the development or upgrade of unmanned underwater vehicles. This may include testing of mine detection capabilities, evaluating the basic functions of individual platforms, or complex events with multiple vehicles.	ASW4, FLS2, HF1, HF4, HF5, HF6, HF7, LF5, MF9, MF10, SAS1, SA2, SAS3, VHF1, E8	16	80	GOMEX RC JAX RC NUWC Newport
				41	205	GOMEX RC
				25	125	JAX RC
				145-146	727	NSWC Panama City

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities[1]*	*5-Year # of Activities*	*Location[2]*
				308-309	1,541	NUWC Newport
				9	45	Riviera Beach, FL
				42	210	SFOMF
Vessel Evaluation						
Explosive	Large Ship Shock Trial	Underwater detonations are used to test new ships or major upgrades.	E17	0-1	1	GOMEX JAX RC VACAPES RC
Explosive	Surface Warfare Testing	Tests capability 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	2	10	GOMEX RC
				13	65	JAX RC
				1	5	Key West RC
				10	50	Northeast RC
				9	45	VACAPES RC
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 underwater targets.	ASW3, ASW4, HF4, HF8, MF1, MF1K, MF4, MF5, MF9, MF10, TORP1, TORP2	2	10	JAX RC Northeast RC VACAPES RC
				0-2	4	JAX RC Northeast RC VACAPES RC JAX RC Navy Cherry Point RC Northeast RC SFOMF VACAPES RC
				2	10	GOMEX RC
				6	30	JAX RC
				3	15	Northeast RC

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities[1]*	*5-Year # of Activities*	*Location[2]*
				2	10	VACAPES RC
Explosive	Small Ship Shock Trial	Underwater detonations are used to test new ships or major upgrades.	E16	0-3	3	JAX RC VACAPES RC
Acoustic	Submarine Sea Trials – Weapons System Testing	Submarine weapons and sonar systems are tested at-sea to meet integrated combat system certification requirements.	HF1, M3, MF3, MF9, MF10, TORP2	2	10	offshore Fort Pierce, FL JAX RC Northeast RC GOMEX RC VACPES RC SFOMF
				4	20	JAX RC
				4	20	Northeast RC
				4	20	VACAPES RC
Other Testing Activities						
Acoustic	Insertion/Extraction	Testing of submersibles capable of inserting and extracting personnel and payloads into denied areas from strategic distances.	MF3, MF9	4	20	Key West RC
				264	1,320	NSWC Panama City
Acoustic	Acoustic Component Testing	Various surface vessels, moored equipment, and materials are tested to evaluate performance in the marine environment.	FLS2, HF5, HF7, LF5, MF9, SAS2	33	165	SFOMF
Acoustic	Semi-Stationary Equipment Testing	Semi-stationary equipment (e.g., hydrophones) is deployed to determine functionality.	AG, ASW3, ASW4, HF5, HF6, LF4, LF5, MF9, MF10, SD1,SD2	4	20	Newport, RI
				11	55	NSWC Panama City
				190	950	NUWC Newport
Acoustic	Towed Equipment Testing	Surface vessels or unmanned surface vehicles deploy and tow equipment to determine functionality of towed systems.	HF6, LF4, MF9	36	180	NUWC Newport
Acoustic	Signature Analysis	Surface ship and submarine testing of	ASW2, HF1,	1	5	JAX RC

Table 1.5-3: Proposed Naval Sea Systems Command Testing Activities Analyzed for this LOA Request within the Study Area

Stressor Category	*Activity Name*	*Activity Description*	*Source Bin*	*Annual # of Activities*[1]	*5-Year # of Activities*	*Location*[2]
	Operations	electromagnetic, acoustic, optical, and radar signature measurements.	LF4, LF5, LF6, M3, MF9, MF10	59	295	SFOMF

[1] For activities where the maximum number of events could vary between years, the information is presented as 'representative-maximum' number of events per year. For activities where no variation is anticipated, only the maximum number of events within a single year is provided.

[2] Locations given are areas where activities typically occur. However, activities could be conducted in other locations within the Study Area. Where multiple locations are provided within a single cell, the number of activities could occur in any of the locations, not in each of the locations.

Notes: JEB LC-FS: Joint Expeditionary Base Little Creek-Fort Story; NS: Naval Station; NSB: Naval Submarine Base; NSWC: Naval Surface Warfare Center; NUWC: Naval Undersea Warfare Center; PNS: Portsmouth Naval Shipyard; SFOMF: South Florida Ocean Measurement Facility Testing Range

1.5.2.3 Office of Naval Research

Table 1.5-4: Proposed Office of Naval Research Testing Activities Analyzed for this LOA Request within the Study Area

	Activity Name			***Annual # of Activities***	***5-Year # of Activities***	***Location***
Acoustic and Oceanographic Science and Technology						
Acoustic, Explosive	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, BB5, BB6, BB7, LF3, LF4, LF5, MF8, MF9, E1, E3	4	18	GOMEX RC
				7	35	Northeast RC
				2	8	VACAPES RC
Acoustic	Emerging Mine Countermeasure Technology Research	Test involves the use of broadband acoustic sources on unmanned underwater vehicles.	BB1, BB2, SAS4	1	5	JAX RC
				2	10	Northeast RC
				1	5	VACAPES RC

Notes: GOMEX: Gulf of Mexico; JAX: Jacksonville, Florida; RC: Range Complex; VACAPES: Virginia Capes

1.5.3 Summary of Acoustic and Explosive Sources Analyzed for Training and Testing

Table 1.5-5 through Table 1.5-8 show the acoustic source classes and numbers, explosive source bins and numbers, air gun sources, and pile driving and removal activities associated with Navy training and testing activities in the study area that were analyzed in this LOA request.

Table 1.5-5 shows the bin use that could occur in any year under the Proposed Action for training and testing activities. Under the Proposed Action, bin use would vary annually, consistent with the number of annual activities described in Section 1.5 (Proposed Action) above. The five-year total for the Proposed Action takes into account that annual variability.

Table 1.5-5: 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	1,308	6,540
	LF4	LF sources equal to 180 dB and up to 200 dB	H	0	0	971	4,855
			C	0	0	20	100
	LF5	LF sources less than 180 dB	H	9	43	1,752	8,760
	LF6	LF sources greater than 200 dB with long pulse lengths	H	145 – 175	784	40	200
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)	H	5,005 – 5,605	26,224	3,337	16,684
	MF1K	Kingfisher mode associated with MF1 sonars	H	117	585	152	760
	MF3	Hull-mounted submarine sonars (e.g., AN/BQQ-10)	H	2,078 – 2,097	10,428	1,257	6,271
	MF4	Helicopter-deployed dipping sonars (e.g., AN/AQS-22 and AN/AQS-13)	H	591 – 611	2,994	370 – 803	2,624
	MF5	Active acoustic sonobuoys (e.g., DICASS)	C	6,708– 6,836	33,796	5,070 – 6,182	27,412
	MF6	Active underwater sound signal devices (e.g., MK84)	C	0	0	1,256 – 1,341	6,390
	MF8	Active sources (greater than 200 dB) not otherwise binned	H	0	0	348	1,740

Source Class Category	*Bin*	*Description*	*Unit*[1]	*Training*		*Testing*	
				Annual[2]	*5-year Total*	*Annual*[2]	*5-year Total*
	MF9	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned	H	0	0	7,395–7,562	37,173
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	870	4,348	5,690	28,450
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%	H	873 – 1,001	4,621	1,424	7,120
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%	H	367 – 397	1,894	1,388	6,940
	MF14	Oceanographic MF sonar	H	0	0	1,440	7,200
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)	H	1,928 – 1,932	9,646	397	1,979
	HF3	Other hull-mounted submarine sonars (classified)	H	0	0	31	154
	HF4	Mine detection, classification, and neutralization sonar (e.g., AN/SQS-20)	H	5,411 – 6,371	29,935	30,772 – 30,828	117,916
	HF5	Active sources (greater than 200 dB) not otherwise binned	H	0	0	1,864 – 2,056	9,704
			C	0	0	40	200
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned	H	0	0	2,193	10,868
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	0	0	1,224	6,120
	HF8	Hull-mounted surface ship sonars (e.g., AN/SQS-61)	H	20	100	2,084	10,419
Very High-Frequency Sonars (VHF): Non-tactical sources that produce signals between 100 – 200 kHz	VHF1	VHF sources greater than 200 dB	H	0	0	12	60
Anti-Submarine Warfare (ASW): Tactical sources	ASW1	MF systems operating above 200 dB	H	582 – 641	3,028	820	4,100

Source Class Category	Bin	Description	Unit[1]	Training		Testing	
				Annual[2]	5-year Total	Annual[2]	5-year Total
(e.g., active sonobuoys and acoustic counter- measures systems) used during ASW training and testing activities	ASW2	MF Multistatic Active Coherent sonobuoy (e.g., AN/SSQ-125)	C	1,476 – 1,556	7,540	4,756 – 5,606	25,480
	ASW3	MF towed active acoustic countermeasure systems (e.g., AN/SLQ-25)	H	4,485 – 5,445	24,345	2,941– 3,325	15,472
	ASW4	MF expendable active acoustic device countermeasures (e.g., MK 3)	C	425 – 431	2,137	3,493	17,057
	ASW5	MF sonobuoys with high duty cycles	H	572 – 652	3,020	608 – 628	3,080
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes	TORP 1	Lightweight torpedo (e.g., MK 46, MK 54, or Anti-Torpedo Torpedo)	C	57	285	806 – 980	4,336
	TORP 2	Heavyweight torpedo (e.g., MK 48)	C	80	400	344 – 408	1,848
	TORP 3	Heavyweight torpedo (e.g., MK 48)	C	0	0	100	440
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	0	0	1,224	6,120
Acoustic Modems (M): Systems used to transmit data through the water	M3	MF acoustic modems (greater than 190 dB)	H	0	0	634	3,169
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	H	0	0	176	880
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	H	0	0	960	4,800
	SAS2	HF SAS systems	H	0 – 8,400	25,200	3,512	17,560
	SAS3	VHF SAS systems	H	0	0	960	4,800
	SAS4	MF to HF broadband mine countermeasure sonar	H	0	0	960	4,800

Source Class Category	Bin	Description	Unit[1]	Training		Testing	
				Annual[2]	5-year Total	Annual[2]	5-year Total
Broadband Sound Sources (BB): Sonar systems with large frequency spectra, used for various purposes	BB1	MF to HF mine countermeasure sonar	H	0	0	960	4,800
	BB2	HF to VHF mine countermeasure sonar	H	0	0	960	4,800
	BB4	LF to MF oceanographic source	H	0	0	876 – 3,252	6,756
	BB5	LF to MF oceanographic source	H	0	0	672	3,360
	BB6	HF oceanographic source	H	0	0	672	3,360
	BB7	LF oceanographic source	C	0	0	120	600

Table 1.5-6: shows the number of air guns shots proposed in the AFTT Study Area for training and testing activities.

Table 1.5-6: 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	604	3,020

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

Table 1.5-7 summarizes the pile driving and pile removal activities that would occur during a 24-hour period.

Table 1.5-7: 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	10 minutes	60 minutes
Pile Removal (Vibratory)	12	3 minutes	36 minutes

Table 1.5-8 shows the number of in-water explosive items that could be used in any year under the Proposed Action for training and testing activities. Under the Proposed Action, bin use would vary annually, consistent with the number of annual activities described in Section 1.5 (Proposed Action). The five-year total for the Proposed Action takes into account that annual variability.

Table 1.5-8: Explosive Source Bins Analyzed and Numbers Used during Training and Testing Activities

Bin	*Net Explosive Weight[1] (lb.)*	*Example Explosive Source*	*Training*		*Testing*	
			Annual[2]	*5-year Total*	*Annual[2]*	*5-year Total*
E1	0.1 – 0.25	Medium-caliber projectile	7,700	38,500	17,840 – 26,840	116,200
E2	> 0.25 – 0.5	Medium-caliber projectile	210 – 214	1,062	0	0
E3	> 0.5 – 2.5	Large-caliber projectile	4,592	22,960	3,054 – 3,422	16,206
E4	> 2.5 – 5	Mine neutralization charge	127 – 133	653	746 – 800	3,784
E5	> 5 – 10	5-inch projectile	1,436	7,180	1,325	6,625
E6	> 10 – 20	Hellfire missile	602	3,010	28 – 48	200
E7	> 20 – 60	Demo block / shaped charge	4	20	0	0
E8	> 60 – 100	Light-weight torpedo	22	110	33	165
E9	> 100 – 250	500 lb. bomb	66	330	4	20
E10	> 250 – 500	Harpoon missile	90	450	68 – 98	400
E11	> 500 – 650	650 lb. mine	1	5	10	50
E12	> 650 – 1,000	2,000 lb. bomb	18	90	0	0
E16[3]	> 7,250 – 14,500	Littoral Combat Ship full ship shock trial	0	0	0 – 12	12
E17[3]	> 14,500 – 58,000	Aircraft carrier full ship shock trial	0	0	0 – 4	4

[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] 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] Shock trials consist of four explosions each. In any given year there could be 0-3 small ship shock trials (E16) and 0-1 large ship shock trials (E17). Over a 5-year period, there could be three small ship shock trials (E16) and one large ship shock trial (E17).

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 and boats ranging in size from small, 22 ft. (7 m) rigid hull inflatable boats to aircraft carriers with lengths up to 1,092 ft. (333 m).

Large Navy ships greater than 60 ft. (18 m) 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. [18 m] 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 vessel group 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. High speed ferries may also be used to support Navy testing in Narragansett Bay.

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 Naval Station Norfolk in Norfolk, Virginia, and Naval Station Mayport in Jacksonville, Florida. 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 10 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 and especially the testing ranges in the Northeast, off South Florida and in the Gulf of Mexico.

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.

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-world 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 Proposed Action, and has included them in the environmental analysis. Standard operating procedures that are recognized as providing a potential secondary benefit on marine mammals during training and testing activities are noted below and discussed in more detail within the AFTT Draft EIS/OEIS.

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

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 to the environment. Information on mitigation measures is provided in Chapter 11 (Mitigation Measures).

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, expeditionary warfare, surface warfare, and other warfare components. The Navy will implement mitigation for the activity categories, stressors, and geographic locations listed in Table 1.5-9 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 1.5-9: 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 11.1.3 (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 Maritime Security Operations – Anti-Swimmer Grenades Line Charge Testing Ship Shock Trials
Section 11.1.4 (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)	Areas for Seafloor Resources Areas off the Northeastern United States Areas off the Mid-Atlantic and Southeastern United States Areas in the Gulf of Mexico

2 DATES, DURATION, AND SPECIFIED GEOGRAPHIC REGION

Training and testing activities would be conducted in the AFTT Study Area throughout the year from 2018 through 2023. The AFTT EIS/OEIS Study Area includes areas of the western Atlantic Ocean along the east coast of North America, portions of the Caribbean Sea, and the Gulf of Mexico. The Study Area begins at the mean high tide line along the U.S. coast and extends east to the 45-degree west longitude line, north to the 65 degree north latitude line, and south to approximately the 20-degree north latitude line. The Study Area also includes Navy pierside locations, bays, harbors, and inland waterways, and civilian ports where training and testing occurs. The Study Area generally follows the Commander Task Force 80 area of operations, covering approximately 2.6 million square nautical miles (NM^2) of ocean area, and includes designated Navy range complexes and associated operating areas (OPAREAs) and special use airspace. While the AFTT Study Area itself is very large, it is important to note that the vast majority of Navy training and testing occurs in designated range complexes and testing ranges.

A Navy range complex consists of geographic areas that encompasses a water component (above and below the surface) and airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur. Range complexes include established operating areas and special use airspace, which may be further divided to provide better control of the area for safety reasons. The terms used to describe the components of the range complexes are described below:

- **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 and some are shared with non-military agencies.
    - **Warning Areas**. Areas of defined dimensions, extending from 3 nautical miles (NM) outward from the coast of the United States, which serve to warn non-participating aircraft of potential danger.
    - **Air Traffic Control 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**
  - **Operating Areas.** An ocean area defined by geographic coordinates with defined surface and subsurface areas and associated special use airspace. Operating Areas include the following:
    - **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 also provide 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 part 334).

The Study Area also includes various bays, harbors, inland waterways, and pierside locations, which are within the boundaries of the range complexes, but are detailed separately in Section 2.10 (Inshore Locations).

The Study Area is depicted Figure 1.1-1 Regional maps are provided in Figure 2.2-1 through Figure 2.2-3 for additional detail of the range complexes and testing ranges. The range complexes and testing ranges are described in the following sections.

2.1 NORTHEAST RANGE COMPLEXES

The Northeast Range Complexes include the Boston Range Complex, Narragansett Bay Range Complex, and Atlantic City Range Complex (Figure 2.2-1). These range complexes span 761 miles (mi.) along the coast from Maine to New Jersey. The Northeast Range Complexes include special use airspace with associated warning areas and surface and subsurface sea space of the Boston OPAREA, Narragansett Bay OPAREA, and Atlantic City OPAREA.

2.1.1 AIRSPACE

The Northeast Range Complexes include over 25,000 NM^2 of special use airspace. The altitude at which aircraft may fly varies from just above the surface to 60,000 feet (ft.), except for one specific warning area (W-107A) in the Atlantic City Range Complex, which is 18,000 ft. to unlimited altitudes. Six warning areas are located within the Northeast Range Complexes.

2.1.2 SEA AND UNDERSEA SPACE

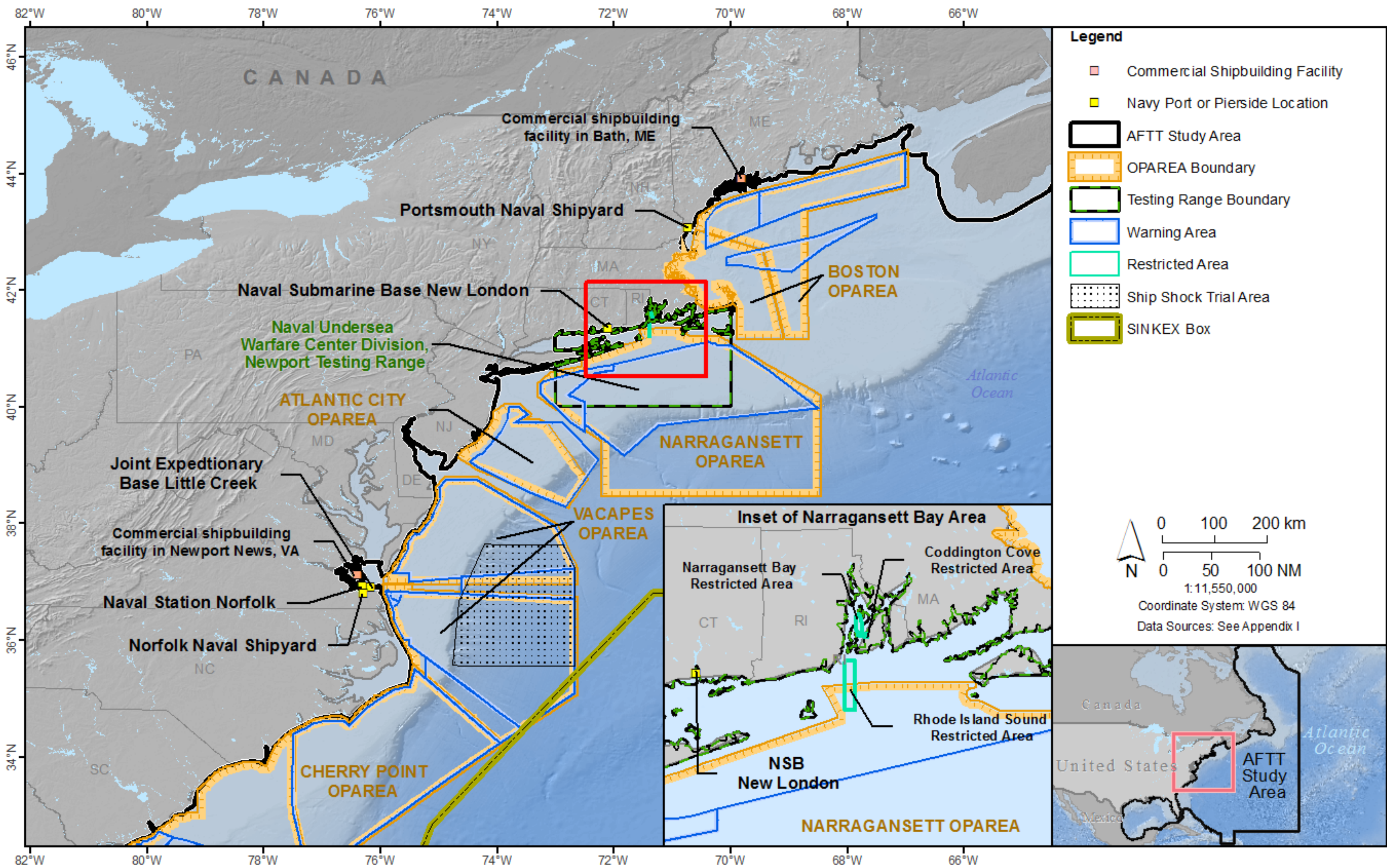
The Northeast Range Complexes include three OPAREAs—Boston, Narragansett Bay, and Atlantic City. These OPAREAs encompass over 45,000 NM^2 of sea space and undersea space. The Boston, Narragansett Bay, and Atlantic City OPAREAs are offshore of the states of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey. The OPAREAs of the three complexes are outside 3 NM but within 200 NM from shore.

2.2 NAVAL UNDERSEA WARFARE CENTER DIVISION, NEWPORT TESTING RANGE

The Naval Undersea Warfare Center Division, Newport Testing Range includes the waters of Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, and Long Island Sound (Figure 2.2-1).

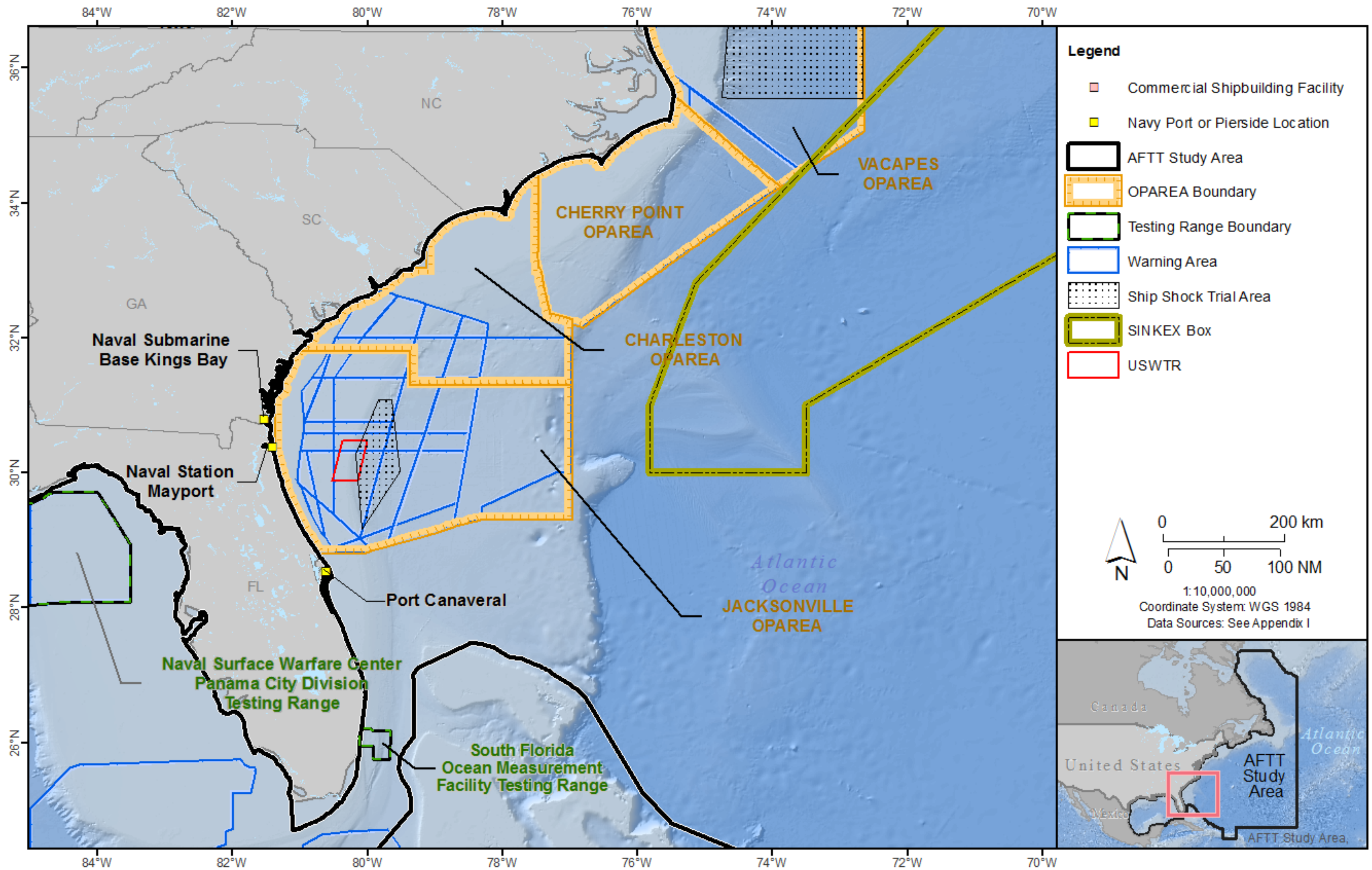
2.2.1 AIRSPACE

A portion of Naval Undersea Warfare Center Division, Newport Testing Range is under restricted area R-4105A, known as No Man’s Land Island. A minimal amount of testing occurs in the airspace within Naval Undersea Warfare Center Division, Newport Testing Range.



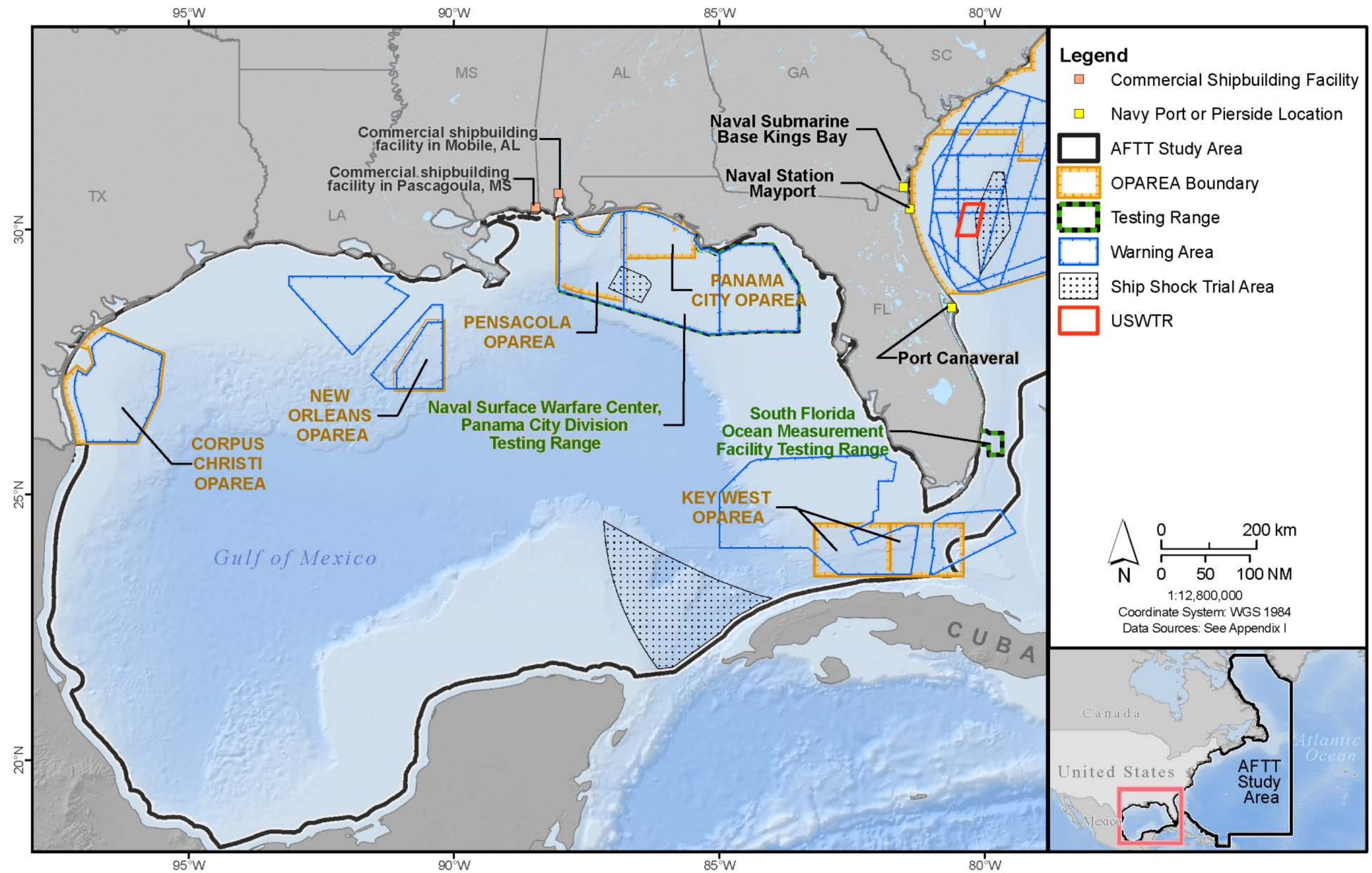
Notes: AFTT = Atlantic Fleet Training and Testing; NSB = Naval Submarine Base; OPAREA = Operating Area; VACAPES = Virginia Capes; SINKEX = Sink Exercise Test

Figure 2.2-1: AFTT Study Area, Mid-Atlantic Region



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area; VACAPES = Virginia Capes; SINKEX = Sink Exercise Test

Figure 2.2-2: AFTT Study Area, Southeast Region



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area

Figure 2.2-3: AFTT Study Area, Gulf of Mexico Region

2.2.2 Sea and Undersea Space

Three restricted areas are located within the Naval Undersea Warfare Center Division, Newport Testing Range:

- Coddington Cove Restricted Area, (0.5 NM^2 adjacent to Naval Undersea Warfare Center Division, Newport
- Narragansett Bay Restricted Area (6.1 NM^2 area surrounding Gould Island) including the Hole Test Area and the North Test Range
- Rhode Island Sound Restricted Area, a rectangular box (27.2 NM^2) located in Rhode Island and Block Island Sounds

2.3 Virginia Capes Range Complex

The Virginia Capes (VACAPES) Range Complex spans 270 mi. along the coast from Delaware to North Carolina from the shoreline to 155 NM seaward (Figure 2.2-1). The VACAPES Range Complex includes special use airspace with associated warning and restricted areas, and surface and subsurface sea space of the VACAPES OPAREA. The VACAPES Range Complex also includes established mine warfare training areas located within the lower Chesapeake Bay and off the coast of Virginia.

2.3.1 Airspace

The VACAPES Range Complex includes over 28,000 NM^2 of special use airspace. Flight altitudes range from surface to ceilings of 18,000 ft. to unlimited altitudes. Five warning areas are located within the VACAPES Range Complex. Restricted airspace extends from the shoreline to approximately the 3 NM state territorial sea limit within the VACAPES Range Complex, and is designated as R-6606.

2.3.2 Sea and Undersea Space

The VACAPES Range Complex shore boundary roughly follows the shoreline from Delaware to North Carolina; the seaward boundary extends 155 NM into the Atlantic Ocean proximate to Norfolk, Virginia. The VACAPES OPAREA encompasses over 27,000 NM^2 of sea space and undersea space. The VACAPES OPAREA is offshore of the states of Delaware, Maryland, Virginia, and North Carolina.

2.4 Navy Cherry Point Range Complex

The Navy Cherry Point Range Complex, off the coast of North Carolina and South Carolina, encompasses the sea space from the shoreline to 120 NM seaward. The Navy Cherry Point Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Cherry Point OPAREA (Figure 2.2-2). The Navy Cherry Point Range Complex is adjacent to the U.S. Marine Corps Cherry Point and Camp Lejeune Range Complexes associated with Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

2.4.1 Airspace

The Navy Cherry Point Range Complex includes over 18,000 NM^2 of special use airspace. The airspace varies from the surface to unlimited altitudes. A single warning area is located within the Navy Cherry Point Range Complex.

2.4.2 Sea and Undersea Space

The Navy Cherry Point Range Complex is roughly aligned with the shoreline and extends out 120 NM into the Atlantic Ocean. The Navy Cherry Point OPAREA encompasses over 18,000 NM^2 of sea space and undersea space.

2.5 Jacksonville Range Complex

The Jacksonville (JAX) Range Complex spans 520 mi. along the coast from North Carolina to Florida from the shoreline to 250 NM seaward. The JAX Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Charleston and JAX OPAREAs. The Undersea Warfare Training Range is located within the JAX Range Complex (Figure 2.2-2).

2.5.1 Airspace

The JAX Range Complex includes approximately 40,000 NM^2 of special use airspace. Flight altitudes range from the surface to unlimited altitudes. Nine warning areas are located within the JAX Range Complex.

2.5.2 Sea and Undersea Space

The JAX Range Complex shore boundary roughly follows the shoreline and extends out 250 NM into the Atlantic Ocean proximate to Jacksonville, Florida. The JAX Range Complex includes two OPAREAs: Charleston and JAX. Combined, these OPAREAs encompass over 50,000 NM^2 of sea space and undersea space. The Charleston and JAX OPAREAs are offshore of the states of North Carolina, South Carolina, Georgia, and Florida. The Undersea Warfare Training Range is located within the JAX Range Complex.

2.6 Naval Surface Warfare Center Carderock Division, South Florida Ocean Measurement Facility Testing Range

The Naval Surface Warfare Center Carderock Division operates the South Florida Ocean Measurement Facility Testing Range, an offshore testing area in support of various Navy and non-Navy programs. The South Florida Ocean Measurement Facility Testing Range is located adjacent to the Port Everglades entrance channel in Fort Lauderdale, Florida (Figure 2.2-2). The test area at the South Florida Ocean Measurement Facility Testing Range includes an extensive cable field located within a restricted anchorage area and two designated submarine operating areas.

2.6.1 Airspace

The South Florida Ocean Measurement Facility Testing Range does not have associated special use airspace. The airspace adjacent to the South Florida Ocean Measurement Facility Testing Range is managed by the Fort Lauderdale International Airport. Air operations at the South Florida Ocean Measurement Facility Testing Range are coordinated with Fort Lauderdale International Airport by the air units involved in the testing events.

2.6.2 Sea and Undersea Space

The South Florida Ocean Measurement Facility Testing Range is divided into four subareas:

- The Port Everglades Shallow Submarine Operating Area is a 120-NM^2 area that encompasses nearshore waters from the shoreline to 900 ft. deep and 8 NM offshore.
- The Training Minefield is a 41-NM^2 area used for special purpose surface ship and submarine operations where the test vessels are restricted from maneuvering and require additional

protection. This Training Minefield encompasses waters from 60 to 600 ft. deep and from 1 to 3 NM offshore.

- The Port Everglades Deep Submarine Operating Area is a 335-NM^2 area that encompasses the offshore range from 900 to 2,500 ft. in depth and from 9 to 25 NM offshore.
- The Port Everglades Restricted Anchorage Area is an 11-NM^2 restricted anchorage area ranging in depths from 60 to 600 ft. where the majority of the South Florida Ocean Measurement Facility Testing Range cables run from offshore sensors to the shore facility and where several permanent measurement arrays are used for vessel signature acquisition.

2.7 Key West Range Complex

The Key West Range Complex lies off the southwestern coast of mainland Florida and along the southern Florida Keys, extending seaward into the Gulf of Mexico 150 NM and south into the Straits of Florida 60 NM. The Key West Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Key West OPAREA (Figure 2.2-3).

2.7.1 Airspace

The Key West Range Complex includes over 20,000 NM^2 of special use airspace. Flight altitudes range from the surface to unlimited altitudes. Eight warning areas, Bonefish Air Traffic Control Assigned Airspace, and Tortugas Military Operating Area are located within the Key West Range Complex.

2.7.2 Sea and Undersea Space

The Key West OPAREA is over 8,000 NM^2 of sea space and undersea space south of Key West, Florida.

2.8 Naval Surface Warfare Center, Panama City Division Testing Range

The Naval Surface Warfare Center, Panama City Division Testing Range is located off the panhandle of Florida and Alabama, extending from the shoreline to 120 NM seaward, and includes St. Andrew Bay. Naval Surface Warfare Center, Panama City Division Testing Range also includes special use airspace and offshore surface and subsurface waters of offshore OPAREAs (Figure 2.2-3).

2.8.1 Airspace

Special use airspace associated with Naval Surface Warfare Center, Panama City Division Testing Range includes three warning areas.

2.8.2 Sea and Undersea Space

The Naval Surface Warfare Center, Panama City Division Testing Range includes the waters of St. Andrew Bay and the sea space within the Gulf of Mexico from the mean high tide line to 120 NM offshore. The Panama City OPAREA covers just over 3,000 NM^2 of sea space and lies off the coast of the Florida panhandle. The Pensacola OPAREA lies off the coast of Alabama and Florida west of the Panama City OPAREA and totals just under 5,000 NM^2.

2.9 Gulf of Mexico Range Complex

Unlike most of the range complexes previously described, the Gulf of Mexico (GOMEX) Range Complex includes geographically separated areas throughout the Gulf of Mexico. The GOMEX Range Complex includes special use airspace with associated warning areas and restricted airspace and surface and subsurface sea space of the Panama City, Pensacola, New Orleans, and Corpus Christi OPAREAs (Figure 2.2-3).

2.9.1 Airspace

The GOMEX Range Complex includes approximately 20,000 NM^2 of special use airspace. Flight altitudes range from the surface to unlimited. Six warning areas are located within the GOMEX Range Complex. Restricted airspace associated with the Pensacola OPAREA, designated R-2908, extends from the shoreline to approximately 3 NM offshore.

2.9.2 Sea and Undersea Space

The GOMEX Range Complex encompasses approximately 17,000 NM^2 of sea and undersea space and includes 285 NM of coastline. The OPAREAs span from the eastern shores of Texas to the western panhandle of Florida. They are described as follows:

- Panama City OPAREA lies off the coast of the Florida panhandle and totals approximately 3,000 NM^2.
- Pensacola OPAREA lies off the coast of Florida west of the Panama City OPAREA and totals approximately 4,900 NM^2.
- New Orleans OPAREA lies off the coast of Louisiana and totals approximately 2,600 NM^2.
- Corpus Christi OPAREA lies off the coast of Texas and totals approximately 6,900 NM^2.

2.10 Inshore Locations

Although within the boundaries of the Range Complexes and testing ranges detailed above, various inshore locations including piers, bays, and civilian ports are identified in Figure 2.2-1 through Figure 2.2-3.

Pierside locations include channels and transit routes in ports and facilities associated with the following Navy ports and naval shipyards:

- Portsmouth Naval Shipyard, Kittery, Maine
- Naval Submarine Base New London, Groton, Connecticut
- Naval Station Norfolk, Norfolk, Virginia
- Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach, Virginia
- Norfolk Naval Shipyard, Portsmouth, Virginia
- Naval Submarine Base Kings Bay, Kings Bay, Georgia
- Naval Station Mayport, Jacksonville, Florida
- Port Canaveral, Cape Canaveral, Florida

Commercial shipbuilding facilities in the following cities are also in the Study Area:

- Bath, Maine
- Groton, Connecticut
- Newport News, Virginia
- Mobile, Alabama
- Pascagoula, Mississippi

2.10.1 Bays, Harbors, and Inland Waterways

Inland waterways used for training and testing activities include:

- Narragansett Bay Range Complex/ Naval Undersea Warfare Center Division, Newport Testing Range: Thames River, Narragansett Bay
- VACAPES Complex: James River and tributaries, Broad Bay, York River, Lower Chesapeake Bay
- JAX Range Complex: southeast Kings Bay, Cooper River, St. Johns River
- GOMEX Range Complex/Naval Surface Warfare Center, Panama City Division (including Naval Surface Warfare Center, Panama City Division): St. Andrew Bay

2.10.2 Civilian Ports

Civilian ports included for civilian port defense training events are listed in Section A.2.7.3 of Appendix A (Navy Activity Descriptions) of the AFTT EIS/OEIS and include:

- Boston, Massachusetts
- Earle, New Jersey
- Delaware Bay, Delaware
- Hampton Roads, Virginia
- Morehead City, North Carolina
- Wilmington, North Carolina
- Savannah, Georgia
- Kings Bay, Georgia
- Mayport, Florida
- Port Canaveral, Florida
- Tampa, Florida
- Beaumont, Texas
- Corpus Christi, Texas

3 SPECIES AND NUMBERS OF MARINE MAMMALS

Forty-eight marine mammal species are known to occur in the Study Area, 45 of which are managed by NMFS. These species and associated stocks are presented in Table 3.1-1 along with an abundance estimate, an associated coefficient of variation value, and minimum abundance estimates. Relevant information on their status and management, habitat and range, and population and abundance is presented in Chapter 4, Affected Species Status and Distribution, incorporating the best available science in addition to information provided in the most recent United States Atlantic and Gulf of Mexico Marine Mammal Stock Assessment Reports (Waring et al., 2016).

3.1 MARINE MAMMALS MANAGED BY NMFS WITHIN THE AFTT STUDY AREA

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Table 3.1-1: Marine Mammals Managed by NMFS within the AFTT Study Area

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] Best / Minimum Population	Occurrence in Study Area[5]		
					Open Ocean	Large Marine Ecosystems	Inland Waters
Order Cetacea							
Suborder Mysticeti (baleen whales)							
Family Balaenidae (right whales)							
Bowhead whale	*Balaena mysticetus*	Eastern Canada-West Greenland	Endangered, strategic, depleted	7,660 (4,500-11,100)[6]	Labrador Current	Newfoundland-Labrador Shelf, West Greenland Shelf, Northeast U.S. Continental Shelf	–
North Atlantic right whale	*Eubalaena glacialis*	Western	Endangered, strategic, depleted	440 (0) / 440	Gulf Stream, Labrador Current, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, Gulf of Mexico (extralimital)	–
Family Balaenopteridae (rorquals)							
Blue whale	*Balaenoptera musculus*	Western North Atlantic (Gulf of St. Lawrence)	Endangered, strategic, depleted	Unknown / 440[11]	Gulf Stream, North Atlantic Gyre, Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico (strandings only)	-
Bryde's whale	*Balaenoptera brydei/edeni*	Northern Gulf of Mexico	Proposed Endangered, Strategic	33 (1.07) / 16	Gulf Stream, North Atlantic Gyre	Gulf of Mexico	-
Fin whale	*Balaenoptera physalus*	Western North Atlantic	Endangered, strategic, depleted	1,618 (0. 33) / 1,234	Gulf Stream, North Atlantic Gyre, Labrador Current	Caribbean Sea, Gulf of Mexico, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	-
		West Greenland	Endangered, strategic, depleted	4,468 (1,343-14,871)[9]	Labrador Current	West Greenland Shelf	-
		Gulf of St. Lawrence	Endangered, strategic, depleted	328 (306-350)[10]		Newfoundland-Labrador Shelf, Scotian Shelf	-
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	Strategic	823 (0) / 823	Gulf Stream, North Atlantic Gyre, Labrador Current	Gulf of Mexico, Caribbean Sea, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	-
Minke whale	*Balaenoptera acutorostrata*	Canadian Eastern Coastal	-	2,591 (0.81) / 1,425	Gulf Stream, North Atlantic Gyre, Labrador Current	Caribbean Sea, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	-
		West Greenland[7]	-	16,609 (7,172-38,461) / NA [7]	Labrador Current	West Greenland Shelf	-
Sei whale	*Balaenoptera borealis*	Nova Scotia	Endangered, strategic, depleted	357 (0.52) / 236	Gulf Stream, North Atlantic Gyre	Gulf of Mexico, Caribbean Sea, Southeast Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	-
		Labrador Sea	Endangered, strategic, depleted	Unknown[8]	Labrador Current	Newfoundland-Labrador Shelf, West Greenland Shelf	-

[1] Taxonomy follows (Committee on Taxonomy, 2016)

[2] Stock designations for the U.S. Exclusive Economic Zone and abundance estimates are from Atlantic and Gulf of Mexico Stock Assessment Reports prepared by National Marine Fisheries Service (Waring et al., 2016), unless specifically noted.

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock abundance, CV, and minimum population are numbers provided by the Stock Assessment Reports (Waring et al., 2016). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in the Study Area includes open ocean areas—Labrador Current, North Atlantic Gyre, Gulf Stream, and coastal/shelf waters of seven large marine ecosystems—West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico, and inland waters of Kennebec River, Piscataqua River, Thames River, Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River, Port Canaveral, St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay.

[6] The bowhead whale population off the west coast of Greenland is not managed by NMFS and, therefore, does not have an associated Stock Assessment Report. Abundance and 95 percent highest density interval were presented in (Frasier et al., 2015).

[7] The West Greenland stock of minke whales is not managed by NMFS and, therefore, does not have an associated Stock Assessment Report. Abundance and 95 percent confidence interval were presented in (Heide-Jørgensen et al., 2010).

[8] The Labrador Sea stock of sei whales is not managed by NMFS and, therefore, does not have an associated Stock Assessment Report. Information was obtained in (Prieto et al., 2014).

[9] The West Greenland stock of fin whales is not managed by NMFS and, therefore, does not have an associated Stock Assessment Report. Abundance and 95 percent confidence interval were presented in (Heide-Jørgensen et al., 2010).

[10] The Gulf of St. Lawrence stock of fin whales is not managed by NMFS and, therefore, does not have an associated Stock Assessment Report. Abundance and 95 percent confidence interval were presented in (Ramp et al., 2014).

[11] Photo identification catalogue count of 440 recognizable blue whale individuals from the Gulf of St. Lawrence is considered a minimum population estimate for the western North Atlantic stock (Waring et al., 2010)

Notes: CV: coefficient of variation; ESA: Endangered Species Act; MMPA: Marine Mammal Protection Act; NA: not applicable

Table 3.1-1: Marine Mammals Managed by NMFS within the AFTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] Best (McVey & Wibbles)/ Min	Occurrence in Study Area[5]		
					Open Ocean	Large Marine Ecosystems	Inland Waters
Family Physeteridae (sperm whale)							
Suborder Odontoceti (toothed whales)							
Sperm whale	*Physeter macrocephalus*	North Atlantic	Endangered, strategic, depleted	2,288 (0.28) / 1,815	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, Caribbean Sea	–
		Northern Gulf of Mexico	Endangered, strategic, depleted	763 (0.38) / 560	–	Gulf of Mexico	–
		Puerto Rico and U.S. Virgin Islands	Endangered, strategic, depleted	Unknown	North Atlantic Gyre	Caribbean Sea	–
Family Kogiidae (sperm whales)							
Pygmy and dwarf sperm whales	*Kogia breviceps* and *Kogia sima*	Western North Atlantic	–	3,785 (0.47) / 2,598[12]	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, Caribbean Sea	–
		Northern Gulf of Mexico	–	186 (1.04) / 90[12]	–	Gulf of Mexico, Caribbean Sea	–
Family Monodontidae (beluga whale and narwhal)							
Beluga whale	*Delphinapterus leucas*	Eastern High Arctic/Baffin Bay[13]	–	21,213 (10,985–32,619) [13]	Labrador Current	West Greenland Shelf	–
		West Greenland[14]	–	10,595 (4.904–24,650) [14]		West Greenland Shelf	–
Narwhal	*Monodon monoceros*	NA[15]	–	NA[15]		Newfoundland-Labrador Shelf, West Greenland Shelf	–
Family Ziphiidae (beaked whales)							
Blainville's beaked whale	*Mesoplodon densirostris*	Western North Atlantic[16]	–	7,092 (0.54) / 4,632[17]	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
		Northern Gulf of Mexico	–	149 (0.91) / 77[18]	–	Gulf of Mexico, Caribbean Sea	–
Cuvier's beaked whale	*Ziphius cavirostris*	Western North Atlantic[16]	–	6,532 (0.32) / 5,021	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
		Northern Gulf of Mexico[16]	–	74 (1.04) / 36		Gulf of Mexico, Caribbean Sea	–
		Puerto Rico and U.S. Virgin Islands	Strategic	Unknown	–	Caribbean Sea	–

[12]Estimates include both the pygmy and dwarf sperm whales in the western North Atlantic (Waring et al., 2014) and the northern Gulf of Mexico (Waring et al., 2013).
[13] Beluga whales in the Atlantic are not managed by NMFS and have no associated Stock Assessment Report. Abundance and 95 percent confidence interval for the Eastern High Arctic/Baffin Bay stock were presented in (Innes et al., 2002).
[14] Beluga whales in the Atlantic are not managed by NMFS and have no associated Stock Assessment Report. Abundance and 95 percent confidence interval for the West Greenland stock were presented in (Heide-Jørgensen et al., 2009).
[15] NA = Not applicable. Narwhals in the Atlantic are not managed by NMFS and have no associated Stock Assessment Report.
[16] Estimates for these western North Atlantic stocks are from Waring et al. (2014) and the northern Gulf of Mexico stock are from (Waring et al. 2013) as applicable.

Table 3.1-1: Marine Mammals Managed by NMFS within the AFTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] Best (McVey & Wibbles)/ Min	Occurrence in Study Area[5]		
					Open Ocean	Large Marine Ecosystems	Inland Waters
Gervais' beaked whale	*Mesoplodon europaeus*	Western North Atlantic[16]	–	7,092 (0.54) / 4,632 [17]	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast United States Continental Shelf	–
		Northern Gulf of Mexico[16]	–	149 (0.91) / 77 [18]	Gulf Stream, North Atlantic Gyre	Gulf of Mexico, Caribbean Sea	–
Northern bottlenose whale	*Hyperoodon ampullatus*	Western North Atlantic	–	Unknown	Gulf Stream, North Atlantic Gyre, Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Sowerby's beaked whale	*Mesoplodon bidens*	Western North Atlantic[16]	–	7,092 (0.54) / 4,632 [17]	Gulf Stream, North Atlantic Gyre	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
True's beaked whale	*Mesoplodon mirus*	Western North Atlantic[16]	–	7,092 (0.54) / 4,632 [17]	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Family Delphinidae (dolphins)							
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic[16]	–	44,715 (0.43) / 31,610	Gulf Stream	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
		Northern Gulf of Mexico	–	Unknown	–	Gulf of Mexico, Caribbean Sea	–
		Puerto Rico and U.S. Virgin Islands	Strategic	Unknown	–	Caribbean Sea	–
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	–	48,819 (0.61) / 30,403	Gulf Steam, Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Clymene dolphin	*Stenella clymene*	Western North Atlantic[16]	–	Unknown	Gulf Stream	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[16]	–	129 (1.0) / 64	–	Gulf of Mexico, Caribbean Sea	–
Common bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic Offshore[19]	Strategic, depleted	77,532 (0.40) / 56,053	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf	–
		Western North Atlantic Northern Migratory Coastal[20]	–	11,548 (0.36) / 8,620	–	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	Long Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River
		Western North Atlantic Southern Migratory Coastal[20]	Strategic, depleted	9,173 (0.46) / 6,326	–	Southeast U.S. Continental Shelf	Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River
		Western North Atlantic South Carolina/Georgia Coastal[20]	Strategic, depleted	4,377 (0.43) / 3,097	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River
		Northern North Carolina Estuarine System[20]	Strategic	823 (0.06) / 782	–	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	Beaufort Inlet, Cape Fear River
		Southern North Carolina Estuarine System[20]	Strategic	Unknown	–	Southeast U.S. Continental Shelf	Beaufort Inlet, Cape Fear River
		Northern South Carolina Estuarine System[20]	Strategic	Unknown	_	Southeast U.S. Continental Shelf	–
		Charleston Estuarine System[20]	Strategic	Unknown	–	Southeast U.S. Continental Shelf	–

[17] Estimate includes undifferentiated *Mesoplodon* species.
[18] Estimate includes Gervais' and Blainville's beaked whales.
[19] Estimate may include sightings of the coastal form.

Table 3.1-1: Marine Mammal Managed by NMFS within the AFTT Study Area (continued)

Common Name	*Scientific Name*[1]	*Stock*[2]	*ESA/MMPA Status*[3]	*Stock Abundance*[4] *Best (McVey & Wibbles)/ Min*	*Occurrence in Study Area*[5]		
					Open Ocean	*Large Marine Ecosystems*	*Inland Waters*
Common bottlenose dolphin (continued)	*Tursiops truncatus* (continued)	Northern Georgia/ Southern South Carolina Estuarine System[20]	Strategic	Unknown	–	Southeast U.S. Continental Shelf	–
		Central Georgia Estuarine System[20]	Strategic	192 (0.04) / 185	-	Southeast U.S. Continental Shelf	–
		Southern Georgia Estuarine System[20]	Strategic	194 (0.05) / 185	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River
		Western North Atlantic Northern Florida Coastal[20]	Strategic, depleted	1,219 (0.67) / 730	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River
		Jacksonville Estuarine System[20]	Strategic	Unknown	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River
		Western North Atlantic Central Florida Coastal[20]	Strategic, depleted	4,895 (0.71) / 2,851	–	Southeast U.S. Continental Shelf	Port Canaveral
		Indian River Lagoon Estuarine System[20]	Strategic	Unknown	–	Southeast U.S. Continental Shelf	Port Canaveral
		Biscayne Bay[16]	Strategic	Unknown	–	Southeast U.S. Continental Shelf	–
		Florida Bay[16]	–	Unknown	–	Gulf of Mexico	–
		Northern Gulf of Mexico Continental Shelf[20]	–	51,192 (0.10) / 46,926	–	Gulf of Mexico	–
		Gulf of Mexico Eastern Coastal[20]	–	12,388 (0.13) / 11,110	–	Gulf of Mexico	–
		Gulf of Mexico Northern Coastal[20]	–	7,185 (0.21) / 6,044	–	Gulf of Mexico	St. Andrew Bay, Pascagoula River
		Gulf of Mexico Western Coastal[20]	–	20,161 (0.17) / 17,491	–	Gulf of Mexico	Corpus Christi Bay, Galveston Bay
		Northern Gulf of Mexico Oceanic[20]	–	5,806 (0.39) / 4,230	–	Gulf of Mexico	–
		Northern Gulf of Mexico Bay, Sound, and Estuaries[21]	Strategic	Unknown	–	Gulf of Mexico	St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay
		Barataria Bay Estuarine System[20]	Strategic	Unknown	–	Gulf of Mexico	–
		Mississippi Sound, Lake Borgne, Bay Boudreau[20]	Strategic	901 (0.63) / 551	-	Gulf of Mexico	–
		St. Joseph Bay[20]	Strategic	152 (0.08) / Unknown	–	Gulf of Mexico	–
		Choctawhatchee Bay[20]	Strategic	179 (0.04) / Unknown	–	Gulf of Mexico	–
		Puerto Rico and U.S. Virgin Islands	Strategic	Unknown	–	Caribbean Sea	–
False killer whale	*Pseudorca crassidens*	Western North Atlantic[22]	Strategic	442 (1.06) / 212	–	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[16]	–	Unknown		Gulf of Mexico, Caribbean Sea	–
Fraser's dolphin	*Lagenodelphis hosei*	Western North Atlantic[23]	–	Unknown	Gulf Stream	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[16]	–	Unknown	–	Gulf of Mexico, Caribbean Sea	–

[20] Estimates for these Gulf of Mexico stocks are from Waring et al. (2016).
[21] NMFS is in the process of writing individual stock assessment reports for each of the 32 bay, sound, and estuary stocks.
[22] Estimates for these stocks are from Waring et al. (2015).

Table 3.1-1: Marine Mammals Managed by NMFS within the AFTT Study Area (continued)

Common Name	*Scientific Name*[1]	*Stock*[2]	*ESA/MMPA Status*[3]	*Stock Abundance*[4] *Best (McVey & Wibbles)/ Min*	*Occurrence in Study Area*[5]		
					Open Ocean	*Large Marine Ecosystems*	*Inland Waters*
Killer Whale	*Orcinus orca*	Western North Atlantic[22]	–	Unknown	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast United States Continental Shelf, Scotian Shelf, Newfoundland – Labrador Shelf	–
		Northern Gulf of Mexico[16]	–	28 (1.02) / 14	-	Gulf of Mexico, Caribbean Sea	–
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	Strategic	5,636 (0.63) / 3,464	Gulf Stream	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Melon-headed Whale	*Peponocephala electra*	Western North Atlantic[23]	–	Unknown	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[16]	–	2,235 (0.75) / 1,274	–	Gulf of Mexico, Caribbean Sea	–
Pantropical spotted-dolphin	*Stenella attenuate*	Western North Atlantic[16]	–	3,333 (0.91) / 1,733	Gulf Stream	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[22]	–	50,880 (0.27) / 40,699	–	Gulf of Mexico, Caribbean Sea	–
Pygmy Killer Whales	*Feresa attenuata*	Western North Atlantic[16]	–	Unknown	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[16]	–	152 (1.02) / 75	–	Gulf of Mexico, Caribbean Sea	–
Risso's dolphin	*Grampus griseus*	Western North Atlantic	–	18,250 (0.46) / 12,619	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast United States Continental Shelf, Scotian Shelf, Newfoundland – Labrador Shel	–
		Northern Gulf of Mexico	–	2,442 (0.57) / 1,563	–	Gulf of Mexico, Caribbean Sea	–
Rough-toothed dolphin	*Steno bredanensis*	Western North Atlantic[16]	–	271 (1.00) / 134	Gulf Stream, North Atlantic Gyre	Caribbean Sea Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
		Northern Gulf of Mexico	–	624 (0.99) / 311	–	Gulf of Mexico, Caribbean Sea	–
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic	Strategic	21,515 (0.37) / 15,913	–	Northeast Continental Shelf, Southeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[22]	–	2,415 (0.66) / 1,456	–	Gulf of Mexico, Caribbean Sea	–
		Puerto Rico and U.S. Virgin Islands	Strategic	Unknown	–	Caribbean Sea	–
Spinner dolphin	*Stenella longirostris*	Western North Atlantic[16]	–	Unknown	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
		Northern Gulf of Mexico[16]	–	11,441 (0.83) / 6,221	–	Gulf of Mexico, Caribbean Sea	–
		Puerto Rico and U.S. Virgin Islands	Strategic	Unknown	–	Caribbean Sea	–
Striped dolphin	*Stenella coeruleoalba*	Western North Atlantic[16]	–	54,807 (0.30) / 42,804	Gulf Stream	Northeast U.S. Continental Shelf, Scotian Shelf	–
		Northern Gulf of Mexico[16]	–	1,849 (0.77) / 1,041	–	Gulf of Mexico, Caribbean Sea	–
Short-beaked common dolphin	*Delphinus delphis*	Western North Atlantic	–	70,184 (0.28) / 55,690	Gulf Stream	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
White-beaked dolphin	*Lagenorhynchus albirostris*	Western North Atlantic[23]	–	2,003 (0.94) / 1,023	Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Family Phocoenidae (porpoises)							
Harbor porpoise	*Phocoena*	Gulf of Maine/Bay of Fundy	–	79,883 (0.32) / 61,415	–-	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebec River
		Gulf of St. Lawrence[24]	–	Unknown[24]	Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
		Newfoundland[25]	–	Unknown[25]	Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–

Table 3.1-1: Marine Mammals Managed by NMFS within the AFTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] Best (McVey & Wibbles)/ Min	Occurrence in Study Area[5]		
					Open Ocean	Large Marine Ecosystems	Inland Waters
		Greenland[26]	–	Unknown[26]	Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, West Greenland Shelf	–
Order Carnivora							
Suborder Pinnipedia							
Family Phocidae (true seals)							
Gray seal	*Halichoerus grypus*	Western North Atlantic	–	Unknown	–	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebeck River
Harbor seal	*Phoca vitulina*	Western North Atlantic	–	75,834 (0.15) / 66,884	–	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	Chesapeake Bay, Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebeck River
Harp seal	*Pagophilus groenlandicus*	Western North Atlantic	–	Unknown	–	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Hooded seal	*Cystophora cristata*	Western North Atlantic	–	Unknown	–	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, West Greenland Shelf	Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebec River

[23] Estimates for these western North Atlantic stocks are from (Waring et al., 2007).
[24] Harbor porpoise in the Gulf of St. Lawrence are not managed by NMFS and have no associated Stock Assessment Report.
[25] Harbor porpoise in Newfoundland are not managed by NMFS and have no associated Stock Assessment Report.
[26] Harbor porpoise in Greenland are not managed by NMFS and have no associated Stock Assessment Report.

4 AFFECTED SPECIES STATUS AND DISTRIBUTION

Four main types of marine mammals are generally recognized: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees, dugongs, and sea cows), and other marine carnivores (sea otters and polar bears) (Jefferson et al., 2008b; Rice, 1998). The order Cetacea is divided into two suborders – Odontoceti and Mysticeti. The toothed whales, dolphins, and porpoises (suborder Odontoceti) range in size from slightly longer than 3.3 ft. (1 m) to more than 60 ft. (18 m) and have teeth, which they use to capture and consume individual prey. The baleen whales (suborder Mysticeti) are universally large (more than 15 ft. [5 m] as adults). They are called baleen whales because, instead of teeth, they have a fibrous structure actually made of keratin, a type of protein like that found in human fingernails, in their mouths which enables them to filter or extract food from the water for feeding. They are batch feeders that use this baleen instead of teeth to engulf, suck, or skim large numbers of prey, such small schooling fish, shrimp, or microscopic sea animals (i.e. plankton) from the water or out of ocean floor sediments (Heithaus & Dill, 2008). The baleen whales are further divided into two families – right whales and rorquals. Rorquals have a series of longitudinal folds of skin, often referred to as throat grooves, running from below the mouth back towards the navel. Rorquals are slender and streamlined in shape, compared with their relatives the right whales, and most have narrow, elongated flippers. Detailed reviews of the different groups of cetaceans can be found in Perrin et al. (2009). Most pinnipeds can be divided into two families: phocids (true seals) and the otariids (fur seals and sea lions). Species managed by the U.S. Fish and Wildlife Service, including the walrus, West Indian manatee, and polar bear, are not discussed in this document.

Cetaceans inhabit virtually every marine environment in the Study Area. Marine mammals in the Study Area occur from coastal and inland waters to the open Atlantic Ocean. Their distribution is influenced by many factors, primarily patterns of major ocean currents, which in turn affect prey productivity. The continuous movement of water from the ocean bottom to the surface creates a nutrient-rich, highly productive environment for marine mammal prey (Jefferson et al., 2008b). For most cetaceans, prey distribution, abundance, and quality largely determine where they occur at any specific time (Heithaus & Dill, 2008). Most of the baleen whales are migratory, but many of the toothed whales do not migrate in the strictest sense. Instead, they undergo seasonal dispersal or shifts in density. Pinnipeds occur mostly in coastal habitats or within those regions over the continental shelf. They require land or shallow coastal waters as habitat for reproducing, resting, and, in some cases, feeding, so open ocean waters is not the primary range for any of these species.

4.1 CETACEANS

4.1.1 MYSTICETES

4.1.1.1 North Atlantic Right Whale (*Eubalaena glacialis*)

4.1.1.1.1 Status and Management

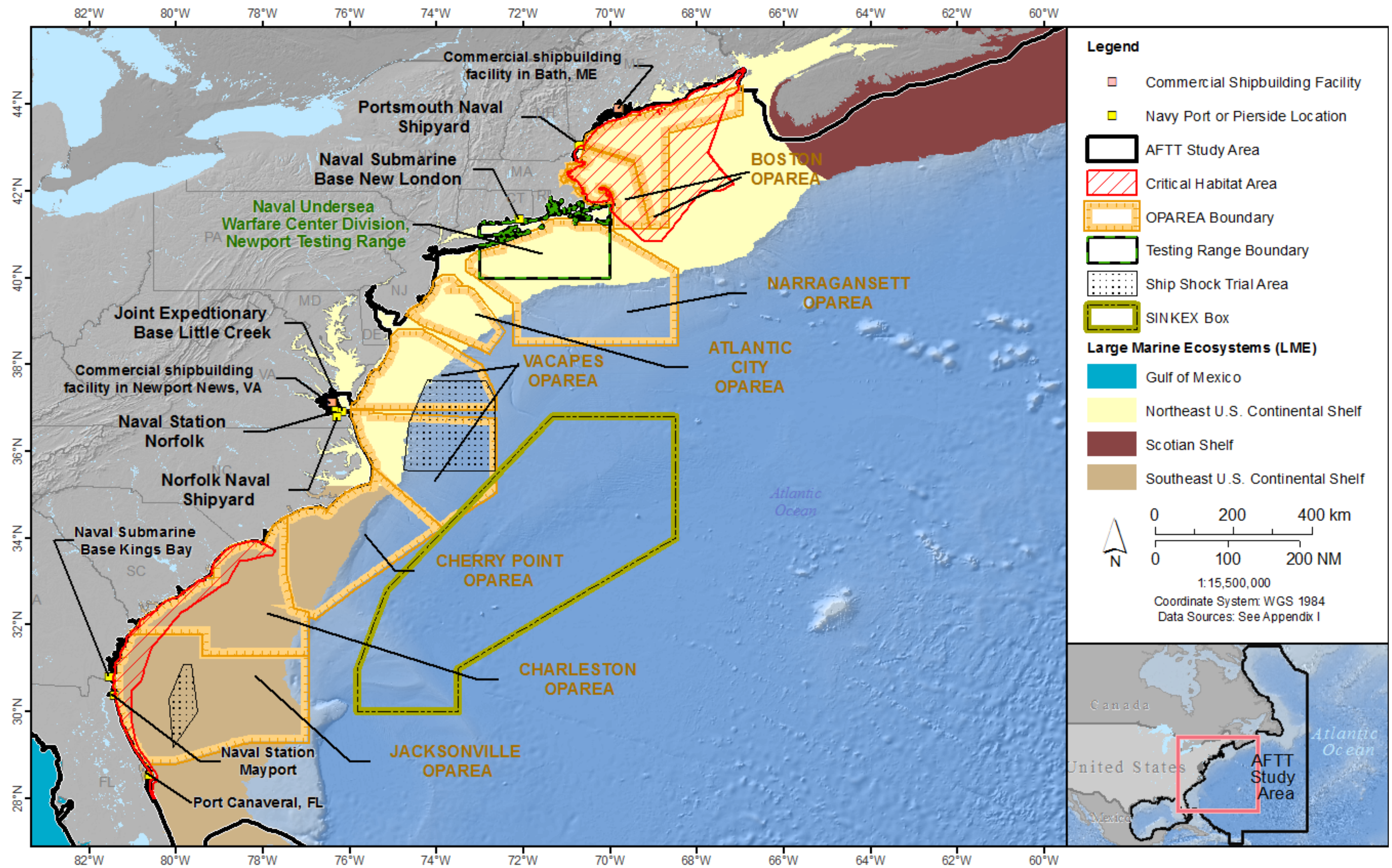
North Atlantic right whale population is considered one of the most critically endangered populations of large whales in the world (Clapham et al., 1999). The size of this stock is considered extremely low relative to the Optimum Sustainable Population in the United States Atlantic Exclusive Economic Zone, and this species is listed as endangered under the ESA. A recovery plan for the North Atlantic right whale is in effect (National Marine Fisheries Service, 2005b). The North Atlantic right whale has been protected from commercial whaling since 1949 by the International Convention for the Regulation of Whaling (62 Stat. 1716; 161 UNTS 72). A NMFS ESA status review in 1996 concluded that the western North Atlantic stock remains endangered. This conclusion was reinforced by the International Whaling Commission (Best et al., 2003), which expressed grave concern regarding the status of this stock. Relative to populations of southern right whales, there are also concerns about growth rate, percentage of reproductive females, and calving intervals in the North Atlantic right whale population. The total level of human-caused mortality and serious injury is unknown, but reported human-caused mortality was a minimum of three right whales per year from 2006 through 2010. Any mortality or serious injury to individuals within this stock should be considered significant. This is a strategic stock because the average annual human-related mortality and serious injury rates exceed potential biological removal and because the North Atlantic right whale is an endangered species.

Two ESA- designated critical habitats (Figure 4.1-1) for North Atlantic right whales have been designated by NMFS to encompass physical and biological features essential to conservation of the species (81 Fed. Reg. 4838-4874 January 27, 2016). The northern unit includes the Gulf of Maine and Georges Bank region, which are key areas essential for right whale foraging. The southern unit includes the coast of North Carolina, South Carolina, Georgia, and Florida, which are key areas essential for calving. These two ESA-designated critical habitats were established in January 2016 to replace three smaller previously ESA-designated critical habitats (Cape Cod Bay/Massachusetts Bay/Stellwagen Bank, Great South Channel, and the coastal waters of Georgia and Florida in the southeastern United States) that had been designated by NMFS in 1994 (59 Fed. Reg. 28805 June 3, 1994). Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the North Atlantic right whale (Brown et al., 2009).

4.1.1.1.2 Habitat and Geographic Range

The western North Atlantic right whale population ranges primarily from calving grounds in coastal waters of the southeastern United States to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence. Generally, right whales can likely be found in Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas, based on limited satellite tag, sighting, and historical whaling data.

Research suggests the existence of seven major habitats or congregation areas for western North Atlantic right whales. These include winter breeding grounds in the coastal waters of the southeastern United States and summer feeding grounds in the Great South Channel, Jordan Basin, Georges Bank along the its northeastern edge, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Roseway Basin on the Scotian Shelf. Movements within and between habitats are extensive, evidenced by one whale making the round-trip migration from Cape Cod to Georgia and back at least twice during the winter (Brown & Marx, 2000). Results from satellite tags clearly indicate that sightings separated by perhaps 2 weeks should not necessarily be assumed to indicate a stationary or resident animal. Instead, telemetry data show rather lengthy and somewhat distant excursions, including into deep water off the continental shelf (Baumgartner & Mate, 2005; Mate et al., 1997).



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; SINKEX: Sink Exercise Test

Figure 4.1-1: Designated Critical Habitat Areas for the North Atlantic Right Whale in the Study Area

The summer range for North Atlantic right whales includes the northeastern United States continental shelf, Scotian Shelf, and Newfoundland-Labrador shelf large marine ecosystems. New England waters are an important feeding habitat for right whales. Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo & Marx, 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney et al., 1986; Kenney et al., 1995). Although feeding in the coastal waters off Massachusetts has been better studied than in other areas, right whale feeding has also been observed on the margins of Georges Bank, in the Great South Channel, in the Gulf of Maine, in the Bay of Fundy, and over the Scotian Shelf. The consistency with which right whales occur in such locations is relatively high, but these studies also highlight the high interannual variability in right whale use of some habitats.

LaBrecque et al. (2015b) identified three seasonal right whale feeding areas located in or near the Study Area (Figure 11.2-1) based on vessel and aerial survey efforts: (1) February to April on Cape Cod Bay and Massachusetts Bay (2) April to June in the Great South Channel and on the northern edge of Georges Bank, and (3) June and July and October to December on Jeffreys Ledge in the western Gulf of Maine. A potential mating area was identified in the central Gulf of Maine (from November through January) based on a demographic study of North Atlantic right whale habitats, and the migratory corridor area along the U.S. East Coast between the southern calving grounds and northern feeding areas. The migratory corridor was substantiated through vessel- and aerial-based survey data, photo-identification data, radio-tracking data, and expert judgment. North Atlantic right whales migrate south to calving grounds in November and December and migrate north to the feeding areas in March and April.

Passive acoustic monitoring is demonstrating that the current understanding of the distribution and movements of right whales in the Gulf of Maine and surrounding waters is incomplete. Right whale calls have been detected by autonomous passive acoustic sensors deployed between 2005 and 2010 at three sites (Massachusetts Bay, Stellwagen Bank, and Jeffreys Ledge) in the southern Gulf of Maine (Morano et al., 2012a; Mussoline et al., 2012). Acoustic detections demonstrate that right whales are present more than aerial survey observations indicate. Comparisons between detections from passive acoustic recorders with observations from aerial surveys in Cape Cod Bay between 2001 and 2005 demonstrated that aerial surveys found whales on approximately two-thirds of the days during which acoustic monitoring detected whales (Clark et al., 2010).

The winter range for North Atlantic right whales includes the Southeast United States Continental Shelf Large Marine Ecosystem. LaBrecque et al. (2015b) used habitat analyses of sea surface temperatures and water depths, and aerial sightings data to delineate a calving area in the southeast Atlantic, extending from Cape Lookout, North Carolina, to Cape Canaveral, Florida that overlaps with the AFTT Study Area (Figure 11.2-2). This area, identified as biologically important, encompasses waters from the shoreline to the 25-meter isobath from mid-November through late April. Passive acoustic monitoring conducted offshore of Cape Hatteras and in Onslow Bay, North Carolina in 2011 and 2007, respectively, confirmed winter occurrence of North Atlantic right whales in these areas (McLellan et al., 2014).

Since 2004, consistent aerial survey efforts have been conducted during the migration and calving season (November 15 to April 15) in coastal areas of Georgia and South Carolina, to the north of currently defined ESA-designated critical habitat (Glass & Taylor, 2006; Khan & Taylor, 2007; Sayre & Taylor, 2008; Schulte & Taylor, 2010). Results suggest that this region may not only be part of the migratory route but also a seasonal residency area. Results from an analysis by Schick et al. (2009) suggest that the migratory corridor of North Atlantic right whales is broader than initially estimated and that suitable habitat exists beyond the 20-NM coastal buffer presumed to represent the primary migratory pathway (National Marine Fisheries Service, 2008a) Results were based on data modeled from two females tagged with satellite-monitored radio tags as part of a previous study.

Four right whale sightings were documented during monthly aerial surveys approximately 50 miles (mi.) (80 kilometers [km]) offshore of Jacksonville, Florida, from 2009 to May 2016, including a female that was observed giving birth in 2010 (Foley et al., 2011). These sightings occurred well outside existing ESA-designated critical habitat for the right whale (Foley et al., 2011; U.S. Department of the Navy, 2011a). However, sighting data alone may not accurately represent North Atlantic right whale distribution. Beginning April 2009 through May 2015, marine autonomous recording units have been deployed between 60 and 150 km offshore from Jacksonville, Florida. While sightings have generally occurred within continental shelf waters offshore from northeastern Florida and southeastern Georgia, recordings of North Atlantic right whales were detected in deeper waters during these monitoring efforts (Kumar et al., 2013; Norris et al., 2012), suggesting that distribution of this species extends further offshore than sighting data previously indicated (Oswald et al., 2016).

Right whales have occasionally been recorded in the Gulf of Mexico Large Marine Ecosystem (Moore & Clark, 1963; Ward-Geiger et al., 2011), but their occurrence there is likely extralimital. The few published records from the Gulf of Mexico (Moore & Clark, 1963; Ward-Geiger et al., 2011) represent either distributional anomalies, normal wanderings of occasional animals, or a more extensive historical range beyond the sole known calving and wintering ground in the waters of the southeastern United States.

4.1.1.1.3 Population Trends

The population growth rate reported for 1986–1992 by Knowlton et al. (1994) was 2.5 percent (CV=0.12), suggesting that the stock was showing signs of slow recovery. However, subsequent work suggested that survival probability of an individual (averaged at the population level) declined from 0.99 per year in 1980 to 0.94 in 1994 (Best et al., 2001; Caswell et al., 1999). Historical patterns of mortalities, including those in the first half of 2005, suggest an increase in the annual mortality rate (Kraus et al., 2005). Examination of the minimum number alive population index calculated from the individual sightings database (as it existed on October 27, 2015) for 1990–2012 suggests a declining trend in numbers (Waring et al., 2017).

4.1.1.2 Bowhead Whale (*Balaena mysticetus*)

4.1.1.2.1 Status and Management

The bowhead whale is listed as endangered under the ESA and is designated as depleted and considered a strategic stock under the MMPA. Three geographically distinct bowhead whale stocks are recognized in the Atlantic: the Spitsbergen, Baffin Bay-Davis Strait, and Hudson Bay-Fox Basin stocks (Allen & Angliss, 2010; Muto & Angliss, 2016; Rugh et al., 2003; Wiig et al., 2007). Satellite tracking studies of whales tagged from the Baffin Bay-Davis Strait and Hudson Bay-Fox Basin stocks suggested and confirmed these two stocks should be considered as one stock (Eastern Canada-West Greenland stock) based on overlapping wintering areas (Frasier et al., 2015; Heide-Jorgensen et al., 2006). These stocks do not occur within United States Atlantic waters and are not managed under NMFS jurisdiction. The Eastern Canada-West Greenland stock is designated as a species of special concern by the Committee on the Status of Endangered Wildlife in Canada (Frasier et al., 2015).

4.1.1.2.2 Habitat and Geographic Range

Bowhead whales are the northernmost of all whales and are found in arctic and subarctic regions of the Atlantic and Pacific Oceans (55° N to 85° N). They are also found in the Bering, Beaufort, Chukchi, and Okhotsk Seas, as well as in the northern parts of Hudson Bay (Wiig et al., 2007). Their range can expand

and contract depending on access through ice-filled Arctic straits (Rugh et al., 2003). Habitat selection varies seasonally, although this is clearly the most polar species of whale. Bowhead whales are found in continental slope and shelf waters during spring and summer while feeding on abundant zooplankton (Citta et al., 2015; Wiig et al., 2007).

Migration is associated with ice edge movements. All but the Sea of Okhotsk stock reside in higher Arctic latitudes during summer and move south in fall as the ice edge grows, spending their winters within the marginal ice zone in lower-latitude areas (Jefferson et al., 2015). The Eastern Canada-West Greenland stock spends winters in northern Hudson Bay, Hudson Strait, and from Labrador across to west Greenland and move north to spend summers in the Canadian High Arctic and around Baffin Island (Heide-Jorgensen et al., 2003). Summer aggregation areas are in northern Hudson Bay and around Baffin Island.

Bowhead whales would likely be found only in the Labrador Current open ocean area. The winter range of the Eastern Canada-West Greenland stock includes the shelf areas of west Greenland, northeastern Hudson Bay and Hudson Strait, the mouths of Cumberland Sound and Frobisher Bay on southeast Baffin Island, and northern Labrador. Bowhead whales would be expected to occur in winter within the Newfoundland-Labrador and Western Greenland Shelf Large Marine Ecosystems from November through April (Heide-Jorgensen et al., 2006). Two bowhead whales were stranded on Newfoundland in 1998 and 2005, from 45° N to 47° N and 52° W to 56° W, which at the time represented the southernmost records of this species in the western North Atlantic (Ledwell et al., 2007). In March 2012, a bowhead whale was observed in Cape Cod Bay and the same whale (identified from photographs) was again observed in Cape Cod Bay in April 2014 (Schweitzer, 2014). These sightings, in the Northeast U.S. Continental Shelf Large Marine Ecosystem now represent the southernmost record of this species in the western North Atlantic.

4.1.1.2.3 Population Trends

All estimates suggest that the population numbers have increased significantly since protection of bowheads from commercial whaling began in the first half of the 20th century (Committee on the Status of Endangered Wildlife in Canada, 2009).

4.1.1.3 Humpback Whale (*Megaptera novaeangliae*)

4.1.1.3.1 Status and Management

A recent status review identified 15 distinct population segments globally based primarily on breeding areas (Bettridge et al., 2015). Partially based on this status review, NMFS issued a final rule to divide the globally listed species into 14 distinct population segments and revise the listing status of each breeding population (FR 81[174]: 62260-62320, September 8, 2016). After evaluating the danger of extinction of each distinct population segment, four distinct population segments (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) are currently listed under the ESA as endangered and one distinct population segment (Mexico) is listed as threatened. The remaining nine distinct population segments, including the West Indies distinct population segment that occurs within the AFTT Study Area, do not warrant listing under the ESA because they are neither in danger of extinction nor likely to become so in the foreseeable future. All humpback whales feeding in the North Atlantic are considered part of the West Indies distinct population segment (Bettridge et al., 2015), including the Gulf of Maine stock. The West Indies distinct population segment feeding range primarily includes the Gulf of Maine, eastern Canada, and western Greenland (FR 80[76]: 22304-22345, April 21,

2015) and breeding grounds include waters of the Dominican Republic and Puerto Rico (FR 81[174]: 62260-62320, September 8, 2016).

For management purposes in U.S. waters, NMFS identified stocks that are based on feeding areas. Although the western North Atlantic population was once treated as a single management stock, the Gulf of Maine stock has been identified as a discrete subpopulation based on strong fidelity of humpbacks feeding in that region (Waring et al., 2016). The Gulf of Maine stock is the only stock of humpbacks in the Atlantic managed under NMFS jurisdiction. However, it should be noted that several other discrete humpback whale subpopulations, based on feeding grounds, are in the western North Atlantic, including the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland (Waring et al., 2016).

4.1.1.3.2 Habitat and Geographic Range

Humpback whales are distributed worldwide in all major oceans and most seas. Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al., 2001; Clapham & Mattila, 1990). Humpback whales of the western North Atlantic are typically found in Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas during seasonal migrations from northern latitude feeding grounds, occupied during the summer, to southern latitude calving and breeding grounds occupied in the winter (Waring et al., 2016). The Gulf of St. Lawrence, Newfoundland Grand Banks, West Greenland, and Scotian Shelf are summer feeding grounds for humpbacks (Cetacean and Turtle Assessment Program, 1982; Kenney & Winn, 1986; Stevick et al., 2006; Whitehead, 1982). The Gulf of Maine is also one of the principal summer feeding grounds for humpback whales in the North Atlantic. The largest numbers of humpback whales are present from mid-April to mid-November. Other feeding locations in this ecosystem are Stellwagen Bank, Jeffreys Ledge, the Great South Channel, the edges and shoals of Georges Bank, Cashes Ledge, and Grand Manan Banks (Cetacean and Turtle Assessment Program, 1982; Kenney & Winn, 1986; Stevick et al., 2006; Weinrich et al., 1997; Whitehead, 1982). LaBrecque et al. (2015b) delineated a humpback whale feeding area in the Gulf of Maine, Stellwagen Bank, and Great South Channel (Figure 11.2-1), substantiated through vessel-and aerial-based survey data, photo-identification data, radio-tracking data, and expert judgment. Humpback whales feed in this area from March through December. Humpback feeding habitats are typically shallow banks or ledges with high seafloor relief (Hamazaki, 2002; Payne et al., 1990).

On breeding grounds, females with calves occur in much shallower waters than other groups of whales, and breeding adults use deeper more offshore waters (Ersts & Rosenbaum, 2003; Smultea, 1994). The habitat requirements of wintering humpbacks appear to be controlled by the conditions necessary for calving, such as warm water and relatively shallow, low-relief ocean bottom in protected areas, created by islands or reefs (Clapham, 2000; Craig & Herman, 2000; Smultea, 1994).

Individual variability in the timing of migrations may result in the presence of individuals in high-latitude areas throughout the year (Straley, 1990). Records of humpback whales off the United States mid-Atlantic coast (New Jersey to North Carolina) from January through March suggest these waters may represent a supplemental winter feeding ground used by juvenile and mature humpback whales of United States and Canadian North Atlantic stocks (LaBrecque et al., 2015b).

Humpbacks are most likely to occur near the mouth of the Chesapeake Bay and coastal waters of Virginia Beach between January and March; however, they could be found in the area year-round, based on sighting and stranding data in both mid-Atlantic waters and the Chesapeake Bay itself (Barco et al., 2002). Photo-identification data support the repeated use of the mid-Atlantic region by individual humpback whales (Barco et al., 2002). Preliminary results of vessel surveys offshore of Virginia show site fidelity in the AFTT Study Area for some individuals and a high level of occurrence within the shipping channels—an important high-use area by both the Navy and commercial traffic (Aschettino et al., 2015). Beginning January 2015, the offshore Norfolk Canyon Region was added to the monthly aerial survey efforts offshore of Virginia, which documented five sightings of humpback whales, mostly during the spring months. Line-transect survey efforts in the Mine Warfare Exercise box within Warning Area-50 of the Virginia Capes Range Complex from August 2012 through August 2015 have resulted in 26 humpback whale sightings across fall, winter, and spring months (Engelhaupt et al., 2015; Engelhaupt et al., 2016).

Aerial and vessel monitoring conducted offshore of Cape Hatteras, North Carolina, in Onslow Bay, North Carolina, and offshore of Jacksonville, Florida confirmed winter occurrence of humpback whales in these three areas of the Atlantic as well as observations in Onslow Bay during the spring months (U.S. Department of the Navy, 2013a).

There are occasional reports of humpback whales in the Gulf of Mexico but those sightings should be considered extralimital.

4.1.1.3.3 Population Trends

Current data suggest that the Gulf of Maine humpback whale stock is steadily increasing in numbers (Waring et al., 2016). This is consistent with an estimated average growth trend of 3.1 percent (SE=0.005) in the North Atlantic population overall for the period 1979–1993 (Stevick et al., 2003).

4.1.1.4 Minke Whale (*Balaenoptera acutorostrata*)

4.1.1.4.1 Status and Management

Minke whales are the smallest species of mysticete in the Study Area and are classified as a single species with three subspecies recently recognized: *Balaenoptera acutorostrata davidsoni* in the North Atlantic, *Balaenoptera acutorostrata scammoni* in the North Pacific, and a subspecies that is formally unnamed but generally called the dwarf minke whale, which mainly occurs in the southern hemisphere (Jefferson et al., 2015). Waring et al. (2016) uses *B. a. acutorostrata* for the Canadian East Coast stock.

There are four recognized populations in the North Atlantic: Canadian east coast, west Greenland, central North Atlantic, and northeastern North Atlantic (Donovan, 1991). As stock structure is still being researched Minke whales off the eastern coast of the United States are considered for now to be part of the Canadian east coast stock, which inhabits the area from the western half of the Davis Strait (45°W) to the Gulf of Mexico (Waring et al., 2016). The relationship between this stock and the other three stocks is uncertain.

4.1.1.4.2 Habitat and Geographic Range

Minke whales have a cosmopolitan distribution in temperate and tropical waters and generally occupy waters over the continental shelf, including inshore bays and even occasionally estuaries (Waring et al., 2016). However, records from whaling catches and research surveys worldwide indicate there may be an open-ocean component to the minke whale’s habitat (Jefferson et al., 2015; Perrin & Brownell, 2008), including the Labrador Current, Gulf Stream, and North Atlantic Gyre Open Ocean Areas while undergoing seasonal migrations. They have an extensive distribution in polar, temperate, and tropical waters in the northern and southern hemispheres (Jefferson et al., 2015; Perrin & Brownell, 2008), and are less common in the tropics than in cooler waters.

The minke whale is common and widely distributed within the United States Exclusive Economic Zone in the Atlantic Ocean (Cetacean and Turtle Assessment Program, 1982). There appears to be a strong seasonal component to minke whale distribution. Like most other baleen whales, minke whales generally occupy the continental shelf proper rather than the continental shelf edge region (Waring et al., 2016). As with several other cetacean species, the possibility of a deep-ocean component to the distribution of minke whales exists but remains unconfirmed.

Minke whales generally undergo annual migrations between low-latitude breeding grounds in the tropics and subtropics in the winter and high-latitude feeding grounds (such as Gulf of Maine as well as the Saguenay-St. Lawrence region [Quebec]) in the summer (Kuker et al., 2005). Timing of movements between high-latitude summer feeding grounds to low-latitude winter habitats occurs between late September and late October (Risch et al., 2014a). Migration paths indicate a clockwise movement pattern, where whales are distributed closer to the shelf break edge during their northbound migration, following the currents of the Gulf Stream and prey availability in the spring and then follow a more directed southerly route in the fall, reaching warmer waters faster and avoiding swimming against the Gulf Stream (Risch et al., 2014a).

During summer and early fall, minke whales are found throughout the lower Bay of Fundy (Ingram et al., 2007). Spring and summer are times of relatively widespread and common occurrence, and are the seasons when the whales are most abundant in New England waters. In New England waters during fall there are fewer minke whales, while during winter the species appears to be largely absent.

(LaBrecque et al., 2015b) delineated two minke whale feeding areas (Figure 11.2-1): (1) waters less than 200 m in the southern and southwestern section of the Gulf of Maine, including Georges Bank, the Great South Channel, Cape Cod Bay, Massachusetts Bay, and Stellwagen Bank, and (2) shallow waters around Parker Ridge and Cashes Ledges in the central Gulf of Maine. These feeding areas were substantiated by vessel- and aerial-based surveys, sightings from whale-watching vessels, and expert judgment. Minke whales would be expected in both feeding areas from March through November.

Minke whales occur in the warmer waters of the southern United States during winter. While no minke whale mating or calving founds have been found in United States Atlantic waters (LaBrecque et al., 2015b), other data suggest a potential winter breeding area offshore the southeastern United States and the Caribbean based on seasonal migration patterns, acoustic survey results, calf stranding records, and sightings of mother-calf pairs in Onslow Bay and offshore of Jacksonville, Florida (Risch et al., 2014a). Since January 2015, monthly aerial surveys have been conducted by the Navy in the offshore area near Norfolk Canyon and have recorded three minke whale sightings (McAlarney et al., 2016). In addition, aerial and vessel surveys conducted offshore of Cape Hatteras, North Carolina since 2011, Onslow Bay, North Carolina since 2007 and Jacksonville, Florida since 2009 resulted in minke whale encounters primarily during the winter months at all three locations (McLellan et al., 2014). High-frequency acoustic recording packages have been deployed at various locations offshore of Cape Hatteras, Onslow Bay, Jacksonville, and the offshore area near Norfolk Canyon since 2012, 2007, 2009, and 2014, respectively. Minke whale calls have shown a winter pattern of occurrence on the Cape Hatteras and Onslow Bay deployment sites, a few detections at the Norfolk Canyon Site, and detections between December and March in Jacksonville (Hodge et al., 2015; Hodge et al., 2016; U.S. Department of the Navy, 2013a). Additional acoustic monitoring using marine autonomous recording units deployed between 60 and 150 km offshore of Jacksonville, Florida in 2009 and 2010 revealed continuous vocalizations at the deep water sites during the winter deployment, while vocalization events were completely absent during the fall deployment suggesting a strong seasonal pattern of occurrence in this area (Oswald et al., 2016). Ongoing acoustic monitoring efforts offshore of Cape Hatteras since March 2012 in water depths of 950 m resulted in frequent detections of minke whales (Debich et al., 2016; Stanistreet et al., 2013), suggesting spring occurrence in this area as minke whales begin to migrate to northern feeding grounds for the summer months.

Although they are not typically expected to occur within the Gulf of Mexico, observation records exist for mostly immature individuals in the Gulf of Mexico and Florida Keys (Stewart & Leatherwood, 1985; Waring et al., 2013). Mitchell (1991) summarized several winter records of minke whale sightings off the southeast United States, Cuba Puerto Rico and the Antilles, hinting at a possible winter distribution in the West Indies, and in the mid-ocean south and east of Bermuda.

4.1.1.4.3 Population Trends

A trend analysis has not been conducted for this stock (Waring et al., 2016).

4.1.1.5 Bryde's Whale (*Balaenoptera brydei/edeni*)

4.1.1.5.1 Status and Management

Bryde's whales are the only baleen whale known to occur year-round in the Gulf of Mexico (Jefferson & Schiro, 1997; Waring et al., 2013). Bryde's whales are among the least known of the baleen whales. The species-level taxonomy remains unresolved as well as the number of species or subspecies (Alves et al., 2010; Jefferson et al., 2015; Kato & Perrin, 2009). Committee on Taxonomy (2016) recognizes two subspecies of Bryde's whale: (1) *B. edeni* (Eden's whale) and (2) *B. brydei* (offshore Bryde's whale). In addition a Bryde's whale's "pygmy form" known as Omura's whale (Kato & Perrin, 2009; Rice, 1998) has been described. Rosel and Wilcox (2014) found that the Gulf of Mexico Bryde's whale population has a unique lineage and appears to be phylogenetically most closely related to Eden's whale, the smaller form found in coastal and continental shelf waters of the northern Indian Ocean and the western Pacific Ocean. Bryde's whales in the Gulf of Mexico are genetically distinct from other Bryde's whales and not genetically diverse within the Gulf of Mexico (Rosel & Wilcox, 2014). The International Whaling Commission continues to use the name *Balaenoptera edeni* for all Bryde's-like whales, although at least two species are recognized.

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 survival of the species (Kanda et al., 2007). Bryde's whales found in the northern Gulf of Mexico may represent a resident stock and are thus considered a separate stock for management purposes; however, there are no data to suggest genetic differentiation from the North Atlantic stock (Waring et al., 2010). In April 2015, NMFS announced a 90-day finding on a petition to list the Gulf of Mexico population of Bryde's whale as an endangered distinct population segment under the ESA (80 Fed. Reg. 18343-18346, April 6, 2015). NMFS determined that petition presented substantial information and a status review of the species would be conducted to determine if listing this distinct population segment under the ESA is warranted.

4.1.1.5.2 Habitat and Geographic Range

Unlike other baleen whale species, Bryde's whales are restricted to tropical and subtropical waters and do not generally occur beyond latitude 40° in either the northern or southern hemisphere (Jefferson et al., 2015; Kato & Perrin, 2009). The primary range of Bryde's whales in the Atlantic is in tropical waters south of the Caribbean, outside the Study Area, with the exception of the Gulf of Mexico. Bryde's whales may range as far north as Virginia (Kato & Perrin, 2009). This species is thought to be the most common baleen whale in the Gulf of Mexico (Würsig et al., 2000). Long migrations are not typical of Bryde's whales, although limited shifts in distribution toward and away from the equator in winter and summer were observed (Best, 1996; Cummings, 1985).

Bryde's whales are unlikely to be found in any open ocean area. In the Gulf of Mexico, Bryde's whales were sighted near the shelf break in DeSoto Canyon (Davis & Fargion, 1996; Davis et al., 2000; Jefferson & Schiro, 1997). Most of the sighting records of Bryde's whales in the northern Gulf of Mexico (i.e., United States Gulf of Mexico) are from NMFS abundance surveys (Waring et al., 2013), which were conducted during the spring (Davis & Fargion, 1996; Davis et al., 2000; Hansen et al., 1995; Hansen et al., 1996; Jefferson & Schiro, 1997; Maze-Foley & Mullin, 2006; Mullin & Hoggard, 2000; Mullin & Fulling, 2004). In addition, there are stranding records from throughout the year (Würsig et al., 2000). The area between the 100- and 300-meter isobaths in the eastern Gulf of Mexico from south of Pensacola (head of DeSoto Canyon) to northwest of Tampa Bay, Florida, has been identified by LaBrecque et al. (2015a) as a small and resident population (Figure 11.2-3).

4.1.1.5.3 Population Trends

A trend analysis has not been conducted for this stock (Waring et al., 2016).

4.1.1.6 Sei Whale (*Balaenoptera borealis*)

4.1.1.6.1 Status and Management

The sei whale is listed as endangered under the ESA and is considered a depleted and strategic stock under the MMPA. Critical habitat is not designated for sei whales. A recovery plan for the sei whale was finalized in 2011 (National Marine Fisheries Service, 2011). There are two stocks for the sei whale in the North Atlantic: a Nova Scotia stock and a Labrador Sea stock (Waring et al., 2013; Waring et al., 2016). The Nova Scotia stock is considered in the management unit under NMFS jurisdiction; it includes the continental shelf waters of the northeastern United States and extends northeastward to south of Newfoundland. The Labrador Sea stock is outside of NMFS jurisdiction but occurs within the Study Area.

4.1.1.6.2 Habitat and Geographic Range

Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes. Sei whales are typically found in the open ocean and are rarely observed near the coast (Horwood, 2009; Jefferson et al., 2015). They are generally found between 10° and 70° latitudes. Satellite tagging data indicate sei whales feed and migrate east to west across large sections of the North Atlantic (Olsen et al., 2009); they are not often seen within the equatorial Atlantic. In the Study Area, the open ocean range includes the Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas.

During the winter, sei whales are found from 20° N to 23° N and during the summer from 35° N to 50° N (Horwood, 2009; Masaki, 1976, 1977; Smultea et al., 2010). They are considered absent or at very low densities in most equatorial areas and in the Arctic Ocean. Sei whales spend the summer feeding in subpolar high latitudes and return to lower latitudes to calve in winter. However, no migratory corridor for sei whales has been identified in United States Atlantic waters (LaBrecque et al., 2015b). There are no known sei whale mating or calving grounds in United States Atlantic waters (LaBrecque et al., 2015b). Whaling data provide some evidence of varied migration patterns, based on reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood, 1987; Perry et al., 1999). Sei whales are known to swim at speeds greater than 25 km per hour and may be one of the fastest cetaceans, after the fin whale (Horwood, 1987; Jefferson et al., 2015).

The range of the Nova Scotia stock includes the continental shelf waters of the northeastern United States and extends northeastward to south of Newfoundland. During the feeding season, a large portion of the Nova Scotia sei whale stock is centered in northerly waters of the Scotian Shelf (Waring et al., 2013). The range of the Labrador Sea stock likely includes continental shelf waters near Labrador and Newfoundland, although satellite tag data indicate that most of that stock may use the deeper water areas between Greenland and Labrador (Prieto et al., 2014). Using data from vessel-based surveys, LaBrecque et al. (2015b) delineated a feeding area for sei whales in the northeast Atlantic between the 25-meter contour off coastal Maine and Massachusetts to the 200-meter contour in central Gulf of Maine, including the northern shelf break area of Georges Bank (Figure 11.2-1). The feeding area also includes the southern shelf break area of Georges Bank from 100 to 2,000 m and the Great South Channel. Feeding activity in the United States Atlantic waters is concentrated from May through November with a peak in July and August.

The southern portion of the species' range during spring and summer includes the northern portions of the United States Exclusive Economic Zone in the Atlantic Ocean, including the Gulf of Maine and Georges Bank. During spring and summer, sei whales occur in waters from the Bay of Fundy to northern Narragansett Bay. Large concentrations are often observed along the northern flank, eastern tip, and southern shelf break of Georges Bank. During the fall, sei whales may be found in limited shelf areas of the Northeast Channel and in the western Gulf of Maine (Cetacean and Turtle Assessment Program, 1982; Simpert et al., 2003). Spring is the period of greatest abundance in Georges Bank and into the Northeast Channel area, along the Hydrographer Canyon (Cetacean and Turtle Assessment Program, 1982; Waring et al., 2010). Although uncommon near the coastline, two strandings of sei whales have been reported on the Virginia coast 2003 and 2011 (King, 2011; Swingle et al., 2014).

Passive acoustic monitoring conducted offshore of Cape Hatteras, North Carolina since 2011 resulted in the detections of sei whales on bottom-mounted high-frequency acoustic recording packages that were not observed during visual surveys (McLellan et al., 2014). Passive acoustic monitoring conducted offshore of Jacksonville, Florida from 2009 through 2012 also included detections of sei whales on marine acoustic recording units during the winter of 2009-2010 (Oswald et al., 2016) and possible detections on high-frequency acoustic recording packages during the winter of 2010 and 2011 (Hodge & Read, 2013).

4.1.1.6.3 Population Trends

Commercial whaling in the 19th and 20th centuries depleted populations in all areas throughout the species' range. While they appear to be recovering in the northern hemisphere as a result of legal protection, a trend analysis has not been conducted for this stock (Waring et al., 2016).

4.1.1.7 Fin Whale (*Balaenoptera physalus*)

4.1.1.7.1 Status and Management

The fin whale is listed as endangered under the ESA and is considered a depleted and strategic stock under the MMPA. A final recovery plan was published in July 2010 for fin whales in United States waters. The International Whaling Commission recognizes seven management stocks of fin whales in the North Atlantic Ocean: (1) Nova Scotia (2) Newfoundland-Labrador, (3) West Greenland, (4) East Greenland-Iceland, (5) North Norway, (6) West Norway-Faroe Islands, and (7) British Isles-Spain-Portugal. NMFS assumes management of the western North Atlantic stock, which is likely equivalent to the Nova Scotia management stock. The stock identity of North Atlantic fin whales has received relatively little attention, and whether the current stock boundaries define biologically isolated units has long been uncertain (Waring et al., 2016). Fin whales in the Gulf of St. Lawrence may be a separate stock (Ramp et al., 2014).

4.1.1.7.2 Habitat and Geographic Range

Fin whales prefer temperate and polar waters and are rarely seen in warm tropical waters (Reeves et al., 2002a). They typically congregate in areas of high productivity and spend most of their time in coastal and shelf waters but can often be found in waters approximately 2,000 m deep (Aissi et al., 2008; Reeves et al., 2002a). Fin whales are often seen closer to shore after periodic patterns of upwelling (underwater motion) and the resultant increased krill density (Azzellino et al., 2008). This species is highly adaptable, following prey, typically off the continental shelf (Azzellino et al., 2008; Panigada et al., 2008). Fin whales are likely common in Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas while undergoing seasonal migrations. However, some fin whales remain in higher latitudes during colder months and in lower latitudes during warmer months, indicating that seasonal fin whale movements differ from the seasonal migrations of other mysticetes, such as blue whales and humpback whales (Edwards et al., 2015). Fin whales are also common off the Atlantic coast of the United States in waters immediately off the coast seaward to the continental shelf (at about the 1,000-fathom contour). In the mid-Atlantic region, they tend to occur north of Cape Hatteras where they accounted for about 46 percent of the large whales observed in surveys conducted between 1978 and 1982 (National Marine Fisheries Service, 2010). During the summer, fin whales in this region tend to congregate in feeding areas between 41°20′ N and 51°00′ N, from the shore seaward to the 1,000-fathom contour. In the western Atlantic, they winter from the edge of sea ice (near the Gulf of St. Lawrence) south to the Gulf of Mexico and the West Indies (National Marine Fisheries Service, 2010).

Fin whales are observed in the Gulf of Maine, the Bay of Fundy, the Gulf of St. Lawrence, and in offshore areas of Nova Scotia (Coakes et al., 2005; Johnston et al., 2005). Near the Bay of Fundy, fin whales are known to congregate close to the tip of Campobello Island, where they feed within localized upwellings and fronts in the Northeast United States Continental Shelf Large Marine Ecosystem (Johnston et al., 2005).

Fin whale sightings and acoustic detections are greatest in New England waters during spring and summer, with scattered sightings over the northeast shelf in winter, indicating that some fin whales are present during the non-feeding season (Hain et al., 1992; Morano et al., 2012b; Waring et al., 2014). Fin whales are also observed in the Gulf of Maine, the Bay of Fundy, the Gulf of St. Lawrence, and in offshore areas of Nova Scotia (Coakes et al., 2005; Johnston et al., 2005). Near the Bay of Fundy, fin whales are known to congregate close to the tip of Campobello Island, where they feed within localized upwellings and fronts in the Northeast United States Continental Shelf Large Marine Ecosystem (Johnston et al., 2005). Acoustic data from the United States Navy's Sound Surveillance System arrays suggest that animals undertaking southward migrations in the fall generally travel south past Bermuda to the West Indies (Clark, 1995); however, a migration corridor for fin whales in the United States Atlantic Exclusive Economic Zone is not known (LaBrecque et al., 2015b).

New England waters are considered a major feeding ground for fin whales, and there is evidence that females continually return to this site (Waring et al., 2010). Forty-nine percent of fin whales sighted in the feeding grounds of Massachusetts Bay were sighted again within the same year, and 45 percent were sighted again in multiple years (Waring et al., 2010). LaBrecque et al. (2015b) identified three feeding areas for fin whales in the North Atlantic within the Study Area (Figure 11.2-1): (1) June to October in the northern Gulf of Maine; (2) year-round in the southern Gulf of Maine, and (3) March to

October east of Montauk Point, as substantiated through vessel-based survey data, photo-identification data, and expert judgment.

Calving may take place during October to January in latitudes of the United States mid-Atlantic region; however, it is unknown where calving, mating, and wintering occur for most of the population (Hain et al., 1992). Results from the Navy's Sound Surveillance System (Clark, 1995) indicate a substantial deep-ocean distribution of fin whales. It is likely that fin whales occurring in the U.S. Exclusive Economic Zone in the Atlantic Ocean undertake migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions. However, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support from the data.

Aerial surveys conducted monthly around the Norfolk Canyon began in January 2015 and have resulted in eight fin whale sightings, six of which were documented in May 2016.

Fin whales have been detected frequently throughout the winter months during passive acoustic monitoring efforts conducted from 2007 through 2015 within the continental shelf break and slope waters off Onslow Bay, North Carolina (Hodge et al., 2015; Hodge et al., 2014, 2016; U.S. Department of the Navy, 2013a). Aerial surveys conducted monthly offshore of Cape Hatteras since May 2011 have resulted in seven total sightings of fin whales, primarily during the fall and spring (McLellan et al., 2014). Additional sightings during small vessel fieldwork conducted off the coast of Cape Hatteras survey area between July 2009 and December 2014 occurred in 2012 (one individual) and 2013 (two individuals) (Foley et al., 2015b). Visual surveys, acoustic and satellite tagging, passive acoustic monitoring, biopsy, and photo-identification efforts conducted from January 2014 to December 2014 resulted in three biopsy samples in 2013 and a new photo-identification catalogue in 2014 for a fin whale that was previously observed offshore of Cape Hatteras in 2013 (Foley et al., 2015b).

Visual surveys and passive acoustic monitoring conducted from 2007 to 2011 in Onslow Bay, North Carolina indicate fin whale occurrence in this area between late fall and early spring (Hodge, 2011). Monthly aerial surveys conducted between June 2007 and April 2011 only resulted in one sighting of fin whales in March 2010. However, high-frequency recording packages deployed between November 2007 and April 2010 in Onslow Bay detected 20-Hz pulses from fin whales primarily in the winter months, starting in November and continuing through mid-April, suggesting that fin whales are migrating past Onslow Bay during this time (Hodge, 2011).

In the western Atlantic, limited data indicate that some fin whales winter from the edge of sea ice (near the Gulf of St. Lawrence) south to the Gulf of Mexico and the West Indies (Clark, 1995).

4.1.1.7.3 Population Trends

A population trend analysis has not been conducted for this stock (Waring et al., 2016).

4.1.1.8 Blue Whale (*Balaenoptera musculus*)

4.1.1.8.1 Status and Management

Blue whales are listed as endangered under the ESA and is designated as a depleted and strategic stock under the MMPA. Critical habitat is not designated for blue whales. A recovery plan is in place for the blue whale in U.S. waters (National Marine Fisheries Service, 1998). Blue whales in the western North Atlantic are classified as a single stock (Waring et al., 2010).

Widespread whaling over the last century is believed to have decreased the worldwide population to approximately 1 percent of its pre-whaling population size, although some authors have concluded that their population was about 200,000 animals before whaling (Branch, 2007; Širović et al., 2004). There was a documented increase in the blue whale population size in some areas between 1979 and 1994, but there is no evidence to suggest an increase in the population since then (Barlow, 1994; Barlow & Taylor, 2001; Carretta et al., 2010).

4.1.1.8.2 Habitat and Geographic Range

The distribution of the blue whale in the western North Atlantic generally extends from the Arctic to at least mid-latitude waters. Blue whales are most frequently sighted in the waters off eastern Canada, with the majority of recent records from the Gulf of St. Lawrence. Members of the North Atlantic population spend much of their time on continental shelf waters from eastern Canada (near the Quebec north shore) to the St. Lawrence Estuary and Strait of Belle Isle. Sightings were reported along the southern coast of Newfoundland during late winter and early spring (Reeves et al., 2004). Blue whales may be found in Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas. Migratory movements in the western North Atlantic Ocean are largely unknown, but acoustic data indicate that blue whales winter as far north as Newfoundland and as far south as Bermuda and Florida, and they have been sighted along the mid-Atlantic ridge (Ryan et al., 2013).

The blue whale is best considered as an occasional visitor in United States Atlantic Exclusive Economic Zone waters, which may represent the current southern limit of its feeding range (Cetacean and Turtle Assessment Program, 1982). All five sightings described in the foregoing two references occurred in August. Using the United States Navy's Sound Surveillance System, blue whales were detected and tracked acoustically in much of the North Atlantic, including in subtropical waters north of the West Indies and in deep water east of the United States. Atlantic Exclusive Economic Zone, indicating the potential for long-distance movements (Clark, 1995). Most of the acoustic detections were around the Grand Banks area of Newfoundland and west of the British Isles. Historical blue whale observations collected by Reeves et al. (2004) show a broad longitudinal distribution in tropical and warm temperate latitudes during the winter months, with a narrower, more northerly distribution in summer. Blue whales tagged in the Gulf of St. Lawrence in late fall left the St. Lawrence Estuary and used habitat more than 1,000 km offshore, as well as shelf and coastal waters of the eastern United States and Canada (Lesage et al., 2016).

Although the exact extent of their southern boundary and wintering grounds are not well understood, blue whales are occasionally found in waters off the U.S. Atlantic coast (Waring et al., 2013). Monthly aerial surveys have been conducted offshore of Cape Hatteras, North Carolina and Onslow Bay, North Carolina since May 2011, although no visual sightings of blue whales have been documented. However, acoustic monitoring has also been conducted in the same region since 2011 and resulted in the detections of blue whales on bottom-mounted high-frequency acoustic recording packages (McLellan et al., 2014; Read et al., 2014). Yochem & Leatherwood (1985) summarized records that suggested an occurrence of this species south to Florida and the Gulf of Mexico, although the actual southern limit of the species' range is unknown. Blue whale strandings have been recorded as far south as the Caribbean and the Gulf of Mexico (Waring et al., 2010).

4.1.1.8.3 Population Trends

There are insufficient data to determine population trends for this species (Waring et al., 2010).

4.1.2 Odontocetes

4.1.2.1 Sperm Whale (*Physeter macrocephalus*)

4.1.2.1.1 Status and Management

The sperm whale has been listed as an endangered species since 1970 under the precursor to the ESA (National Marine Fisheries Service, 2009) and is listed as depleted and strategic under the MMPA. Whether the northwestern Atlantic population is discrete from northeastern Atlantic is currently unresolved. The International Whaling Commission recognizes one stock for the North Atlantic, based on reviews of many types of stock studies (e.g., tagging, genetics, catch data, mark and recapture, biochemical markers). A recovery plan is in place for the sperm whale in United States waters (National Marine Fisheries Service, 1998). There are currently two stocks of sperm whales recognized within the Study Area managed under NMFS jurisdiction: the western North Atlantic and the Gulf of Mexico stocks. In 2013, NMFS determined that a petition to list the Gulf of Mexico stock as a distinct population segment was not warranted based on a review of best available information on physical, physiological, ecological, and behavioral factors (78 Fed. Reg. 68032-68037, November 13, 2013). A five-year review for sperm whales was finalized in 2015 (National Marine Fisheries Service, 2015).

4.1.2.1.2 Habitat and Geographic Range

Sperm whales are found throughout the world's oceans in deep waters to the edge of the ice at both poles (Leatherwood & Reeves, 1983; Rice, 1989; Whitehead, 2002). Sperm whales show a strong preference for deep waters (Rice, 1989; Whitehead, 2003). Their distribution is typically associated with waters over the continental shelf break, over the continental slope, and into deeper waters and mid-ocean regions. However, in some areas, adult males are reported to consistently frequent waters with bottom depths less than 100 m and as shallow as 40 m (Jefferson et al., 2008b; Jefferson et al., 2015; Romero et al., 2001). 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 form large matrilineal social groups consisting of adult females and their offspring, which generally inhabit waters greater than 1,000 m deep at latitudes less than 40°. Young males stay with the matrilineal group for 4 to 21 years, then leave to join bachelor schools consisting of young males. As males age, they are found in progressively smaller groups and at progressively higher latitudes. Sperm whale migration is not well understood and is not as seasonally based as that observed in mysticete whales.

Sperm whales may be found in Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas. Sperm whales are found throughout the Gulf Stream and North Atlantic Gyre, and adult male distribution likely extends into the Labrador Current. In 1972, extensive survey cruises covering much of the western and central North Atlantic Ocean found high densities of sperm whales in the Gulf Stream region, between 40° N and 50° N and over the North Atlantic Ridge (National Marine Fisheries Service, 2006).

Off Nova Scotia, coastal whalers found sperm whales primarily in deep continental slope waters, especially in submarine canyons and around the edges of banks. During late spring and throughout the summer, sperm whales are found on the continental shelf in waters less than 100 m deep on the southern Scotian Shelf and into the northeast United States (National Marine Fisheries Service, 2006; Palka, 2006). High densities of sperm whales were also found in the Grand Banks of Newfoundland (National Marine Fisheries Service, 2006).

Sperm whales that occur in the eastern United States Exclusive Economic Zone in the Atlantic Ocean likely represent only a fraction of the total stock. The nature of linkages of the United States habitat with those to the south, north, and offshore is unknown. Historical whaling records compiled by Schmidly (1981) suggested an offshore distribution off the southeast United States, over the Blake Plateau, and into deep ocean waters. Distribution along the East Coast of the United States is centered along the shelf break and over the slope. In winter, sperm whales are concentrated east and northeast of Cape Hatteras, North Carolina. In spring, the center of distribution shifts northward to east of Delaware and Virginia and is widespread throughout the central portion of the mid-Atlantic Bight and the southern portion of Georges Bank. In summer, the distribution is similar but now also includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100-m isobath) south of New England. In fall, sperm whale occurrence south of New England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic Bight. Similar inshore (less than 200 m) observations were made on the southwestern and eastern Scotian Shelf, particularly in the region of "the Gully" (Whitehead & Weilgart, 1991).

Beginning January 2015, monthly aerial surveys have been conducted around the Norfolk Canyon, which to date has resulted in four sperm whale sightings during the summer and fall. Aerial surveys conducted offshore of Cape Hatteras, North Carolina since 2011 have resulted in common occurrence of sperm whales, primarily in the spring and summer months (McLellan et al., 2014). Since 2012, passive acoustic monitoring has been conducted within continental shelf break and slope waters off Cape Hatteras. Sperm whale clicks have been detected consistently throughout the recording days, however there is significant difference between day and night occurrence (U.S. Department of the Navy, 2013a). Additional passive acoustic monitoring continued in this area through 2015, which resulted in detection of sperm whale foraging clicks on 70 percent of the recording days demonstrating seasonal variability patterns (Stanistreet et al., 2015). Tagging studies conducted between January and December 2014 resulted in two sperm whale encounters between May and October, one biopsy sample collected in June, and the first sperm whale photo-identification catalogue match occurred in 2014 with a sperm whale last seen in May 2013 (Foley et al., 2015b).

Passive acoustic monitoring conducted in Onslow Bay, North Carolina between 2007 and 2013 confirmed year-round occurrence of sperm whales, along with a nocturnal increase in occurrence of clicks, and greater vocal activity on recorders located in deeper waters of the monitoring area (Hodge, 2011; Read et al., 2014; U.S. Department of the Navy, 2013a). Researchers confirmed occurrence of sperm whale vocalizations in Onslow Bay on recorder deployed at water depths of 230 m and 366 m along with regular nocturnal occurrence of sperm whale clicks near the shelf break suggesting that foraging activities were occurring at that time (Hodge & Read, 2013). This diel pattern is in contrast to what was recorded offshore of Cape Hatteras (Stanistreet et al., 2013). Habitat models also support findings of sperm whale occurrence in the U.S. Economic Exclusion Zone waters offshore of Onslow Bay (Best et al., 2012). Visual surveys in Onslow Bay and analysis of remotely-sensed oceanographic data were used to determine the effects of dynamic oceanography. The findings from this study indicate that the presence of Gulf Stream frontal eddies and the location of the Gulf Stream Front influenced sperm whale vocalization rates, among other species (Thorne et al., 2012).

Monthly aerial surveys conducted since January 2009 offshore of Jacksonville, Florida have only documented two sperm whale sightings in pelagic waters of the survey area (Cummings et al., 2016). Deployment of high frequency acoustic recording packages off Jacksonville from 2009 through 2015 have resulted in zero sperm whale detections. However, sperm whales were one of the most commonly detected species on marine autonomous recording units deployed just beyond the shelf in approximate water depth of 183 m during the fall and winter of 2009 and 2010 offshore of Jacksonville (Oswald et al., 2016). Sperm whales detections were recorded exclusively near the continental shelf break during the fall deployment with detections recorded every day. They were also the third most common species with detections on all but 2 days during the winter deployment (Oswald et al., 2016). Recordings showed a strong diel pattern with almost all vocalization events occurring between sunset and sunrise (Kumar et al., 2013; Oswald et al., 2016).

The sperm whale is the most common large cetacean in the northern Gulf of Mexico (Palka & Johnson, 2007). The distribution of sperm whales in the Gulf of Mexico is strongly linked to surface oceanography, such as Loop Current eddies that locally increase production and availability of prey (O'Hern & Biggs, 2009). Most sperm whale groups were found within regions of enhanced sea surface chlorophyll (O'Hern & Biggs, 2009). Ship-based and aerial based surveys indicate that sperm whales are widely distributed only in waters deeper than 200 m in the northern Gulf of Mexico (Waring et al., 2014), specifically inhabiting the continental slope and oceanic waters (Fulling et al., 2003; Maze-Foley & Mullin, 2006; Mullin & Hoggard, 2000; Mullin & Fulling, 2004; Mullin et al., 2004). Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Hansen et al., 1996; Mullin et al., 1994a; Mullin & Hoggard, 2000). Sperm whales aggregate at the mouth of the Mississippi River and along the continental slope in or near cyclonic cold-core eddies (counterclockwise water movements in the northern hemisphere with a cold center) or anticyclone eddies (clockwise water movements in the northern hemisphere) (Davis et al., 2007). Habitat models for sperm whale occurrence indicate a high probability of suitable habitat along the shelf break off the Mississippi delta, Desoto Canyon, and western Florida (Best et al., 2012; Weller et al., 2000). Due to the nutrient-rich freshwater plume from the Mississippi Delta the continental slope waters south of the Mississippi River Delta and the Mississippi Canyon play an important ecological role for sperm whales (Davis et al., 2002; Weller et al., 2000). Sightings during extensive surveys in this area consisted of mixed-sex groups of females, immature males, and mother-calf pairs as well as groups of bachelor males (Jochens et al., 2008; Weller et al., 2000). Female sperm whales have displayed a high level of site fidelity and year round utilization off the Mississippi River Delta compared to males (Jochens et al., 2008) suggesting this area may also support year-round feeding, breeding, and nursery areas (Baumgartner et al., 2001; National Marine Fisheries Service, 2010), although the seasonality of breeding in Gulf of Mexico sperm whales is not known (Jochens et al., 2008).

In the eastern Gulf of Mexico, the continental slope waters west of the Florida Keys and the Dry Tortugas also support sperm whale occurrence (Maze-Foley & Mullin, 2006; Mullin & Fulling, 2004) likely due to the influence of the Loop Current and eddies on primary productivity and prey availability in the area (Biggs et al., 2005; Oey et al., 2005). The information for southern Gulf of Mexico waters is more limited, but there are sighting and stranding records from each season, with sightings widely distributed in continental slope waters of the western Bay of Campeche (Ortega-Ortiz, 2002).

NMFS winter ship surveys of waters surrounding Puerto Rico and the United States Virgin Islands indicate that sperm whales inhabit continental slope and oceanic waters (Roden & Mullin, 2000; Swartz & Burks, 2000; Swartz et al., 2002). Earlier sightings from the northeastern Caribbean were reported by Erdman (1970), Erdman et al. (1973), and Taruski and Winn (1976), and these and other sightings from Puerto Rican waters are summarized by Mignucci-Giannoni (1988). For years up to 1989, Mignucci-Giannoni found 43 records for sperm whales in waters of Puerto Rico, United States Virgin Islands, and British Virgin Islands and suggested these whales occur from late fall through winter and early spring but are rare from April to September. In addition, sperm whales are one of the most common species to strand in waters of Puerto Rico and the Virgin Islands (Mignucci-Giannoni et al., 1999). In the southeast

Caribbean, both large and small adults, as well as calves and juveniles of different sizes, are reported (Watkins et al., 1985).

4.1.2.1.3 Population Trends

There has been considerable variation in point estimates of northern Gulf of Mexico sperm whale abundance based on data collected in 1991–2009. Differences in temporal abundance will be difficult to interpret without a Gulf of Mexico-wide (including waters belonging to Mexico and Cuba) understanding of sperm whale abundance. Studies based on abundance and distribution surveys restricted to U.S. waters are unable to detect temporal shifts in distribution beyond U.S. waters that might account for changes in abundance (Waring et al., 2016). As a result, a trend analysis for the North Atlantic stock of sperm whales has not been conducted (Waring et al., 2016).

4.1.2.2 Dwarf/Pygmy Sperm Whale (*Kogia sima* and *Kogia breviceps*)

4.1.2.2.1 Status and Management

Before 1966, dwarf and pygmy sperm whales were thought to be a single species, until form and structure distinction were shown (Handley, 1966); misidentifications of these two species are still common (Jefferson et al., 2015). Dwarf and pygmy sperm whales are not often observed at sea, but they are among the more frequently stranded cetaceans (Caldwell & Caldwell, 1989; Jefferson et al., 2015; McAlpine, 2009). Rare sightings indicate they may avoid human activity, and they are rarely active at the sea surface. They usually appear slow and sluggish, often resting motionless at the surface with no visible blow (Baird, 2005; Jefferson et al., 2015). Because of the scarcity of biological information available for individual dwarf and pygmy sperm whales, the difficulty of species-level identifications, and the lack of data on individual stock structure and abundance estimates, dwarf and pygmy sperm whales are presented collectively here with species-specific information if available.

Although virtually nothing is known of population status for these species, stranding frequency suggests they may not be as uncommon as sighting records would suggest (Jefferson et al., 2015; Maldini et al., 2005). The western North Atlantic population(s) and the northern Gulf of Mexico population(s) are considered separate stocks for management purposes, but there is no genetic evidence that these two populations differ (Waring et al., 2010).

4.1.2.2.2 Habitat and Geographic Range

Dwarf and pygmy sperm whales appear to be distributed worldwide in temperate to tropical waters (Caldwell & Caldwell, 1989; McAlpine, 2002). Both species may be found in the Gulf Stream and North Atlantic Gyre open ocean areas. Most sightings are in the Gulf Stream, perhaps an artifact of survey effort rather than a reflection of actual distribution. Dwarf and pygmy sperm whales can occur close to shore and sometimes over the outer continental shelf. However, several studies show that they may also generally occur beyond the continental shelf edge (Bloodworth & Odell, 2008; MacLeod et al., 2004). The pygmy sperm whale may frequent more temperate habitats than the dwarf sperm whale, which is more of a tropical species. The dwarf sperm whale may also have a more pelagic distribution, and dive deeper during feeding bouts, than pygmy sperm whales (Barros & Wells, 1998). Although deep oceanic waters may be the primary habitat for this species, there are very few oceanic sighting records offshore (Waring et al., 2014). The lack of sightings may have more to do with the difficulty of detecting and identifying these animals at sea and lack of effort than with any real distributional preferences.

In the Study Area, dwarf and pygmy sperm whales are found primarily in the Northeast and Southeast United States Continental Shelf Large Marine Ecosystems, the Gulf of Mexico, and Caribbean Sea

(Bloodworth & Odell, 2008; Caldwell & Caldwell, 1989; Cardona-Maldonado & Mignucci-Giannoni, 1999). A stranded pygmy sperm on the north shore of the Gulf of St. Lawrence represents the northernmost record for this species in the western Atlantic (Measures et al., 2004).

Aerial surveys conducted monthly offshore of Cape Hatteras since May 2011 have only resulted in three total sightings of dwarf and sperm whales, to date. Similarly, monthly aerial surveys offshore of Jacksonville since 2009 have only documented one sighting of these species. However, passive acoustic monitoring has been more successful in documenting dwarf and pygmy sperm whale occurrence in the Study Area. Analysis of vocalizations collected during passive acoustic monitoring efforts conducted offshore of Onslow Bay, North Carolina between 2007 and 2013 indicate that dwarf and pygmy sperm whales only occur sporadically in this area (Hodge, 2011; U.S. Department of the Navy, 2013a). Additional passive acoustic data collected in Onslow Bay between August 2011 and October 2012 resulted in dwarf and pygmy sperm whales click detections during August to December 2011 and July to October 2012 deployments with a peak in vocal activity in late November 2011 (Hodge et al., 2013). Dwarf/pygmy sperm whale clicks were present throughout a deployment period from October 2012 through the end of March 2013 with no specific temporal pattern in occurrence. This deployment resulted in more detections of dwarf/pygmy sperm whale clicks than any other deployment in Onslow Bay (Hodge & Read, 2015).

Aerial surveys conducted offshore of Jacksonville, Florida between January 2009 and December 2015 resulted in only one sighting of a dwarf/pygmy sperm whale (Cummings et al., 2016).

Pygmy sperm whales were one of the most commonly sighted species in the northern Gulf of Mexico from 1992 to 1994 and from 1996 to 2001 (Mullin & Fulling, 2004). Fulling and Fertl (2003) noted a concentration of sightings in continental slope waters near the Mississippi River Delta. The delta is considered an important area for cetaceans in the northern Gulf of Mexico because of its high levels of productivity associated with oceanographic features. Data from the Gulf of Mexico suggest that dwarf and pygmy sperm whales may associate with frontal regions along the continental shelf break and upper continental slope, where squid densities are higher (Baumgartner et al., 2001; Jefferson et al., 2015).

4.1.2.2.3 Population Trends

A trend analysis has not been conducted for dwarf and pygmy sperm whales in the western North Atlantic stock. Furthermore, there are insufficient data to determine the population trends for northern Gulf of Mexico dwarf sperm whales due to uncertainty in species identification at sea (Waring et al., 2014).

4.1.2.3 Beluga Whale (*Delphinapterus leucas*)

4.1.2.3.1 Status and Management

The only stocks of beluga whales managed under NMFS jurisdiction occur outside of the Study Area in Alaska. Two recognized stocks of beluga whales that may occur within the Study Area: the Eastern High Arctic/Baffin Bay and the West Greenland (Jefferson et al., 2015). Beluga whales should be listed as Near Threatened, based on classifications under the International Union for Conservation of Nature Red List Categories and Criteria (Jefferson et al., 2015). At the global level, the species does not qualify for a status of threatened, although there is substantial uncertainty about numbers and trends for some parts of their range. Moreover, national and international, taxon-specific conservation programs that currently monitor and manage hunting could result in the beluga whale qualifying for threatened status (under criterion A3) within 5 years.

4.1.2.3.2 Habitat and Geographic Range

Beluga whales are found only in high latitudes of the northern hemisphere. Belugas are found in Arctic and subarctic waters along the northern coasts of Canada, Alaska, Russia, Norway, and Greenland (O'Corry-Crowe, 2008).

Beluga whales occur primarily in coastal waters, as shallow as 1 to 3 m, although they can also be found in offshore waters greater than 800 m deep (Jefferson et al., 2008a; Jefferson et al., 2015; Richard et al., 2001). During the winter, beluga whales are believed to occur in offshore waters associated with pack ice, but little is known about the distribution, ecology, or behavior in winter. In most regions, beluga whales are believed to migrate in the direction of the advancing polar ice front. However, in some areas, they may remain behind this front and overwinter in enclosed areas of unfrozen water and ice leads. In the spring, they migrate to warmer shallow water in coastal estuaries, bays, and rivers for molting and calving (North Atlantic Marine Mammal Commission, 2000).

Beluga whales may be found in the Labrador Current open ocean area. This species is also known to occur in the extreme northwestern portion of the Study Area. Beluga whales are found on the west coast of Greenland and along the Newfoundland coast (Committee on the Status of Endangered Wildlife in Canada, 2003), but are not normally seen farther south. In June 2014, a beluga whale was observed in several bays and inlets of Rhode Island and Massachusetts (Swaintek, 2014). This sighting likely represents an extralimital beluga whale occurrence in the Northeast United States Continental Shelf Large Marine Ecosystem.

4.1.2.3.3 Population Trends

The current population trend for beluga whales within the Eastern High Arctic/Baffin Bay and the West Greenland stocks is unknown (Jefferson et al., 2015).

4.1.2.4 Narwhal (*Monodon monoceros*)

4.1.2.4.1 Status and Management

There is no stock of narwhal that occurs in the United States Exclusive Economic Zone in the Atlantic Ocean; however, populations from Hudson Strait and Davis Strait may extend into the Study Area at its northwest extreme (Heide-Jorgensen, 2009).

4.1.2.4.2 Habitat and Geographic Range

Narwhals prefer cold Arctic waters, and are the most northerly cetacean. They are also known to be a deepwater species. In the summer, they are found in more northern areas, and as ice begins to form, they tend to follow the ice to more open waters for the winter. They are often found in deep fjords and cracks and leads in the ice (Heide-Jorgensen, 2009; Reeves & Tracey, 1980). Narwhals may be found in the Labrador Current open ocean area.

Narwhals winter in the regions of Hudson Strait and Baffin Bay-Davis Strait, as well as Disko Bay in West Greenland. Narwhals wintering in Hudson Strait in smaller numbers are assumed to belong to the northern Hudson Bay summer population. Tagged narwhals in the summering grounds in Admiralty Inlet showed their annual migration following the ice during the autumn to more open waters of Melville Bay and Eclipse Sound in central and southern Baffin Bay and northern Davis Strait (Dietz et al., 2008; Heide-Jorgensen, 2009). Before the fast ice forms in the fall, narwhals move into deep water along the edge of the continental shelf, with depths of up to 1,000 to 2,000 m (Heide-Jorgensen, 2009).

4.1.2.4.3 Population Trends

There are insufficient data to assess population trends for this species (Muto et al., 2017).

4.1.2.5 Beaked Whales (Various Species)

Six species of beaked whales are known in the western North Atlantic Ocean: Cuvier's beaked whale (*Ziphius cavirostris*), northern bottlenose whale (*Hyperoodon ampullatus)* discussed in Section 4.1.2.6, Northern Bottlenose Whale), and four members of the genus *Mesoplodon* —True's (*M. mirus*), Gervais' (*M. europaeus*), Blainville's (*M. densirostris*), and Sowerby's (*M. bidens*) beaked whales. Cuvier's, Blainville's, and Gervais' beaked whales are also known to regularly occur in the Gulf of Mexico, based on stranding or sighting data (Hansen et al., 1995; Würsig et al., 2000). Sowerby's beaked whale in the Gulf of Mexico is considered extralimital because there is only one known stranding of this species (Bonde & O'Shea, 1989) and because it normally occurs in northern temperate waters of the North Atlantic (Mead, 1989b). With the exception of the Cuvier's beaked whale and northern bottlenose whale, beaked whales are nearly indistinguishable at sea (Coles, 2001). Because of the scarcity of biological information available for individual species, the difficulty of species-level identifications for *Mesoplodon*, and the lack of data on individual stock structure and abundance estimates, Cuvier's, True's, Gervais', Blainsville's, and Sowerby's beaked whales are presented collectively here with species-specific information if available.

4.1.2.5.1 Status and Management

.Stock structure of beaked whales in the Atlantic, Gulf of Mexico, and United States Virgin Islands is unknown; however, these are assumed to be separate for management purposes.

4.1.2.5.2 Habitat and Geographic Range

Cuvier's, True's, Gervais', Blainville's, and Sowerby's beaked whales are found in Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas and are also known to occur in the Northeast U.S. Continental Shelf, Scotian Shelf, and Newfoundland-Labrador Shelf Large Marine Ecosystems. The continental shelf margins from southern Nova Scotia to Cape Hatteras have been identified as key areas for beaked whales in a global review by MacLeod and Mitchell (2006). Cuvier's, Gervais', Blainville's, and True's beaked whales may also occur in the Southeast U.S. Continental Shelf Large Marine Ecosystem, while Cuvier's, Gervais' and Blainville's beaked whales may occur in the Gulf of Mexico and Caribbean Sea Large Marine Ecosystems.

Cuvier's beaked whale is one of the more commonly seen and the best known. Similar to other beaked whale species, this oceanic species generally occurs in waters past the edge of the continental shelf and occupies almost all temperate, subtropical, and tropical waters of the world, as well as subpolar and even polar waters in some areas (Waring et al., 2014). The distribution of Cuvier's beaked whales is poorly known, and is based mainly on stranding records (Leatherwood et al., 1976). Strandings were reported from Nova Scotia along the eastern United States coast south to Florida, around the Gulf of Mexico, and within the Caribbean (Cetacean and Turtle Assessment Program, 1982; Heyning, 1989; Houston, 1990; Leatherwood et al., 1976; MacLeod, 2006; Mignucci-Giannoni et al., 1999). Cuvier's beaked whale sightings have occurred principally along the continental shelf edge in the mid-Atlantic region off the northeast United States coast (Cetacean and Turtle Assessment Program, 1982; Hamazaki, 2002; Palka, 2006; Waring et al., 1992; Waring et al., 2001) in late spring or summer, although strandings and sightings were reported in the Caribbean Sea and the Gulf of Mexico as well (Dalebout et al., 2006). 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 (Falcone et al., 2009; Jefferson et al., 2008b; Jefferson et al., 2015).

True's beaked whales appear to occur only in temperate waters, and possibly only in warm temperate waters. Most records of it occurring in the northwest Atlantic suggest a probable relation with the Gulf Stream (MacLeod, 2000; Mead, 1989a).

Gervais' beaked whale occurs only in the Atlantic Ocean and Gulf of Mexico, within a range both north and south of the equator to a latitude of 40° (Jefferson et al., 2008b; Jefferson et al., 2015; MacLeod, 2006). Although the distribution seems to range across the entire temperate and tropical Atlantic, most records are from the western North Atlantic waters from New York to Texas (more than 40 published records), and they are the most common species of *Mesoplodon* to strand along the United States Atlantic coast (Waring et al., 2014).

Sowerby's beaked whales appear to inhabit more temperate waters than many other members of the genus. They are the most northerly distributed of Atlantic species of *Mesoplodon*, and are found in cold temperate waters of the North Atlantic Ocean, generally north of 30˚ N. In the Study Area, they range from Massachusetts to Labrador (MacLeod et al., 2006; Mead, 1989b). There were several at-sea sightings off Nova Scotia and Newfoundland, from New England waters north to the ice pack (MacLeod et al., 2006; Waring et al., 2010). Sowerby's beaked whale occurrence in the Gully Marine Protected Area (east of Nova Scotia) increased during the period from 1988 to 2011 (Whitehead, 2013).

Blainville's beaked whales are one of the most widely distributed of the distinctive toothed whales in the *Mesoplodon* genus (Jefferson et al., 2008b; MacLeod et al., 2006). In the Study Area, this species is known to occur in enclosed deepwater seas, such as the Gulf of Mexico and Caribbean Sea. There are records for this species from the eastern coast of the United States and Canada, from as far north as Nova Scotia and south to Florida and the Bahamas (MacLeod & Mitchell, 2006; Mead, 1989b).

Starting January 2015, monthly aerial surveys have been conducted in the offshore area near Norfolk Canyon and have resulted in only one True's beaked whale sighting to date. Passive acoustic monitoring conducted offshore of Cape Hatteras between March and April 2012 recorded beaked whale clicks on nearly 40 percent of the recording days (Stanistreet et al., 2013). Closer examination of these beaked whale click events suggested they belonged to Cuvier's and Gervais' beaked whales (Stanistreet et al., 2012). During aerial surveys conducted between May 2011 and December 2014, beaked whales were observed in every month of the year offshore of Cape Hatteras, with Cuvier's beaked whale being the most commonly encounter beaked whale species (McLellan et al., 2015). The highest number of beaked sightings occurred between May and August and all sightings occurred along the continental shelf break (McLellan et al., 2015). Tag data obtained from three Cuvier's beaked whales offshore of Cape Hatteras in September 2014 provided the first long-distance movement information for Cuvier's beaked whales off the United States Atlantic coast (McLellan et al., 2015). Two individuals were tagged in the same encounter in September 2014 but remained separated by distances up to 214 km during the tag period. The three tagged whales exhibited varied movement patterns, transiting north and south of the tagging location, with two individuals returning to the tagging location. These results suggest some degree of residency for beaked whales in this area (McLellan et al., 2015). Median water depths at tagging locations ranged from 1,725 to 2,274 m, with a maximum water depth of 3,015 m. Diving data captured by the tags showed a maximum dive depth of 2,800 m suggesting that many of the dives were likely to, or close to, the seafloor (McLellan et al., 2015).

Passive acoustic monitoring conducted between 2007 and 2013 in Onslow Bay, North Carolina resulted in detections of multiple beaked whale vocalization events. Beaked whale detections were documented throughout the monitoring period with no specific diel pattern, but there were more detections from October 2012 through the end of March 2013 (Hodge & Read, 2015). Gervais' beaked whales were detected significantly more than any other beaked whale species. Cuvier's beaked whale clicks were detected in November 2012 and Blainville's beaked whale clicks were detected primarily in April and May 2013 (Hodge & Read, 2015). True's and Sowerby's beaked whales were not detected during this effort, but there were two detections in December 2012 of a click type assigned to an unidentified beaked whale species.

MacLeod and Mitchell (2006) described the northern Gulf of Mexico continental shelf margin as "a key area" for beaked whales. Beaked whales were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico (i.e., United States Gulf of Mexico) (Hansen et al., 1996; Mullin & Hoggard, 2000). Some of the aerial survey sightings may have included Cuvier's beaked whale, but identification of beaked whale species from aerial surveys is problematic. Beaked whale sightings made during spring and summer vessel surveys were widely distributed in waters greater than 500 m deep.

4.1.2.5.3 Population Trends

A trend analysis has not been conducted for the western North Atlantic Cuvier's beaked whale stock. Additionally, trend analyses have not been conducted for any of the four species of *Mesoplodon* in the western North Atlantic (Waring et al., 2014).

Further analysis of northern Gulf of Mexico Cuvier's beaked whale survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred over this period (Waring et al., 2013). Additionally, a Gulf-wide assessment of Cuvier's beaked whale abundance has not been made (Waring et al., 2013). There are insufficient data to determine population trends for Blainville's and Gervais' beaked whales in the northern Gulf of Mexico.

4.1.2.6 Northern Bottlenose Whale (*Hyperoodon ampullatus*)

4.1.2.6.1 Status and Management

There are two populations of northern bottlenose whales in the western North Atlantic: one on the Scotian Shelf in the area referred to as the Gully and a second in Davis Strait off northern Labrador. The Gully is a unique ecosystem that appears to have long provided a stable year-round habitat for a distinct population of bottlenose whales (Dalebout et al., 2006). The Scotian Shelf population of northern bottlenose whales is listed as endangered by the Committee on the Status of Endangered Wildlife in Canada and the Davis Strait-Baffin Bay-Labrador Sea population is designated as a population of special concern (Committee on the Status of Endangered Wildlife in Canada, 2011).

4.1.2.6.2 Habitat and Geographic Range

Northern bottlenose whales are largely a deep-water species and seldom found in waters less than 2,000 m deep (Mead, 1989a). Distribution is concentrated in areas of high relief, including shelf breaks and submarine canyons.

Northern bottlenose whales are commonly found in the Labrador Current and likely occur in the Gulf Stream open ocean areas. The Gully straddles the Scotian Shelf and Gulf Stream areas.

Northern bottlenose whales are distributed in the North Atlantic primarily from Nova Scotia to about 70° in the Davis Strait, along the east coast of Greenland to 77°, and from England to the west coast of

Spitzbergen (Waring et al., 2015). There are two main centers of bottlenose whale distribution in the western North Atlantic, the Scotian Shelf (including the Gully), and Davis Strait off northern Labrador (Reeves et al., 1993). Genetic studies have shown that these two populations are likely distinct from one another (Dalebout et al., 2006). Northern bottlenose whales have been sighted in deep waters off New England, but are uncommon in United States waters. Strandings have occurred as far south as North Carolina, although that is outside of the natural range or at the edge of the southern range for this more subarctic species (Jefferson et al., 2008b; Jefferson et al., 2015; MacLeod et al., 2006).

4.1.2.6.3 Population Trends

There are insufficient data to determine population trends for northern bottlenose whales.

4.1.2.7 Rough-Toothed Dolphin (*Steno bredanensis*)

4.1.2.7.1 Status and Management

Rough-toothed dolphins are among the most widely distributed species of tropical dolphins, but little information is available on population status (Jefferson et al., 2008b; Jefferson, 2009; Jefferson et al., 2015). The Western North Atlantic and Gulf of Mexico populations of the rough-toothed dolphin are considered two separate stocks for management purposes, but there is insufficient genetic information to differentiate these stocks (Waring et al., 2013; Wimmer & Whitehead, 2004).

4.1.2.7.2 Habitat and Geographic Range

The distribution of the rough-toothed dolphin is poorly understood worldwide. These dolphins are thought to be a tropical to warm-temperate species and historically have been reported in deep oceanic waters in the Atlantic, Pacific, and Indian Oceans and the Mediterranean and Caribbean Seas (Gannier & West, 2005; Leatherwood & Reeves, 1983; Perrin & Walker, 1975; Reeves et al., 2003). Rough-toothed dolphins occur in the Gulf Stream and North Atlantic Gyre open ocean areas.

Rough-toothed dolphins were observed in both shelf and oceanic waters in the northern Gulf of Mexico (Fulling et al., 2003; Mullin & Fulling, 2003) and off the United States East Coast from North Carolina to Delaware (Waring et al., 2014). In the western North Atlantic, tracking of five rough-toothed dolphins that were rehabilitated and released following a mass stranding on the East Coast of Florida in 2005 demonstrated a variety of ranging patterns (Wells et al., 2008). All tagged rough-toothed dolphins moved through a large range of water depths averaging greater than 100 ft. (30 m), though each of the five tagged dolphins transited through very shallow waters at some point, with most of the collective movements recorded over a gently sloping seafloor. Monthly aerial surveys conducted offshore of Cape Hatteras, North Carolina since 2011 have only resulted in one sighting of four individual rough-toothed dolphins just beyond the 100 meter isobaths (U.S. Department of the Navy, 2013a).

Since 2007, monthly aerial surveys offshore of Onslow Bay, North Carolina have been conducted, but only three rough-toothed dolphin surveys have been documented during these efforts. However, passive acoustic monitoring efforts have supplemented the limited sighting data of this species. Analysis of clicks and whistles recorded during towed hydrophone array line-transect surveys in Onslow Bay, North Carolina between September 2007 and August 2010 characterized one recording session with vocalizations belonging to rough-toothed dolphins, which corresponded with one visual sighting of the species in 2009 (U.S. Department of the Navy, 2013a).

Aerial surveys conducted between 2009 and 2016 offshore of Jacksonville, Florida resulted in nine sightings of rough-toothed dolphins in primarily in the summer and fall months. Sightings from aerial surveys have been documented inside the 100 meter isobaths in continental shelf waters (Cummings et al., 2016; U.S. Department of the Navy, 2013a).

4.1.2.7.3 Population Trends

A trend analysis has not been conducted for the Western North Atlantic stock of rough-toothed dolphins (Waring et al., 2014).

Further analysis of Gulf of Mexico rough-toothed dolphin survey data from 2003–2004 and 2009 is required in order to determine whether changes in abundance have occurred (Waring et al., 2017). Additionally, a Gulf-wide assessment of rough-toothed dolphin abundance has not been made (Waring et al., 2017).

4.1.2.8 Bottlenose Dolphin (*Tursiops truncatus*)

4.1.2.8.1 Status and Management

Along the United States East Coast and northern Gulf of Mexico, the bottlenose dolphin stock structure is well studied. There are currently 53 management stocks identified by NMFS in the western North Atlantic and Gulf of Mexico, including oceanic, coastal, and estuarine stocks (Waring et al., 2016). Most stocks in the Study Area are designated as Strategic or Depleted under the MMPA. For a complete listing of currently identified stocks within the Study Area, see Figure 4.1-1.

4.1.2.8.2 Habitat and Geographic Range

The bottlenose dolphin occurs in tropical to temperate waters of the Atlantic Ocean as well as inshore, nearshore, and offshore waters of the Gulf of Mexico and United States East Coast(Waring et al., 2016). They generally do not range north or south of 45° latitude (Jefferson et al., 2008b; Jefferson et al., 2015; Wells & Scott, 2008). They occur in most enclosed or semi-enclosed seas in habitats ranging from shallow, murky, estuarine waters to deep, clear offshore waters in oceanic regions (Jefferson et al., 2008b; Jefferson et al., 2015; Wells et al., 2009). Open ocean populations occur far from land; however, population density appears to be highest in nearshore areas (Scott & Chivers, 1990). Bottlenose dolphins occur in the North Atlantic Gyre and Gulf Stream open ocean areas.

There are two morphologically and genetically distinct bottlenose dolphin morphotypes (distinguished by physical differences) (Duffield et al., 1983) described as coastal and offshore forms. Both inhabit waters in the western North Atlantic Ocean and Gulf of Mexico (Curry & Smith, 1997; Hersh & Duffield, 1990; Mead & Potter, 1995) along the United States Atlantic coast. The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York, around the Florida peninsula, and along the Gulf of Mexico coast. The range of the offshore bottlenose dolphin includes waters beyond the continental slope (Kenney, 1990), and offshore bottlenose dolphins may move between the Gulf of Mexico and the Atlantic (Wells et al., 1999). Dolphins with characteristics of the offshore type have stranded as far south as the Florida Keys.

In Canadian waters, bottlenose dolphins were occasionally sighted on the Scotian Shelf, particularly in the Gully (Gowans & Whitehead, 1995). Seasonally, bottlenose dolphins occur over the outer continental shelf and inner slope as far north as Georges Bank (Cetacean and Turtle Assessment Program, 1982; Kenney, 1990). Sightings occurred along the continental shelf break from Georges Bank to Cape Hatteras during spring and summer (Cetacean and Turtle Assessment Program, 1982; Kenney, 1990).

Acoustic monitoring data indicate that dolphins are present in coastal waters of Norfolk and Virginia Beach nearly every day (Lammers et al., 2015). Seasonally, diminished acoustic activity was observed in that area for the February timeframe. A combination of visual line-transect surveys, photo-identification, and acoustic monitoring methods were employed between August 2012 and December 2014 off the Atlantic coast Virginia. The majority of the sightings consisted of bottlenose dolphins, on which further analyses indicated spatial and seasonal variation in density and abundance (Engelhaupt et al., 2016). The greatest abundance was observed during the fall in an area from the shore out to 3.7 km, extending from Naval Station Norfolk down to the Virginia/North Carolina border (Engelhaupt et al., 2016). Diel patterns with increased detections during nighttime hours were documented at two sites near Naval Station Norfolk, and one site near Joint Expeditionary Base-Little Creek (Engelhaupt et al., 2016).

North of Cape Hatteras, the coastal and offshore morphotypes are separated across bathymetry during summer months. Aerial surveys flown during 1979–1981 indicated a concentration of bottlenose dolphins in waters less than 25 m deep corresponding to the coastal morphotype, and an area of high abundance along the shelf break corresponding to the offshore stock (Cetacean and Turtle Assessment Program, 1982; Kenney, 1990).During winter months and south of Cape Hatteras, North Carolina, the ranges of the coastal and offshore morphotypes overlap to some degree. Bottlenose dolphins have been sighted regularly during surveys conducted offshore of Cape Hatteras from 2009 through 2014 (Foley et al., 2015a). Monthly aerial and vessel surveys conducted between June 2007 and June 2010 offshore of Onslow Bay, North Carolina showed the fauna was also dominated strongly by bottlenose dolphins, with year-round occurrence. Most bottlenose dolphin encounters occurred just off the shelf break (Read et al., 2014).

Similar with other United States Atlantic coast areas, bottlenose dolphins were among the most frequently observed cetacean species during vessel surveys conducted along the continental shelf break and pelagic waters offshore of Jacksonville, Florida from July 2009 through December 2013. Bottlenose dolphins were encountered throughout the area including within deeper pelagic waters (Swaim et al., 2014). Genetic analyses of biopsy samples confirmed that all sampled bottlenose dolphins were off the offshore morphotype, suggesting there is limited overlap between coastal and offshore populations in this area of the Atlantic Ocean (Swaim et al., 2014). Photo-identification catalogs of bottlenose dolphins from Cape Hatteras, Onslow Bay, Jacksonville survey areas have been compared, but no matches have been identified (Foley et al., 2015a; Swaim et al., 2014) suggesting a high degree of residency to these areas.

Several lines of evidence support a distinction between coastal stock dolphins and those present primarily in the inshore waters of the bays, sounds, and estuaries (LaBrecque et al., 2015a). Photo-identification and genetic studies support the existence of more than 40 stock populations in bays, sounds, and estuaries. These populations inhabit estuaries and bays from North Carolina to the Gulf of Mexico coast (Caldwell, 2001; Gubbins, 2002; Gubbins et al., 2003; Litz, 2007; Mazzoil et al., 2005; Zolman, 2002).

LaBrecque et al. (2015b) identified nine small and resident bottlenose dolphin population areas within estuarine areas along the United States East Coast (Figures 11.2-2). These areas include estuarine and nearshore areas extending from Pamlico Sound, North Carolina down to Florida Bay, Florida and were substantiated through vessel- and aerial based survey data, photo-identification data, genetic analyses, and expert judgment (LaBrecque et al., 2015b). The Northern North Carolina, Southern North Carolina, and Charleston Harbor partially overlaps with nearshore portions of the Navy Cherry Point Range

Complex and Jacksonville Estuarine System Populations partially overlaps with nearshore portions of the Jacksonville Range Complex. The Southern Georgia Estuarine System Population area also overlaps with the Jacksonville Range Complex, specifically within Naval Submarine Base Kings Bay, Kings Bay, Georgia and includes estuarine and intercoastal waterways from Altamaha Sound, to the Cumberland River (LaBrecque et al., 2015b). The remaining four biologically important areas are outside but adjacent to the AFTT Study Area boundaries.

In the Gulf of Mexico alone, 32 distinct stocks are recognized, although the structure of these stocks is uncertain but appears to be complex. Residency patterns of dolphins in bays, sounds, and estuaries range from transient to seasonally migratory to stable resident communities, and various stocks may overlap at times. Year-round residency patterns of some individual bottlenose dolphins in bays, sounds, and estuaries have been reported for almost every survey area where photo-identification or tagging studies have been conducted.

LaBrecque et al. (2015a) delineated 11 small and resident population areas for bottlenose dolphins within the Gulf of Mexico (Figure 11.2-3). These areas include bays, sounds, and estuaries ranging from Aranas Pass, Texas to the Florida Keys, Florida and were substantiated through a combination of extensive photo-identification data, genetic analyses, radio-tracking data, and expert knowledge (LaBrecque et al., 2015a). Of the 11 biologically important areas identified for bottlenose dolphins in the Gulf of Mexico, three overlap with the Gulf of Mexico Range Complex (Aranas Pass Area, Texas; Mississippi Sound Area, Mississippi; and St. Joseph Bay Area, Florida) and eight are located adjacent to the AFTT Study Area boundaries.

4.1.2.8.3 Population Trends

A trend analysis has not been conducted for the following stocks of bottlenose dolphins: Western North Atlantic Offshore Stock and Northern Gulf of Mexico Oceanic Stock (Waring et al., 2015).

There are insufficient data to determine the population trends for the following stocks of bottlenose dolphins: Northern Gulf of Mexico Continental Shelf Stock; Northern North Carolina Estuarine System Stock; Southern North Carolina Estuarine System Stock; Northern South Carolina Estuarine System Stock; Charleston Estuarine System Stock; Northern Georgia/Southern South Carolina Estuarine System Stock; Central Georgia Estuarine System Stock; Southern Georgia Estuarine System Stock; Jacksonville Estuarine System Stock; Indian River Lagoon Estuarine System Stock; Biscayne Bay Stock; Florida Bay Stock; Gulf of Mexico Eastern Coastal Stock; Gulf of Mexico Northern Coastal Stock; Gulf of Mexico Western Coastal Stock; most of the Northern Gulf of Mexico Bay, Sound, and Estuary Stocks, Barataria Bay Estuarine System Stock; Mississippi Sound Stock; Lake Borgne Bay Boudreau Stock; St. Joseph Bay Stock; Choctawhatchee Bay Stock; and Puerto Rico and United States Virgin Islands Stock (Waring et al., 2012; Waring et al., 2015).

There are limited data available to assess population trends for the following stocks of bottlenose dolphins: Western North Atlantic Northern Migratory Coastal Stock, Western North Atlantic Southern Migratory Coastal Stock, Western North Atlantic South Carolina-Georgia Coastal Stock, Western North Atlantic Northern Florida Coastal Stock, and Western North Atlantic Central Florida Coastal Stock (Waring et al., 2013, 2014).

4.1.2.9 Pantropical Spotted Dolphin (*Stenella attenuata*)

4.1.2.9.1 Status and Management

The western North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes, although there is currently not enough information to distinguish them (Waring et al., 2016).

4.1.2.9.2 Habitat and Geographic Range

The pantropical spotted dolphin is distributed in offshore tropical and subtropical waters of the Atlantic Ocean between about 40° N and 40° S (Baldwin et al., 1999; Perrin, 2008b). 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., 2008b; Jefferson et al., 2015; Perrin, 2001). Pantropical spotted dolphins may occur in the Gulf Stream open ocean area.

The pantropical spotted dolphin is the most commonly sighted species of cetacean in the oceanic waters of the northern Gulf of Mexico. Pantropical spotted dolphins were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000). Most sightings of this species in the Gulf of Mexico and Caribbean occur over the lower continental slope (Mignucci-Giannoni et al., 2003; Moreno et al., 2005). Pantropical spotted dolphins in the offshore Gulf of Mexico do not appear to have a preference for any one specific habitat type, such as within the Loop Current, inside cold-core eddies, or along the continental slope (Baumgartner et al., 2001). Along the United States Atlantic coast, sightings have been concentrated in the slope waters east of New England and Florida, and sightings extend into the deeper slope and offshore waters of the mid-Atlantic east of Cape Hatteras (Waring et al., 2014).

4.1.2.9.3 Population Trends

A population trend analysis has not been conducted for the western North Atlantic Stock of pantropical spotted dolphins due to insufficient data (Waring et al., 2007).

Further analysis of Gulf of Mexico pantropical spotted dolphin survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred (Waring et al., 2015). Additionally, a Gulf-wide assessment of pantropical spotted dolphin abundance has not been made (Waring et al., 2015).

4.1.2.10 Atlantic Spotted Dolphin (*Stenella frontalis*)

4.1.2.10.1 Status and Management

The Atlantic spotted dolphin occurs in two forms that may be distinct subspecies (Perrin et al., 1987; Perrin, 2008a; Rice, 1998): the large, heavily spotted form, which inhabits the continental shelf and is usually found inside or near the 200-m isobath; and the smaller, less spotted island and offshore form, which occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico (Fulling et al., 2003; Mullin & Fulling, 2003, 2004). The western North Atlantic population is provisionally being considered a separate stock from the Gulf of Mexico stock(s) for management purposes based on genetic analysis (Waring et al., 2014; Waring et al., 2016). The United States Virgin Islands population is provisionally being considered a separate stock, although there is currently no information to differentiate this stock from the Atlantic Ocean and Gulf of Mexico stocks.

4.1.2.10.2 Habitat and Geographic Range

The Atlantic spotted dolphin is found in nearshore tropical to warm-temperate waters, predominantly over the continental shelf and upper slope (Waring et al., 2013, 2014). In the eastern Gulf of Mexico, for instance, the species often occurs over the mid-shelf (Griffin & Griffin, 2003). In the western Atlantic, this species is distributed from New England to Brazil and is found in the Gulf of Mexico as well as the Caribbean Sea (Perrin, 2008a). Atlantic spotted dolphins may occur in the Gulf Stream open ocean area.

The large, heavily spotted coastal form of the Atlantic spotted dolphin typically occurs over the continental shelf but usually at least 4.9 to 12.4 mi. offshore (Davis et al., 1998; Perrin, 2002, 2008a). Atlantic spotted dolphin sightings have been concentrated in the slope waters north of Cape Hatteras, but in the shelf waters south of Cape Hatteras sightings extend into the deeper slope and offshore waters of the mid-Atlantic (Mullin & Fulling, 2003; Waring et al., 2014). Vessel surveys conducted between January 2009 and December 2014 offshore of Cape Hatteras, North Carolina resulted in multiple sightings of Atlantic spotted dolphins annually from 2011 to 2014 (Foley et al., 2015a). Aerial and shipboard surveys conducted between 2007 and 2010 in offshore waters of Onslow Bay, North Carolina indicate that spotted dolphins have a strong preference for waters over the continental shelf and do not typically occur beyond the shelf break (Read et al., 2014). Numerous re-sightings of multiple individuals over several years and across seasons supports the existence of considerable fine-scale population structure and a degree of residency for Atlantic spotted dolphins in Onslow Bay (Swaim et al., 2014).

Photo-identification catalogs of Atlantic spotted dolphins from Cape Hatteras, Onslow Bay, Jacksonville survey areas have been compared, but no matches have been identified (Foley et al., 2015a; Swaim et al., 2014) suggesting a high degree of residency to these areas. Atlantic spotted dolphins were one of the dominant species sighted during vessel surveys conducted along the continental shelf break and pelagic waters offshore of Jacksonville, Florida from July 2009 through December 2013 (Swaim et al., 2014). Sightings were restricted to the relatively shallow shelf waters of the survey area. Photo-identification catalogs of Atlantic spotted dolphins from Cape Hatteras, Onslow Bay, Jacksonville survey areas have been compared, but no matches have been identified (Foley et al., 2015a; Swaim et al., 2014) further supporting some degree of residency to these areas.

Higher numbers of spotted dolphins are reported over the west Florida continental shelf from November to May than during the rest of the year, suggesting that this species may migrate seasonally (Griffin & Griffin, 2003).

In the Gulf of Mexico, Atlantic spotted dolphins occur primarily from continental shelf waters 10-200 m deep to slope waters greater than 500 m deep (Fulling et al., 2003; Maze-Foley & Mullin, 2006; Mullin & Fulling, 2004). Atlantic spotted dolphins were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico from 1992 to 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000).

4.1.2.10.3 Population Trends

Due to imprecise abundance estimates and long periods of time between surveys, a trend analysis has not been conducted for the western North Atlantic Stock of Atlantic spotted dolphins (Waring et al., 2014).

The current population size for the Atlantic spotted dolphin in the northern Gulf of Mexico is unknown because the survey data from the continental shelf that covers the majority of this stock's range are more than 8 years old (Wade & Angliss, 1997). Additionally, there are insufficient data to determine the population trend for the Northern Gulf of Mexico Stock of Atlantic spotted dolphins (Waring et al., 2013) and for the Puerto Rico and United States Virgin Islands stock of Atlantic spotted dolphins (Waring et al., 2012).

4.1.2.11 Spinner Dolphin (*Stenella longirostris*)

4.1.2.11.1 Status and Management

For management purposes, the western North Atlantic and Gulf of Mexico populations of spinner dolphins are considered separate stocks, although there is currently insufficient data to differentiate them (Waring et al., 2014).

4.1.2.11.2 Habitat and Geographic Range

This is presumably an offshore, deep-water species (Perrin & Gilpatrick, 1994; Schmidly, 1981), although its distribution in the Atlantic is very poorly known. Spinner dolphins likely occur in the Gulf Stream and North Atlantic Gyre open ocean areas, based on their preference for waters greater than 2,000 m deep.

In the western North Atlantic, these dolphins occur in deep water along most of the United States coast south to the West Indies and Venezuela, including the Gulf of Mexico (Waring et al., 2014). Spinner dolphin sightings have occurred exclusively in deeper (greater than 2,000 m) oceanic waters of the northeast United States coast (Cetacean and Turtle Assessment Program, 1982; Waring et al., 1992). Stranding records exist from North Carolina, South Carolina, Florida, and Puerto Rico in the Atlantic and in Texas and Florida in the Gulf of Mexico, and there was one recent sighting during summer 2011 in oceanic waters off North Carolina. Monthly aerial surveys offshore of Cape Hatteras conducted since May 2011 have only resulted in one sighing of spinner dolphins in a mixed group of Clymene dolphins within the northern offshore waters of the survey area (U.S. Department of the Navy, 2013a). Although spinner dolphins were sighted and stranded off the southeastern United States coast, they are not common in those waters, except perhaps off southern Florida (Waring et al., 2010). In the northern Gulf of Mexico, spinner dolphins are found mostly in offshore waters beyond the edge of the continental shelf and primarily east of the Mississippi River (Waring et al., 2013). This species was seen during all seasons in the northern Gulf of Mexico during aerial surveys between 1992 and 1998 (Waring et al., 2013).

4.1.2.11.3 Population Trends

Due to imprecise abundance estimates and long periods of time between surveys, a trend analysis has not been conducted for the western North Atlantic Stock of spinner dolphins (Waring et al., 2014).

Further analysis of northern Gulf of Mexico spinner dolphin survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred over this period (Waring et al., 2013). Additionally, a Gulf-wide assessment of spinner dolphin abundance has not been made (Waring et al., 2013).

There are insufficient data to determine the population trends for the Puerto Rico and United States Virgin Islands stock of spinner dolphins (Waring et al., 2012).

4.1.2.12 Clymene Dolphin (*Stenella clymene*)

4.1.2.12.1 Status and Management

The species is not listed under the ESA but is protected under the MMPA. The Clymene dolphin has an extensive range in the tropical Atlantic Ocean. For management purposes, the western North Atlantic and Northern Gulf of Mexico populations are considered separate stocks.

4.1.2.12.2 Habitat and Geographic Range

Clymene dolphins are a tropical to subtropical species, primarily sighted in deep waters well beyond the edge of the continental shelf (Fertl et al., 2003). Clymene dolphins likely occur in the Gulf Stream open ocean area.

In the western North Atlantic, Clymene dolphins were observed as far north as New Jersey, although sightings were primarily in offshore waters east of Cape Hatteras over the continental slope and are likely to be strongly influenced by oceanographic features of the Gulf Stream (Fertl et al., 2003; Moreno et al., 2005; Mullin & Fulling, 2003). Monthly aerial surveys conducted offshore of Cape Hatteras since May 2011 have resulted in 10 total Clymene dolphin sightings, including one sighing of Clymene dolphins in a mixed group of spinner dolphins within the northern offshore waters of the survey area in 2011 (U.S. Department of the Navy, 2013a). All Clymene dolphin sightings were documented primarily during the summer and fall months.

Clymene dolphins in the Gulf of Mexico are observed most frequently on the lower slope and deepwater areas, primarily west of the Mississippi River, in regions of cyclonic or confluent circulation (Davis et al., 2002; Mullin et al., 1994a). Clymene dolphins were seen in the winter, spring and summer during GulfCet aerial surveys of the northern Gulf of Mexico during 1992 to 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000).

4.1.2.12.3 Population Trends

There are insufficient data to determine population trends for the western North Atlantic stock of Clymene dolphins (Waring et al., 2013, 2014). Further analysis of northern Gulf of Mexico Clymene dolphin survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred over this period (Waring et al., 2013). Additionally, a Gulf-wide assessment of Clymene dolphin abundance has not been made (Waring et al., 2013).

4.1.2.13 Striped Dolphin (*Stenella coeruleoalba*)

4.1.2.13.1 Status and Management

For management purposes, the Gulf of Mexico population of striped dolphin is provisionally considered a separate stock, although there are not sufficient genetic data to differentiate the Gulf of Mexico stock from the western North Atlantic stock (Waring et al., 2010). There is very little information on stock structure in the western North Atlantic and insufficient data to assess population trends of this species (Waring et al., 2010).

4.1.2.13.2 Habitat and Geographic Range

The striped dolphin is one of the most common and abundant dolphin species, with a worldwide range that includes both tropical and temperate waters (Waring et al., 2014). 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* (spotted, spinner, Clymene, and striped dolphins). Striped dolphins are found in the western North Atlantic from Nova Scotia south to at least Jamaica as well as in the Gulf of Mexico. In general, striped dolphins appear to prefer continental slope waters offshore to the Gulf Stream (Leatherwood et al., 1976; Perrin et al., 1994; Schmidly, 1981).

Striped dolphins are relatively common in the cooler offshore waters of the United States East Coast. Along the mid-Atlantic ridge in oceanic waters of the North Atlantic Ocean, striped dolphins are sighted in significant numbers south of 50° N (Waring et al., 2010). In waters off the northeastern United States coast, striped dolphins are distributed along the continental shelf edge from Cape Hatteras to the southern margin of Georges Bank and also occur offshore over the continental slope and rise in the mid-Atlantic region (Cetacean and Turtle Assessment Program, 1982; Mullin & Fulling, 2003). Continental shelf edge sightings in the Cetacean and Turtle Assessment Program (1982) were generally centered along the 1,000-m depth contour in all seasons. During 1990 and 1991 cetacean habitat-use surveys, striped dolphins were associated with the Gulf Stream north wall and warm-core ring features (Waring et al., 1992). Striped dolphins seen in a survey of the New England Sea Mounts (Palka, 1997) were in waters that were between 20 degrees Celsius (°C) and 27°C and deeper than about 3,000 ft. (900 m).

In January 2015, monthly aerial surveys began in the offshore area near Norfolk Canyon and to date six striped dolphin sightings have been recorded during these efforts (McAlarney et al., 2016). Monthly aerial surveys have been ongoing offshore of Cape Hatteras since May 2011, which have resulted in a total of five striped dolphin sightings, primarily in late winter and early spring.

Striped dolphins are also found throughout the deep, offshore waters of the northern Gulf of Mexico. Sightings of striped dolphins in the northern Gulf of Mexico typically occur in oceanic waters and during all seasons (Waring et al., 2010).

4.1.2.13.3 Population Trends

A trend analysis has not been conducted for the western North Atlantic stock of striped dolphins (Waring et al., 2014).

Further analysis of northern Gulf of Mexico striped dolphin survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred over this period (Waring et al., 2013) (Waring et al., 2013). Additionally, a Gulf-wide assessment of striped dolphin abundance has not been made (Waring et al., 2013).

4.1.2.14 Fraser's Dolphin (*Lagenodelphis hosei*)

4.1.2.14.1 Status and Management

The Gulf of Mexico population of Fraser's dolphin is provisionally being considered a separate stock for management purposes, although there are no genetic data to differentiate this stock from the western North Atlantic stock (Waring et al., 2013).

4.1.2.14.2 Habitat and Geographic Range

Fraser's dolphin is a tropical, oceanic species, except where deep water approaches the coast (Dolar, 2008). Frasier's dolphins likely occur in the Gulf Stream open ocean area.

This species is assumed to occur in the tropical western North Atlantic, although only a single sighting of approximately 250 individuals was recorded in waters 3,300 m deep in the waters off Cape Hatteras during a 1999 vessel survey. Monthly aerial surveys offshore of Cape Hatteras since May 2011 have resulted in only one sighing of Fraser's dolphins offshore of the 1,500 meter isobaths (U.S. Department of the Navy, 2013a). The first record for the Gulf of Mexico was a mass stranding in the Florida Keys in 1981 (Hersh & Odell, 1986; Leatherwood et al., 1993). Since then, there have been documented strandings on the west coast of Florida and in southern Texas (Yoshida et al., 2010). Sightings of Fraser's dolphin in the northern Gulf of Mexico typically occur in oceanic waters greater than 200 m. This species was observed in the northern Gulf of Mexico during all seasons.

4.1.2.14.3 Population Trends

There are insufficient data to determine population trends for the western North Atlantic stock of Fraser's dolphins (Waring et al., 2007).

There are also insufficient data to determine population trends for the northern Gulf of Mexico stock of Fraser's dolphins. The large relative changes in the total abundances of Fraser's dolphin are probably due to a number of factors. Fraser's dolphin is most certainly a resident species in the Gulf of Mexico but probably occurs in low numbers, and the survey effort is not sufficient to estimate the abundance of uncommon or rare species with precision. Also, these temporal abundance estimates are difficult to interpret without a Gulf of Mexico-wide understanding of Fraser's dolphin abundance. Studies based on abundance and distribution surveys restricted to United States waters are unable to detect temporal shifts in distribution beyond United States waters that might account for any changes in abundance (Waring et al., 2013).

4.1.2.15 Risso's Dolphin (*Grampus griseus*)

4.1.2.15.1 Status and Management

For management purposes, Risso's dolphins in the Gulf of Mexico and the Atlantic Ocean are currently considered two separate stocks (Waring et al., 2010; Waring et al., 2016).

4.1.2.15.2 Habitat and Geographic Range

Risso's dolphins are distributed worldwide in tropical and temperate waters along the continental shelf break and over the continental slope and 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). Risso's dolphins were also found in association with submarine canyons (Mussi et al., 2004). The range of the Risso's dolphin distribution in open-ocean waters of the North Atlantic is known to include the Gulf Stream and the southwestern portions of the North Atlantic Gyre.

In the northwest Atlantic, Risso's dolphins occur from Florida to eastern Newfoundland (Baird & Stacey, 1991; Leatherwood et al., 1976). Off the northeast United States coast, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank during spring, summer, and autumn (Cetacean and Turtle Assessment Program, 1982). In winter, the range is in the mid-Atlantic Bight and extends outward into oceanic waters. In general, the population occupies the mid-Atlantic continental shelf edge year-round and is rarely seen in the Gulf of Maine. During 1990, 1991, and 1993, spring/summer surveys conducted along the continental shelf edge and in deeper oceanic waters sighted Risso's dolphins associated with strong bathymetric features, Gulf Stream warm core rings, and the Gulf Stream north wall (Hamazaki, 2002; Waring et al., 1992, 1993).

Monthly aerial survey efforts began in January 2015 in the offshore area near Norfolk Canyon and have resulted in seven Risso's dolphin sightings to date.

Monthly aerial surveys offshore of Cape Hatteras since May 2011 have documented 24 Risso's dolphin sightings, primarily during the summer months. Vessel surveys conducted offshore of Cape Hatteras, North Carolina from January 2009 to December 2014 also resulted in regular sightings of Risso's dolphins (Foley et al., 2015a). Risso's dolphins were also sighted from inside the 100 meter isobath out to 2,000 meter water depth during aerial surveys conducted between January to December 2014 (McAlarney et al., 2014).

Risso's dolphins were also one of the most commonly encountered pelagic dolphins found during surveys conducted in Onslow Bay, North Carolina and offshore of Jacksonville, Florida (McLellan et al., 2014). Risso's dolphins observed during aerial and vessel surveys conducted monthly between June 2007 and June 2010 offshore of Onslow Bay, North Carolina were exclusively found over the continental shelf break and in deeper waters of the survey area (Read et al., 2014; U.S. Department of the Navy, 2013a). Passive acoustic monitoring in Onslow Bay preliminarily indicated that Risso's dolphins are present in that area throughout the year (Hodge, 2011). High-frequency acoustic recording packages were deployed from July 2010 through December 2011 and showed an increase in nocturnal increases in Risso's dolphin click occurrences (2010–2011 Annual Report). Additional deployments of high-frequency acoustic recording packages from October 2012 through June 2013 at water depth of 853 m detected calls of Risso's dolphins mainly during spring and summer months (April to June) and no detections were recorded during fall and winter (October through late February) (Hodge & Read, 2015).

Vessel surveys conducted offshore of Jacksonville, Florida between July 2009 and December 2014 have resulted in a few Risso's dolphin sightings including two sightings in 2010, one sighting in May 2013 (Swaim et al., 2014) and one sighting in October 2014 (Swaim et al., 2015). Aerial surveys conducted between July 2010 and December 2011 documented higher numbers of Risso's dolphin encounters, with 16 sightings occurring within deeper waters of the survey area (U.S. Department of the Navy, 2013a).

Risso's dolphins in the northern Gulf of Mexico occur throughout oceanic waters but are concentrated in continental slope waters (Baumgartner, 1997; Maze-Foley & Mullin, 2006). Risso's dolphins were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000).

4.1.2.15.3 Population Trends

A trend analysis has not been conducted for the western North Atlantic stock or for the Gulf of Mexico stock of Risso's dolphins (Waring et al., 2015).

Further analysis of northern Gulf of Mexico Risso's dolphin survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred over this period (Waring et al., 2015). Additionally, a Gulf-wide assessment of Risso's dolphin abundance has not been made (Waring et al., 2015).

4.1.2.16 Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*)

4.1.2.16.1 Status and Management

Three stocks of the Atlantic white-sided dolphin in the western North Atlantic Ocean were suggested for conservation management: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Palka et al., 1997; Waring et al., 2004). However, genetic analysis indicates that no definite stock structure exists. The species is considered abundant in the North Atlantic (Jefferson et al., 2008b; Waring et al., 2013).

4.1.2.16.2 Habitat and Geographic Range

This species is found primarily in cold temperate to subpolar continental shelf waters to the 328 ft. (100 m) depth contour (Cetacean and Turtle Assessment Program, 1982; Mate et al., 1994; Selzer & Payne, 1988). Occurrence of Atlantic white-sided dolphins in the northeastern United States probably reflects fluctuations in food availability as well as oceanographic conditions (Palka et al., 1997; Selzer & Payne, 1988). Before the 1970s, Atlantic white-sided dolphins were found primarily offshore in waters over the continental slope; however, since then, they occur primarily in waters over the continental shelf, replacing white-beaked dolphins, which were previously sighted in the area. This shift may have been the result of an increase in sand lance and a decline in herring in continental shelf waters (Payne et al., 1990). Areas of feeding importance are around Cape Cod and on the northwest edge of Georges Bank, in an area defined as the Great South Channel-Jeffreys Ledge corridor (Cetacean and Turtle Assessment Program, 1982; Palka et al., 1997). Selzer and Payne (1988) sighted white-sided dolphins more frequently in areas of high seafloor relief and where sea surface temperatures and salinities were low, although these environmental conditions might be only secondarily influencing dolphin distribution; seasonal variation in sea surface temperature and salinity and local nutrient upwelling in areas of high seafloor relief may affect preferred prey abundances, which in turn might affect dolphin distribution (Selzer & Payne, 1988).

Atlantic white-sided dolphins would be expected to occur in the Labrador Current and possibly in the northern extent of the Gulf Stream open ocean area. Atlantic white-sided dolphins are common in waters of the continental slope from New England to southern Greenland (Cipriano, 2008; Jefferson et al., 2008b; Jefferson et al., 2015). Along the Canadian and United States Atlantic coast, this species is most common from Hudson Canyon north to the Gulf of Maine (Palka et al., 1997). From January to May, low numbers of white-sided dolphins may be found from Georges Bank to Jeffreys Ledge. Even lower numbers are found south of Georges Bank (Palka et al., 1997; Payne et al., 1990; Waring et al., 2004). From June through September, large numbers of white-sided dolphins are found from Georges Bank to the lower Bay of Fundy (Payne et al., 1990; Waring et al., 2004). During this time, strandings occur from New Brunswick to New York (Palka et al., 1997). From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to the southern Gulf of Maine. Sightings occur year-round south of Georges Bank, particularly around Hudson Canyon, but in low densities (Cetacean and Turtle Assessment Program, 1982; Palka, 1997; Payne et al., 1990; Waring et al., 2004). A few strandings were collected on Virginia and North Carolina beaches, which appear to represent the southern edge of the range for this species (Cipriano, 2008).

4.1.2.16.3 Population Trends

A trend analysis has not been conducted for the western North Atlantic stock of Atlantic white-sided dolphins (Waring et al., 2015).

4.1.2.17 White-Beaked Dolphin (*Lagenorhynchus albirostris*)

4.1.2.17.1 Status and Management

There are at least two separate stocks of the white-beaked dolphin in the North Atlantic: one in the eastern and another in the western North Atlantic.

4.1.2.17.2 Habitat and Geographic Range

White-beaked dolphins are found in cold-temperate and subarctic waters of the North Atlantic (Waring et al., 2007). In the western North Atlantic Ocean, the white-beaked dolphin occurs throughout northern waters of the East Coast of the United States and eastern Canada, from eastern Greenland through the Davis Strait and south to Massachusetts (Lien et al., 2001). White-beaked dolphins would be expected to occur in the Labrador Current.

Within the Study Area, white-beaked dolphins are concentrated in the western Gulf of Maine and around Cape Cod (Cetacean and Turtle Assessment Program, 1982; Palka et al., 1997). Before the 1970s, these dolphins were found primarily in waters over the continental shelf of the Gulf of Maine and Georges Bank. Since then, they occur mainly in waters over the continental slope and are replaced by large numbers of Atlantic white-sided dolphins (Katona et al., 1993; Palka et al., 1997). This habitat shift might be a result of an increase in sand lance and a decline in herring in continental shelf waters (Payne et al., 1990). Sightings are common in nearshore waters of Newfoundland and Labrador (Lien et al., 2001). They also occur in the Gulf of St. Lawrence (Waring et al., 2010). During Cetacean and Turtle Assessment Program (1982) surveys, white-beaked dolphins were typically sighted in shallow coastal waters near Cape Cod and along Stellwagen Bank, with a bottom depth ranging from 43 to 2,454 ft. (Palka et al., 1997).

4.1.2.17.3 Population Trends

Abundance has declined in some areas, such as the Gulf of Maine, but this may be more closely related to habitat shifts than to direct changes in population size. However, there are insufficient data to determine population trends for this species (Waring et al., 2007).

4.1.2.18 Common Dolphin (*Delphinus delphis/capensis*)

4.1.2.18.1 Status and Management

Only the short-beaked common dolphin is found within the Study Area: the western North Atlantic stock (Jefferson et al., 2009; Waring et al., 2013). A discrete population of long-beaked common dolphins is known from the east coast of South America in the western Atlantic (Jefferson et al., 2008b; Jefferson et al., 2015); however, they are outside of the Study Area and not discussed further.

4.1.2.18.2 Habitat and Geographic Range

In the North Atlantic, common dolphins occur over the continental shelf along the 100- to 2,000-meter isobaths and over prominent underwater topography and east to the mid-Atlantic Ridge (29°W) (Doksaeter et al., 2008; Waring et al., 2008). There is a well-studied population of short-beaked common dolphins in the western North Atlantic associated with the Gulf Stream (Jefferson et al., 2009). It occurs mainly in offshore waters, ranging from Canada maritime provinces to the Florida/Georgia border (Waring et al., 2010).

In waters off the northeastern United States coast, common dolphins are distributed along the continental slope and are associated with Gulf Stream features (Cetacean and Turtle Assessment Program, 1982; Hamazaki, 2002; Selzer & Payne, 1988). They primarily occur from Cape Hatteras northeast to Georges Bank (35° to 42°N) during mid-January to May (Cetacean and Turtle Assessment Program, 1982; Hain et al., 1981). Common dolphins move onto Georges Bank and the Scotian Shelf from mid-summer to autumn. Selzer and Payne (1988) reported very large aggregations (greater than 3,000 animals) on Georges Bank in autumn. Common dolphins are occasionally found in the Gulf of Maine (Selzer & Payne, 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11°C (Gowans & Whitehead, 1995). The species is less common south of Cape Hatteras, although schools were reported as far south as the Georgia/South Carolina border (32° N) (Jefferson et al., 2009).

The short-beaked common dolphin was one of the many species sighted in more than 5 years of aerial and vessel monitoring of waters off Cape Hatteras, North Carolina and Jacksonville, Florida. Aerial surveys offshore of Cape Hatteras resulted in one sighing of 300 common dolphins just beyond the 100 meter isobath in May 2011 (U.S. Department of the Navy, 2013a), three sightings in March and May 2013 between the 100 meter and 1,000 meter isobaths (McAlarney et al., 2014). From January 2009 through December 2014, common dolphin sightings have occurred each year between 2011 through 2014 (Foley et al., 2015a). A single location-only tag was deployed on a short-beaked common dolphin offshore of Cape Hatteras in June 2014, and location data were obtained over a 40-day period. This individual was observed to remain primarily over the continental shelf break and continental slope, and traveled north away from the tagging location to shallower continental shelf waters off New England during the mid-summer (Baird et al., 2015). The median depth of tagged animal locations over the 40-day span was 297 m (Baird et al., 2015).

4.1.2.18.3 Population Trends

A trend analysis has not been conducted for the western North Atlantic stock of common dolphins (Waring et al., 2016).

4.1.2.19 Melon-Headed Whale (*Peponocephala electra*)

4.1.2.19.1 Status and Management

For management purposes, the western North Atlantic population and Gulf of Mexico population of melon-headed whales are considered separate stocks, although genetic data that differentiate these two stocks is lacking (Waring et al., 2007; Waring et al., 2010, 2013).

4.1.2.19.2 Habitat and Geographic Range

Melon-headed whales are found worldwide in tropical and subtropical waters. They are occasionally reported at higher latitudes, but these movements are considered to be beyond their typical range because the records indicate these movements occurred during incursions of warm water currents (Perryman et al., 1994). Melon-headed whales are most often found in offshore deep waters, and could occur in the southern parts of the Gulf Stream and North Atlantic Gyre open ocean areas.

Sightings of whales from the Western North Atlantic stock are rare, but a group of 20 whales was sighted during surveys in 1999 offshore of Cape Hatteras, and a group of 80 whales was also sighted off Cape Hatteras, in 2002, in waters greater than 2,500 m deep (Waring et al., 2013).

Deployment of high frequency acoustic recording packages offshore of Cape Hatteras, Onslow Bay, Jacksonville and the offshore areas near Norfolk Canyon from 2009 through 2015 have resulted in zero melon-headed whale detections. However, passive acoustic data were collected from marine autonomous recording units deployed on the continental shelf, just beyond the shelf, and offshore from the shelf break off Jacksonville, Florida in late 2009 and early 2010. These deployments resulted in detections of the melon-headed whales, pygmy killer whales, false killer whales, killer whales, and short-finned pilot whales. These species were detected every day during deployments but there were no obvious or consistent differences in the occurrence of vocalizations relative to water depth or time of day (Oswald et al., 2016). The grouping of these five species into the same category may have masked any patterns in vocal behaviors (Oswald et al., 2016).

This species was observed in deep waters of the Gulf of Mexico, well beyond the edge of the continental shelf and in waters over the abyssal plain, primarily west of Mobile Bay, Alabama (Davis & Fargion, 1996; Mullin et al., 1994b; Waring et al., 2010, 2013). Sightings of melon-headed whales in the northern Gulf of Mexico were documented in all seasons during GulfCet aerial surveys 1992 and 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000).

4.1.2.19.3 Population Trends

There are insufficient data to determine the population trends for the Western North Atlantic stock of melon-headed whales (Waring et al., 2007). A trend analysis has not been conducted for the northern Gulf of Mexico stock of melon-headed whales (Waring et al., 2013). Further analysis of northern Gulf of Mexico melon-headed whale survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred over this period. Additionally, a Gulf-wide assessment of melon-headed whale abundance has not been made (Waring et al., 2013).

4.1.2.20 Pygmy Killer Whale (*Feresa attenuata*)

4.1.2.20.1 Status and Management

For management purposes, the Gulf of Mexico population of pygmy killer whale is considered a separate stock although there is not yet sufficient genetic information to differentiate this stock from the western North Atlantic stocks (Waring et al., 2007; Waring et al., 2013).

4.1.2.20.2 Habitat and Geographic Range

Although the pygmy killer whale has an extensive global distribution, it is not known to occur in high densities in any region and is, therefore, probably one of the least abundant pantropical delphinids (Waring et al., 2013). The pygmy killer whale is generally an open ocean deepwater species (Davis et al., 2000; Würsig et al., 2000). This species has a worldwide distribution in tropical and subtropical oceans. Pygmy killer whales generally do not range poleward of 40° N or of 35° S (Donahue & Perryman, 2008; Jefferson et al., 2015). This species occurs in the North Atlantic Gyre and the Gulfstream, although sightings are rare. Most observations outside the tropics are associated with strong, warm western boundary currents that effectively extend tropical conditions into higher latitudes (Ross & Leatherwood, 1994).

A group of 6 pygmy killer whales was sighted during a 1992 vessel survey of the western North Atlantic off of Cape Hatteras, North Carolina, in waters greater than 1,500 m deep, but this species was not sighted during subsequent surveys (Waring et al., 2007).

Deployment of high frequency acoustic recording packages offshore of Cape Hatteras, Onslow Bay, Jacksonville and the offshore areas near Norfolk Canyon from 2009 through 2015 have resulted in zero pygmy killer whale detections. However, passive acoustic monitoring data was collected from marine autonomous recording units deployed on the continental shelf, just beyond the shelf, and offshore from the shelf break off Jacksonville, Florida in late 2009 and early 2010. Recordings included detections of the blackfish group of cetaceans, which includes pygmy killer whales, along with melon-headed whales, false killer whales, killer whales, and short-finned pilot whales. Blackfish were detected every day during monitoring but there were no obvious diel patterns or differences in the occurrence of blackfish vocalizations relative to water depth (Oswald et al., 2016). Since five species are combined into the blackfish category, patterns in pygmy killer whale vocal behaviors may have masked by the presence of other species (Oswald et al., 2016).

In the northern Gulf of Mexico, the pygmy killer whale is found primarily in deeper waters off the continental shelf and in waters over the abyssal plain (Davis et al., 2000; Würsig et al., 2000). The majority of sightings are in the eastern oceanic Gulf of Mexico.

4.1.2.20.3 Population Trends

There are insufficient data to determine population trends for the western North Atlantic stock of pygmy killer whales (Waring et al., 2007).

A trend analysis has not been conducted for the northern Gulf of Mexico stock of pygmy killer whales (Waring et al., 2013). Further analysis of northern Gulf of Mexico pygmy killer whale survey data from 1991–2009 is required in order to determine whether changes in abundance have occurred over this period. Additionally, a Gulf-wide assessment of pygmy killer whale abundance has not been made (Waring et al., 2013).

4.1.2.21 False Killer Whale (*Pseudorca crassidens*)

4.1.2.21.1 Status and Management

Little is known of the status of most false killer whale populations around the world. While the species is not considered rare, few areas of high density are known. The population found in the Gulf of Mexico is considered a separate stock from the western North Atlantic stock for management purposes; however, there are no genetic data to differentiate between the two stocks (Waring et al., 2013).

4.1.2.21.2 Habitat and Geographic Range

False killer whales occur worldwide throughout warm temperate and tropical oceans in deep open-ocean waters and around oceanic islands and only rarely come into shallow coastal waters (Baird et al., 2008; Leatherwood & Reeves, 1983; Odell & McClune, 1999). Occasional inshore movements are associated with movements of prey and shoreward flooding of warm ocean currents. False killer whales are unlikely to be found in any open ocean area.

False killer whales have been sighted in United States Atlantic waters from southern Florida to Maine (Schmidly, 1981). There are periodic records (primarily stranding) from southern Florida to Cape Hatteras dating back to 1920 (Schmidly, 1981). Few false killer whales have been sighted during shipboard or aerial surveys, but one sighting of 11 animals occurred during a shipboard survey conducted in summer 2011 (Waring et al., 2016).

Deployment of high frequency acoustic recording packages offshore of Cape Hatteras, Onslow Bay, Jacksonville and the offshore areas near Norfolk Canyon from 2009 through 2015 have resulted in zero false killer whale detections. However, deployments of marine autonomous recording units on the continental shelf, just beyond the shelf, and offshore from the shelf break off Jacksonville, Florida occurred in late 2009 and early 2010. Recordings included detections of the blackfish group of cetaceans, which includes false killer whales, along with melon-headed whales, pygmy killer whales, killer whales, and short-finned pilot whales. Blackfish were detected every day during monitoring but there were no obvious differences in the occurrence of blackfish vocalizations relative to water depth and no diel patterns were evident (Oswald et al., 2016). Since five species are combined into the blackfish category, false killer whale vocalization patterns and behaviors may have masked by the presence of other species (Oswald et al., 2016).

Sightings of this species in the northern Gulf of Mexico (i.e., United States Gulf of Mexico) occur in oceanic waters, primarily in the eastern Gulf (Maze-Foley & Mullin, 2006; Mullin & Fulling, 2004). False killer whales were seen only in the spring and summer during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000) and in the spring during vessel surveys (Mullin et al., 2004).

4.1.2.21.3 Population Trends

There are insufficient data to determine population trends for the western North Atlantic stock of false killer whales (Waring et al., 2016). A trend analysis has not been conducted for the northern Gulf of Mexico stock of false killer whales (Waring et al., 2013). Further analysis of northern Gulf of Mexico false killer whale survey data from 1991–2004 is required in order to determine whether changes in abundance have occurred over this period. Additionally, a Gulf-wide assessment of false killer whale abundance has not been made (Waring et al., 2013).

4.1.2.22 Killer Whale (*Orcinus orca*)

4.1.2.22.1 Status and Management

Although some populations of killer whales, particularly in the northwest Pacific, are extremely well studied, little is known about killer whale populations in most areas including the northwest Atlantic and Gulf of Mexico. Killer whales are apparently not highly abundant anywhere but are observed in higher concentration in Antarctic waters. For management purposes, the western North Atlantic population and Gulf of Mexico population are considered separate stocks (Waring et al., 2010, 2013; 2016).

4.1.2.22.2 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 generally most numerous in coastal waters and at higher latitudes (Dahlheim & Heyning, 1999). Killer whales are likely found in Labrador Current, Gulf Stream, and North Atlantic Gyre open ocean areas.

Killer whales are considered rare and uncommon in waters of the United States Exclusive Economic Zone in the Atlantic Ocean (Katona et al., 1988; Waring et al., 2010, 2013). During the 1978 to 1981 Cetacean and Turtle Assessment Program surveys, there were 12 killer whale sightings, which made up 0.1 percent of the 11,156 cetacean sightings in the surveys (Cetacean and Turtle Assessment Program, 1982; Waring et al., 2010, 2013). Nearshore observations are rare. Forty animals were observed in the southern Gulf of Maine in September 1979 and 29 animals in Massachusetts Bay in August 1986 (Katona et al., 1988; Waring et al., 2010).

Deployment of high frequency acoustic recording packages offshore of Cape Hatteras, Onslow Bay, Jacksonville and the offshore areas near Norfolk Canyon from 2009 through 2015 have resulted in zero killer whale detections. During the fall and winter of 2009 and 2010, passive acoustic monitoring was conducted by marine autonomous recording units deployed over the continental shelf, just beyond the shelf, and offshore from the shelf break off Jacksonville, Florida. Recordings included detections of the blackfish group of cetaceans, which includes killer whales, along with melon-headed whales, pygmy killer whales, false killer whales, and short-finned pilot whales. Blackfish were detected every day during monitoring but there were no obvious differences in the occurrence of blackfish vocalizations relative to water depth and diel patterns were not apparent (Oswald et al., 2016). Since five species are combined into the blackfish category, vocalization patterns and behaviors may have masked by the presence of other species (Oswald et al., 2016).

Sightings of killer whales in the Gulf of Mexico on surveys from 1921 to 1995 were in water depths ranging from 840 to 8,700 ft., with an average of 4,075 ft., and were most frequent in the north-central region of the Gulf of Mexico (Waring et al., 2013). Killer whales were seen only in the summer during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000), were reported from May through June during vessel surveys (Maze-Foley & Mullin, 2006; Mullin & Fulling, 2004) and recorded in May, August, September and November by earlier opportunistic ship-based sources (O'Sullivan & Mullin, 1997).

4.1.2.22.3 Population Trends

There are insufficient data to determine population trends for the western North Atlantic and Gulf of Mexico stocks of killer whales (Waring et al., 2013).

4.1.2.23 Long-Finned Pilot Whale (*Globicephala melas*)

4.1.2.23.1 Status and Management

The structure of the Western North Atlantic stock of long-finned pilot whales is uncertain (Fullard et al., 2000; International Council of the Exploration of the Sea, 1993). Morphometric (Bloch & Lastein, 1993) and genetic (Fullard et al., 2000) studies have provided little support for stock structure across the Atlantic (Fullard et al., 2000). However, Fullard et al. (2000) have proposed a stock structure that is related to sea-surface temperature: (1) a cold-water population west of the Labrador/North Atlantic Current and (2) a warm-water population that extends across the Atlantic in the Gulf Stream. The area of overlap between the long-finned and short-finned pilot whales occurs primarily along the shelf break off the coast of New Jersey between 38°N and 40°N latitude (Waring et al., 2016).

4.1.2.23.2 Habitat and Geographic Range

Long-finned pilot whales occur along the continental shelf break, in continental slope waters, and in areas of high topographic relief, inhabiting temperate and subpolar zones from North Carolina to North Africa (and the Mediterranean) and north to Iceland, Greenland and the Barents Sea (Abend & Smith, 1999; Buckland et al., 1993; Leatherwood et al., 1976). Long-finned pilot whales are likely found in the Gulf Stream and Labrador Current open ocean areas, and might be found in the North Atlantic Gyre.

In U.S. Atlantic waters, pilot whales (*Globicephala* spp.) are distributed principally along the continental shelf edge off the northeastern U.S. coast in winter and early spring, moving onto Georges Bank and into the Gulf of Maine and more northern waters in late spring (Abend & Smith, 1999; Cetacean and Turtle Assessment Program, 1982; Hamazaki, 2002; Payne & Heinemann, 1993). They remain in these areas through late autumn (Cetacean and Turtle Assessment Program, 1982; Payne & Heinemann, 1993). Pilot whales tend to occupy areas of high relief or submerged banks. They are also associated with the Gulf Stream wall and thermal fronts along the continental shelf edge. Long- and short-finned pilot whales overlap spatially along the mid-Atlantic shelf break between Cape Hatteras, North Carolina, and New Jersey (Payne & Heinemann, 1993).

4.1.2.23.3 Population Trends

A trend analysis has not been conducted for the western North Atlantic stock of long-finned pilot whales (Waring et al., 2016)

4.1.2.24 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

4.1.2.24.1 Status and Management

Studies are currently being conducted at the NMFS Southeast Fisheries Science Center to evaluate genetic population structure in short-finned pilot whales (Waring et al., 2016). The short-finned pilot whale population is managed as three stocks: Western North Atlantic stock, Puerto Rico and U.S. Virgin Islands stock, and Gulf of Mexico Oceanic stock.

4.1.2.24.2 Habitat and Geographic Range

Short-finned pilot whales range throughout warm temperate to tropical waters of the world, generally in deep offshore areas (Waring et al., 2016). Thus, the species occupies waters over the continental shelf break, in slope waters, and in areas of high topographic relief (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. Genetic analysis of stranded pilot whales, evaluated as a function of sea surface temperature and water depth, indicated that short-finned pilots whales were not likely to be found at water temperatures less than 22°C and highly likely to occur where water temperatures were greater than 25°C. Probability of a short-finned pilot whale also increased with increasing water depth. The area of overlap between short-finned and long-finned pilot whales occurs primarily along the shelf break off the coast of New Jersey between 38°N and 40°N latitude (Waring et al., 2014). Short-finned pilot whales are likely found in the Gulf Stream open ocean area.

Sightings of pilot whales (*Globicephala* spp.) in the western North Atlantic occur primarily near the continental shelf break ranging from Florida to the Nova Scotian Shelf (Mullin & Fulling, 2003). Long-finned and short-finned pilot whales overlap spatially along the mid-Atlantic shelf break between Cape Hatteras, North Carolina, and New Jersey (Payne & Heinemann, 1993).

Pilot whales are one of the most common cetacean species observed off Cape Hatteras during aerial surveys, specifically from the 100 meter isobaths out to water depths greater than 2,000 m (U.S. Department of the Navy, 2013a). Satellite tagging efforts were conducted in the summers of 2014 and 2015 in an area off Cape Hatteras. Twenty satellite tags were deployed on short-finned pilot whales in 2014 and 19 were deployed in 2015. The satellite tag study provided the first information on long-term and long-distance movements of short-finned pilot whales in the area, other than information obtained from tags on previously stranded and rehabilitated individuals. While photo-ID work suggests that short-finned pilot whales display a high degree of residence off Cape Hatteras, satellite tagging demonstrates that these animals cover a significant range up and down the continental slope, from Georges Bank in the north, down to Cape Lookout Shoals in the south, with movements at least occasionally into waters beyond the United States Exclusive Economic Zone (Baird et al., 2015, 2016a).

Deployment of high frequency acoustic recording packages offshore of Cape Hatteras, Onslow Bay, Jacksonville and the offshore areas near Norfolk Canyon from 2009 through 2015 have resulted in zero short-finned pilot whale detections. Passive acoustic data were collected from marine autonomous recording units deployed on the continental shelf, just beyond the shelf, and offshore from the shelf break off Jacksonville, Florida in late 2009 and early 2010. These deployments resulted in detections of the blackfish group of cetaceans, which includes short-finned pilot whales, along with melon-headed whales, pygmy killer whales, false killer whales, and killer whales. Blackfish were detected every day during deployments but there were no obvious or consistent differences in the occurrence of blackfish vocalizations relative to water depth or time of day (Oswald et al., 2016). The fact that five species are combined into the blackfish category may have masked any patterns in vocal behaviors (Oswald et al., 2016).

Short-finned pilot whales are also documented along the continental shelf and continental slope in the northern Gulf of Mexico (Hansen et al., 1996; Mullin & Hoggard, 2000; Mullin & Fulling, 2003), and in the Caribbean. Short-finned pilot whales were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al., 1996; Mullin & Hoggard, 2000).

4.1.2.24.3 Population Trends

A trend analysis has not been conducted for the western North Atlantic stock of short-finned pilot whales (Waring et al., 2016).

A trend analysis has not been conducted for the northern Gulf of Mexico stock of short-finned pilot whales (Waring et al., 2016). Further analysis of northern Gulf of Mexico short-finned pilot whale survey data from 1991–2004 is required in order to determine whether changes in abundance have occurred over this period. Additionally, a Gulf-wide assessment of short-finned pilot whale abundance has not been made (Waring et al., 2016).

4.1.2.25 Harbor Porpoise (*Phocoena phocoena*)

4.1.2.25.1 Status and Management

The Gulf of Maine–Bay of Fundy stock is the only stock of harbor porpoise under NMFS management within the Study Area. There are three additional harbor porpoise populations that occur within the Study Area–Gulf of St. Lawrence, Newfoundland, and Greenland (Gaskin, 1992).

4.1.2.25.2 Habitat and Geographic Range

Harbor porpoises inhabit cool temperate-to-subpolar waters, often where prey aggregations are concentrated (Watts & Gaskin, 1985). Thus, they are frequently found in shallow waters, most often near shore, but they sometimes move into deeper offshore waters. Harbor porpoises are rarely found in waters warmer than 63°F (17°C) (Read, 1999) and closely follow the movements of their primary prey, Atlantic herring (Gaskin, 1992).

Harbor porpoise would likely be found only in the Labrador Current open ocean area. In the western North Atlantic, harbor porpoise range from Cumberland Sound on the east coast of Baffin Island, south-east along the eastern coast of Labrador to Newfoundland and the Gulf of St. Lawrence, thence south-west to about 34°N on the coast of North Carolina (Waring et al., 2016). Harbor porpoise are also found in southwest Greenland. During summer (July to September), harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150 ft. deep (Gaskin, 1977; Kraus et al., 1983; Palka, 1995a; Palka, 1995b), with a few sightings in the upper Bay of Fundy and on the northern edge of Georges Bank (Palka, 2000).

They are seen from the coastline to deep waters (greater than 5,906 ft.) (Westgate et al., 1998).) (Westgate et al., 1998), although most of the population is found over the continental shelf. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada (Waring et al., 2016). Harbor porpoises sighted off the mid-Atlantic states during winter include porpoises from other western North Atlantic populations (Rosel et al., 1999). There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region (Waring et al., 2016).

LaBrecque et al. (2015b) identified a small and resident population area for harbor porpoise in the Gulf of Maine (Figure 11.2-1) based on sightings documented by NOAA Fisheries ship and aerial surveys, strandings, and animals taken incidental to fishing reported by NOAA Fisheries observers. From July to September, harbor porpoises are concentrated in waters less than 150 m deep in the northern Gulf of Maine and southern Bay of Fundy. During fall (October to December) and spring (April to June), harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south (LaBrecque et al., 2015b).

4.1.2.25.3 Population Trends

A trend analysis has not been conducted for the Gulf of Maine/Bay of Fundy stock of harbor porpoises (Palka, 2012). Since there are no population estimates available for the Gulf of St. Lawrence, Newfoundland, or Greenland stocks, trend analyses have not been conducted for these populations either (Waring et al., 2016).

4.1.3 Pinnipeds

4.1.3.1 Hooded Seal (*Cystophora cristata*)

4.1.3.1.1 Status and Management

The International Council for the Exploration of the Sea/Northwest Atlantic Fisheries Organization Working Group on Harp and Hooded Seals currently recognizes two separate stocks of hooded seals: the Northwest Atlantic and Greenland Sea stocks (International Council for the Exploration of the Sea, 2014). The western North Atlantic stock (synonymous with the Northwest Atlantic Stock) pups off the coast of eastern Canada; the whelping area for the Greenland Sea stock is in the "West Ice" near Jan Mayen Island, east of Greenland (Kovacs, 2009).

4.1.3.1.2 Habitat and Geographic Range

Hooded seals are distributed in the Arctic and the cold temperate North Atlantic Ocean (Bellido et al., 2007). At sea, hooded seals stay primarily near continental coastlines but are known to wander widely. This species follows the seasonal movement of pack ice, on which it breeds. In the Study Area, its primary range is around the Newfoundland-Labrador, West Greenland, and Scotian Shelf.

Most hooded seals occur in the western Atlantic (Stenson et al., 1996). They migrate between winter/spring pupping areas along the Canadian coast, and summer and molting areas off Greenland. The western North Atlantic stock breeds and pups at three main areas around Canada, including the Gulf of St. Lawrence, north of Newfoundland in an area that is known as the Front, and Davis Strait (Hammill et al., 1997; Jefferson et al., 2008b; Kovacs, 2008). Based on data from satellite relay data loggers deployed on hooded seals during 2004–2008, males appeared to prefer areas with complex seabed relief such as Davis Strait and the Flemish cap, whereas females preferred the Labrador Shelf (Andersen et al., 2013).

Hooded seals are highly migratory and may wander as far south as Puerto Rico (Mignucci-Giannoni & Odell, 2001), with increased occurrences from Maine to Florida. These appearances usually occur between January and May in New England waters, and in summer and autumn off the southeast United States coast and in the Caribbean (Harris et al., 2001; McAlpine et al., 1999; Mignucci-Giannoni & Odell, 2001). Six hooded seal strandings were also reported between 1975 and 1996 in North Carolina, Florida, Georgia, Puerto Rico, and the United States Virgin Islands (Mignucci-Giannoni & Odell, 2001).

4.1.3.1.3 Population Trends

The number of hooded seals in the western North Atlantic is relatively well known and is derived from pup production estimates produced from pack-ice whelping pack surveys. Available data are insufficient to determine a population estimate for United States waters (Waring et al., 2007); thus, population trends are also unknown.

4.1.3.2 Harp Seal (*Pagophilus groenlandicus*)

4.1.3.2.1 Status and Management

Three distinct populations or stocks of harp seals are generally recognized, including one in the Barents Sea that breeds on the "East Ice" in the White Sea, a population off eastern Greenland that breeds on the "West Ice" near Jan Mayen, and a third population in the northwest Atlantic off eastern Canada (Lavigne, 2008). The Western North Atlantic stock is the largest and is divided into two breeding herds: the Front herd, which breeds off the coast of Newfoundland and Labrador, and the Gulf herd, which breeds near the Magdalen Islands in the Gulf of St. Lawrence (Reeves et al., 2002b; Waring et al., 2004; Waring et al., 2014).

4.1.3.2.2 Habitat and Geographic Range

The primary range of harp seals is throughout the Arctic, but the secondary range includes the western waters of the Scotian Shelf and the Northeast United States Continental Shelf. Harp seals are closely associated with drifting pack ice, where they breed, molt, and forage in the surrounding waters (Lydersen & Kovacs, 1993; Ronald & Healey, 1981). Harp seals make extensive movements over much of the continental shelf within their winter range in the waters off Newfoundland (Bowen & Siniff, 1999).

Typically, harp seals are distributed in the pack ice of the North Atlantic segment of the Arctic Ocean and through Newfoundland and the Gulf of St. Lawrence (Reeves et al., 2002b). Most western North Atlantic harp seals congregate off the east coast of Newfoundland-Labrador (the Front) to pup and breed; the remainder (the Gulf herd) gathers to pup near the Magdalen Islands in the Gulf of St. Lawrence (Morissette et al., 2006; Ronald & Dougan, 1982).

The number of sightings and strandings of harp seals off the northeastern United States has been increasing since the 1990s, based on records from Maine to New Jersey, primarily during the months of January to May (Harris et al., 2002; McAlpine & Walker, 1999). A few sightings and strandings are also reported annually for Virginia and North Carolina (Lloyd, 2015; Soulen et al., 2013; Swingle et al., 2016). An increase in strandings along the United States East Coast has been correlated with poor ice conditions in the Gulf of St. Lawrence whelping area (Soulen et al., 2013). Harp seals occasionally enter the Bay of Fundy, but McAlpine and Walker (1999) suggested that winter ocean surface currents might limit the probability of occurrences in the Bay of Fundy.

4.1.3.2.3 Population Trends

Currently available data are insufficient to determine a minimum population estimate for United States waters (Waring et al., 2013); thus, population trends are also unknown.

4.1.3.3 Gray Seal (*Halichoerus grypus*)

4.1.3.3.1 Status and Management

There are three main populations of gray seal in the North Atlantic, including eastern Canada, northwestern Europe, and the Baltic Sea (Katona et al., 1993; Waring et al., 2010; Waring et al., 2016). These stocks are separated by geography, different breeding seasons, and genetic variation (Waring et al., 2010). In eastern Canada there are three major breeding areas: Sable Island, the pack ice in the Gulf of St. Lawrence, and the coast of Nova Scotia (Laviguer & Hammill, 1993).

4.1.3.3.2 Habitat and Geographic Range

The Western North Atlantic stock corresponds to the eastern Canada population, ranging from New Jersey to Labrador (Waring et al., 2016). This gray seal population is centered in the Canadian Maritimes, including the Gulf of St. Lawrence and the Atlantic coasts of Nova Scotia, Newfoundland, and Labrador. In the Study Area, the primary range of this species includes the northwestern waters of the Newfoundland-Labrador Shelf, the Scotian Shelf, and the Northeast United States Continental Shelf (Davies, 1957; Hall & Thompson, 2008).

The gray seal is considered a coastal species and may forage far from shore but does not appear to leave the continental shelf regions (Lesage & Hammill, 2001). Gray seals haul out on land-fast ice, exposed reefs, or beaches of undisturbed islands (Hall & Thompson, 2008; Lesage & Hammill, 2001). Remote uninhabited islands tend to have the largest gray seal haul-outs (Reeves et al., 1992).

The Canadian population is divided into three groups for management purposes: Sable Island, Gulf of St. Lawrence, and Coastal Nova Scotia (Hammill et al., 2014). The largest pupping site of gray seals in the world is located at Sable Island (Bowen et al., 2007). In the Gulf of St. Lawrence, gray seals pup on the pack-ice (Davies, 1957; Hammill & Gosselin, 1995; Hammill et al., 1998); this is second largest breeding colony in eastern Canada (Hammill et al., 2014). Smaller numbers of seals pup on islands along the coast of Nova Scotia (Hammill et al., 2014).

Gray seals range south into the northeastern United States, with strandings and sightings as far south as North Carolina (Hammill et al., 1998; Waring et al., 2004). Gray seal distribution along the United States Atlantic coast has shifted in recent years, with an increased number of seals reported in southern New England (Kenney, 2014; Waring et al., 2016). Recent sightings included a gray seal in lower Chesapeake Bay during the winter of 2014–2015 (Rees et al., 2016). Along the coast of the United States, gray seals are known to pup at three or more colonies, including Muskeget Island, Massachusetts, which is the southernmost breeding site (Rough, 1995; Waring et al., 2004), and Green and Seal Islands, Maine (Waring et al., 2016). Pupping has also been reported at Matinicus Rock and Mount Desert Rock in Maine (Waring et al., 2016). Gray seals are observed in New England outside of the pupping season on Muskeget Island and Monomoy and locations along the shoreline between southern Maine and Woods Hole, Massachusetts.

4.1.3.3.3 Population Trends

Gray seal abundance is likely increasing in the United States waters, but the rate of increase is unknown (Waring et al., 2016). Single-day pup counts at three United States established colonies detected an increase from the 2001-2002 through the 2007-2008 pupping season (Wood LaFond, 2009). However, no recent surveys or modeling of gray seal abundance in United States Atlantic waters are available (Waring et al., 2016).

4.1.3.4 Harbor Seal (*Phoca vitulina*)

4.1.3.4.1 Status and Management

Western Atlantic harbor seals (*P. v. concolor*) that occur along the coast of the eastern United States and Canada represent a single population (Temte et al., 1991; Waring et al., 2010; Waring et al., 2016).

4.1.3.4.2 Habitat and Geographic Range

The harbor seal is one of the most widely distributed seals, found in temperate to polar coastal waters of the northern hemisphere (Jefferson et al., 2008b; Jefferson et al., 2015). Harbor seals occur in nearshore waters and are rarely found more than 20 km from shore; they frequently occupy bays, estuaries, and inlets (Baird, 2001). Individual seals have been observed several kilometers upstream in coastal rivers (Baird, 2001). Haul-out sites vary but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, and even peat banks in salt marshes (Burns, 2008; Gilbert & Guldager, 1998; Prescott, 1982; Schneider & Payne, 1983; Wilson, 1978). Harbor seals occur in the cold and temperate nearshore waters of the northwest Atlantic, typically north of 35° N (Waring et al., 2016). In the Study Area, their approximate year-round coastal range includes the Gulf of St. Lawrence, Scotian Shelf, Gulf of Maine, Bay of Fundy, and northeast United States continental shelf down to the Virginia/North Carolina border.

Harbor seals are found year-round in the coastal waters of eastern Canada and Maine; from September to May they also occur from southern New England to New Jersey (Katona et al., 1993; Waring et al., 2010). A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter (Barlas, 1999; Jacobs & Terhune, 2000; Rosenfeld et al., 1988; Whitman & Payne, 1990). A northward movement from southern New England to Maine and eastern Canada occurs before the pupping season, which takes place from mid-May through June along the Maine coast (DeHart, 2002; Kenney, 1994; Richardson et al., 1995; Whitman & Payne, 1990; Wilson, 1978). In northeastern United States, breeding and pupping normally occur north of the New Hampshire and Maine borders, although breeding has been recorded historically as far south as Cape Cod (Katona et al., 1993; Waring et al., 2010). Several thousand seals overwinter between New Hampshire and Massachusetts (Waring et al., 2010).

Harbor seal distribution along the United States Atlantic coast has shifted in recent years, with an increased number of seals reported in southern New England to the mid-Atlantic region (Kenney, 2014; Waring et al., 2016). During systematic land-based counts by the United States Navy during 2014–2015 near Naval Station Newport, Narragansett Bay, harbor seals were observed on 24 out of 46 survey days; the average number hauled out was 15, but as many as 44 seals were hauled out on April 16, 2015 (Rees et al., 2016). In addition, 112 locations with harbor seal occurrences were recorded for Rhode Island during 1992–2013 by Save the Bay (Rees et al., 2016). Winter haul-out sites for a small number of seals (less than 50) have also been reported for Chesapeake Bay and near Oregon Inlet, North Carolina (Waring et al., 2016). During land-based counts in lower Chesapeake Bay from November 2014 to May 2015, 112 occurrences were recorded at four different haul-out sites during 12 survey days; peak numbers were recorded during March (Rees et al., 2016). Follow-up surveys in the lower Chesapeake Bay were conducted between October 2015 to May 2016 and resulted in 184 harbor seal sightings between December 2015 and April 2016; similar to the 2014–2015 season, the highest counts were recorded in the months of February and March (Rees et al., 2016). Surveys were also conducted in Narragansett Bay between November 2015 and April 2016 and similar to the 2014–2015 season, the highest counts were recorded in the months of February and March with peak numbers observed in March (Rees et al., 2016). Many strandings were reported for the coast of Virginia (Lockhart, 2013). South of Oregon Inlet, North Carolina rare sightings and strandings were recorded as far south as Florida (Waring et al., 2013; Waring et al., 2016).

4.1.3.4.3 Population Trends

The number of harbor seals in United States Atlantic waters increased since the 1980s to 2010 (Waring et al., 2010). The current population trend is unknown, but it is possible that the population along the Maine coast may be declining (Waring et al., 2009). A trend analysis has not been conducted for the Western North Atlantic stock (Waring et al., 2017).

5 TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

The United States Department of the Navy (Navy) requests regulations and two Letters of Authorization for the take of marine mammals incidental to proposed activities in the AFTT 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 (PL 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 (PL 107-314). Military training and testing activities within the AFTT Study Area are composed of military readiness activities as that term is defined in PL 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 6.4.2.1.1.2 (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 AFTT 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/extraction)
- **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 AFTT 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, 2017a). 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 PTS to 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 AFTT Study Area from Navy training and testing activities is presented in Chapter 6 (Take Estimates for Marine Mammals). Based on the model results and post-model analysis described in Chapter 6, Table 1.5-1 summarizes the Navy's take request from acoustic and explosive sources for training and testing activities annually (based on the maximum number of activities per 12-month period) and the summation over a 5-year period. Table 5.1-2 summarizes the Navy's take request for individual small and large ship shock trials and the take that could occur over a 5-year period for all ship shock activities. Table 5.1-3 through Table 5.1-5 display the takes by species associated with all training, testing, and ship shock activities.

Table 5.1-1: Summary of Annual and 5-Year Take Request from Acoustic and Explosive Sources for AFTT Training and Testing Activities (Excluding Ship Shock Trials)

MMPA Category	*Source*	*Annual Authorization Sought*		*5-Year Authorization Sought*	
		Training Activities[1]	*Testing Activities*[2]	*Training Activities*	*Testing Activities*[2]
Mortality	Explosive	None	None	None	None
Level A	Acoustic & Explosive	262	365	1,301	1,731
Level B	Acoustic & Explosive	1,419,677	1,524,455	6,808,185	7,149,884

[1] Take estimates for acoustic and explosive sources for training activities are based on the maximum number of activities in a 12-month period. Species specific information shown in Table 5.1-3.

[2] Take estimates for acoustic and explosive sources for testing activities are based on the maximum number of activities in a 12-month period (excluding ship shock trials). Species specific information shown in Table 5.1-4.

Table 5.1-2: Summary of Small, Large, and 5-Year Take Request from Explosions Used During the AFTT Ship Shock Trials

MMPA Category[1]	*Small Ship Shock Authorization Sought*[2]	*Large Ship Shock Authorization Sought*	*5-Year Authorization Sought*
Mortality	1	6	9
Level A	193	529	1,117
Level B	394	840	2,022

[1] Species specific shown Table 5.1-5.

[2] Based on a single event during the 5-year authorizations 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 modeled potential exposures to acoustic and explosive sources from training and testing activities within the AFTT Study Area. Table 5.1-3 summarizes the Navy's take request (exposures which may lead to Level B harassment and exposures which may lead to 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 acoustic and explosive effects modeling. No mortalities are requested under training activities.

Table 5.1-3: 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 Balaenidae (right whales)					
North Atlantic right whale*	Western North Atlantic	246	0	1,176	0
Family Balaenopteridae (roquals)					
Blue whale*	Western North Atlantic (Gulf of St. Lawrence)	26	0	121	0
Bryde's whale	Northern Gulf of Mexico	207	0	965	0
Minke whale	Canadian East Coast	2,425	0	11,262	0
Fin whale*	Western North Atlantic	1,498	3	7,295	13
Humpback whale	Gulf of Maine	232	1	1,116	3
Sei whale*	Nova Scotia	292	0	1,400	0
Suborder Odontoceti (toothed whales)					
Family Physeteridae (sperm whale)					
Sperm whale*	Gulf of Mexico Oceanic	24	0	118	0
	North Atlantic	14,084	0	68,839	0
Family Kogiidae (sperm whales)					
Dwarf sperm whale	Gulf of Mexico Oceanic	14	0	71	0
	Western North Atlantic	8,527	10	39,914	48
Pygmy sperm whale	Northern Gulf of Mexico	14	0	71	0
	Western North Atlantic	8,527	10	39,914	48
Family Ziphiidae (beaked whales)					
Blainville's beaked whale	Northern Gulf of Mexico	35	0	173	0
	Western North Atlantic	12,532	0	61,111	0
Cuvier's beaked whale	Northern Gulf of Mexico	34	0	172	0
	Western North Atlantic	46,401	0	226,286	0
Gervais' beaked whale	Northern Gulf of Mexico	35	0	173	0
	Western North Atlantic	12,532	0	61,111	0

Species	*Stock*	*Annual*		*5-Year Total*	
		Level B	*Level A*	*Level B*	*Level A*
Northern bottlenose whale	Western North Atlantic	1,074	0	5,360	0
Sowersby's beaked whale	Western North Atlantic	12,532	0	61,111	0
True's beaked whale	Western North Atlantic	12,532	0	61,111	0
Family Delphinidae (dolphins)					
Atlantic spotted dolphin	Northern Gulf of Mexico	951	0	4,710	0
	Western North Atlantic	117,458	9	570,940	45
Atlantic white-sided dolphin	Western North Atlantic	14,493	1	71,050	3
Bottlenose dolphin	Choctawhatchee Bay	7	0	33	0
	Gulf of Mexico Eastern Coastal	42	0	125	0
	Gulf of Mexico Northern Coastal	218	0	1,088	0
	Gulf of Mexico Western Coastal	4,148	0	12,568	0
	Indian River Lagoon Estuarine System	283	0	1,414	0
	Jacksonville Estuarine System	84	0	421	0
	Mississippi Sound, Lake Borgne, Bay Boudreau	0	0	0	0
	Northern Gulf of Mexico Continental Shelf	1,560	2	7,798	9
	Northern Gulf of Mexico Oceanic	194	0	969	0
	Northern North Carolina Estuarine System	3,221	0	11,798	0
	Southern North Carolina Estuarine System	0	0	0	0
	Western North Atlantic Northern Florida Coastal	906	0	4,323	0
	Western North Atlantic Central Florida Coastal	5,341	0	25,594	0

Species	*Stock*	*Annual*		*5-Year Total*	
		Level B	*Level A*	*Level B*	*Level A*
	Western North Atlantic Northern Migratory Coastal	25,188	4	125,183	19
	Western North Atlantic Offshore	308,206	39	1,473,308	193
	Western North Atlantic South Carolina/Georgia Coastal	4,328	0	20,559	0
	Western North Atlantic Southern Migratory Coastal	12,493	2	58,061	10
Clymene dolphin	Northern Gulf of Mexico	99	0	495	0
	Western North Atlantic	69,773	3	330,027	13
False killer whale	Northern Gulf of Mexico	41	0	207	0
	Western North Atlantic	8,270	0	39,051	0
Fraser's dolphin	Northern Gulf of Mexico	59	0	296	0
	Western North Atlantic	3,930	0	18,633	0
Killer whale	Northern Gulf of Mexico	1	0	4	0
	Western North Atlantic	78	0	372	0
Long-finned pilot whale	Western North Atlantic	17,040	0	83,050	0
Melon-headed whale	Northern Gulf of Mexico	70	0	352	0
	Western North Atlantic	37,156	1	175,369	3
Pantropical spotted dolphin	Northern Gulf of Mexico	565	0	2,827	0
	Western North Atlantic	145,125	2	686,775	10
Pygmy killer whale	Northern Gulf of Mexico	16	0	82	0
	Western North Atlantic	6,482	0	30,639	0
Risso's dolphin	Northern Gulf of Mexico	39	0	197	0
	Western North Atlantic	21,033	0	100,018	0

Species	*Stock*	*Annual*		*5-Year Total*	
		Level B	*Level A*	*Level B*	*Level A*
Rough-toothed dolphin	Northern Gulf of Mexico	97	0	434	0
	Western North Atlantic	19,568	0	92,313	0
Short-beaked common dolphin	Western North Atlantic	218,145	12	1,046,192	61
Short-finned pilot whale	Northern Gulf of Mexico	36	0	179	0
	Western North Atlantic	31,357	0	150,213	0
Spinner dolphin	Northern Gulf of Mexico	227	0	1,136	0
	Western North Atlantic	73,691	1	347,347	6
Striped dolphin	Northern Gulf of Mexico	67	0	336	0
	Western North Atlantic	91,038	3	451,001	13
White-beaked dolphin	Western North Atlantic	39	0	192	0
Family Phocoenidae (porpoises)					
Harbor porpoise	Gulf of Maine/Bay of Fundy	29,789	161	147,289	802
Suborder Pinnipedia					
Family Phocidae (true seals)					
Gray seal	Western North Atlantic	1,443	0	7,172	0
Harbor seal	Western North Atlantic	2,341	0	11,631	0
Harp seal	Western North Atlantic	8,444	1	42,188	4
Hooded seal	Western North Atlantic	128	0	631	0

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

† NSD: No stock designated

5.1.2 Incidental Take Request from Acoustic and Explosive Sources for Testing Activities

Table 5.1-4 summarizes the Navy's take request (exposures which may lead to Level B harassment and exposures which may lead to Level A harassment) for testing activities (excluding ship shock trials) 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.

Table 5.1-4: Species Specific Take Requests from Modeling Estimates of Acoustic and Explosive Source Effects for All Testing Activities (Excluding Ship Shock Trials)

Species	Stock	Annual		5-Year Total	
		Level B	Level A	Level B	Level A
Suborder Mysticeti (baleen whales)					
Family Balaenidae (right whales)					
North Atlantic right whale*	Western North Atlantic	339	0	1,667	0
Family Balaenopteridae (roquals)					
Blue whale*	Western North Atlantic (Gulf of St. Lawrence)	20	0	97	0
Bryde's whale	Northern Gulf of Mexico	177	0	870	0
Minke whale	Canadian East Coast	1,616	1	7,971	7
Fin whale*	Western North Atlantic	3,868	3	18,781	16
Humpback whale	Gulf of Maine	493	0	2,412	0
Sei whale*	Nova Scotia	502	0	2,431	0
Suborder Odontoceti (toothed whales)					
Family Physeteridae (sperm whale)					
Sperm whale*	Gulf of Mexico Oceanic	1,106	0	5,237	0
	North Atlantic	11,296	0	51,752	0
Family Kogiidae (sperm whales)					
Dwarf sperm whale	Gulf of Mexico Oceanic	728	6	3,424	27
	Western North Atlantic	4,383	14	21,159	65
Pygmy sperm whale	Northern Gulf of Mexico	728	6	3,424	27
	Western North Atlantic	4,383	14	21,159	65
Family Ziphiidae (beaked whales)					
Blainville's beaked whale	Northern Gulf of Mexico	1,392	0	6,710	0
	Western North Atlantic	10,565	0	49,646	0

Species	Stock	Annual		5-Year Total	
		Level B	Level A	Level B	Level A
Cuvier's beaked whale	Northern Gulf of Mexico	1,460	0	6,987	0
	Western North Atlantic	38,780	0	182,228	0
Gervais' beaked whale	Northern Gulf of Mexico	1,392	0	6,710	0
	Western North Atlantic	10,565	0	49,646	0
Northern bottlenose whale	Western North Atlantic	971	0	4,485	0
Sowersby's beaked whale	Western North Atlantic	10,593	0	49,764	0
True's beaked whale	Western North Atlantic	10,593	0	49,764	0
Family Delphinidae (dolphins)					
Atlantic spotted dolphin	Northern Gulf of Mexico	71,883	2	333,793	12
	Western North Atlantic	109,582	11	504,537	50
Atlantic white-sided dolphin	Western North Atlantic	31,780	1	150,063	6
Bottlenose dolphin	Choctawhatchee Bay	966	0	4,421	0
	Gulf of Mexico Eastern Coastal	0	0	0	0
	Gulf of Mexico Northern Coastal	16,258	1	76,439	5
	Gulf of Mexico Western Coastal	3,677	0	18,036	0
	Indian River Lagoon Estuarine System	3	0	14	0
	Jacksonville Estuarine System	3	0	13	0
	Mississippi Sound, Lake Borgne, Bay Boudreau	1	0	3	0
	Northern Gulf of Mexico Continental Shelf	125,941	8	594,921	39
	Northern Gulf of Mexico Oceanic	14,448	1	67,243	5
	Northern North Carolina Estuarine System	107	0	533	0
	Southern North Carolina Estuarine System	0	0	0	0

Species	Stock	Annual		5-Year Total	
		Level B	Level A	Level B	Level A
	Western North Atlantic Northern Florida Coastal	328	0	1,613	0
	Western North Atlantic Central Florida Coastal	2,273	0	10,950	0
	Western North Atlantic Northern Migratory Coastal	11,854	3	56,321	14
	Western North Atlantic Offshore	119,880	24	566,572	115
	Western North Atlantic South Carolina/Georgia Coastal	1,632	0	8,017	0
	Western North Atlantic Southern Migratory Coastal	4,221	0	20,828	0
Clymene dolphin	Northern Gulf of Mexico	4,164	0	19,919	0
	Western North Atlantic	35,985	2	170,033	7
False killer whale	Northern Gulf of Mexico	1,931	0	9,116	0
	Western North Atlantic	3,766	0	17,716	0
Fraser's dolphin	Northern Gulf of Mexico	1,120	0	5,314	0
	Western North Atlantic	1,293	0	6,069	0
Killer whale	Northern Gulf of Mexico	32	0	150	0
	Western North Atlantic	42	0	188	0
Long-finned pilot whale	Western North Atlantic	20,502	2	94,694	6
Melon-headed whale	Northern Gulf of Mexico	3,058	0	14,544	0
	Western North Atlantic	16,688	1	78,545	4
Pantropical spotted dolphin	Northern Gulf of Mexico	25,929	1	121,468	4
	Western North Atlantic	77,450	4	355,889	17
Pygmy killer whale	Northern Gulf of Mexico	719	0	3,415	0

Species	Stock	Annual		5-Year Total	
		Level B	Level A	Level B	Level A
	Western North Atlantic	2,848	0	13,427	0
Risso's dolphin	Northern Gulf of Mexico	1,649	0	7,817	0
	Western North Atlantic	20,071	1	94,009	6
Rough-toothed dolphin	Northern Gulf of Mexico	3,927	0	18,493	0
	Western North Atlantic	8,766	0	41,492	0
Short-beaked common dolphin	Western North Atlantic	353,012	16	1,675,885	71
Short-finned pilot whale	Northern Gulf of Mexico	1,823	0	8,613	0
	Western North Atlantic	17,002	1	80,576	6
Spinner dolphin	Northern Gulf of Mexico	7,815	0	36,567	0
	Western North Atlantic	33,350	2	157,241	7
Striped dolphin	Northern Gulf of Mexico	2,447	0	11,700	0
	Western North Atlantic	102,047	5	465,392	21
White-beaked dolphin	Western North Atlantic	44	0	213	0
Family Phocoenidae (porpoises)					
Harbor porpoise	Gulf of Maine/Bay of Fundy	135,221	230	627,215	1,093
Suborder Pinnipedia					
Family Phocidae (true seals)					
Gray seal	Western North Atlantic	899	2	4,375	9
Harbor seal	Western North Atlantic	1,496	5	7,095	16
Harp seal	Western North Atlantic	7,791	0	38,273	11
Hooded seal	Western North Atlantic	782	0	3,805	0

* ESA-listed species (all stocks) within the AFTT Study Area
†NSD: No stock designated

Table 5.1-5 summarizes the Navy's take request (level B, A, and Mortality) for ship shock trials under testing activities per small and large ship shock events and the summation over a 5-year period.

Table 5.1-5: Species Specific Take Requests from Modeling Estimates of Ship Shock Trials

Species	*Small Ship Shock*			*Large Ship Shock*			*5-Year Total*		
	Level B	*Level A*	*Mortality*	*Level B*	*Level A*	*Mortality*	*Level B*	*Level A*	*Mortality*
Suborder Mysticeti (baleen whales)									
Family Balaenidae (right whales)									
North Atlantic right whale*	1	0	0	2	0	0	5	0	0
Family Balaenopteridae (roquals)									
Blue whale*	1	0	0	1	0	0	1	0	0
Bryde's whale	3	0	0	6	1	0	15	1	0
Minke whale	19	1	0	39	3	0	96	6	0
Fin whale*	131	3	0	234	27	0	627	36	0
Humpback whale	8	0	0	20	2	0	44	2	0
Sei whale*	12	1	0	27	4	0	63	7	0
Suborder Odontoceti (toothed whales)									
Family Physeteridae (sperm whale)									
Sperm whale*	1	1	0	3	4	0	6	7	0
Family Kogiidae (sperm whales)									
Dwarf sperm whale	46	28	0	91	70	0	229	154	0
Pygmy sperm whale	46	28	0	91	70	0	229	154	0
Family Ziphiidae (beaked whales)									
Blainville's beaked whale	1	0	0	1	1	0	4	1	0
Cuvier's beaked whale	2	1	0	2	3	0	8	6	0
Gervais' beaked whale	1	0	0	1	1	0	4	1	0
Northern bottlenose whale	0	0	0	0	0	0	0	0	0
Sowersby's beaked whale	1	0	0	1	1	0	4	1	0
True's beaked whale	1	0	0	1	1	0	4	1	0
Family Delphinidae (dolphins)									
Atlantic spotted dolphin	6	4	0	8	12	0	26	24	0
Atlantic white-sided dolphin	1	1	0	3	9	1	6	13	1
Bottlenose dolphin	13	10	0	16	24	0	55	54	0

Species	Small Ship Shock			Large Ship Shock			5-Year Total		
	Level B	Level A	Mortality	Level B	Level A	Mortality	Level B	Level A	Mortality
Clymene dolphin	2	5	0	9	8	0	15	23	0
False killer whale	0	0	0	2	1	0	2	1	0
Fraser's dolphin	0	0	0	2	3	0	2	3	0
Killer whale	0	0	0	0	0	0	0	0	0
Long-finned pilot whale	2	2	0	5	6	0	11	12	0
Melon-headed whale	1	1	0	5	4	0	8	7	0
Pantropical spotted dolphin	2	3	0	25	20	1	31	30	1
Pygmy killer whale	0	0	0	1	1	0	1	1	0
Risso's dolphin	1	1	0	3	1	0	6	4	0
Rough-toothed dolphin	1	0	0	3	2	0	6	2	0
Short-beaked common dolphin	40	51	1	67	107	3	187	266	6
Short-finned pilot whale	2	2	0	4	5	0	10	11	0
Spinner dolphin	3	1	0	37	45	1	46	49	1
Striped dolphin	4	8	0	10	12	0	22	36	0
White-beaked dolphin	0	0	0	0	0	0	0	0	0
Family Phocoenidae (porpoises)									
Harbor porpoise	43	41	0	120	81	0	249	204	0
Suborder Pinnipedia									
Family Phocidae (true seals)									
Gray seal	0	0	0	0	0	0	0	0	0
Harbor seal	0	0	0	0	0	0	0	0	0
Harp seal	0	0	0	0	0	0	0	0	0
Hooded seal	0	0	0	0	0	0	0	0	0

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

†NSD: No stock designated

5.2 Incidental Take Request from Vessel Strikes

A detailed analysis of strike data is contained in Section 6.6, Estimated Numbers and Species Taken 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 probabilities of whale strikes suggested by an analysis of past strike data and anticipated future vessel movements provided in Section 6.6 (Estimated Numbers and Species Taken by Vessel Strike) of this application, the Navy requests authorization for take of three (3) marine mammals by injury or mortality, resulting from vessel strike incidental to the training and testing activities combined, within any portion of the AFTT Study Area over the course of the 5 years of the regulations. Because of the number of incidents in which the struck animal has remained unidentified to species, the Navy cannot quantifiably predict that the proposed takes will be of any particular species, and therefore seeks take authorization for any combination of the following marine mammal stocks in the AFTT study area:

- Gulf of Maine humpback
- Western North Atlantic Fin whale
- Nova Scotia sei whale
- Canadian East Coast minke whale
- Northwest Atlantic blue whale
- North Atlantic sperm whale
- Gulf of Mexico sperm whale

Based on the broad distribution of training and testing activities and the relative distribution and abundances of large whale species within the AFTT study area, it is anticipated that vessel strikes would not exceed two (2) from any individual stock.

In addition to procedural mitigation, the Navy will implement measures in mitigation areas used by North Atlantic right whales for foraging, calving, and migration (Chapter 11, Mitigation Measures). These measures (e.g., funding of and communication with sightings systems, implementation of speed reductions during applicable circumstances in certain areas) have helped the Navy avoid striking a North Atlantic right whale during training and testing activities in the past; and therefore, are likely to eliminate the potential for future strikes to occur.

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 45 marine mammal species known to exist in the Study Area that are managed by NMFS (Table 3.1-1). 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., 2007; 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 AFTT EIS. 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, temporary changes in biologically important behaviors, avoidance of a sound source or area, to aggression or prolonged flight.

Figure 6.2-1 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, as used here, includes 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.

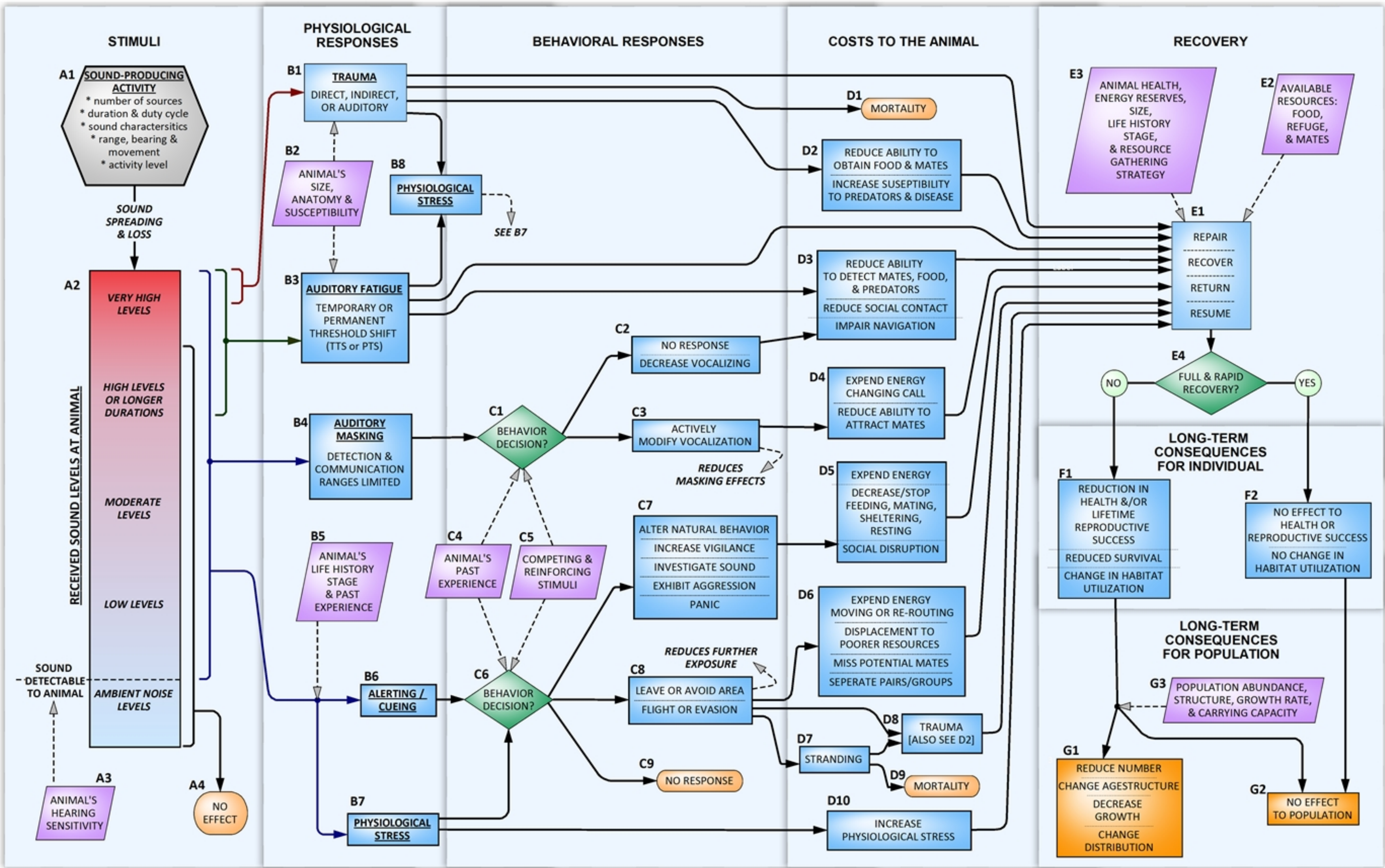


Figure 6.2-1: Flow Chart of the Evaluation Process of Sound-Producing Activities

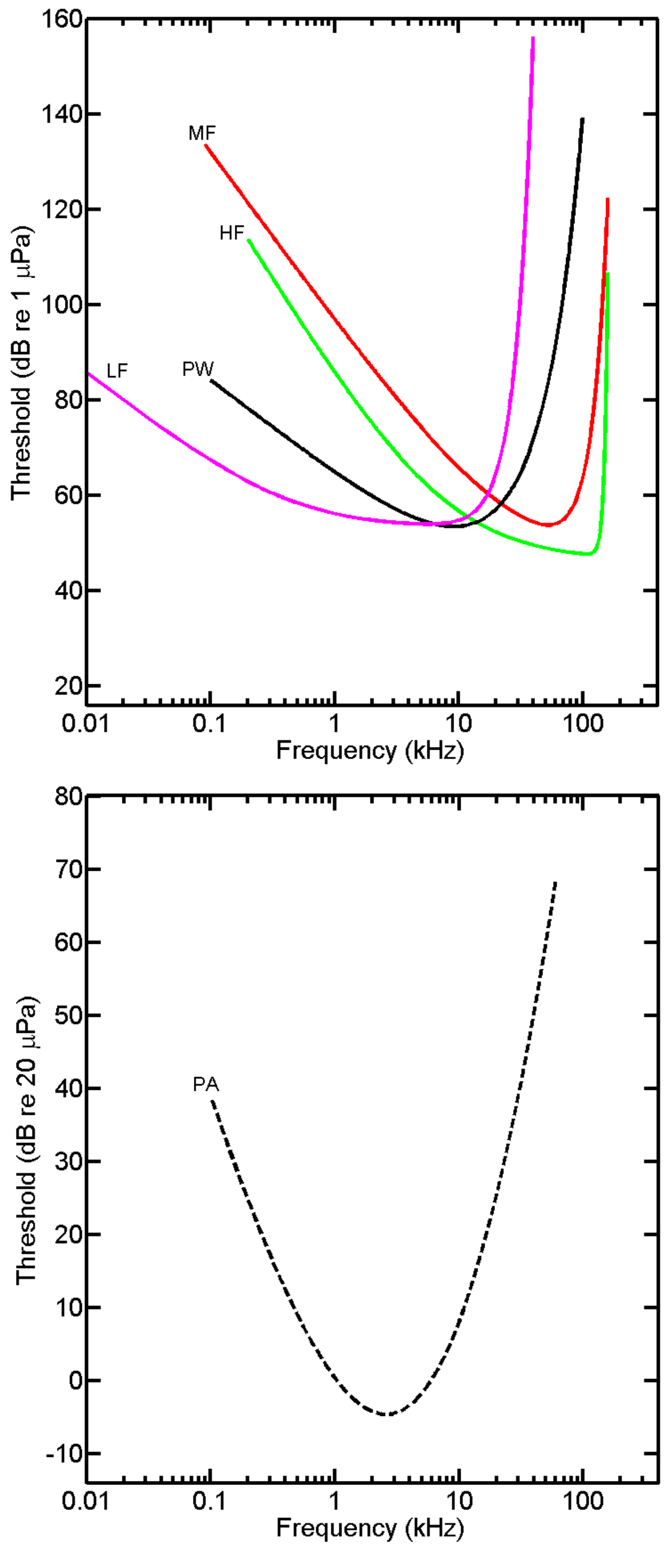
6.3 Hearing and Vocalization of Marine Mammals

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 cetaceans, it is narrow and sealed with wax and debris, and external pinnae are absent (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, which are 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 (Finneran et al., 2016). For marine mammal species for which access is limited and therefore psychophysical or auditory evoked potential measurements are 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 6.3-1 summarizes hearing capabilities for marine mammal species in the Study Area. 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 hearing sensitivity between groups, as opposed to conventions used to describe active sonar systems. For analyses, a single representative composite audiogram (see Figure 6.3-1) 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* (U.S. Department of the Navy, 2017d). 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).



Source: Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects (U.S. Department of the Navy, 2017d)
Note: For hearing in the water (left) and in air (right, phocids only).
LF = low frequency, MF = mid-frequency, HF = high frequency, PW = phocids in water, PA = phocids in air

Figure 6.3-1: Composite Audiograms for Hearing Groups Likely to be Found in the Study Area

Table 6.3-1: Species in Marine Mammal Hearing Groups Potentially Within the Study Area

Hearing Group	*Species in the Study Area*
High-frequency cetaceans	Dwarf sperm whale
	Harbor porpoise
	Pygmy sperm whale
Mid-frequency cetaceans	Atlantic spotted dolphin
	Atlantic white-sided dolphin
	Beluga whale
	Bottlenose dolphin
	Clymene dolphin
	Common dolphin
	False killer whale
	Fraser’s dolphin
	Gervais’ beaked whale
	Killer whale
	Long-finned pilot whale
	Melon-headed whale
	Narwhal
	Northern bottlenose whale
	Pantropical spotted dolphin
	Pygmy killer whale
	Risso’s dolphin
	Rough-toothed dolphin
	Short-finned pilot whale
	Sowerby’s beaked whale
	Sperm whale
	Spinner dolphin
	Striped dolphin
	True’s beaked whale
	White-beaked dolphin
Low-frequency cetaceans	Bowhead whale
	Blue whale
	Bryde’s whale
	Fin whale
	Humpback whale
	Minke whale
	North Atlantic right whale
	Sei whale
Phocids	Gray seal
	Harbor seal
	Harp seal
	Hooded seal

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 (kHz). Of particular note are the very low-frequency calls of mysticete whales that range from tens of hertz (Hz) to several kHz, and have source levels of 150 to 200 dB referenced to 1 micropascal (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, 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 (50–200 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 & 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).

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., 2007; 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 Acoustic and Explosive Activities (Section 6.2, Conceptual Framework for Assessing Effects from Acoustic Explosive Sources). 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 either be 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 6.4.1.6, Stranding). 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 Acoustic and Explosive Activities (see Section 6.2, Conceptual Framework for Assessing Effects from Acoustic Explosive Sources) 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 utilized by the mid-frequency sonar systems associated with the Bahamas event or any sonar systems used by the U.S. Navy. Furthermore, air cavity vibrations, even at resonant frequencies, were not considered to be of sufficient amplitude to cause tissue damage, even under an 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, 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).

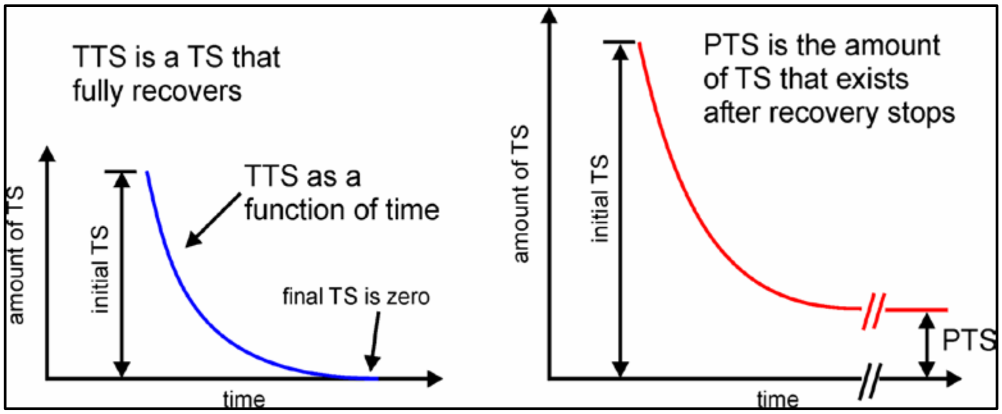
6.4.1.2 Hearing Loss and Auditory Injury

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.

The Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (see Section 6.2, Conceptual Framework for Assessing Effects from Acoustic Explosive Sources) 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.

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). Figure 6.4-1 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 hr, the TTS measured after 2 min would have likely been 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.



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

Figure 6.4-1: 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., 2014b; 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; Kastelein et al., 2014c; 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 Impacts to Marine Mammals and Sea Turtles* technical report (U.S. Department of the Navy, 2017d), 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 TTS 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 µPa2s. 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 µPa2s, 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 µPa2s, 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 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.

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, 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 gray 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.

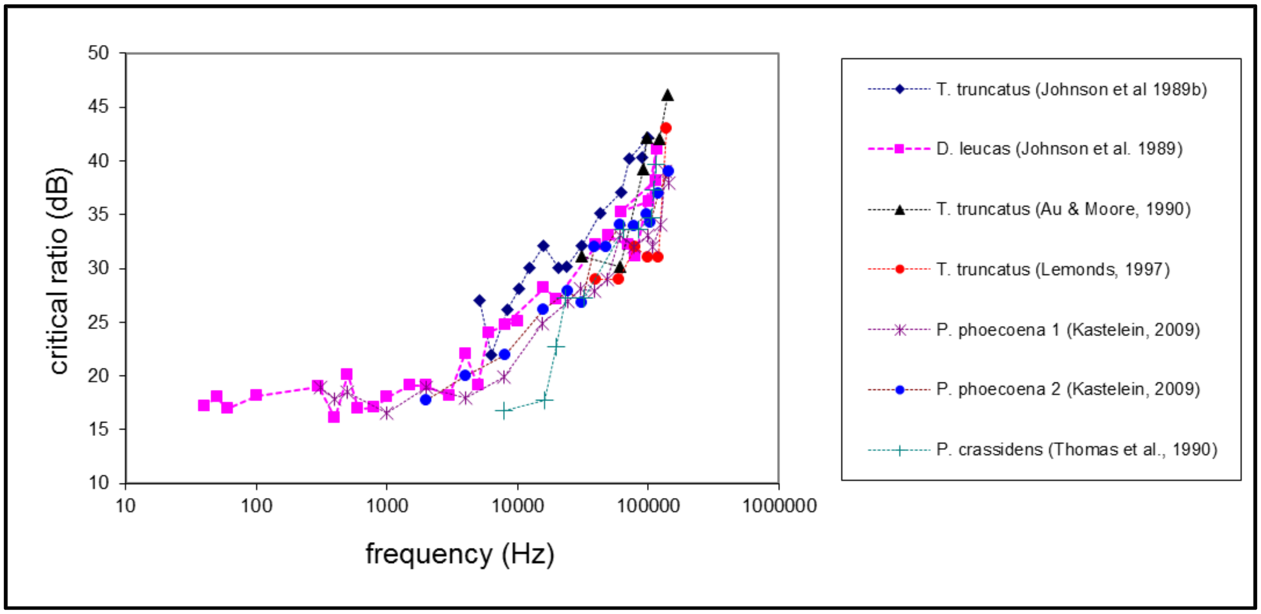
Whereas a limited amount of work has addressed the potential for acute sound exposures to produce a stress response, almost nothing is known about how chronic exposure to acoustic stressors affect stress hormones in marine mammals, particularly as it relates to survival or reproduction. In what is probably the only study of chronic noise exposure in marine mammals 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 measurements 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 Stressors), 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 changes (e.g., Lombard effect, 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 detection occurrence (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 (Figure 6.4-2) (Au & Moore, 1990; Johnson et al., 1989; Kastelein & Wensveen, 2008; Lemonds et al., 2011; Thomas et al., 1990a), 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).



Source: (from Finneran & Branstetter, 2013)

Figure 6.4-2: 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 and 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 (Curé et al., 2016; 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 indicate 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. Although air guns used in full scale seismic surveys are larger and used for a longer duration than for the Proposed Action, studies of these events can be informative for understanding the responses to Navy air gun use. 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^2s cumulative SEL), but once the received level rose above 127 dB re 1 μPa^2s cumulative SEL the call rate began decreasing, and stopped altogether once received levels reached 170 dB re 1 μPa^2s 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 marine mammals as sonar tones occur over a relatively short duration and narrow bandwidth that does not overlap with vocalizations for most 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 continuous 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, Conceptual Framework for Assessing Effects from Acoustic Explosive Sources), 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 (Nowacek et al., 2007; 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 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 (U.S. Department of the Navy, 2017d). 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 to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d)].

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. 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 airguns, 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 airgun noise, and similar responses were observed in control trials with vessel movement but no airguns so some of the response was likely due to the presence of the vessel and not the received level of the airguns. 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 affect 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 $\mu Pa^2 s$ (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 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 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 $\mu Pa^2 s$ cumulative SEL, and ceased altogether at received levels over 170 dB re 1 $\mu Pa^2 s$ 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., swimmer defense 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. (2006) 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 nautical miles (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 might 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 gray 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 airgun 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 (Southall et al., 2007). Pinnipeds may even experience TTS (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 6.2 (Conceptual Framework for Assessing Effects from Acoustic Explosive Sources) 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 their potential impacts better. 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 to determine what might produce a significant behavioral response.

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., 2015; 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 (Campbell et al., 2010; Farak et al., 2011; Mobley, 2011; Norris et al., 2012; Smultea & Mobley, 2009; Smultea et al., 2009; Trickey et al., 2015; U.S. Department of the Navy, 2011c, 2013a, 2014a, 2015). 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 observations 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 behavioral response type studies or passive acoustic monitoring, including conducting controlled exposures on captive animals with scaled sources (smaller sized and deployed at closer proximity), 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.

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., 2015; 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 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 no-sonar control vessel approaches 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., 2015). 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 the same 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 µPa), 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 exercises 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, 2011b). 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. (2015) 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, Florida 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., 2007). 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); (Risch et al., 2014b) 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 experiment. 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 the Ocean Acoustic Waveguide Remote Sensing experiment, 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, 2011c, 2014b; Watwood et al., 2012).

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; Henderson et al., 2015; 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 real 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. (2013b) 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 et al. (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; Henderson et al., 2015; Manzano-Roth et al., 2016; 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 1 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 1 µPa) and sperm whales (mean 140 dB re 1 µPa) 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., 2012). 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., 2012). 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, 2013c).

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. (2013a; 2014; 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 exercises. 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. (2016b) 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. (2016b) 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 re 1 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, 2005a; U.S. Department of the Navy, 2003) estimated a mean received SPL of approximately 169 dB re 1 µPa 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 1 µPa). 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., 2014). 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, 2011b; Watwood et al., 2012). During small boat surveys near the Navy's 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 to 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 third and seventh 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 the 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., 2013a), 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., 2014d), 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., 2014d). 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., 2014d). 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 (lowest and 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.

Pinnipeds

Different responses displayed by captive and wild phocid seals to sound 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., 2013b). 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 U.S.C. 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) (Dierauf & Gulland, 2001; Geraci & Lounsbury, 2005), and noise (Cox et al., 2006; National Research Council, 2003; Richardson et al., 1995). For some stranding events, environmental factors (e.g., ocean temperature, wind speed, and topographic 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, 2016). Several mass strandings (strandings that involve two or more cetaceans 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, 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, 2017). These five mass strandings have resulted in about 40 known cetacean deaths consisting mostly of beaked whales and with potential 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 mitigation measures and implemented changes to reduce the potential for acoustic related strandings to occur in the future. The Navy implements mitigation measures to satisfy requirements of the MMPA, such as the use of Lookouts, mitigation zones, shutdown procedures, and training and testing activity reports, as discussed in Chapter 11 (Mitigation Measures).

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).

6.4.1.7 Long-Term Consequences

Long-term consequences to a population are determined by examining changes in the population growth rate (Figure 3.0-16). 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., North Atlantic right whales); 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 stress responses to 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 northwest Atlantic tended to adjust to vessel traffic over a number of years, trending towards more neutral responses to passing vessels (Watkins, 1986), indicating that some animals may habituate or otherwise learn to cope with high levels of human activity. 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 1996–2014 (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, which 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 et al. (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 6 percent 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. Similarly, Costa et al. (2016b) placed similar 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 decrease 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 measures. The results of this long-term monitoring are now being compiled and analyzed for trends in occurrence or abundance over time (e.g., 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 (Section 6.4.1.2, Hearing Loss and Auditory Injury; Section 6.4.1.3, Physiological Stress; Section 6.4.1.4, Masking; and Section 6.4.1.5, Behavioral Reactions).

6.4.2.1 Methods for Analyzing Impacts from Sonars and Other Transducers

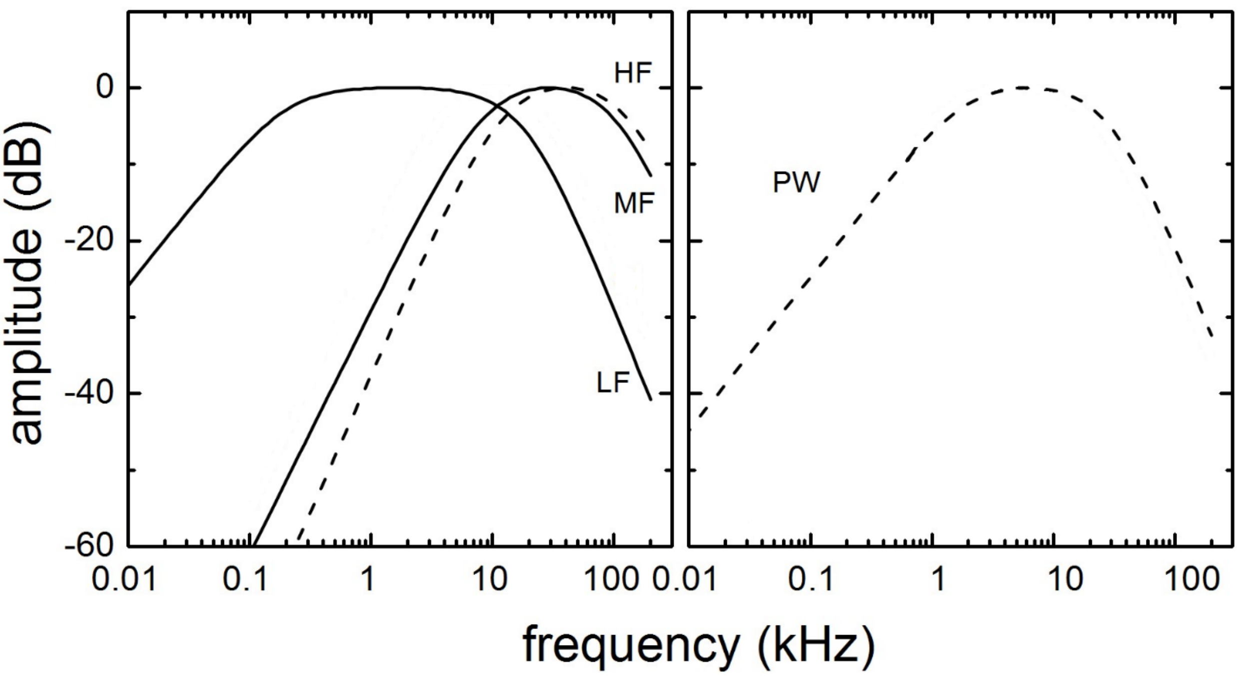
The Navy performed a quantitative analysis to estimate the number of times that marine mammals could be affected by sonars and other transducers used during Navy training and testing activities. The Navy Acoustic Effects Model is used to produce initial estimates of the number of animals that may experience 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, 2017a).

6.4.2.1.1 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 Impacts to Marine Mammals and Sea Turtles (U.S. Department of the Navy, 2017d) for detailed information on how the criteria and thresholds were derived.

6.4.2.1.1.1 Auditory Weighting Functions

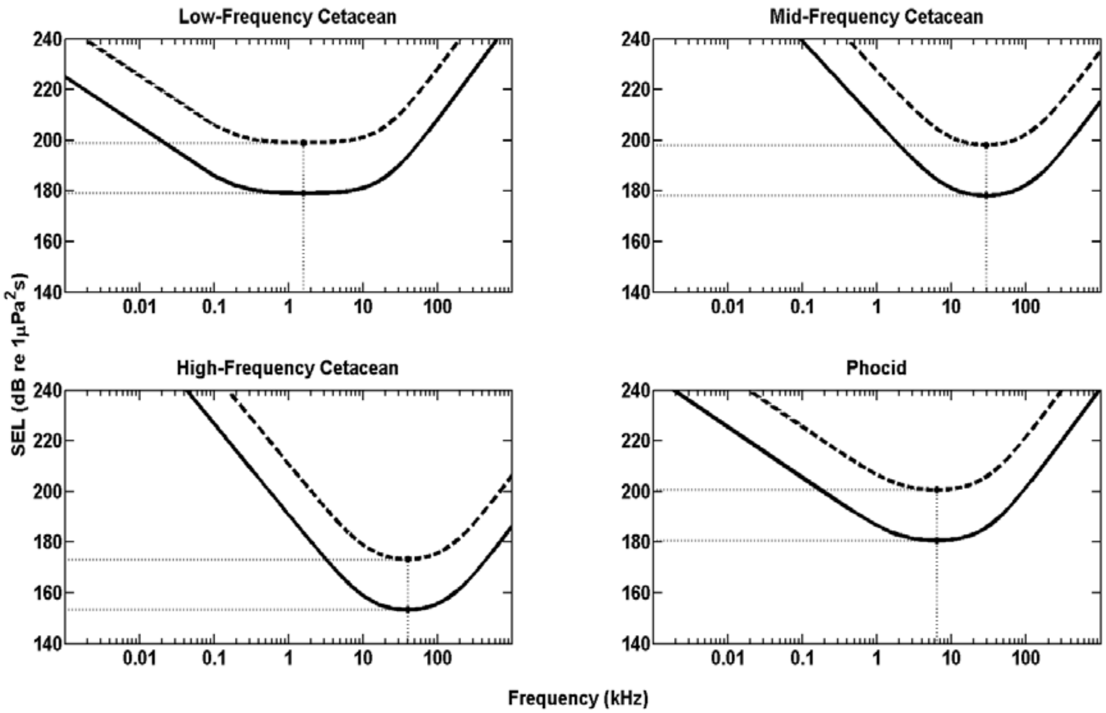
Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used (Figure 6.4-3). Auditory weighting functions are mathematical functions that adjust received sound levels to emphasize ranges of best 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.



Note: HF: High-Frequency Cetacean, LF: Low-Frequency Cetacean, MF: Mid-Frequency Cetacean, and PW: Phocid (In-water).

Figure 6.4-3: Navy Auditory Weighting Functions for All Species Groups

Defining the TTS and PTS exposure functions (Figure 6.4-4) 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. An SEL 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).



Note: 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 6.4-4: TTS and PTS Exposure Functions for Sonar and Other Active Acoustic Sources

6.4.2.1.1.2 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 Impacts to Marine Mammals and Sea Turtles Technical Report (U.S. Department of the Navy, 2017d) 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 U.S.C. 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 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 6.4-5 through Figure 6.4-8). In most cases, these divisions are driven by taxonomic classifications (e.g., mysticetes, pinnipeds).

The information currently available regarding harbor porpoises suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (Kastelein et al., 2000; Kastelein et al., 2005) and wild harbor porpoises (Johnston, 2002) responded to sound (e.g., acoustic harassment devices, acoustic deterrent devices, or other non-impulsive sound sources) are very low, approximately 120 dB re 1 µPa. Therefore, a SPL of 120 dB re 1 µPa is used in this analysis as a threshold for predicting behavioral responses in harbor porpoises.

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 6.4-1). 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.

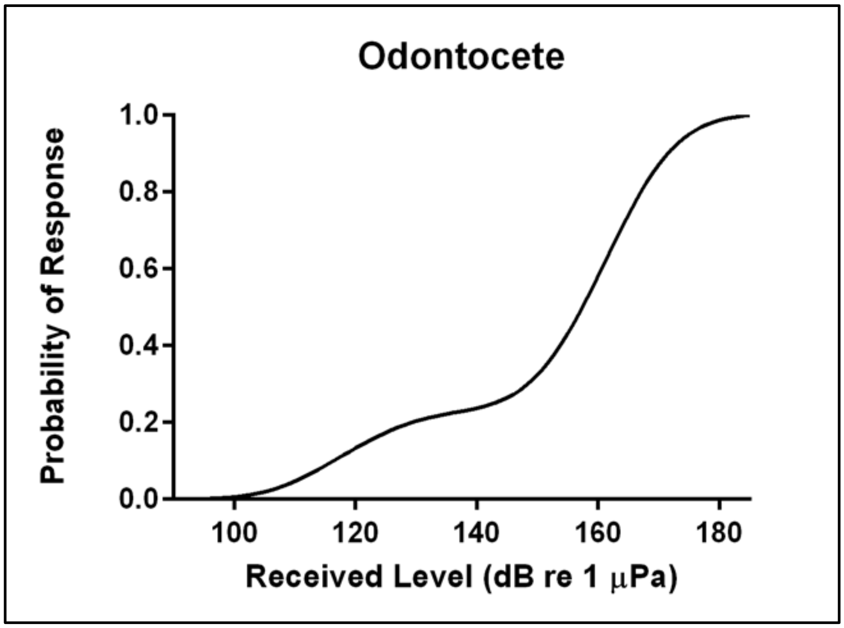


Figure 6.4-5: Behavioral Response Function for Odontocetes

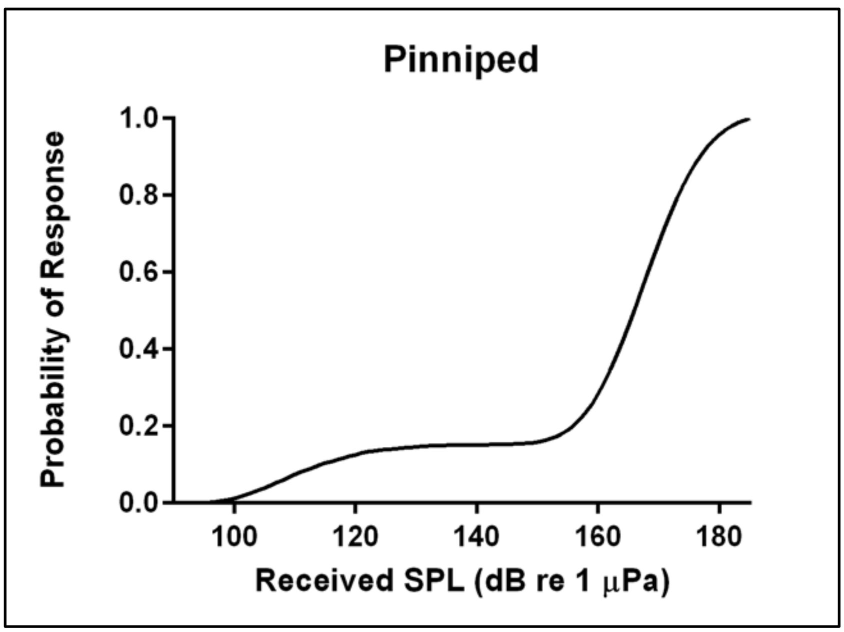


Figure 6.4-6: Behavioral Response Function for Mysticetes

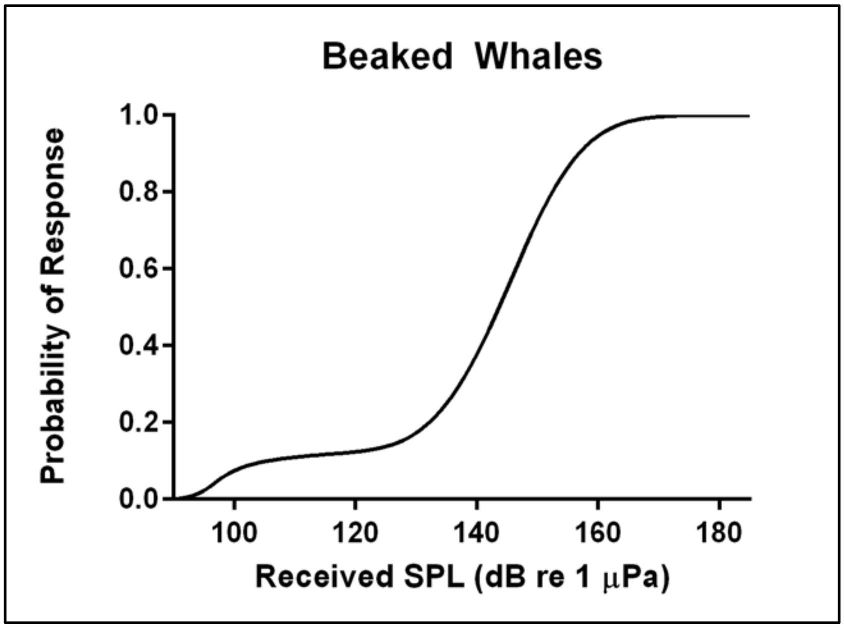


Figure 6.4-7: Behavioral Response Function for Beaked Whales

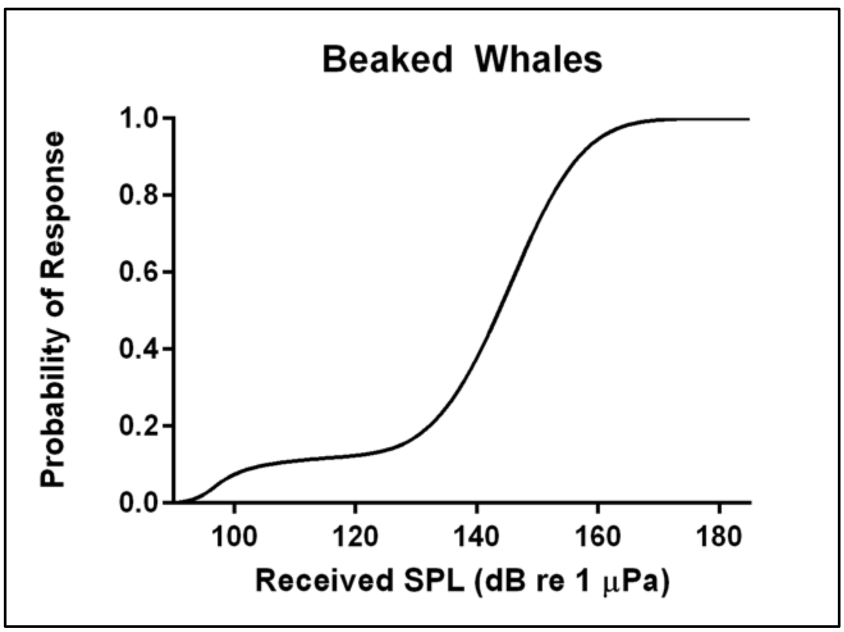


Figure 6.4-8: Behavioral Response Function for Beaked Whales

Table 6.4-1: 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 and Manatees	10 km	20 km
Beaked Whales	25 km	50 km
Harbor Porpoise	20 km	40 km

Notes: dB re 1 µPa @ 1 m: decibels referenced to 1 micropascal at 1 meter; km: kilometer; SL: source level

6.4.2.1.1.3 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.

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 6.4-9).

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 6.4.1.6, Figure 6.4-9), 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.

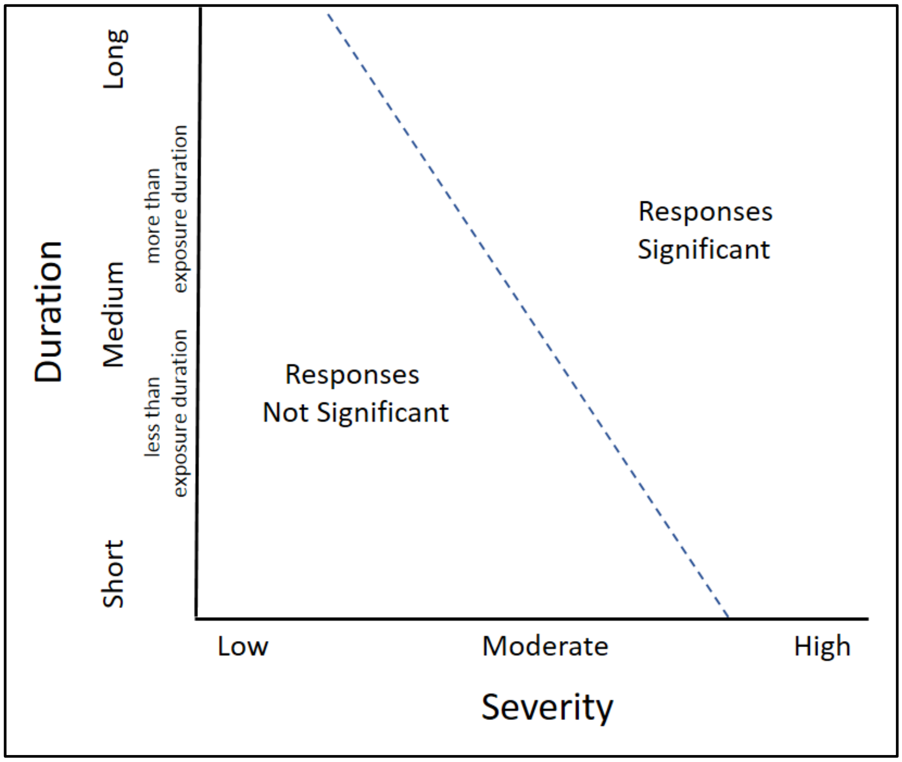


Figure 6.4-9: Relative Likelihood of a Response Being Significant Based on the Duration and Severity of Behavioral Reactions

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. Therefore, the Navy had precautionarily requested take for all of the estimated behavioral reactions from the quantitative analysis, after mitigation measures are taken into consideration.

6.4.2.1.2 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. This database is described in the technical report titled U.S. Navy Marine Species Density Database Phase III for the Atlantic Fleet Training and Testing Area (U.S. Department of the Navy, 2017), 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 possible models in order of preference.

1. Spatial density models [see Roberts et al. (2016)] predict spatial variability of animal presence based on 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; therefore, this model cannot be used for species with low numbers of sightings. In the AFTT Study Area, this model is available for certain species along the east coast to the offshore extent of available survey data and in the Gulf of Mexico.
2. Design-based density models predict animal density based on survey data. Like spatial density models, they are applied to areas with survey data. Design-based density models may be stratified, in which a density is predicted for each sub-region of a survey area, allowing for better prediction of species distribution across the density model area. In the AFTT Study Area, stratified density models are used for certain species on both the east coast and the Gulf of Mexico. In addition, a few species' stratified density models are applied to areas east of regions with available survey data and cover a substantial portion of the Atlantic Ocean portion of the Study Area.
3. Extrapolative models are used in areas where there is insufficient or no survey data. These models use a limited set of environmental variables to predict possible species densities based on environmental observations during actual marine mammal surveys [see Mannocci et al. (2017)]. In the AFTT Study Area, extrapolative models are typically used east of regions with available survey data and cover a substantial portion of the Atlantic Ocean portion of the Study Area. Because some unsurveyed areas have oceanographic conditions that are very different from surveyed areas (e.g., the Labrador Sea and North Atlantic gyre) and some species models rely on a very limited data set, the predictions of some species' extrapolative density models

and some regions of certain species' extrapolative density models are considered highly speculative. Extrapolative models are not used in the Gulf of Mexico.
4. Existing Relative Environmental Suitability models include a high degree of uncertainty, but are applied when no other model is available.

When interpreting the results of the quantitative analysis, as described in the density technical report (U.S. Department of the Navy, 2017), "it is important to consider that even the best estimate of marine species density is really a model representation of the values of concentration where these animals might occur. 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 species biodiversity, any single model method will not completely explain the actual distribution and abundance of marine mammal species. It is expected that there would be anomalies in the results that need to be evaluated, with independent information for each case, to support if we might accept or reject a model or portions of the model".

The Navy's estimate of density and abundance in the Study Area may differ from population abundances estimated in the NMFS Stock Assessment Reports for a variety of reasons. For some species, the stock assessment for a given species may exceed the Navy's density prediction because their home range extends beyond the Study Area boundaries. Therefore, the assumed abundance in the Study Area is a subset (i.e. smaller than) the total stock abundance. Abundances predicted by models that are not directly based on geographically-specific survey data (e.g., extrapolative, Relative Environmental Suitability, and, in some cases, stratified models) have the potential to overestimate the number of animals and, consequently, the number of potential impacts. Even though use of these models in certain areas may be the only means of estimating density due to lack of survey or sighting data, they should be considered speculative.

In addition, even some of the best models, ranked in accordance with the Navy Marine Species Density Database hierarchical approach (i.e., Spatial and Stratified density models), may not be directly comparable to a given species estimated population within the NMFS Stock Assessment Reports. Even though the density models rely on some of the same survey data used in NMFS Stock Assessment Reports, the Navy's density models sometimes assigned a lower value for g(0) than assumed in the NMFS Stock Assessment Reports, resulting in a higher predicted abundance of animals for specific surveys in the Navy's density model.

These caveats 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.

6.4.2.1.3 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, 2017a).

6.4.2.1.4 Accounting for Mitigation

The Navy implements mitigation measures (described in Chapter 11, Mitigation Measures) during activities that use active sonar, including a power down or shut down (i.e., power-off) of active sonar transmission when a marine mammal is observed in the mitigation zone. The Navy designed the mitigation zones to encompass the average ranges to PTS to the maximum extent practicable. 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 that will be implemented 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, 2017a).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation will be implemented, 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., 2013b) 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.

6.4.2.1.5 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 exposed within these ranges for the shown duration are predicted to experience 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 an exposure of 30 seconds are shown in Table 6.4-2 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 192 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.

Table 6.4-2: Range to Permanent Threshold Shift for Five Representative Sonar Systems

Functional Hearing Group	Approximate PTS (30 seconds) Ranges (meters)[1]				
	Sonar Bin LF5 (Low Frequency Sources <180 dB Source Level)	Sonar Bin MF1 (e.g., SQS-53 ASW Hull Mounted Sonar)	Sonar Bin MF4 (e.g., AQS-22 ASW Dipping Sonar)	Sonar Bin MF5 (e.g., SSQ-62 ASW Sonobuoy)	Sonar Bin HF4 (e.g., SQS-20 Mine Hunting Sonar)
Low-frequency Cetaceans	0 (0—0)	66 (65—80)	15 (15—18)	0 (0—0)	0 (0—0)
Mid-frequency Cetaceans	0 (0—0)	16 (16—16)	3 (3—3)	0 (0—0)	1 (0—2)
High-frequency Cetaceans	0 (0—0)	192 (170—270)	31 (30—40)	9 (8—13)	34 (20—85)
Phocid Seals	0 (0—0)	46 (45—55)	11 (11—13)	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.

Notes: ASW: anti-submarine warfare; HF: high frequency; LF: low frequency; MF: mid-frequency; PTS: permanent threshold shift; NA: Not applicable because there is no overlap between species and sound source.

For all other functional hearing groups (low-frequency cetaceans, mid-frequency cetaceans, phocid seals, and sirenia), 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 1, 30, 60, and 120 seconds from five representative sonar systems (see Table 6.4-3 through Table 6.4-7). 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 6.4-3: Ranges to Temporary Threshold Shift for Sonar Bin LF5 over a Representative Range of Environments within the Study Area

Functional Hearing Group	*Approximate TTS Ranges (meters)[1]*			
	Sonar Bin LF5 (Low Frequency Sources <180 dB Source Level)			
	1 second	*30 seconds*	*60 seconds*	*120 seconds*
Low-frequency Cetaceans	4 (0—5)	4 (0—5)	4 (0—5)	4 (0—5)
Mid-frequency Cetaceans	222 (200—310)	222 (200—310)	331 (280—525)	424 (340—800)
High-frequency Cetaceans	0 (0—0)	0 (0—0)	0 (0—0)	0 (0—0)
Phocid Seals	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 parenthesis. Notes: Ranges for 1-sec and 30-sec periods are identical for Bin MF1 because this system nominally pings every 50 seconds, therefore these periods encompass only a single ping.
PTS: permanent threshold shift; TTS: temporary threshold shift

Table 6.4-4: Ranges to Temporary Threshold Shift for Sonar Bin MF1 over a Representative Range of Environments within the Study Area

Functional 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 Cetaceans	1111 (650—2775)	1111 (650—2775)	1655 (800—3775)	2160 (900—6525)
Mid-frequency Cetaceans	222 (200—310)	222 (200—310)	331 (280—525)	424 (340—800)
High-frequency Cetaceans	3001 (1275—8275)	3001 (1275—8275)	4803 (1525—13525)	6016 (1525—16775)
Phocid Seals	784 (575—1275)	784 (575—1275)	1211 (850—3025)	1505 (1025—3775)

[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 parenthesis.
Notes: Ranges for 1-sec and 30-sec periods are identical for Bin MF1 because this system nominally pings every 50 seconds, therefore these periods encompass only a single ping.
ASW: anti-submarine warfare; MF: mid-frequency; PTS: permanent threshold shift; TTS: temporary threshold shift

Table 6.4-5: Ranges to Temporary Threshold Shift for Sonar Bin MF4 over a Representative Range of Environments within the Study Area

Functional 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 Cetaceans	89 (85—120)	175 (160—280)	262 (220—575)	429 (330—875)
Mid-frequency Cetaceans	22 (22—25)	36 (35—45)	51 (45—60)	72 (70—95)
High-frequency Cetaceans	270 (220—575)	546 (410—1025)	729 (525—1525)	1107 (600—2275)
Phocid Seals	67 (65—90)	119 (110—180)	171 (150—260)	296 (240—700)

[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 parenthesis.

Notes: ASW: anti-submarine warfare; MF: mid-frequency; PTS: permanent threshold shift; TTS: temporary threshold shift

Table 6.4-6: Ranges to Temporary Threshold Shift for Sonar Bin MF5 over a Representative Range of Environments within the Study Area

Functional 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 Cetaceans	11 (0—14)	11 (0—14)	16 (0—20)	23 (0—25)
Mid-frequency Cetaceans	5 (0—10)	5 (0—10)	12 (0—15)	17 (0—22)
High-frequency Cetaceans	122 (110—320)	122 (110—320)	187 (150—525)	286 (210—750)
Phocid Seals	9 (8—13)	9 (8—13)	15 (14—18)	22 (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 parenthesis.

Notes: ASW: anti-submarine warfare; MF: mid-frequency; PTS: permanent threshold shift; TTS: temporary threshold shift

Table 6.4-7: Ranges to Temporary Threshold Shift for Sonar Bin HF4 over a Representative Range of Environments within the Study Area

Functional 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 Cetaceans	1 (0—3)	3 (0—5)	5 (0—7)	7 (0—12)
Mid-frequency Cetaceans	10 (7—17)	19 (11—35)	27 (17—60)	39 (22—100)
High-frequency Cetaceans	242 (100—975)	395 (170—1775)	524 (230—2775)	655 (300—4275)
Phocid Seals	2 (0—5)	5 (0—8)	8 (5—13)	12 (8—20)

[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 parenthesis.

Notes: HF: high frequency; PTS: permanent threshold shift; TTS: temporary threshold shift

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 6.4-8 through Table 6.4-12, respectively. See Section 6.4.2.1 (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 6.4-8: 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)	*Mean Range (m) with minimum to maximum values in parentheses*	*Probability of Behavioral Response*				
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*	*Harbor Porpoises*
196	0 (0—0)	100%	100%	100%	100%	100%
190	0 (0—0)	100%	98%	99%	100%	100%
184	0 (0—0)	99%	88%	98%	100%	100%
178	1 (0—1)	97%	59%	92%	100%	100%
172	2 (1—2)	91%	30%	76%	99%	100%
166	4 (1—6)	78%	20%	48%	97%	100%
160	10 (1—13)	58%	18%	27%	93%	100%
154	21 (1—25)	40%	17%	18%	83%	100%
148	46 (1—60)	29%	16%	16%	66%	100%
142	104 (1—140)	25%	13%	15%	45%	100%
136	242 (120—430)	23%	9%	15%	28%	100%
130	573 (320—1,275)	20%	5%	15%	18%	100%
124	1,268 (550—2,775)	17%	2%	14%	14%	100%

Table 6.4-8: 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)	*Mean Range (m) with minimum to maximum values in parentheses*	*Probability of Behavioral Response*				
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*	*Harbor Porpoises*
118	2,733 (800—6,525)	12%	1%	13%	12%	0%
112	5,820 (1,025—18,275)	6%	0%	9%	11%	0%
106	13,341 (1,275—54,525)	3%	0%	5%	11%	0%
100	31,026 (2,025—100,000*)	1%	0%	2%	8%	0%

* Indicates maximum range of acoustic model, a distance of approximately 100 kilometers from the sound source.
Notes: 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. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 6.4-9 for behavioral cut-off distances).
dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

Table 6.4-9: 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)	*Mean Range (m) with minimum to maximum values in parentheses*	*Probability of Behavioral Response*				
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*	*Harbor Porpoises*
196	109 (100—150)	100%	100%	100%	100%	100%
190	257 (220—370)	100%	98%	99%	100%	100%
184	573 (400—1,000)	99%	88%	98%	100%	100%
178	1,235 (725—3,525)	97%	59%	92%	100%	100%
172	3,007 (875—9,775)	91%	30%	76%	99%	100%
166	6,511 (925—19,525)	78%	20%	48%	97%	100%
160	11,644 (975—36,275)	58%	18%	27%	93%	100%
154	18,012 (975—60,775)	40%	17%	18%	83%	100%
148	26,037 (1,000—77,525)	29%	16%	16%	66%	100%
142	33,377 (1,000—100,000*)	25%	13%	15%	45%	100%
136	41,099 (1,025—100,000*)	23%	9%	15%	28%	100%
130	46,618 (3,275—100,000*)	20%	5%	15%	18%	100%
124	50,173 (3,525—100,000*)	17%	2%	14%	14%	100%
118	52,982 (3,775—100,000*)	12%	1%	13%	12%	0%
112	56,337 (4,275—100,000*)	6%	0%	9%	11%	0%
106	60,505 (4,275—100,000*)	3%	0%	5%	11%	0%
100	62,833 (4,525—100,000*)	1%	0%	2%	8%	0%

* Indicates maximum range of acoustic model, a distance of approximately 100 kilometers from the sound source.
Notes: 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. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 6.4-9 for behavioral cut-off distances). dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

Table 6.4-10: 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)	*Mean Range (m) with minimum to maximum values in parentheses*	*Probability of Behavioral Response*				
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*	*Harbor Porpoises*
196	8 (1—10)	100%	100%	100%	100%	100%
190	17 (1—21)	100%	98%	99%	100%	100%
184	35 (1—40)	99%	88%	98%	100%	100%
178	71 (1—95)	97%	59%	92%	100%	100%
172	156 (110—410)	91%	30%	76%	99%	100%
166	431 (280—1,275)	78%	20%	48%	97%	100%
160	948 (490—3,525)	58%	18%	27%	93%	100%
154	1,937 (750—10,025)	40%	17%	18%	83%	100%
148	3,725 (1,025—20,525)	29%	16%	16%	66%	100%
142	7,084 (1,525—38,525)	25%	13%	15%	45%	100%
136	11,325 (1,775—56,275)	23%	9%	15%	28%	100%
130	16,884 (1,775—74,275)	20%	5%	15%	18%	100%
124	24,033 (2,275—80,775)	17%	2%	14%	14%	100%
118	31,950 (2,275—100,000*)	12%	1%	13%	12%	0%
112	37,663 (2,525—100,000*)	6%	0%	9%	11%	0%
106	41,436 (2,775—100,000*)	3%	0%	5%	11%	0%
100	44,352 (2,775—100,000*)	1%	0%	2%	8%	0%

* Indicates maximum range of acoustic model, a distance of approximately 100 kilometers from the sound source.

Notes: 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. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 6.4-9 for behavioral cut-off distances). dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

Table 6.4-11: 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)	*Mean Range (m) with minimum to maximum values in parentheses*	*Probability of Behavioral Response*				
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*	*Harbor Porpoises*
196	0 (0—0)	100%	100%	100%	100%	100%
190	2 (1—3)	100%	98%	99%	100%	100%
184	4 (1—9)	99%	88%	98%	100%	100%
178	14 (1—18)	97%	59%	92%	100%	100%
172	29 (1—35)	91%	30%	76%	99%	100%
166	61 (1—80)	78%	20%	48%	97%	100%
160	141 (1—400)	58%	18%	27%	93%	100%
154	346 (1—1,000)	40%	17%	18%	83%	100%
148	762 (420—2,525)	29%	16%	16%	66%	100%
142	1,561 (675—5,525)	25%	13%	15%	45%	100%

Table 6.4-11: 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)	Mean Range (m) with minimum to maximum values in parentheses	Probability of Behavioral Response				
		Odontocetes	Mysticetes	Pinnipeds	Beaked Whales	Harbor Porpoises
136	2,947 (1,025—10,775)	23%	9%	15%	28%	100%
130	5,035 (1,025—17,275)	20%	5%	15%	18%	100%
124	7,409 (1,275—22,525)	17%	2%	14%	14%	100%
118	10,340 (1,525—29,525)	12%	1%	13%	12%	0%
112	13,229 (1,525—38,025)	6%	0%	9%	11%	0%
106	16,487 (1,525—46,025)	3%	0%	5%	11%	0%
100	20,510 (1,775—60,525)	1%	0%	2%	8%	0%

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. Cut-off ranges in this table are for activities with high source levels and/or multiple platforms (see Table 6.4-9 for behavioral cut-off distances). dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

Table 6.4-12: 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)	Mean Range (m) with minimum to maximum values in parentheses	Probability of Behavioral Response				
		Odontocetes	Mysticetes	Pinnipeds	Beaked Whales	Harbor Porpoises
196	3 (1—6)	100%	100%	100%	100%	100%
190	8 (1—14)	100%	98%	99%	100%	100%
184	18 (1—35)	99%	88%	98%	100%	100%
178	37 (1—100)	97%	59%	92%	100%	100%
172	78 (1—300)	91%	30%	76%	99%	100%
166	167 (1—725)	78%	20%	48%	97%	100%
160	322 (25—1,525)	58%	18%	27%	93%	100%
154	555 (45—3,775)	40%	17%	18%	83%	100%
148	867 (70—6,775)	29%	16%	16%	66%	100%
142	1,233 (150—12,775)	25%	13%	15%	45%	100%
136	1,695 (260—20,025)	23%	9%	15%	28%	100%
130	2,210 (470—29,275)	20%	5%	15%	18%	100%
124	2,792 (650—40,775)	17%	2%	14%	14%	100%
118	3,421 (950—49,775)	12%	1%	13%	12%	0%
112	4,109 (1,025—49,775)	6%	0%	9%	11%	0%
106	4,798 (1,275—49,775)	3%	0%	5%	11%	0%
100	5,540 (1,275—49,775)	1%	0%	2%	8%	0%

Notes: dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

6.4.2.3 Impact from Sonar and Other Transducers Under the Proposed Action

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 are described in Sections 1.4 and 1.5 as well as Appendix A (Navy Activity Descriptions) of the AFTT EIS/OEIS.

Major training exercises (Composite Training Unit Exercise, Fleet Exercise/Sustainment Exercise) are multi-day exercises that transition across large areas and involve multiple anti-submarine warfare assets. These exercises take place in the Virginia Capes, Navy Cherry Point, Jacksonville, or Gulf of Mexico Range Complexes. 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, and structures and landforms that likely constrain sound propagation 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 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 in Section 6.4.1. Anti-submarine warfare and vessel evaluation testing activities are more likely to occur close to homeports and testing facilities 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 exercises 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. Most anti-submarine warfare activities 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.

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 6.4.2.1, 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 under the Proposed Action are shown in Section 5.1 (Estimated Impacts to Marine Mammals and Sea Turtles Under the Proposed Action) and presented below in figures for each species of marine mammal with any estimated effects (e.g., Figure 6.4-10). The activity categories that are most likely to cause impacts and the most likely region in which impacts could occur are represented in the pie 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 pie charts below. All (i.e., grand total) estimated impacts for that species are included in the figures, regardless of region or category.

Note that the numbers of activities planned under the Proposed Action can vary from year-to-year. Results are presented for a "minimum sonar use year" and a "maximum sonar use year" to provide a range of potential impacts that could occur. The number of hours these sonars would be operated under the Proposed Action are described in Section 1.5.5 (Summary of Acoustic and Explosive Sources Analyzed for Training and Testing).

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, Behavior 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 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 3.7.3.1.2.1, 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 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 (Impacts from 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 6.4.2.2 Impact Ranges for Sonar and other Transducers*, 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 activities 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 North Atlantic Right Whales (Endangered Species Act-Listed)

In the Southeast North Atlantic Right Whale Mitigation Area from 15 November through 15 April, the Navy will not conduct low-frequency, mid-frequency, or high-frequency active sonar, except for sources that will be minimized to the maximum extent practicable during helicopter dipping, navigation training, and object detection exercises. Within the Southeast North Atlantic Right Whale Mitigation Area, the Navy would conduct navigation training and object detection exercises when surface ships or submarines enter or exit ports located in Kings Bay, Georgia, and Mayport, Florida. In addition, training or testing activities involving helicopter dipping sonar would occur off Mayport, Florida. The Southeast North Atlantic Right Whale Mitigation Area encompasses a portion of the North Atlantic right whale migration and calving areas identified by LaBrecque et al. (2015a) and a portion of the southeastern North Atlantic right whale critical habitat. Outside of the Southeast North Atlantic Right Whale Mitigation Area, active sonar would be used for anti-submarine warfare activities and for pierside sonar testing at Kings Bay, Georgia. The best available density data for the Study Area shows that the areas of highest density are off the southeastern United States in areas that coincide with the Southeast North Atlantic Right Whale Mitigation Area. Therefore, the majority of active sonar use would occur outside of the areas of highest seasonal North Atlantic right whale density off the southeastern United States. As discussed in detail in Chapter 11 (Mitigation Measures), before transiting through or conducting any training or testing activities within the Southeast North Atlantic Right Whale Mitigation Area during calving season (November 15 to April 15), the Navy will initiate communication with the Fleet Area Control and Surveillance Facility, Jacksonville to obtain Early Warning System North Atlantic right whale sightings data. When transiting within the mitigation area, vessels will use the obtained sightings information to reduce potential interactions with North Atlantic right whales during transits. This high level of awareness will further enhance the Navy's mitigation effectiveness for reducing potential acoustic impacts to North Atlantic right whales.

The Navy will also minimize the use of active sonar in the Northeast North Atlantic Right Whale Mitigation Area. See Chapter 11 (Mitigation Measures) for a description of the area. A limited number of torpedo activities (non-explosive) would be conducted in August and September, after many North Atlantic right whales have migrated south out of the area. These torpedo areas were established during previous ESA consultations with NMFS. Torpedo training or testing activities would not occur within 2.7 NM of the Stellwagen Bank National Marine Sanctuary.

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

North Atlantic right whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-10 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 from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

As previously described in Section 4.1.1.1 (North Atlantic Right Whale [*Eubalaena glacialis*]) a migratory corridor, a calving area, a mating area, and feeding areas for North Atlantic right whales have been identified by LaBrecque et al. (2015a, 2015b) that seasonally overlap with Virginia Capes, Navy Cherry Point, Jacksonville, and the Northeast Range Complexes within the Study Area. The Navy will implement mitigation in mitigation areas off the northeastern, mid-Atlantic, and southeastern United States that overlap these range complexes, which will further avoid impacts on North Atlantic right whales. Navy training activities that use sonar could occur in these range complexes throughout the year, with some year-round or seasonal restrictions for certain sources in the mitigation areas. Impacts to feeding and mating behaviors could occur due to sonar training activities on the feeding or mating areas identified by LaBrecque et al. (2015a, 2015b). Impacts in this area are primarily due to navigation and object avoidance activities taking place at Groton, Connecticut, although impacts to feeding and mating behaviors from these activities are likely to be short-term and minor to moderate within the feeding and mating areas identified by LaBrecque et al. (2015a, 2015b). North Atlantic right whale migration behaviors could be impacted within the Virginia Capes, Navy Cherry Point, or Jacksonville Range Complex, which overlap the identified migration corridor. Mysticetes disturbed during migration have been observed pausing or rerouting around an activity using sonar only if it is directly on their path; therefore, impacts to migration behavior are likely to be short-term and moderate if they were to occur within the migratory corridor identified by LaBrecque et al. (2015a, 2015b). Impacts to North Atlantic right whales could occur within designated calving areas that overlap the Jacksonville and Navy Cherry Point Range Complexes. Impact in this area are primarily due to navigation and object avoidance activities taking place at Mayport, Florida and Port Canaveral, Florida, although impacts to calving behaviors from these activities are likely to be short-term and minor to moderate within the calving area identified by LaBrecque et al. (2015a, 2015b).

The Study Area does overlap North Atlantic right whale critical habitat and some limited use of sonar and other transducers does take place within these areas; however, the sound from sonar and other transducers would not affect the biological or physical features that are essential for the reproduction, rest and refuge, health, continued survival, conservation and recovery of the northern right whale population.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of North Atlantic right whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

North Atlantic right whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-10 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 from Sonar and Other Transducers).

As described for other mysticetes above, 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. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected. Estimated impacts apply to the Western North Atlantic stock.

As previously described in Sections 4.1.1.1 (North Atlantic Right Whale [*Eubalaena glacialis*]) a migratory corridor, a calving area, a mating area, and feeding areas for North Atlantic right whales have been identified by LaBrecque et al. (2015a, 2015b) that seasonally overlap with Virginia Capes, Navy Cherry Point, Jacksonville, and the Northeast Range Complexes within the Study Area. Navy testing activities that use sonar could occur in these range complexes year-round. Impacts to feeding and mating behaviors could occur due to sonar testing activities on the feeding or mating areas identified by LaBrecque et al. (2015a, 2015b). Impacts to feeding and mating behaviors from these activities are likely to be short-term and minor to moderate within the feeding and mating areas identified by LaBrecque et al. (2015a, 2015b). North Atlantic right whale migration behaviors could be impacted within the Virginia Capes, Navy Cherry Point, or Jacksonville Range Complex, which overlap the identified migration corridor. Mysticetes disturbed during migration have been observed pausing or rerouting around an activity using sonar only if it is directly on their path; therefore, impacts to migration behavior are likely to be short-term and moderate if they were to occur within the migratory corridor identified by LaBrecque et al. (2015a, 2015b). Impacts to North Atlantic right whales could occur within designated calving areas that overlap the Jacksonville and Navy Cherry Point Range Complexes. Impacts to calving behaviors from these activities are likely to be short-term and minor to moderate within the calving area identified by LaBrecque et al. (2015a, 2015b).

The Study Area does overlap North Atlantic right whale critical habitat and some limited use of sonar and other transducers does take place within these areas; however, the sound from sonar and other transducers would not affect the biological or physical features that are essential for the reproduction, rest and refuge, health, continued survival, conservation and recovery of the northern right whale population.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of North Atlantic right whales incidental to those activities as outlined in Table 5.1-4.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-10: North Atlantic Right Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.2.2 Blue Whales

<u>Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities</u>

Blue whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See below Figure 6.4-11 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 from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

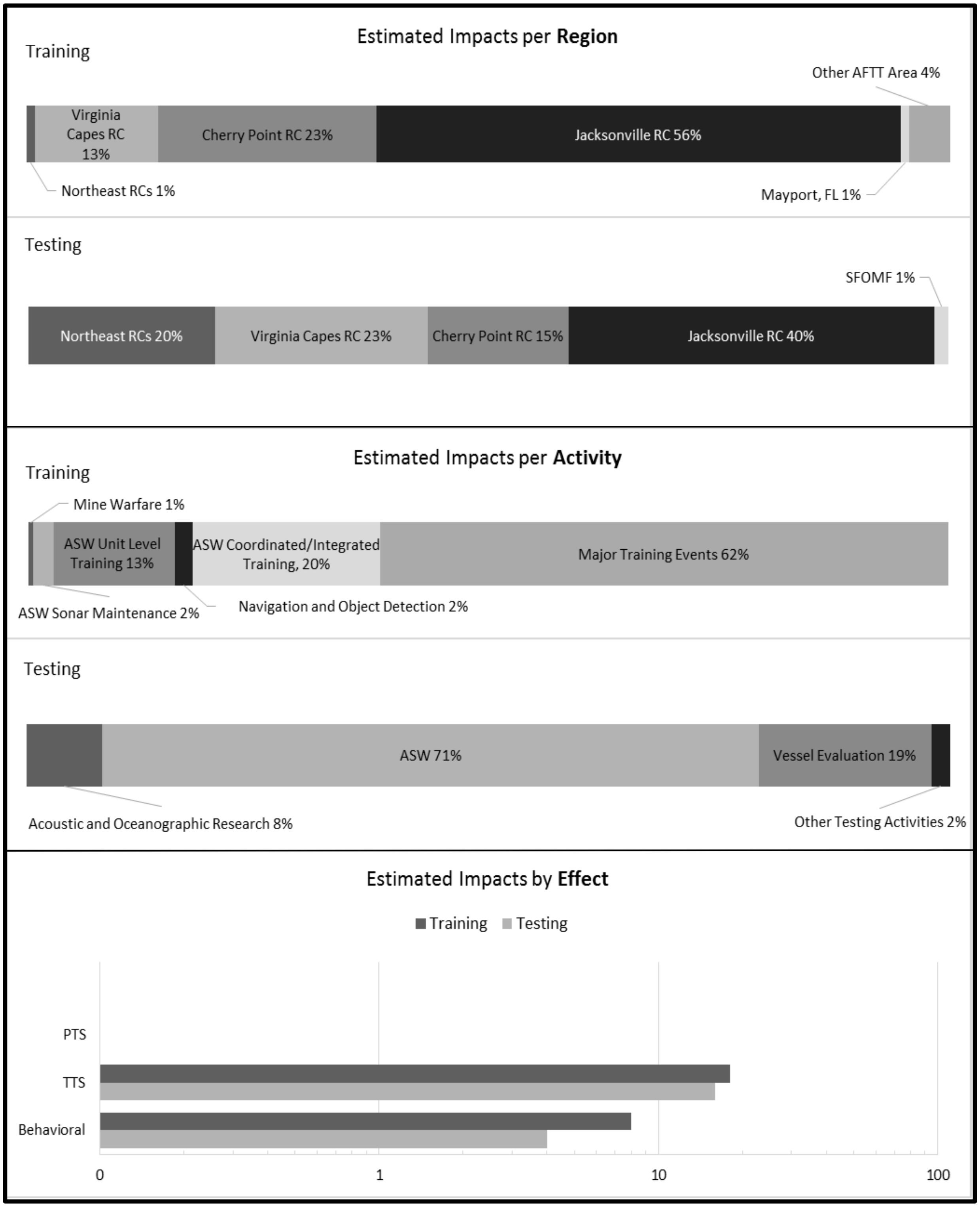
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of blue whales incidental to those activities as outlined in Table 5.1-3.

<u>Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities</u>

Blue whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See below Figure 6.4-11 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 from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of blue whales incidental to those activities as outlined in Table 5.1-4.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic (Gulf of St. Lawrence) Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-11: Blue Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.2.3 Bryde's Whales

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Bryde's whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See below Figure 6.4-12 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 from Sonar and Other Transducers). Estimated impacts apply to the Northern Gulf of Mexico stock.

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 implemented 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 Bryde's whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Gulf of Mexico Range Complex within the Study Area. Navy training activities that use sonar and other transducers could occur year round within the Gulf of Mexico Range Complex; however, the quantitative analysis indicates no impacts to Bryde's whales in the Gulf of Mexico. Bryde's whales residing in this area could be exposed to sound from sonar; however, impacts to natural behaviors or abandonment of the area would not be anticipated within Bryde's whale small and resident population area identified by LaBrecque et al. (2015a, 2015b).

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of Bryde's whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Bryde's whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-12 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 from Sonar and Other Transducers). Estimated impacts apply to the Northern Gulf of Mexico stock.

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 implemented 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 Bryde's whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Gulf of Mexico Range Complex within the Study Area. Navy testing activities that use sonar and other transducers could occur year round within the Gulf of Mexico Range Complex; however, the quantitative analysis indicates no impacts to Bryde's whales within these areas. Impacts to natural behaviors or abandonment of the area would not be anticipated within Bryde's whale small and resident population area identified by LaBrecque et al. (2015a, 2015b).

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of Bryde's whales incidental to those activities as outlined in Table 5.1-4.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Northern Gulf of Mexico Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-12: Bryde's Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.2.4 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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-13 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 from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for fin whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to fin whale feeding behavior could occur on the fin whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, fin whale reactions to sonar are most likely short-term and mild to moderate; therefore, significant impacts to fin whale feeding behaviors are unlikely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from training with sonar and other transducers.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of fin whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Fin whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6.4-13 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 from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stock.

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 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for fin whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to fin whale feeding behavior could occur on the fin whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, fin whale reactions to sonar reactions are most likely short-term and mild to moderate to sonar; therefore, significant impacts to fin whale feeding behaviors are unlikely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from testing with sonar and other transducers.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of fin whales incidental to those activities as outlined in Table 5.1-4.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% Western North Atlantic Stock.
ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-13: Fin Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.2.5 Humpback Whales

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Humpback whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-14 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 from Sonar and Other Transducers). Estimated impacts apply to the Gulf of Maine stock. 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for humpback whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to humpback feeding behavior could occur on the humpback whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, humpback whale reactions to sonar are most likely short-term and mild to moderate; therefore, significant impacts to humpback whale feeding behaviors are unlikely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from training with sonar and other transducers.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of humpback whales incidental to those activities as outlined in Table 5.1-3.

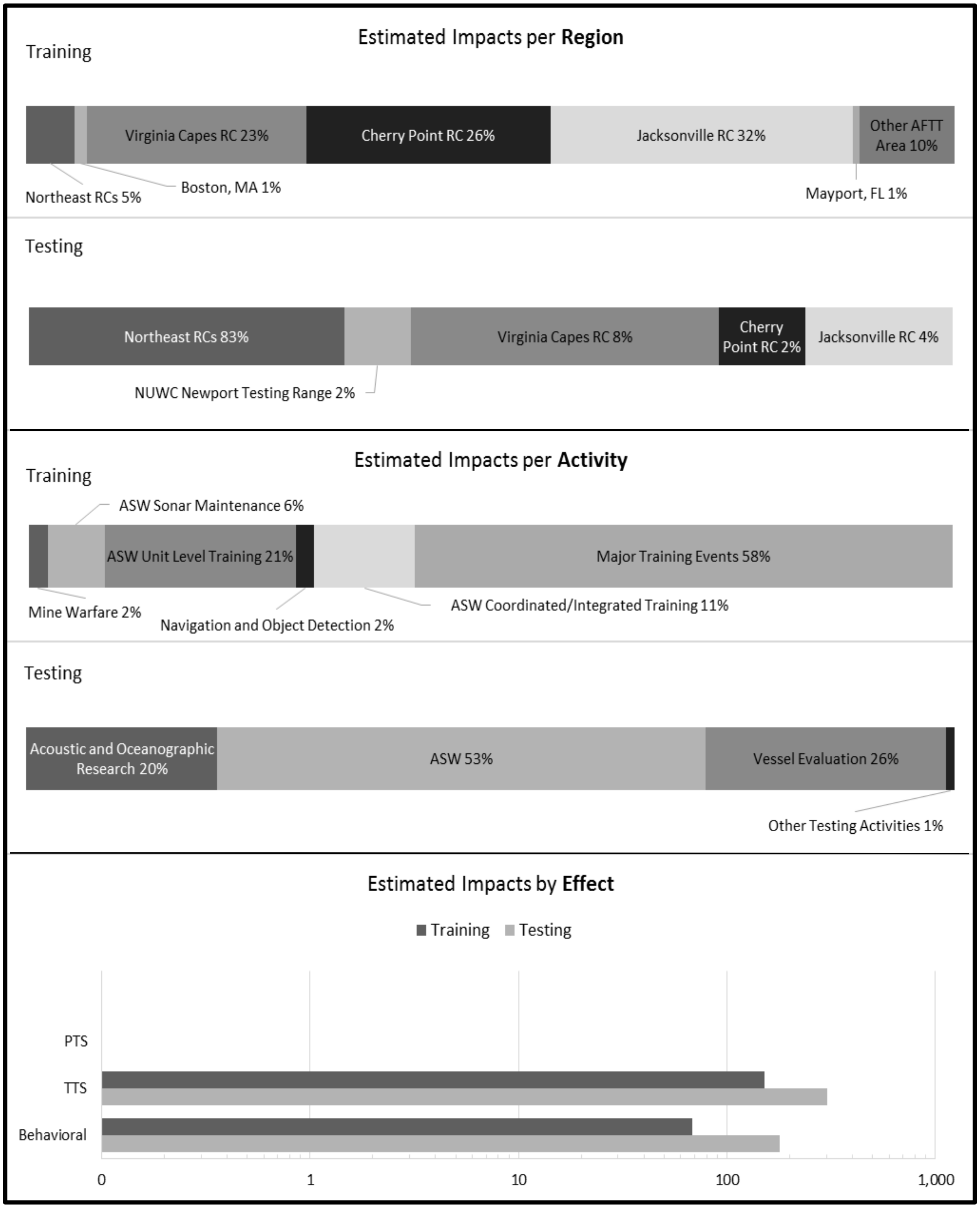
Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Humpback whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-14 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 from Sonar and Other Transducers). Estimated impacts apply to the Gulf of Maine stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for humpback whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to humpback feeding behavior could occur on the humpback whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, humpback whale reactions to sonar are most likely short-term and mild to moderate; therefore, significant impacts to humpback whale feeding behaviors are unlikely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from testing with sonar and other transducers.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of humpback whales incidental to those activities as outlined in Table 5.1-4.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Gulf of Maine Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-14: Humpback Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-15 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 from Sonar and Other Transducers). Estimated impacts apply to the Canadian East Coast stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for minke whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to minke feeding behavior could occur on the minke whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, minke whale reactions to sonar are most likely short-term and moderate; therefore, only few impacts to minke whale feeding behaviors are likely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from training with sonar and other transducers.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of minke whales incidental to those activities as outlined in Table 5.1-3.

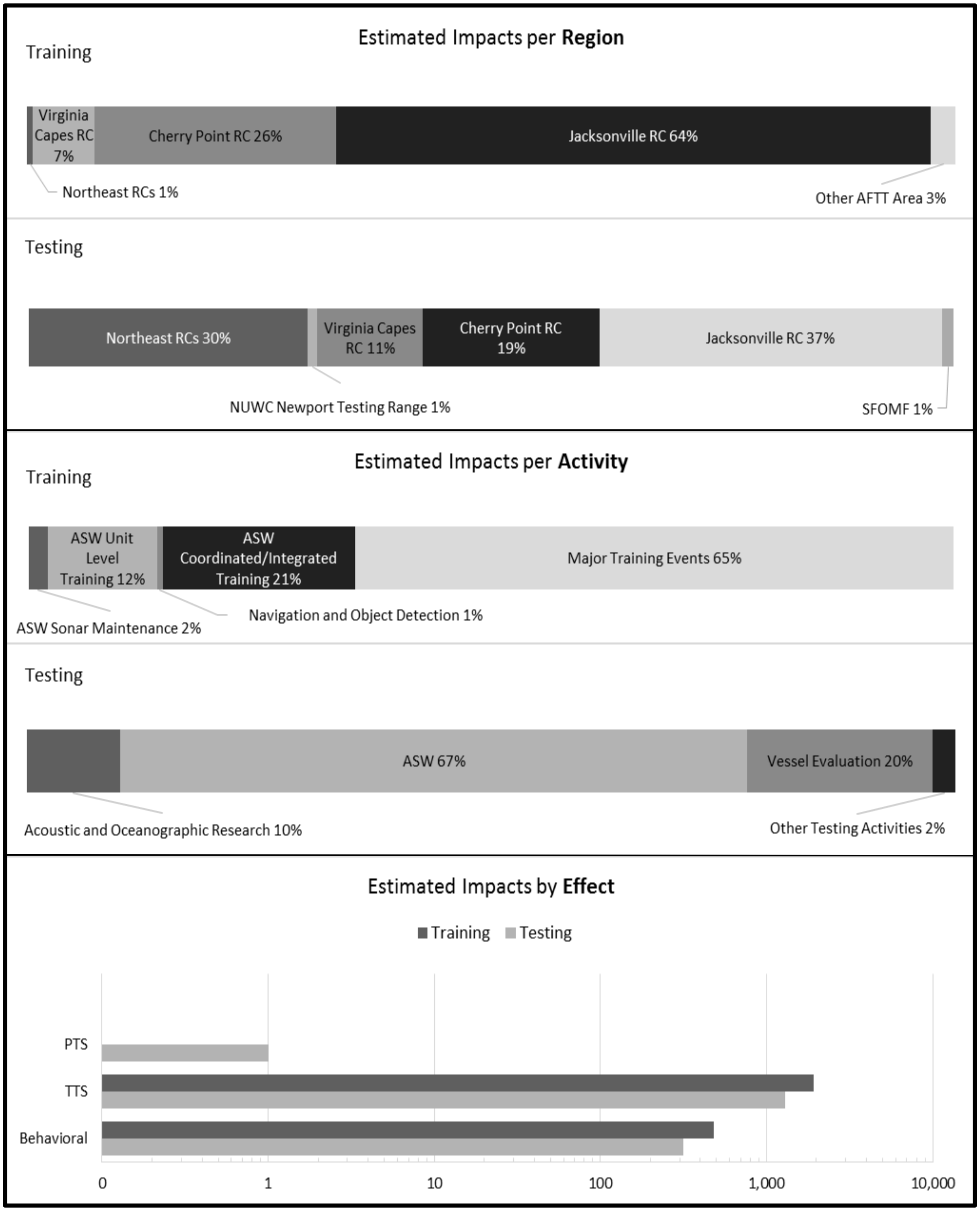
Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Minke Whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6.4-15 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 from Sonar and Other Transducers). Estimated impacts apply to the Canadian East Coast stock.

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 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for minke whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to minke feeding behavior could occur on the minke whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, minke whale reactions to sonar are most likely short-term and moderate; therefore, only few impacts to minke whale feeding behaviors are likely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from testing with sonar and other transducers.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of minke whales incidental to those activities as outlined in Table 5.1-4.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Canadian East Coast Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-15: Minke Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-16 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 from Sonar and Other Transducers). Estimated impacts apply to the Nova Scotia stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for sei whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to sei feeding behavior could occur on the sei whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, sei whale reactions to sonar are most likely short-term and mild to moderate; therefore, significant impacts to sei whale feeding behaviors are unlikely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from training with sonar and other transducers.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of sei whales incidental to those activities as outlined in Table 5.1-3.

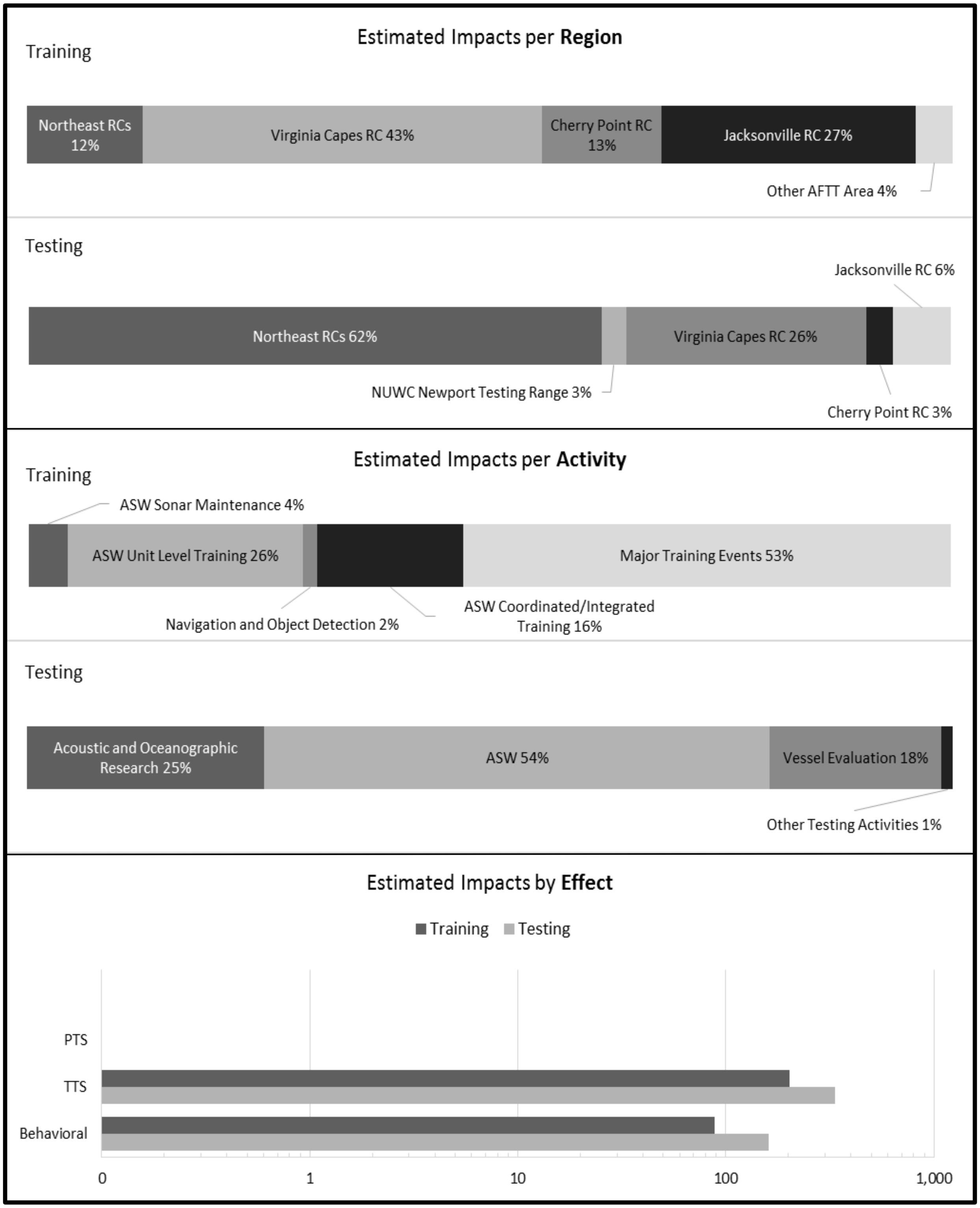
Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Sei whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-16 below and 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 from Sonar and Other Transducers). Estimated impacts apply to the Nova Scotia stock.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for sei whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to sei feeding behavior could occur on the sei whale feeding area identified by LaBrecque et al. (2015a, 2015b). As discussed above, sei whale reactions to sonar are most likely short-term and mild to moderate; therefore, significant impacts to sei whale feeding behaviors are unlikely to occur within the feeding area identified by LaBrecque et al. (2015a, 2015b) from testing with sonar and other transducers.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of sei whales incidental to those activities as outlined in Table 5.1-4.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Nova Scotia Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-16: Sei Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.3 Odontocetes

Odontocetes may be exposed to sound from sonar and other transducers associated with training 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, 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 6.4.2 (Impacts from 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 *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, Behavior Reactions). 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 and testing activities 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 activities and 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 vessel). Coordinated/integrated anti-submarine warfare exercises involve multiple sonar systems and can last for a period of days, making 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 behavior 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 training and testing activities and 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/integrated anti-submarine warfare exercises involve multiple sonar systems and can last for a period of days, making significant response more likely. 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 (Behavior Reactions) discusses these species' observed reactions to sonar and other active acoustic sources. Displaced animals would likely return after the sonar activity subsides within an area, as seen in Blainville's beaked whales in the Bahamas (Tyack et al., 2011) and Hawaii (Henderson et al., 2015; Henderson et al., 2016; Manzano-Roth et al., 2016). This 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 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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-17 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-13).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

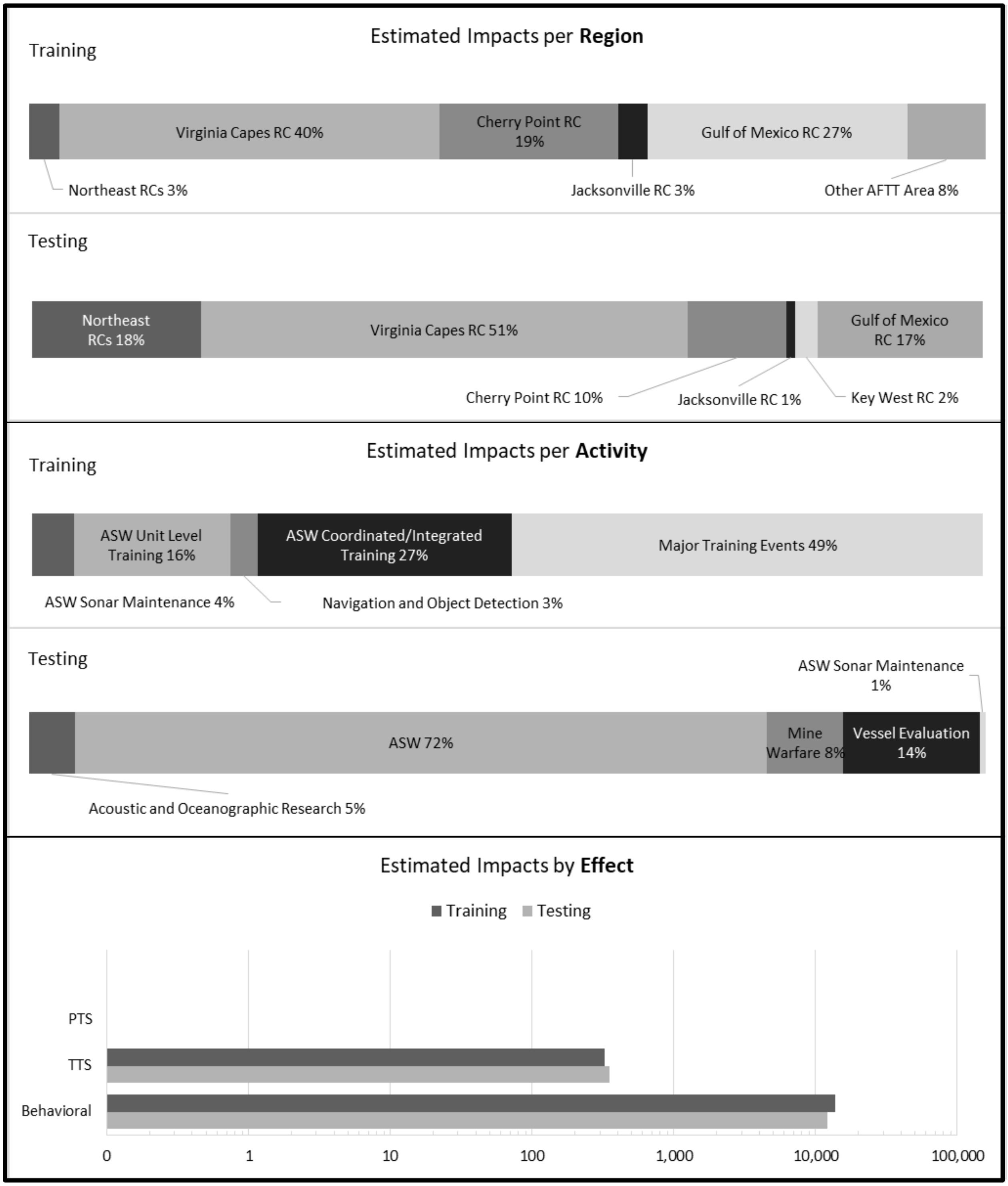
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of sperm whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Sperm whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-17 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-13).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of sperm whales incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-17: Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-13: 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***
Gulf of Mexico Oceanic	27%	18%
North Atlantic	73%	82%

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.

The quantitative analysis predicts a few PTS per year; however, as discussed above for odontocetes overall, Kogia whales would likely avoid sound levels that could cause higher levels of TTS (greater than 20 dB) or PTS. TTS and PTS thresholds for high-frequency cetaceans, including Kogia whales, 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). Kogia whales that do experience hearing loss (i.e., TTS or PTS) from sonar sounds may have 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 Kogia whale had hearing loss, biologically important sounds could be more difficult to detect or interpret. Odontocetes, including Kogia whales, use echolocation clicks to find and capture prey. These echolocation clicks are at frequencies above a few tens of kHz in Kogia whales; therefore, a threshold shift at lower frequencies is unlikely to affect echolocation and should not affect a Kogia whale’s ability to locate prey or rate of feeding.

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Kogia whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS per year under the Proposed Action. See Figure 6.4-18 and Figure 6.4-19 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-14 and Table 6.4-15).

A few minor to moderate TTS or short-term 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, 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

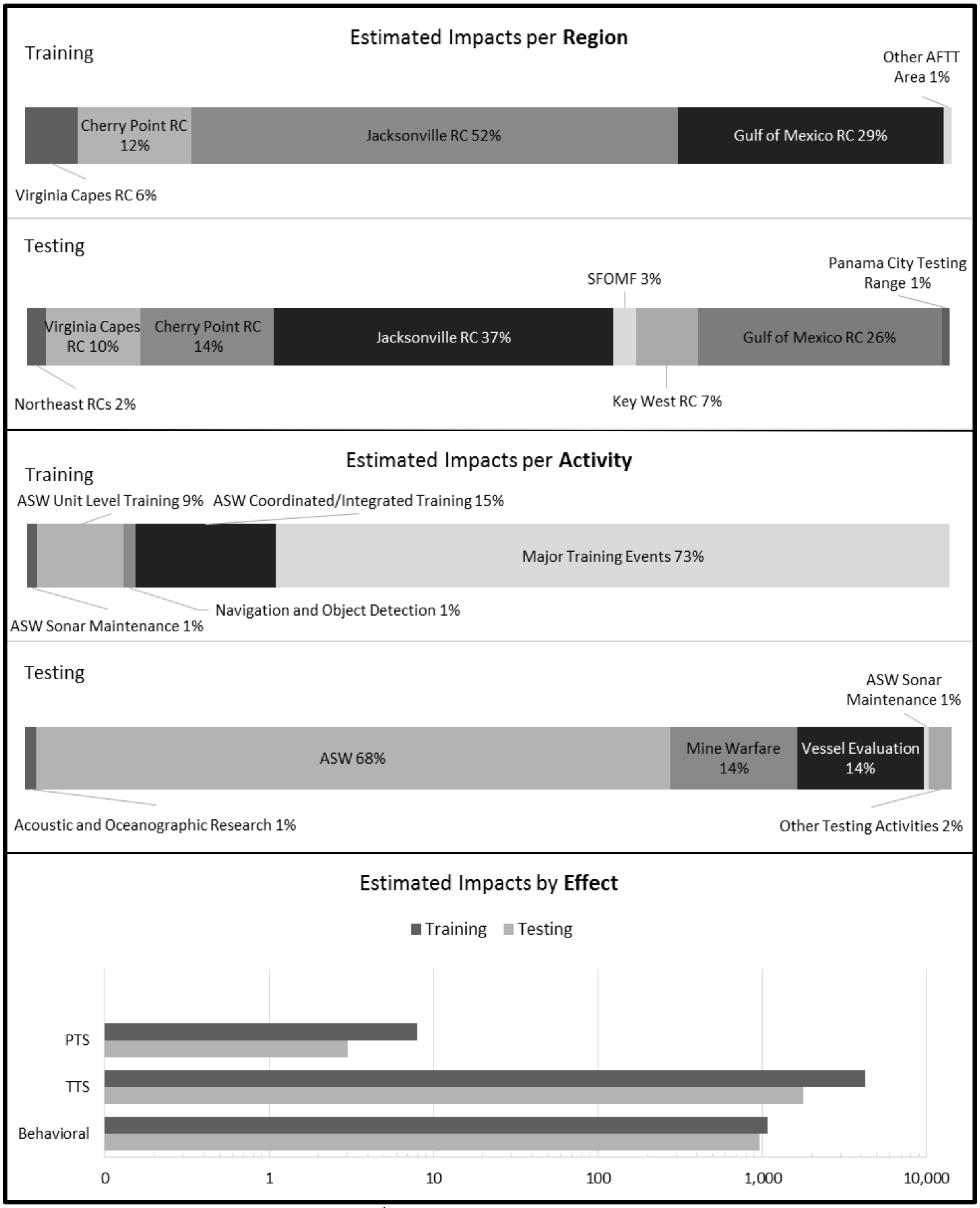
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of Kogia whales (dwarf sperm whales and pygmy sperm whales) incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Kogia whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and a few PTS per year under the Proposed Action. See Figure 6.4-18 and Figure 6.4-19 or (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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-14 and Table 6.4-15).

A few minor to moderate TTS or short-term 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, 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of Kogia whales (dwarf sperm whales and pygmy sperm whales) incidental to those activities as outlined in Table 5.1-4.

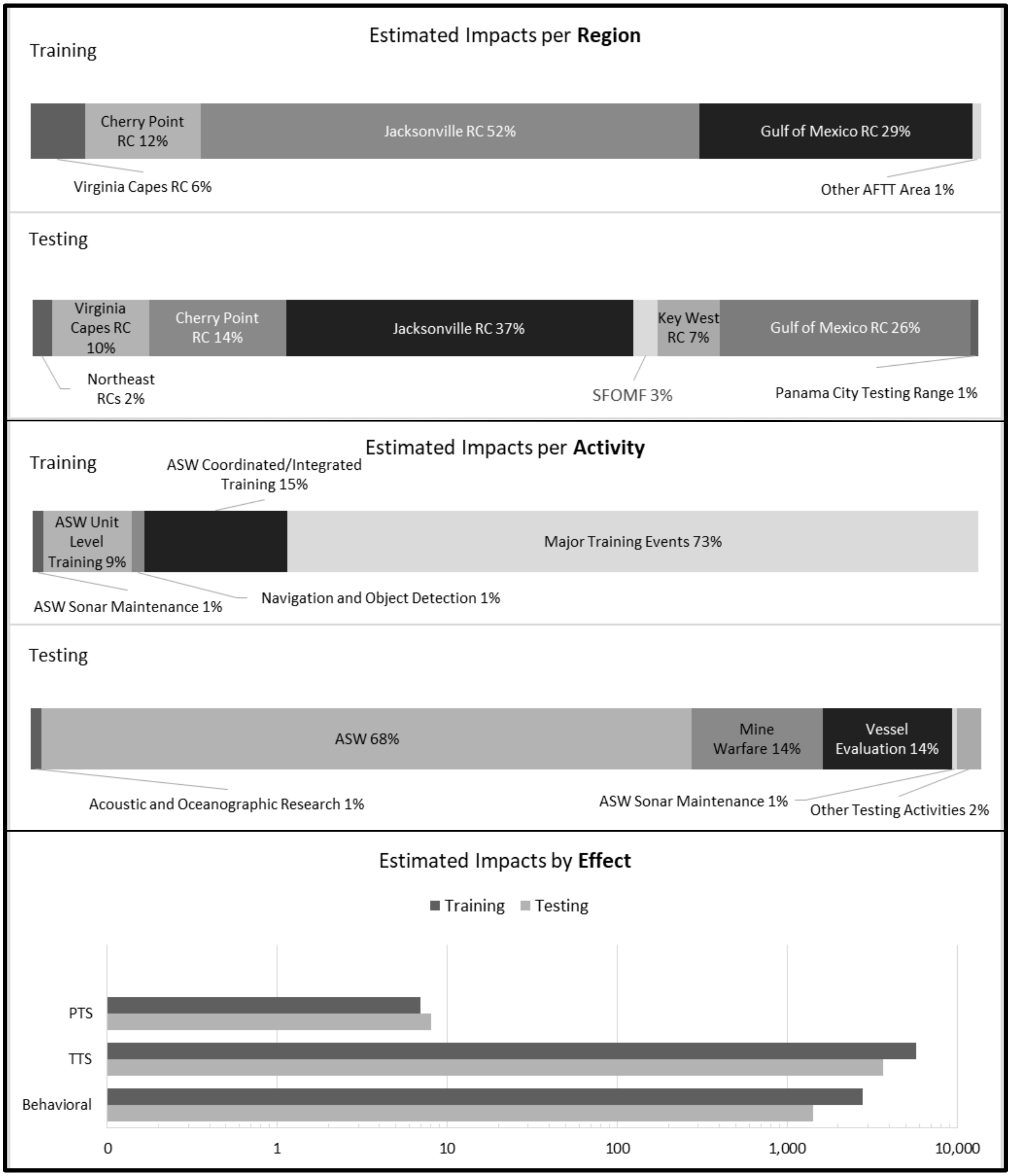


Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-18: Dwarf Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-14: Estimated Impacts on Individual Dwarf 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***
Gulf of Mexico Oceanic	29%	29%
Western North Atlantic	71%	71%



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-19: Pygmy Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-15: Estimated Impacts on Individual Pygmy 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***
Northern Gulf of Mexico	29%	29%
Western North Atlantic	71%	71%

6.4.2.3.3.3 Beaked Whales

Beaked whales are a group of species which within the AFTT Study Area includes: Cuvier's beaked whales, True's beaked whales, Gervais' beaked whales, Sowerby's beaked whales, Blainville's beaked whales, and Northern bottlenose whales.

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. These are 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 range 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 (Henderson et al., 2015; Henderson et al., 2016; Manzano-Roth et al., 2016; 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 that 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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-20 through Figure 6.4-25 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks for Blainville's beaked whales, Cuvier's beaked whales, and Gervais' beaked whales (Table 6.4-16 through Table 6.4-18) and for the Western North Atlantic stock of the Northern bottlenose whale, as well as Sowerby's and True's beaked whales.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of beaked whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Beaked whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-20 through Figure 6.4-25 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks for Blainville's beaked whales, Cuvier's beaked whales, and Gervais' beaked whales (Table 6.4-16 through Table 6.4-18) and for the Western North Atlantic stock of the Northern bottlenose whale, as well as Sowerby's and True's beaked whales .

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of beaked whales incidental to those activities as outlined in Table 5.1-4.

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; RC: Range Complex

Figure 6.4-20: Blainville's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-16: Estimated Impacts on Individual Blainesville's Beaked 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***
Northern Gulf of Mexico	25%	23%
Western North Atlantic	75%	77%

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; RC: Range Complex

Figure 6.4-21: Cuvier's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-17: Estimated Impacts on Individual Cuvier's Beaked Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

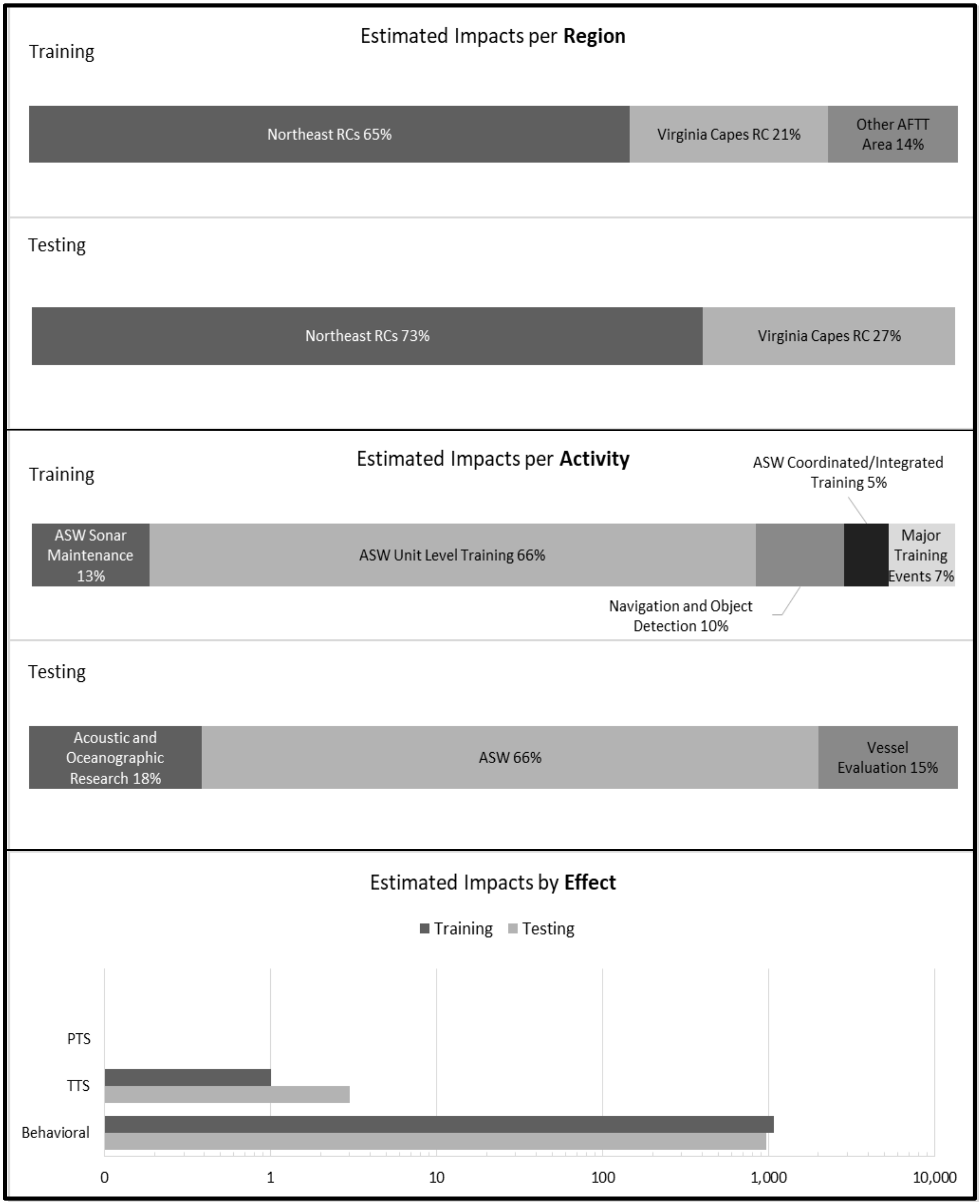
Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Northern Gulf of Mexico	8%	8%
Western North Atlantic	92%	92%

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; RC: Range Complex

Figure 6.4-22: Gervais' Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-18: Estimated Impacts on Individual Gervais' Beaked 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***
Northern Gulf of Mexico	25%	23%
Western North Atlantic	75%	77%



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-23: Northern Bottlenose Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-24: Sowersby's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-25: True's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.3.4 Atlantic Spotted Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Atlantic spotted dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-26 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-19).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of Atlantic spotted dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Atlantic spotted dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-26 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-19).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of Atlantic spotted dolphins incidental to those activities as outlined in Table 5.1-4.

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; RC: Range Complex

Figure 6.4-26: Atlantic Spotted Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-19: Estimated Impacts on Individual Atlantic 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***
Northern Gulf of Mexico	10%	24%
Western North Atlantic	90%	76%

6.4.2.3.3.5 Atlantic White-Sided Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Atlantic white-sided dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-27 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 from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of Atlantic white-sided dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Atlantic white-sided dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-27 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 from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of Atlantic white-sided dolphins incidental to those activities as outlined in Table 5.1-4.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-27: Atlantic White-Sided Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing

6.4.2.3.3.6 Bottlenose Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Bottlenose dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6.4-28 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-20).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

There are 21 small and resident population areas for bottlenose dolphins identified by LaBrecque et al. (2015a, 2015b) which overlap, or are directly adjacent to the, AFTT Study Area. These identified areas are within bays and estuaries where the Navy does not typically train with sonar and other transducers. Bottlenose dolphins in the identified small and resident population areas identified by LaBrecque et al. (2015a, 2015b) would not typically be exposed to sound from sonar and other transducers; therefore, impacts to natural behaviors or abandonment of the area would not be anticipated within the identified bottlenose dolphin small and resident population areas from training with explosives.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of bottlenose dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

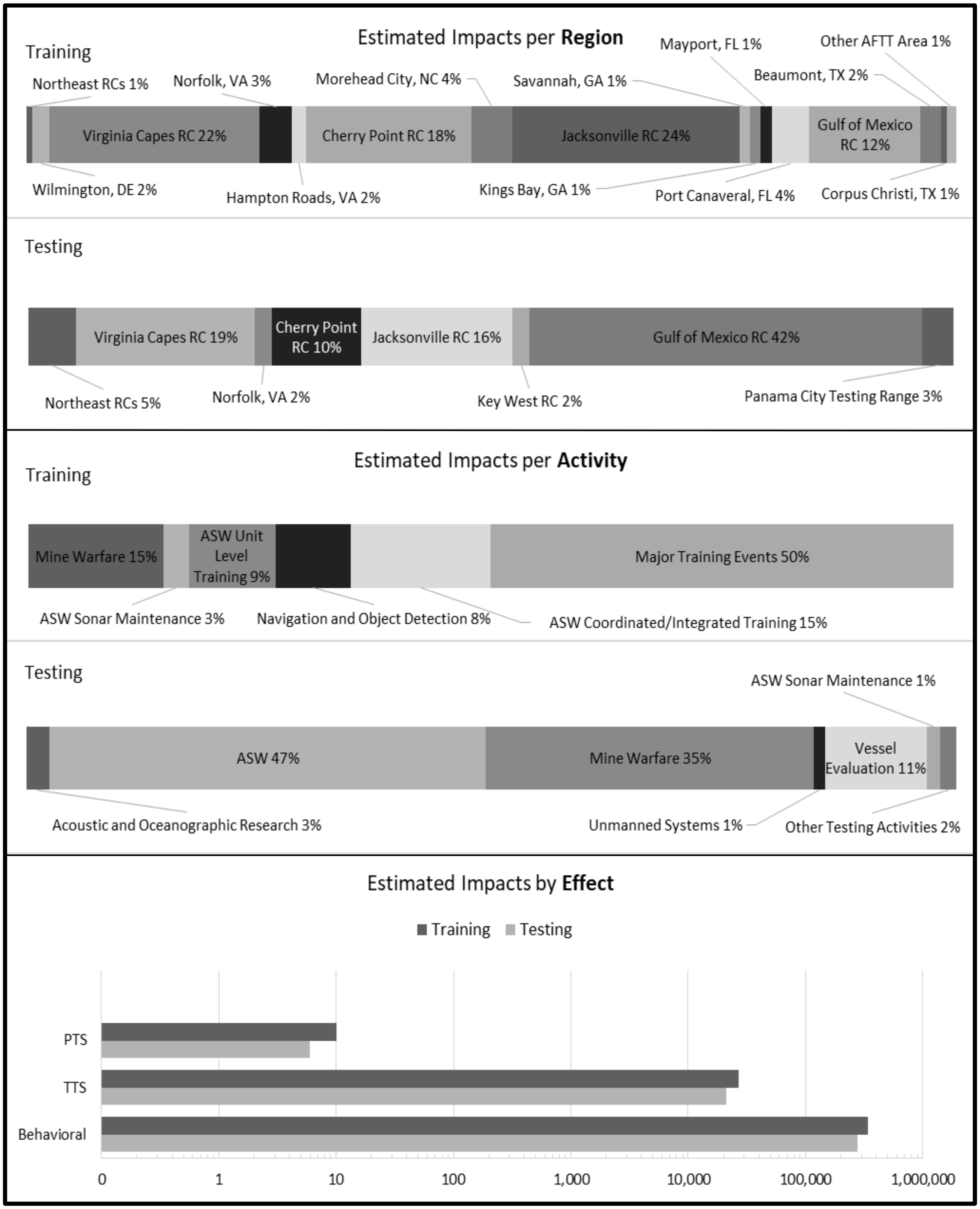
Bottlenose dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6.4-28 or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-20).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

There are 21 small and resident population areas for bottlenose dolphins identified by LaBrecque et al. (2015a, 2015b) which overlap, or are directly adjacent to the, AFTT Study Area. These identified areas are within bays and estuaries where the Navy does not typically test with sonar and other transducers.

Bottlenose dolphins in the identified small and resident population areas identified by LaBrecque et al. (2015a, 2015b) would not typically be exposed to sound from sonar and other transducers; therefore, impacts to natural behaviors or abandonment of the area would not be anticipated within the identified bottlenose dolphin small and resident population areas.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of bottlenose dolphins incidental to those activities as outlined in Table 5.1-4.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-28: Bottlenose Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing

Table 6.4-20: 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***
Gulf of Mexico Northern Coastal	1%	4%
Gulf of Mexico Western Coastal	3%	4%
Northern Gulf of Mexico Continental Shelf	9%	35%
Northern Gulf of Mexico Oceanic	1%	4%
Northern North Carolina Estuarine System	2%	0%
Western North Atlantic Central Florida Coastal	1%	1%
Western North Atlantic Northern Migratory Coastal	3%	5%
Western North Atlantic Offshore	76%	46%
Western North Atlantic South Carolina/ Georgia Coastal	1%	1%
Western North Atlantic Southern Migratory Coastal	3%	2%

6.4.2.3.3.7 Clymene Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Clymene dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-29 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 from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-21).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

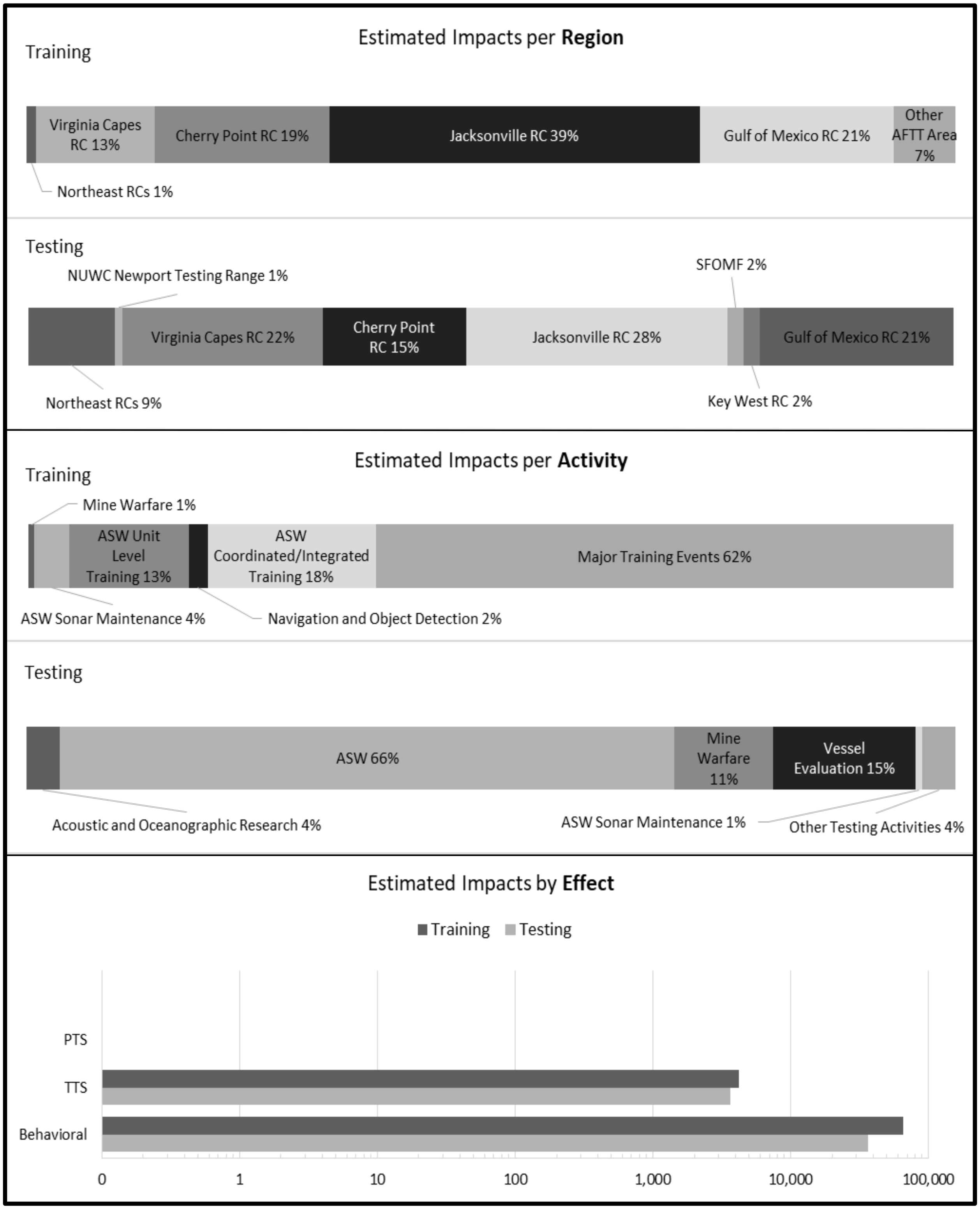
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of clymene dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Clymene dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-29 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-21).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of clymene dolphins incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-29: Clymene Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing

Table 6.4-21: Estimated Impacts on Individual Clymene 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***
Northern Gulf of Mexico	21%	21%
Western North Atlantic	79%	79%

6.4.2.3.3.8 False Killer Whales

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

False killer whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-30 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-22).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

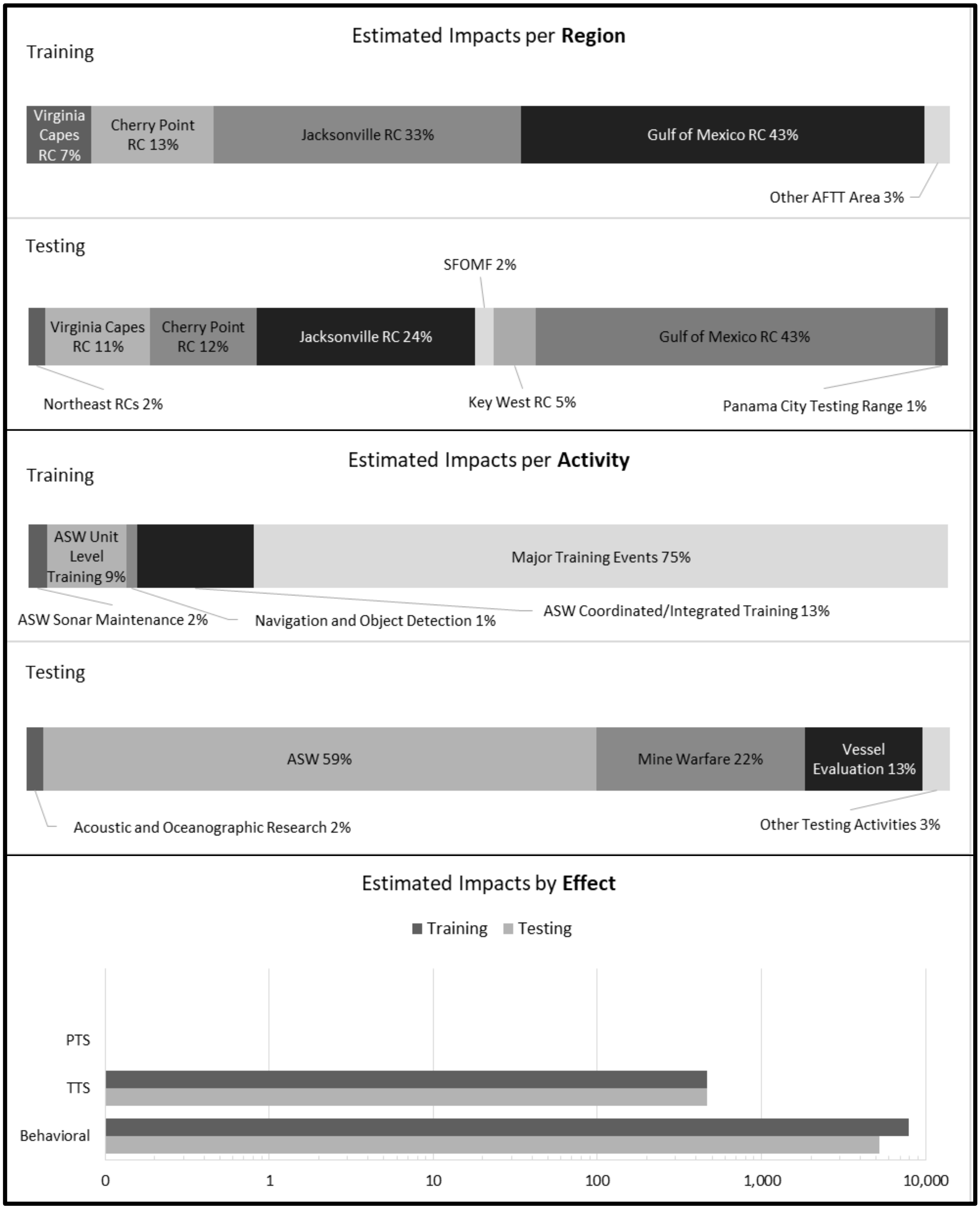
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of false killer whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

False killer whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-30 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-22).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of false killer whales incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-30: False Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-22: 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***
Northern Gulf of Mexico	43%	46%
Western North Atlantic	57%	54%

6.4.2.3.3.9 Fraser's Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Fraser's dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-31 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-23).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

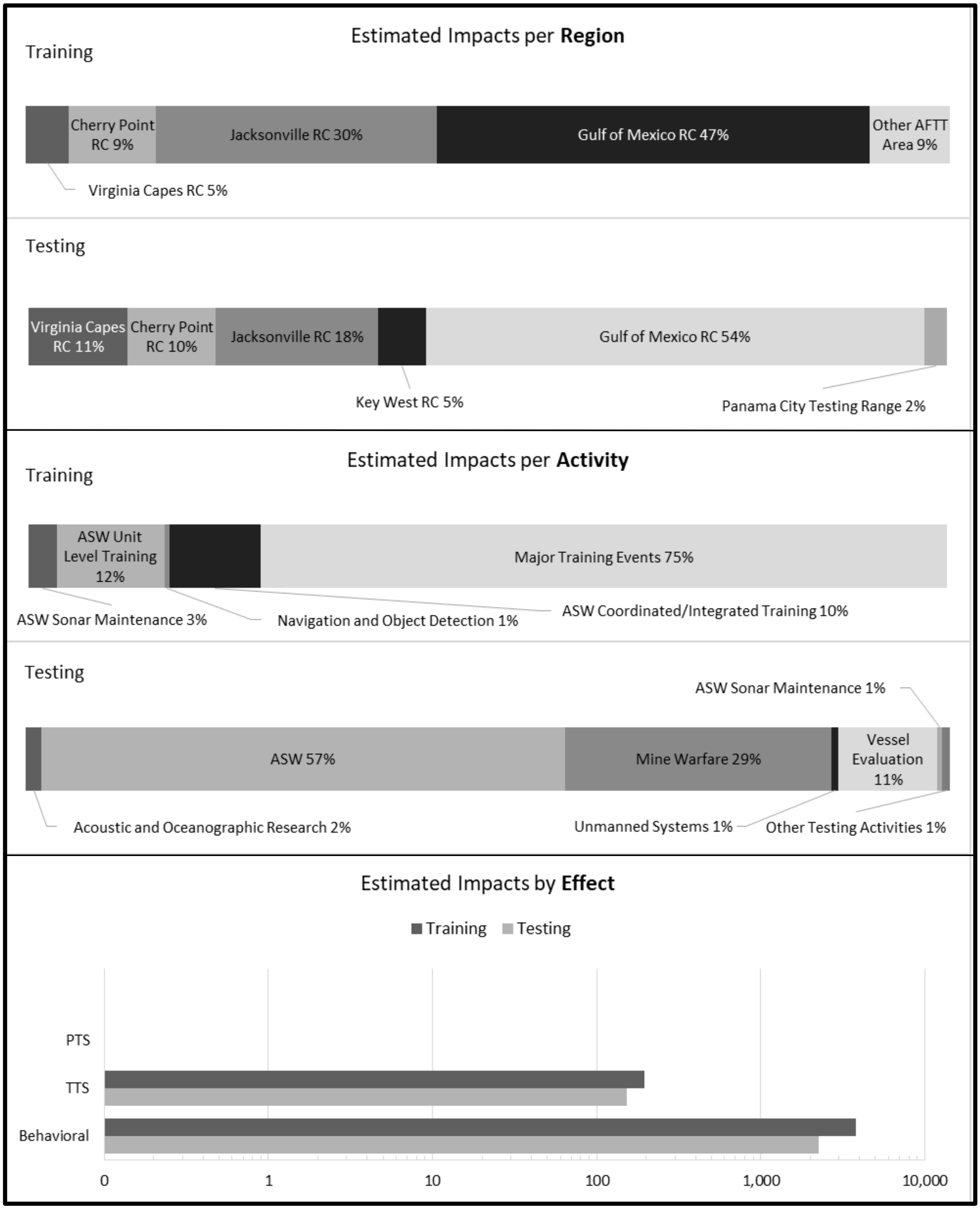
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of Fraser's dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Fraser's dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-31 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-23).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of Fraser's dolphins incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-31: Fraser's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-23: Estimated Impacts on Individual Fraser'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***
Northern Gulf of Mexico	47%	58%
Western North Atlantic	53%	42%

6.4.2.3.3.10 Killer Whales

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Killer whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-32 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-24).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

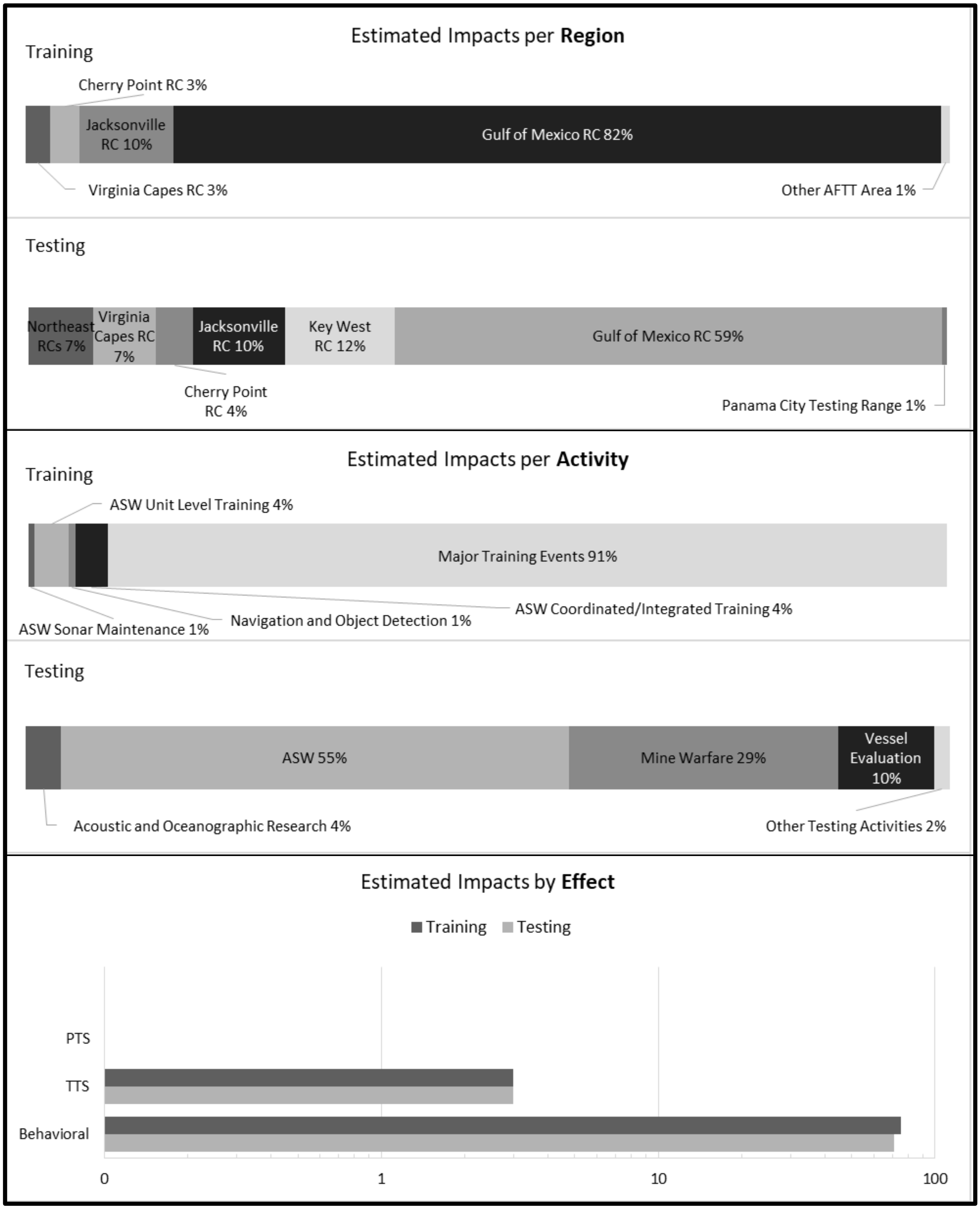
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of killer whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Killer whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-32 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-24).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of killer whales incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-32: Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-24: Estimated Impacts on Individual Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Northern Gulf of Mexico	82%	63%
Western North Atlantic	18%	37%

6.4.2.3.3.11 Melon-Headed Whales

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Melon-headed whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-33 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-25).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

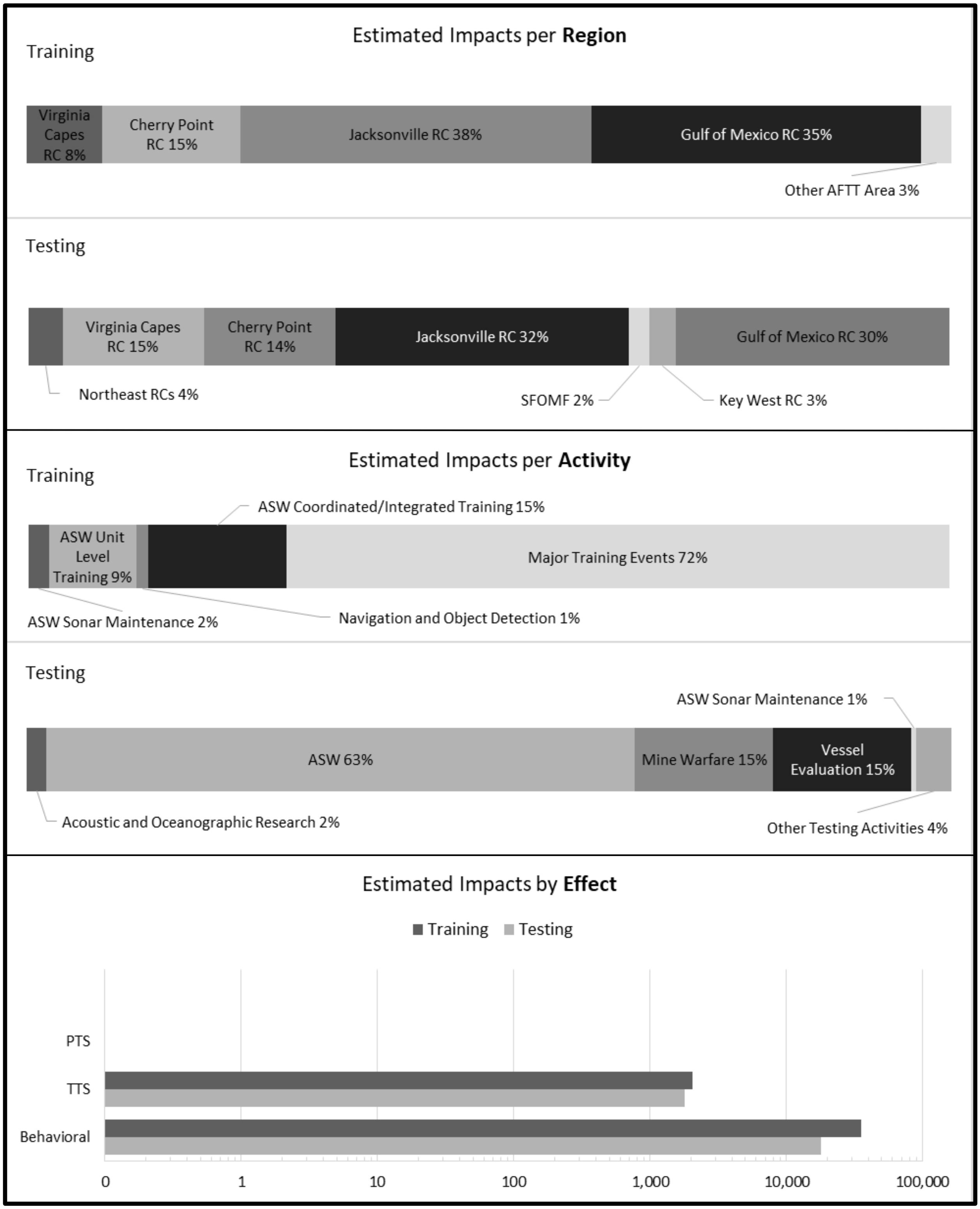
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of melon-headed whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Melon-headed whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-33 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-25).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of melon-headed whales incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-33: Melon-Headed Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-25: 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***
Northern Gulf of Mexico	35%	31%
Western North Atlantic	65%	69%

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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-34 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-26).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of pantropical spotted dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Pantropical spotted dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-34 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-26).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of pantropical spotted dolphins incidental to those activities as outlined in Table 5.1-4.

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; RC: Range Complex

Figure 6.4-34: Pantropical Spotted Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-26: 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***
Northern Gulf of Mexico	59%	42%
Western North Atlantic	41%	58%

6.4.2.3.3.13 Pilot Whales

Pilot whales include two species that are often difficult to distinguish from one another: long-finned pilot whales and short-finned pilot whales.

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Pilot whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action for both long-finned and short-finned pilot whales. See Figure 6.4-35 and Figure 6.4-36 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stock of long-finned pilot whales and multiple stocks of short-finned pilot whales (see Table 6.4-27).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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

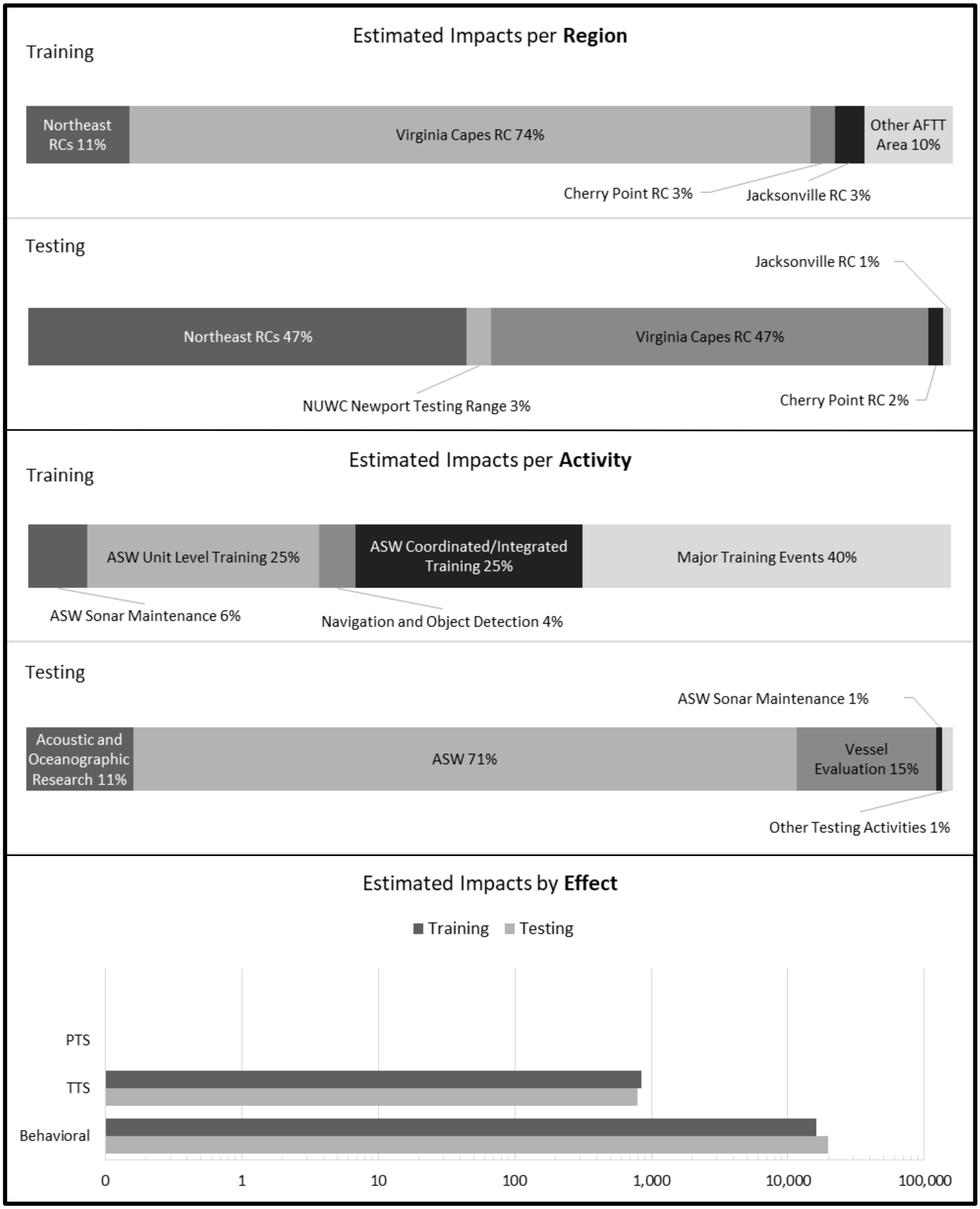
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of pilot whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Pilot whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action for both long-finned and short-finned pilot whales. See Figure 6.4-35 and Figure 6.4-36 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stock of long-finned pilot whales and multiple stocks of short-finned pilot whales (see Table 6.4-27).

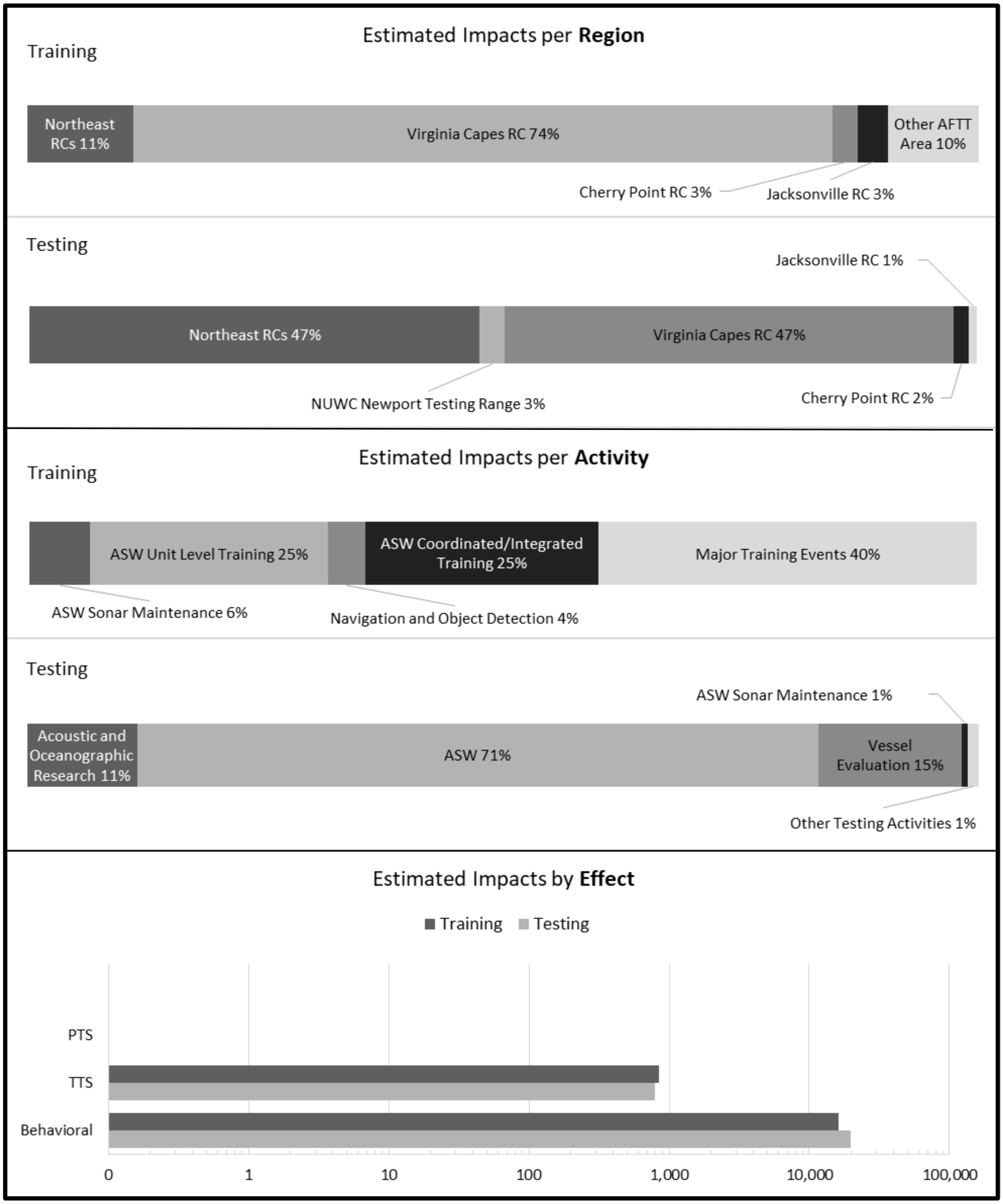
As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of pilot whales incidental to those activities as outlined in Table 5.1-4.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-35: Long-Finned Pilot Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.



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; RC: Range Complex

Figure 6.4-36: Short-finned Pilot Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-27: 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***
Northern Gulf of Mexico	12%	20%
Western North Atlantic	88%	80%

6.4.2.3.3.14 Pygmy Killer Whales

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Pygmy killer whales may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-37 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-28).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

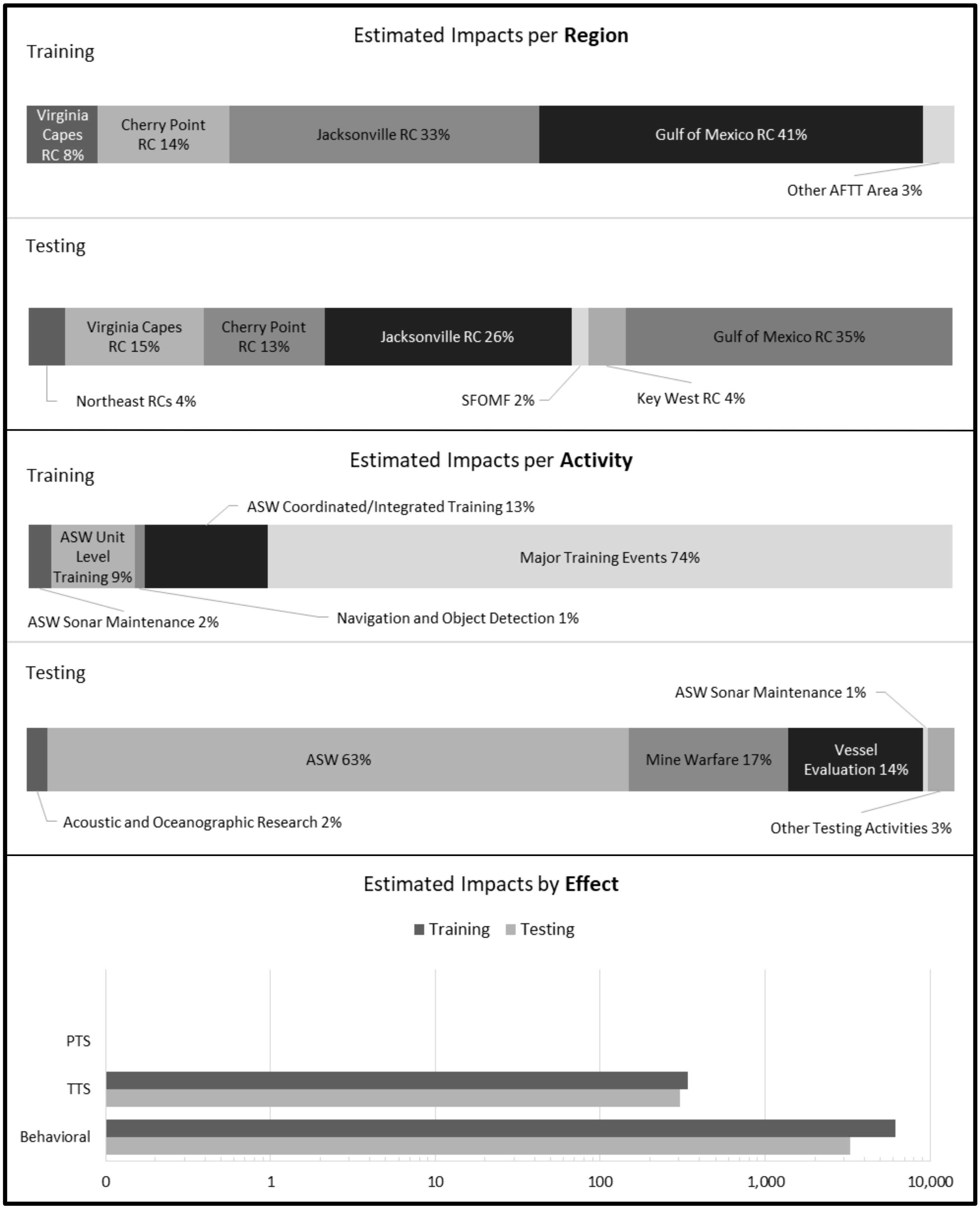
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of pygmy killer whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Pygmy killer whales may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-37 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-28).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of pygmy killer whales incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-37: Pygmy Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Trainingand Testing.

Table 6.4-28: 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***
Northern Gulf of Mexico	41%	36%
Western North Atlantic	59%	64%

6.4.2.3.3.15 Risso's Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Risso's dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-38 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-29).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

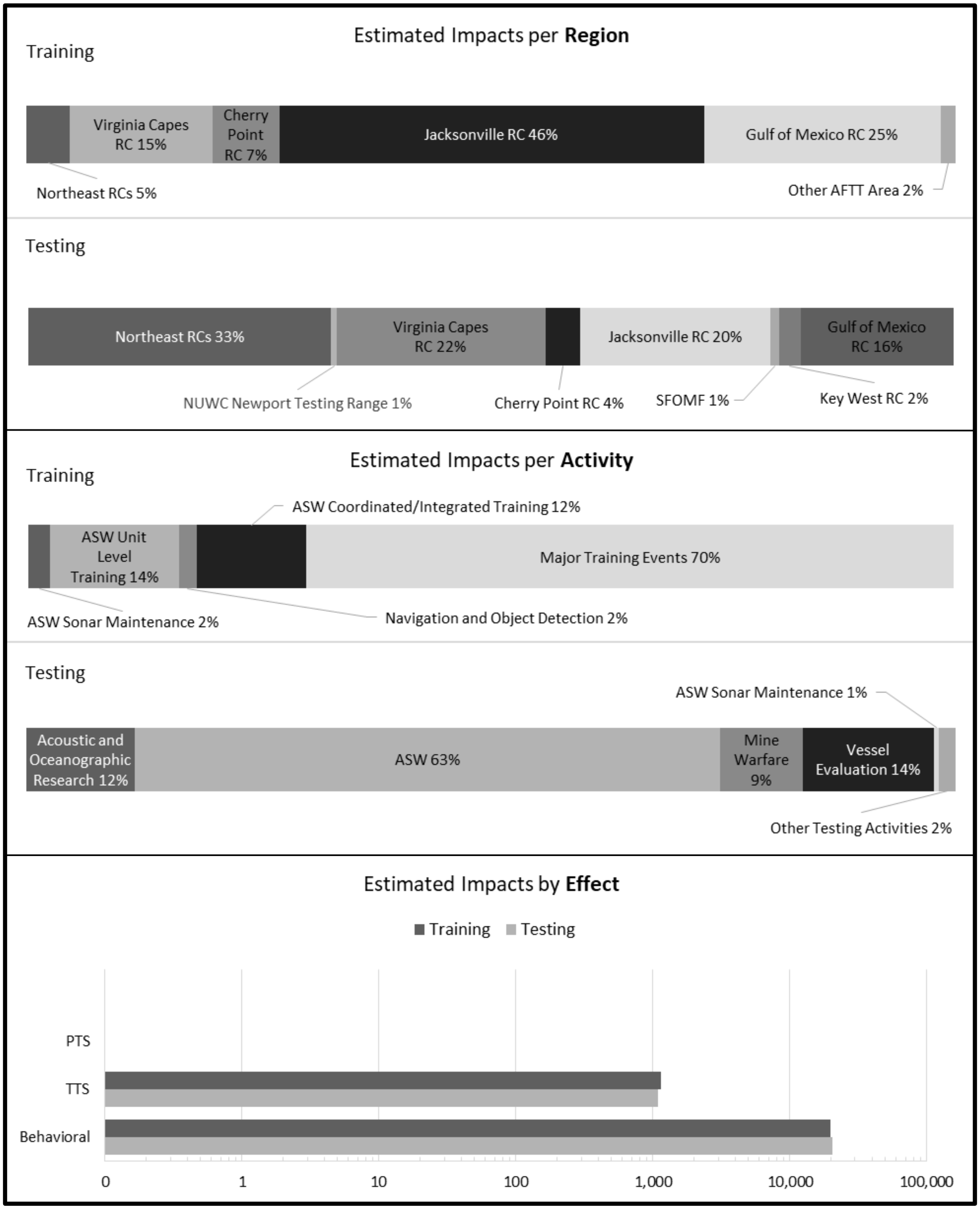
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of Risso's dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Risso's dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-38 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-29).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of Risso's dolphins incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-38: Risso's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used during Training and Testing.

Table 6.4-29: 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***
Northern Gulf of Mexico	25%	18%
Western North Atlantic	75%	82%

6.4.2.3.3.16 Rough-Toothed Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Rough-toothed dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-39 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-30).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

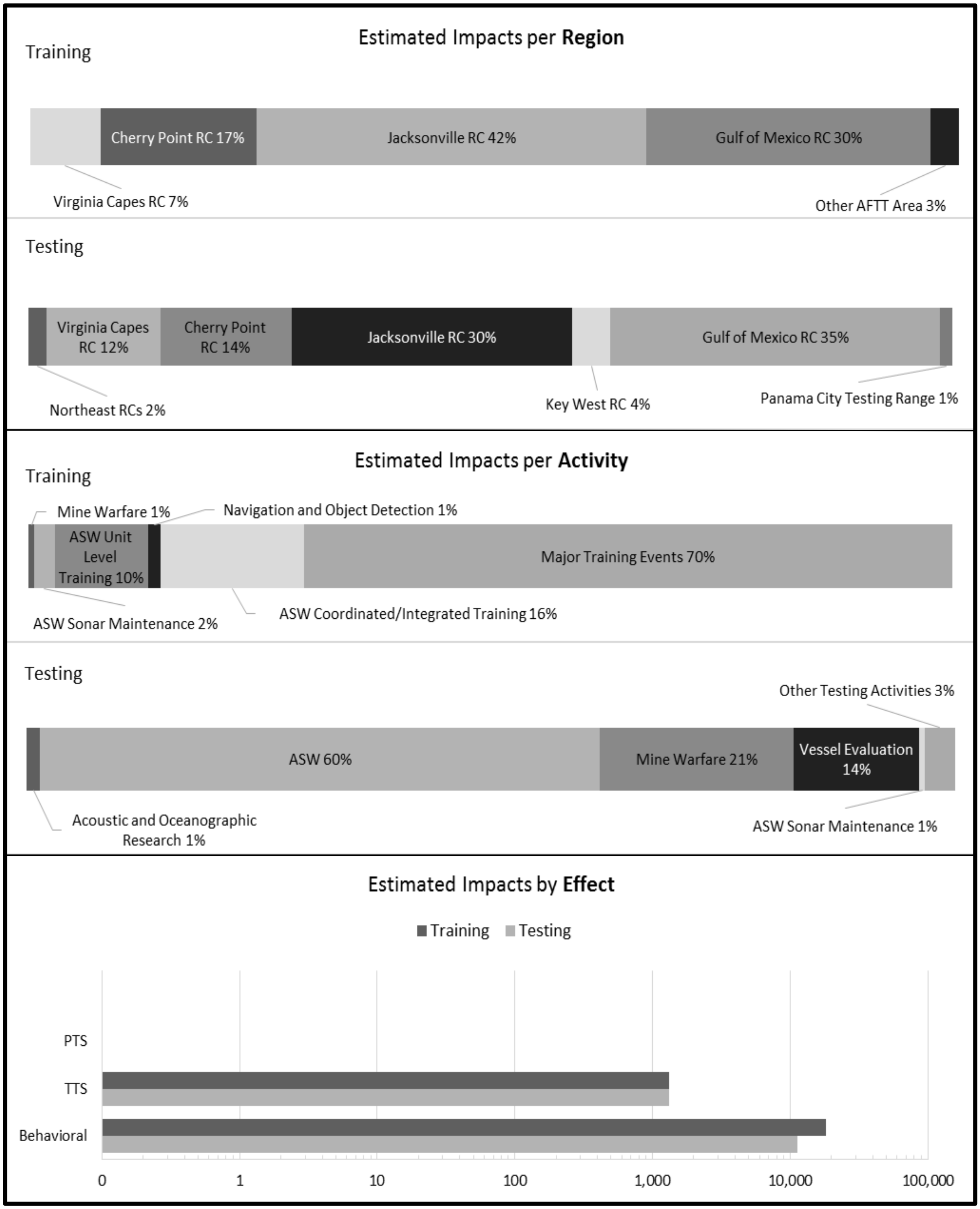
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of rough-toothed dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Rough-toothed dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-39 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-30).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of rough-toothed dolphins incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-39: Rough-Toothed Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-30: Estimated Impacts on Individual Rough-Toothed 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***
Northern Gulf of Mexico	30%	37%
Western North Atlantic	70%	63%

6.4.2.3.3.17 Short-Beaked Common Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Short-beaked common dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-40 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of short-beaked common dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Short-beaked common dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-40 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of short-beaked common dolphins incidental to those activities as outlined in Table 5.1-4.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-40: Short-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-41 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-31).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of spinner dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Spinner dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-41 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-31).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of spinner dolphins incidental to those activities as outlined in Table 5.1-4.

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; RC: Range Complex

Figure 6.4-41: Spinner Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-31: 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***
Northern Gulf of Mexico	56%	38%
Western North Atlantic	44%	62%

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 sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-42 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-32).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

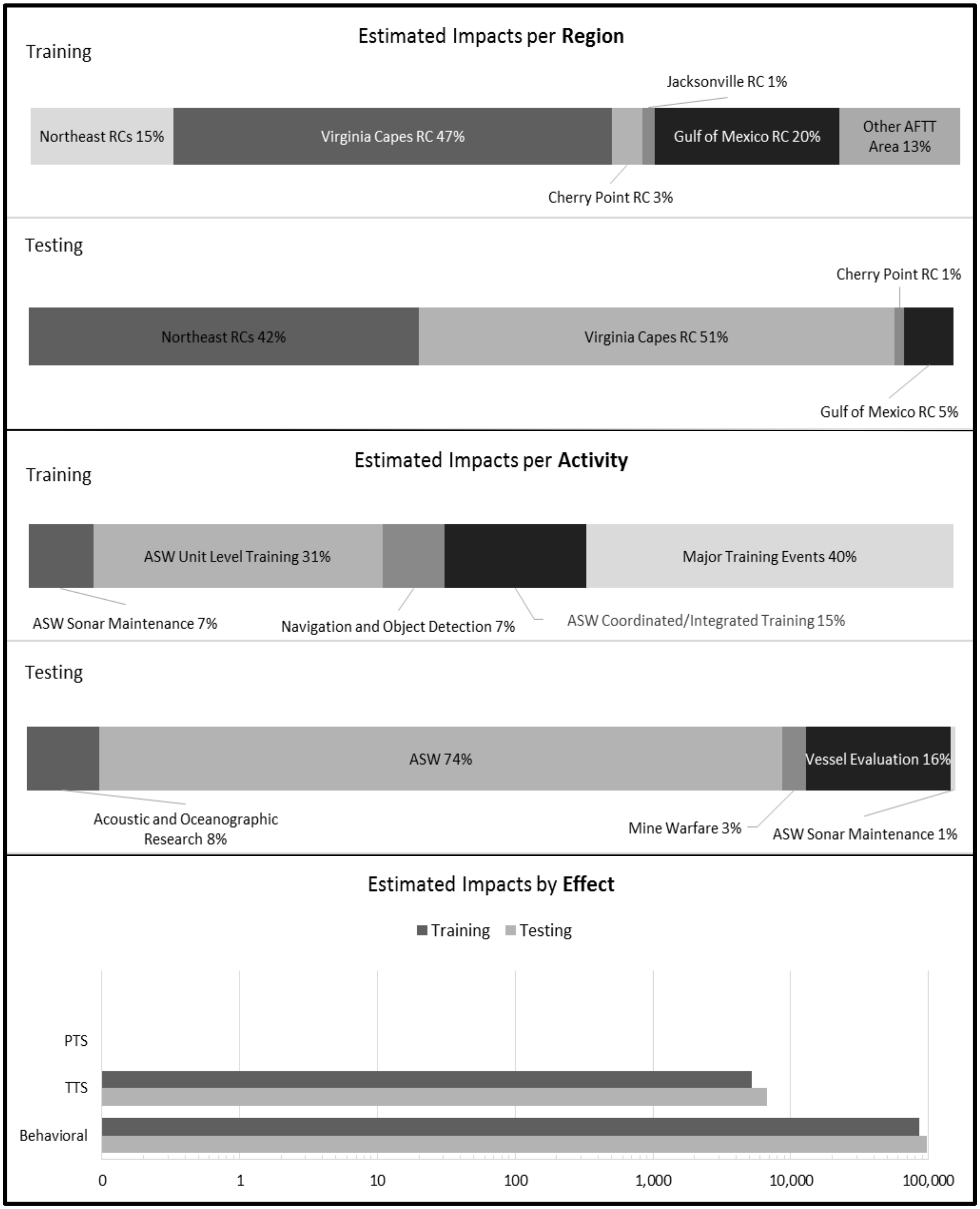
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of striped dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Striped dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-42 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6.4-32).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of striped dolphins incidental to those activities as outlined in Table 5.1-4.



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; RC: Range Complex

Figure 6.4-42: Striped Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

Table 6.4-32: 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***
Northern Gulf of Mexico	20%	5%
Western North Atlantic	80%	95%

6.4.2.3.3.20 White-Beaked Dolphins

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

White-beaked dolphins may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-43 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

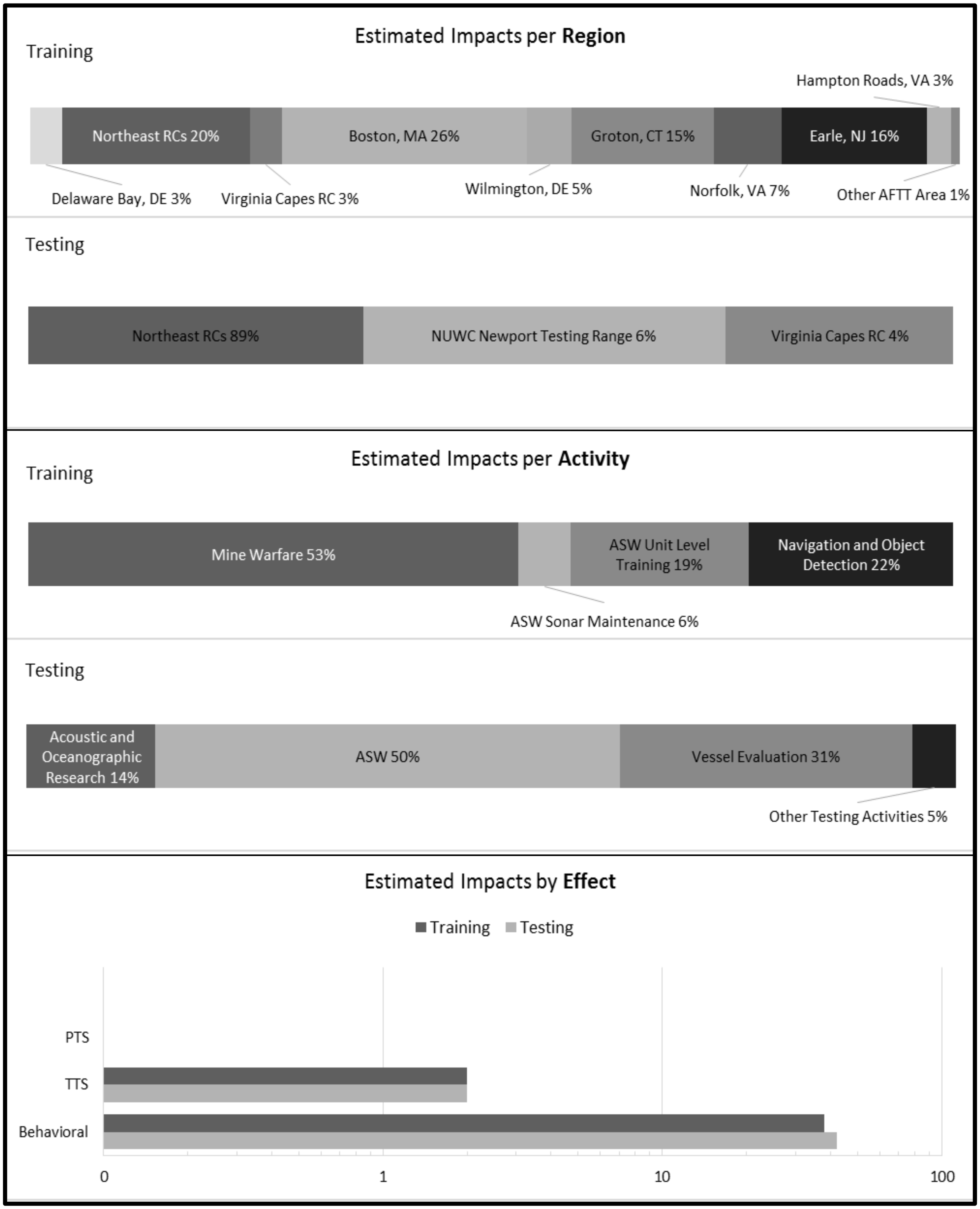
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of white-beaked dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

White-beaked dolphins may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6.4-43 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of white-beaked dolphins incidental to those activities as outlined in Table 5.1-4.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-43: White-Beaked Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.3.21 Harbor Porpoises

Harbor porpoise 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 (i.e., a few minutes to a few hours). The quantitative analysis predicts a few PTS per year; however, as discussed above, marine mammals would likely avoid sound levels that could cause higher levels of TTS (greater than 20 dB) or PTS. TTS and PTS thresholds for high-frequency cetaceans, including Harbor porpoise, 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). Harbor porpoises are particularly sensitive to human-made noise and disturbance and will avoid sound levels between 120 and 140 dB re 1 µPa at distances up to 30 km for more intense activities (as discussed below). This means that the quantitative analysis greatly overestimates hearing loss in harbor porpoises because most animals would avoid sound levels that could cause TTS or PTS. Harbor porpoises that do experience hearing loss (i.e., TTS or PTS) from sonar sounds may have 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 harbor porpoise had hearing loss, biologically important sounds could be more difficult to detect or interpret. Harbor porpoises use echolocation clicks, which are at frequencies above 100 kHz, to find and capture prey. Therefore, echolocation is unlikely to be affected by a threshold shifts at lower frequencies and should not affect a harbor porpoise's ability to locate prey or rate of feeding.

Research and observations (see Section 6.4.1.5, Behavioral Reactions) of harbor porpoises show that this small species is very wary of human activity and will avoid anthropogenic sound sources in many situations at levels down to 120 dB re 1 µPa. This level was determined by observing harbor porpoise reactions to acoustic deterrent and harassment devices used to drive away animals from around fishing nets and aquaculture facilities. Avoidance distances typically were about 1 km or more to these low-level acoustic sources (i.e., transducers). It is unlikely that animals would react similarly if the sound source were at a distance of tens of kilometers based on observed responses to seismic noise extending at most to 30 km. Harbor porpoises may startle and leave the immediate area of the anti-submarine warfare training exercise but return within a few days after the cessation of the event. Significant behavioral reactions seem more likely than with most other odontocetes. Since these species are typically found in nearshore and inshore habitats, animals that are resident during all or part of the year near Navy ports or fixed ranges could receive multiple exposures over a short period and throughout the year. Animals that do exhibit a significant behavioral reaction would likely recover from any incurred costs, reducing the likelihood of long-term consequences for the individual or population.

<u>**Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities**</u>

Harbor porpoises may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and a few PTS per year under the Proposed Action. See Figure 6.4-44 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Gulf of Maine/Bay of Fundy 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 harbor 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 implemented 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 harbor porpoises identified by LaBrecque et al. (2015a, 2015b) overlaps a portion of the northeast corner of the Northeast Range Complexes. Navy training activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to harbor porpoise behavior could occur within the small and resident population area identified by LaBrecque et al. (2015a, 2015b). As discussed above, harbor porpoise reactions to sonar could be significant in some cases. Due to the limited overlap of the identified harbor porpoise area and the Northeast Range Complexes, only a subset of estimated behavioral reactions would occur within the identified harbor porpoise small and resident population area. It is unlikely that these behavioral reactions would have significant impacts on the natural behavior of harbor porpoises or cause abandonment of the harbor porpoise small and resident population area identified by LaBrecque et al. (2015a, 2015b).

The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of harbor porpoises incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Harbor porpoises may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and a few PTS per year under the Proposed Action. See Figure 6.4-44 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Gulf of Maine/Bay of Fundy 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 harbor 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 implemented 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 harbor porpoises identified by LaBrecque et al. (2015a, 2015b) overlaps a portion of the northeast corner of the Northeast Range Complexes. Navy testing activities that use sonar and other transducers could occur year round within the Northeast Range Complexes. Impacts to harbor porpoise behavior could occur within the small and resident population area identified by LaBrecque et al. (2015a, 2015b). As discussed above, harbor porpoise reactions to sonar could be significant in some cases. Due to the limited overlap of the identified harbor porpoise area and the Northeast Range Complexes, only a subset of estimated behavioral reactions would occur within the identified harbor porpoise small and resident population area. It is unlikely that these behavioral reactions would have significant impacts on the natural behavior of harbor porpoises or cause abandonment of the harbor porpoise small and resident population area identified by LaBrecque et al. (2015a, 2015b).

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of harbor porpoises incidental to those activities as outlined in Table 5.1-4.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% Gulf of Maine/Bay of Fundy Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-44: Harbor Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

6.4.2.3.4 Phocid Seals

Phocid seals in AFTT Study Area include harbor seals, gray seals, harp seals, and hooded seals.

Phocid seals may be exposed to sound from sonar and other transducers associated with training 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 phocid seals (see Section 6.3, 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.

A few behavioral reactions in phocid seals 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 6.4-1 Background, 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. Almost all of the impacts estimated by the quantitative assessment are due to navigation and object avoidance (detection) activities in navigation lanes entering Groton, Connecticut. Navigation and object avoidance (detection) activities normally involve a single ship or submarine using a limited amount of sonar, therefore significant reaction are unlikely, especially in phocid seals. Research shows that pinnipeds in the water are generally tolerant of human made sound and activity (see Section 6.4.1.5, Behavioral Reactions). If seals 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. Seals 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. The use of sonar from navigation and object avoidance in Groton, Connecticut likely exposes the same sub-population of animals multiple times throughout the year. However, as discussed above phocid seals do not appear sensitive to sound in the water so few of the impacts estimated by the quantitative analysis are likely to be significant. Significant behavioral reactions would not be expected in most cases, and long-term consequences for individual seals from a single or several impacts per year are unlikely.

Behavioral research indicates that most phocid seals 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 phocid seal had TTS, social calls from conspecifics could be more difficult to detect or interpret. Killer whales are a primary predator of phocid seals. Some TTS could make killer whale calls more difficult to detect at further ranges until hearing recovers. Phocid seals probably use sound and vibrations to find and capture prey underwater. Therefore, it could be more difficult for phocid seals 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 phocid seals. Many anti-submarine warfare (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 phocid seals due to exposure to sonar used during anti-submarine warfare activities. Phocid seals 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 phocid seals 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, phocid seals 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. Phocid seals probably use sound and vibrations to find and capture prey underwater. Therefore, it could be more difficult for phocid seals 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 phocid per year are unlikely to have any long-term consequences for that individual.

Impacts from Sonar and Other Transducers Under the Proposed Action for Training Activities

Phocid seals may be exposed to sound from sonar and other transducers used during training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS, and some PTS for harp seals, under the Proposed Action. See Figure 6.4-45 through Figure 6.4-48 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stocks of gray, harbor, harp, and hooded seals.

A few minor to moderate TTS or behavioral reactions 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.

It is likely that the same sub-population of seals that are resident during all or part of the year at Groton, Connecticut are exposed to navigation and object detection (avoidance) sonar and other transducers multiple times per year; however, phocid seals are likely to only have minor and short-term behavioral reactions to these types of activities. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

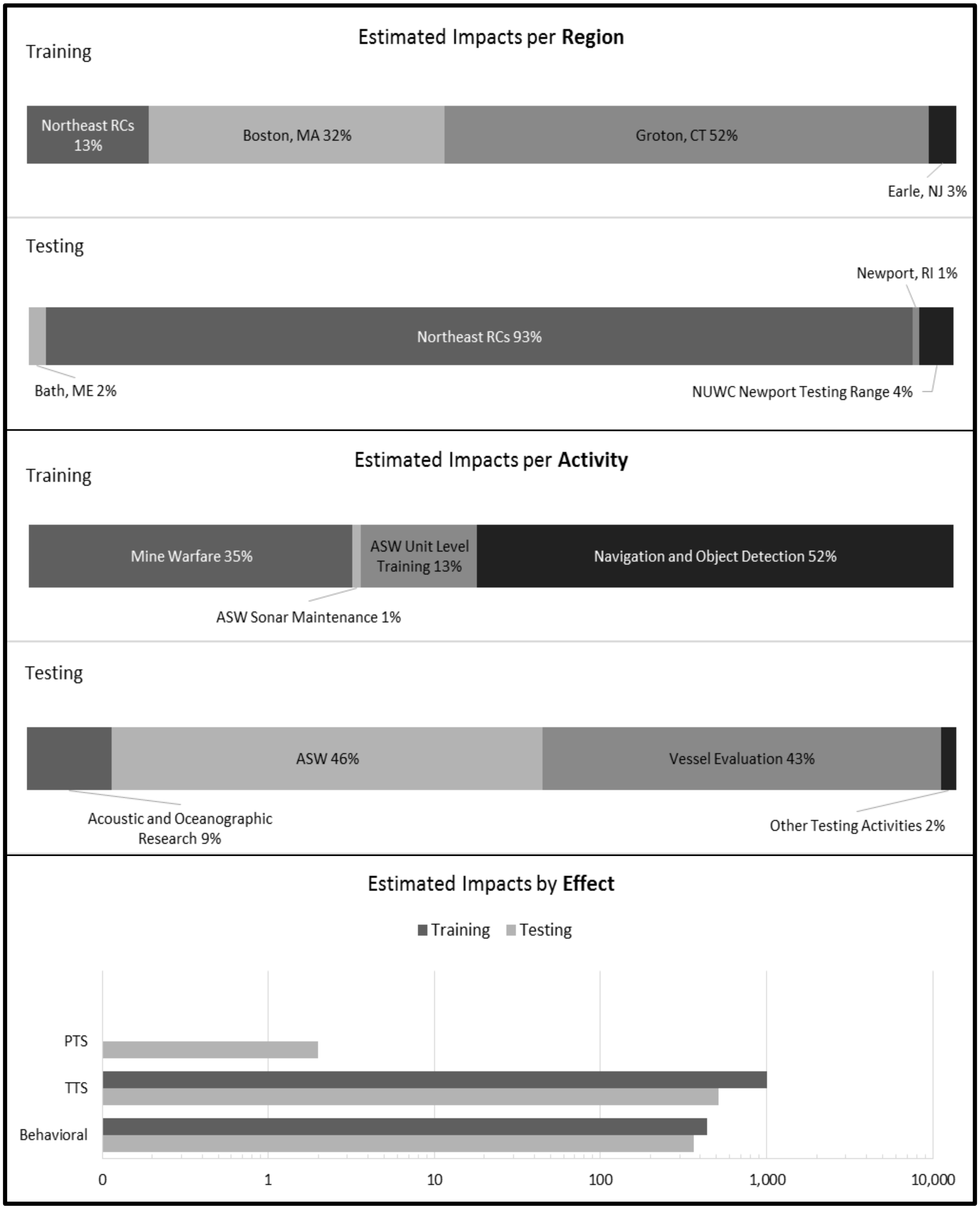
The use of sonar and other transducers during training activities as described under the Proposed Action may result in the unintentional taking of phocid seals incidental to those activities as outlined in Table 5.1-3.

Impacts from Sonar and Other Transducers Under the Proposed Action for Testing Activities

Phocid seals may be exposed to sound from sonar and other transducers used during testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS for gray and harbor seals, and behavioral reactions and TTS for harp and hooded seals under the Proposed Action. See Figure 6.4-45 through Figure 6.4-48 or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to the Western North Atlantic stocks of gray, harbor, harp, and hooded seals.

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of sonar and other transducers during testing activities as described under the Proposed Action may result in the unintentional taking of phocid seals incidental to those activities as outlined in Table 5.1-4.

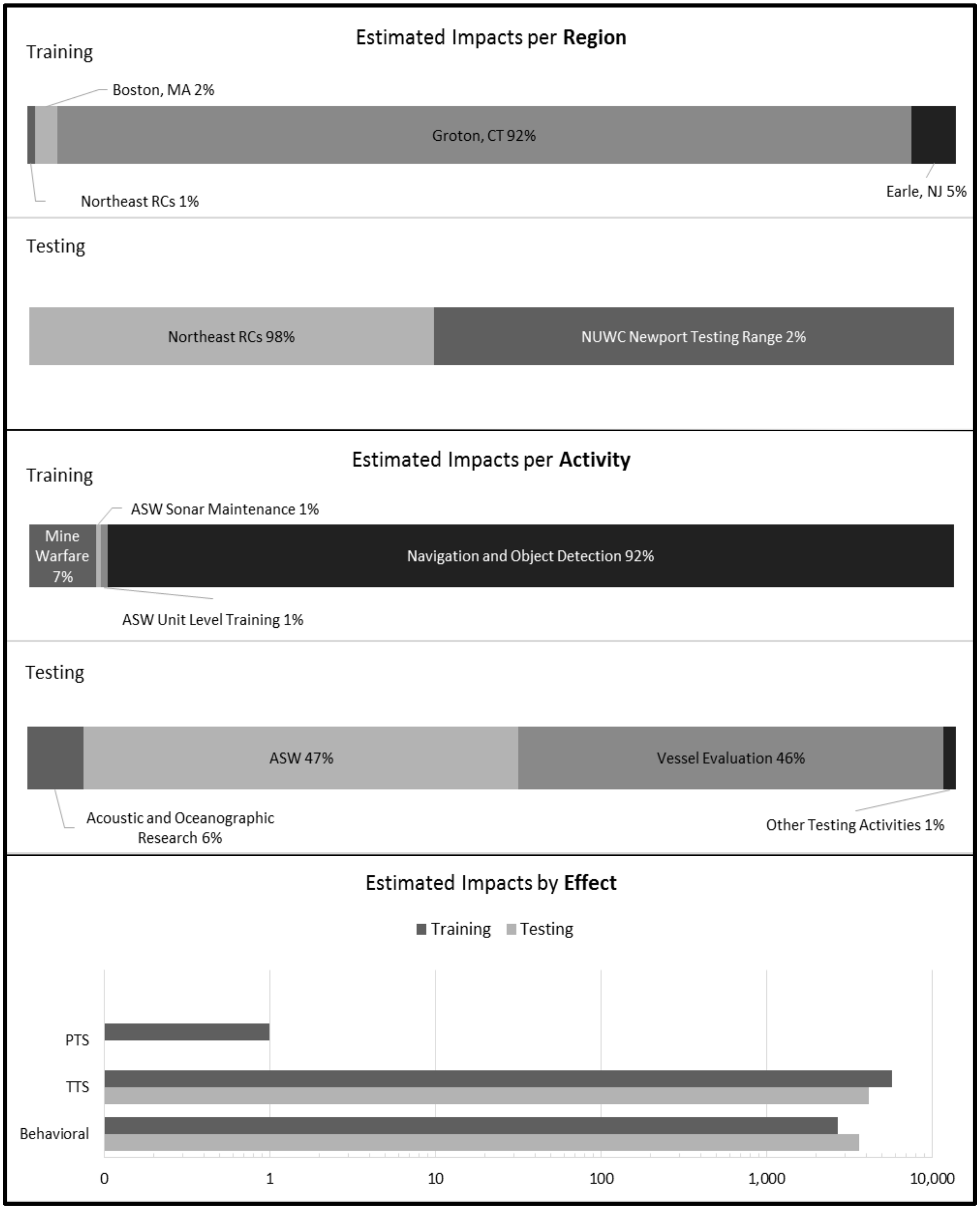


Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% Western North Atlantic Stock.
ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-45: Gray Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

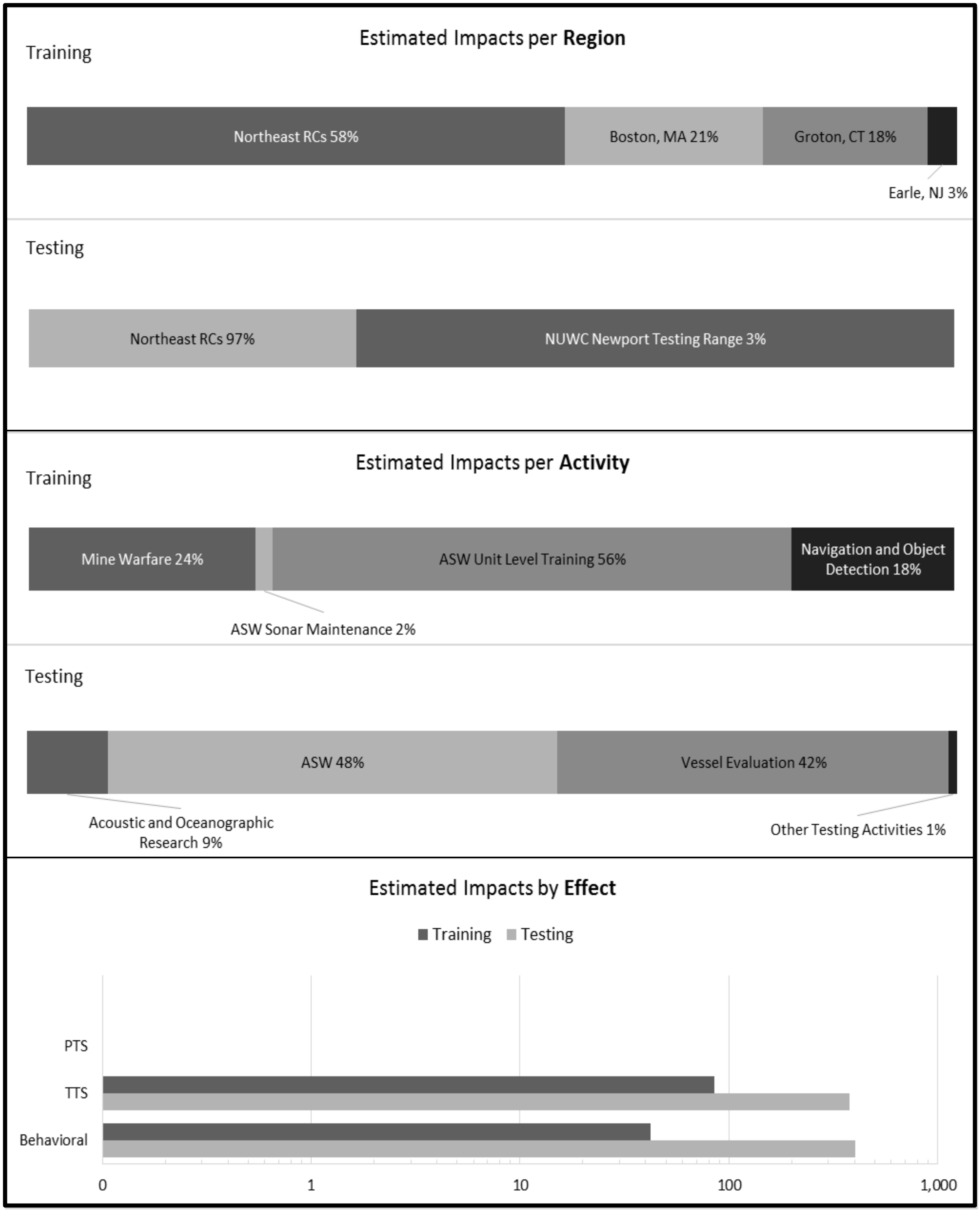
Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% Western North Atlantic Stock.
ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-46: Harbor Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-47: Harp Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.4-48: Hooded Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing.

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, 2017a).

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 Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d) 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 Section 6.4.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers, for information on the weighting thresholds used for analyzing sound from air guns.

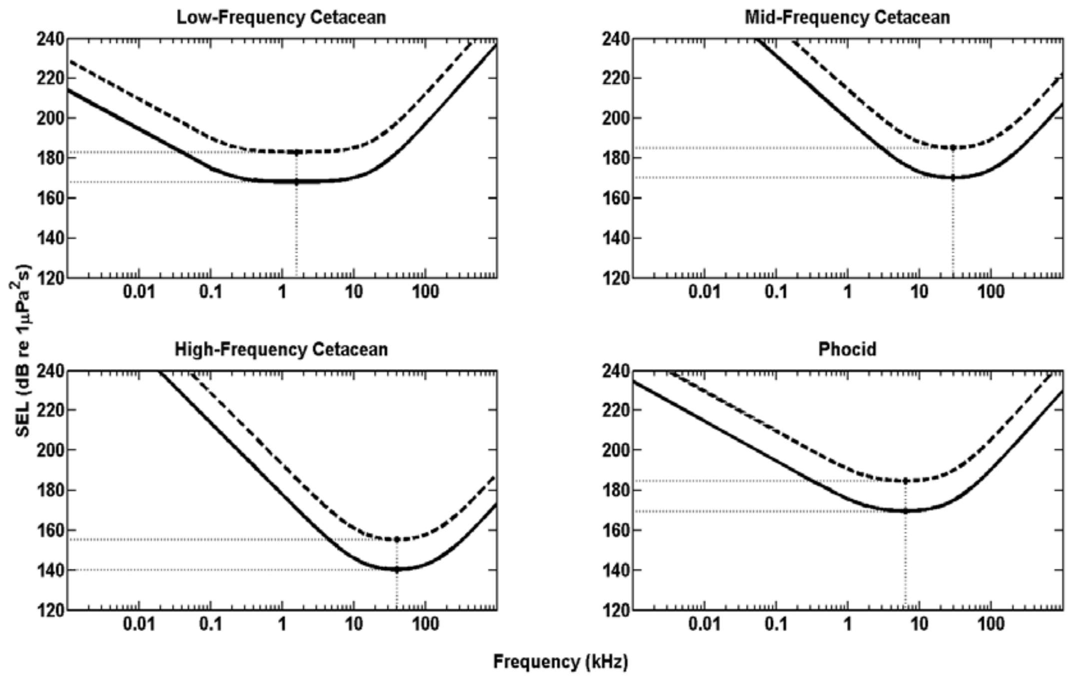
6.4.3.1.1.2 Hearing Loss from Air Guns

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 Figure 6.4-49 and Table 6.4-33).

Table 6.4-33: Thresholds for Onset of TTS and PTS for Underwater Air Gun Sounds

Hearing Group	*Onset TTS*		*Onset PTS*	
	SEL dB re 1 µPa²s (weighted)	*SPL peak dB re 1 µPa (unweighted)*	*SEL dB re 1 µPa²s (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
Phocid seals in water	170	212	185	218

Notes: PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift



Notes: The solid dark curve is the exposure function for TTS onset and the large dashed curve is the exposure function for PTS onset. Small dashed lines indicate the SEL threshold for TTS and PTS onset at each group's most sensitive frequency (i.e., the weighted SEL threshold).

Figure 6.4-49: 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, 2017). These caveats 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.

6.4.3.1.3 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, 2017a) for additional details.

6.4.3.2 Impact Ranges for Air Guns

Table 6.4-34 and Table 6.4-35 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for air guns for 10 and 100 pulses, respectively. Ranges are specific to the AFTT Study area and also 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 6.4-34: Range to Effects from Air Guns for 10 Pulses

Range to Effects for Airguns[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)	15 (15—15)	0 (0—0)	25 (25—25)	700 (250–1,025)
Low-Frequency Cetacean	13 (12—13)	2 (2—2)	72 (70—80)	4 (4—4)	685 (170–1,025)
Mid-Frequency Cetacean	0 (0—0)	0 (0—0)	0 (0—0)	0 (0—0)	680 (160–2,275)
Phocids	0 (0—0)	2 (2—2)	3 (3—3)	4 (4—4)	708 (220–1,025)

[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 6.4-35: Range to Effects from Air Guns for 100 Pulses

Range to Effects for Airguns[1] for 100 pulses (m)					
Hearing Group	PTS (SEL)	PTS (Peak SPL)	TTS (SEL)	TTS (Peak SPL)	Behavioral[2]
High-Frequency Cetacean	4 (4—4)	40 (40—40)	48 (45—50)	66 (65—70)	2,546 (1,025–5,525)
Low-Frequency Cetacean	122 (120—130)	3 (3—3)	871 (600—1,275)	13 (12—13)	2,546 (1,025–5,525)
Mid-Frequency Cetacean	0 (0—0)	0 (0—0)	0 (0—0)	0 (0—0)	2,546 (1,025–5,525)
Phocids	3 (2—3)	3 (3—3)	25 (25—25)	14 (14—15)	2,546 (1,025–5,525)

[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

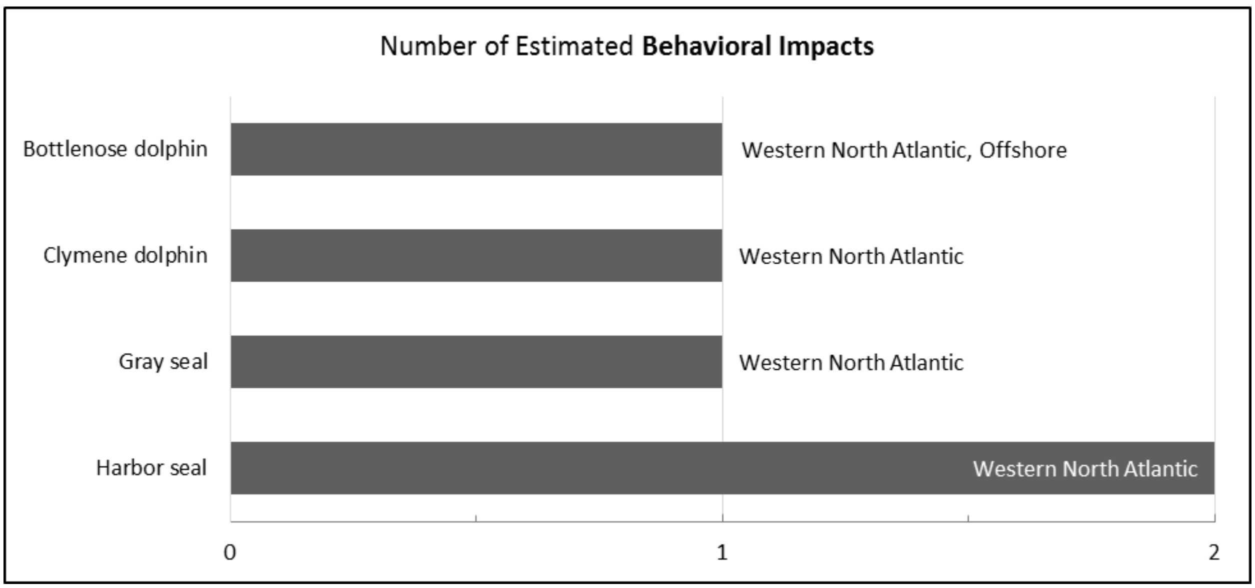
Training activities do not include the use of air guns.

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 1.4.1.2 (Acoustic Stressors). Activities using air guns would be conducted as described in Section 1.3 (Overview of Training and Testing Activities) and Appendix A (Navy Activity Descriptions) of the AFTT EIS/OEIS.

Under the Proposed Action, small air guns (12–60 in.^{3}) would be fired pierside at the Naval Undersea Warfare Center Division, Newport Testing Range, and at off-shore locations typically in the Northeast, Virginia Capes, and Gulf of Mexico 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 temporary hearing loss, behavioral reactions, physiological stress and masking, although the quantitative analysis only estimates behavioral responses (see Figure 6.4-50 and Section 5.1 for tabular results).



Notes: No TTS or PTS is estimated for any species. See Section 5.1 for tabular results.

Figure 6.4-50: Estimated Annual Behavioral Responses from Air Gun Use

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.

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. 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.

LaBrecque et al. (2015a, 2015b) identified a North Atlantic right whale migration area, a reproduction area, and feeding areas, which overlap the Northeast and Virginia Capes Range Complexes. Although use of air guns would occur in these range complexes, the quantitative analysis estimates that no North Atlantic right whales would be exposed to levels of air gun sound that would result in any behavioral responses.

Feeding areas for sei, humpback, minke, and fin whales identified by LaBrecque et al. (2015a, 2015b) overlap the Northeast Range Complexes within the Study Area. Similarly, the quantitative analysis estimates that no fin, humpback, or minke whales would be exposed to levels of air gun sound that would result in any behavioral responses.

LaBrecque et al. (2015a, 2015b) identified a small resident population area for harbor porpoises that overlaps the Northeast Range Complex. Navy air gun testing activities could occur year-round within the identified area. Similarly, the quantitative analysis estimates that no harbor porpoises would be exposed to levels of air gun sound that would result in any behavioral responses.

There are 21 small and resident population areas for common bottlenose dolphins identified by LaBrecque et al. (2015a, 2015b) which overlap, or are directly adjacent to, the AFTT Study Area. The quantitative analysis estimates behavioral responses in bottlenose dolphins from air gun sounds; however, as discussed above for marine mammals overall, behavioral reactions to single air guns are likely to be minor and short-term. Therefore, it is unlikely that the sound from single air guns would affect bottlenose dolphin's natural behavior patterns or cause abandonment of the small and resident population areas identified by LaBrecque et al. (2015a, 2015b).

The use of air guns during testing activities as described under the Proposed Action may result in the unintentional taking of bottlenose dolphins, clymene dolphins, gray seals, and harbor 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 System described in Section 1.3 (Overview of Training Activities within the Study Area), Table 1.3-2. 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 Impacts to Marine Mammals and Sea Turtles* technical report (U.S. Department of the Navy, 2017d) 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 (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, 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 6.4-36).

Table 6.4-36: 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

Notes: 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 micropascal; 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, 2017). These caveats 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.

6.4.4.1.3 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 System (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 System 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 Joint Expeditionary Base Little Creek-Fort Story and Camp Lejeune (within a few kilometers) is known to be patchy and infrequent with the exception of a few coastal species (e.g., bottlenose dolphins).

6.4.4.2 Impact Ranges for Pile Driving

Table 6.4-37 and Table 6.4-38 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for impact pile driving and vibratory pile removal, respectively.

Table 6.4-37: 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

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

Table 6.4-38: 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

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

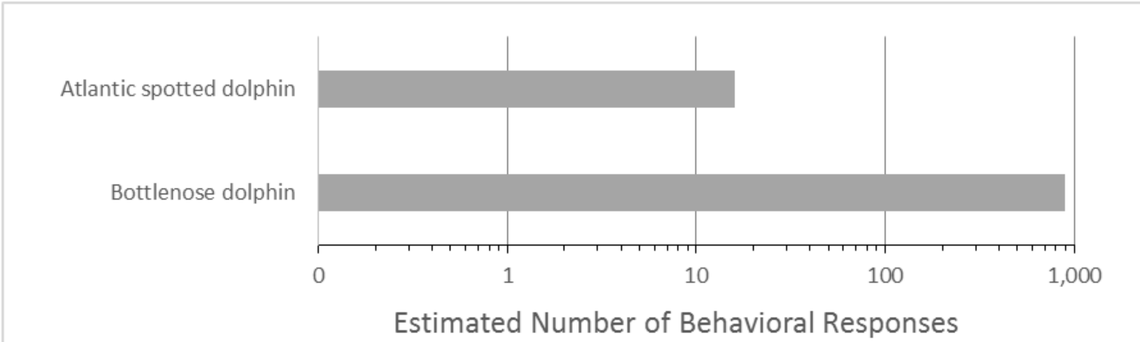
6.4.4.3 Impacts from Pile Driving Under the Proposed Action

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 1.4.1.3 (Pile Driving/Extraction) and Appendix A (Navy Activity Descriptions) of the AFTT EIS/OEIS. This activity would take place nearshore and within the surf zone, up to two times per year, once at Joint Expeditionary Base Little Creek/Fort Story, Virginia, and once at Marine Corps Base Camp Lejeune, North Carolina.

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. The quantitative analysis (see Figure 6.4-51 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 System.

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.



Note: No impacts are anticipated for any other species within the AFTT Study Area. See Section 5.1 for tabular results.

Figure 6.4-51: Estimated Annual Impacts (Assuming Two Events per Year) from Pile Driving and Extraction 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 Section 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 System 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 within 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 measure discussed in Chapter 11 (Mitigation Measures) would be conducted to further reduce any potential for impacts.

The vibratory hammer is 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 rate of strikes (30–50 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 System consist of primarily short-term behavioral reactions and potentially a few minor to moderate TTS (6–20 dB measured directly after exposure). 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 TTS or 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.

Construction and removal of the Elevated Causeway System at Marine Corps Base Camp Lejeune, North Carolina would take place within the North Atlantic right whale reproduction area, which is active mid-November through April, and within the North Atlantic right whale migration area identified by LaBrecque et al. (2015a, 2015b). Animals could be exposed to sound from pile driving within these identified areas; however, the quantitative analysis estimates no impacts to North Atlantic right whales due to exposure to pile driving activities. As discussed above for marine mammals overall, behavioral reactions to limited amount of pile driving in the nearshore and surf zones are likely to be minor and short-term. Therefore, sounds from pile driving associated with Navy training activities are unlikely to significantly impact North Atlantic right whale reproductive (calving) behaviors in the reproductive area or migratory behaviors in the migration area identified by LaBrecque et al. (2015a, 2015b).

Construction and removal of the Elevated Causeway System at Marine Corps Base Camp Lejeune, North Carolina would take place within 2 of the 21 small and resident population areas for common bottlenose dolphins identified by LaBrecque et al. (2015a, 2015b). Construction and removal of the Elevated Causeway System could occur during any time of year at Camp Lejeune. Bottlenose dolphins in the identified small and resident population areas identified by LaBrecque et al. (2015a, 2015b) may be exposed to sound or energy from pile driving. The quantitative analysis estimates behavioral reactions. Odontocete reactions to impulsive sound would most likely be 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, it is unlikely that pile-driving noise would affect bottlenose dolphin's natural behavior patterns or cause abandonment of these small and resident population areas identified by LaBrecque et al. (2015b) as a result of pile driving and extraction associated with the construction and removal of the Elevated Causeway System.

Pile driving and removal during training activities as described under the Proposed Action may result in the unintentional taking of Atlantic spotted dolphins, bottlenose dolphins, clymene dolphins, spinner dolphins, and melon-headed whale incidental to those activities as outlined in Table 5.1-3.

6.4.4.3.2 Impacts from Pile Driving for Testing Activities

Testing activities do not include pile driving.

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 explosives. The Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (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 Explosives Concepts) 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 had 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 6.4.1.2, 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 Acoustic and Explosive Stressors (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, Hearing Loss and Auditory Injury).

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 Acoustic and Explosive Stressors (see Section 6.2, Acoustic Stressors) 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 6.5.1.2, Hearing Loss and Auditory Injury). 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 Acoustic and Explosive Stressors (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 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, Masking). 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 Behavioral Reactions

As discussed in the Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (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, Behavioral Reactions).

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 U.S.C. 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, three 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 Section 6.2 Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (Section 3.0.3.6.1 of the AFTT EIS for detailed discussion). 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 explosives 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 explosives 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, 2017a).

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 Impacts to Marine Mammals and Sea Turtles* technical report (U.S. Department of the Navy, 2017a) 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 6.5-1). The second set (Table 6.5-2) 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 Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

Table 6.5-1: 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

Notes: 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 6.5-2: Criteria for Estimating Ranges to Potential Effect for Mitigation Purposes

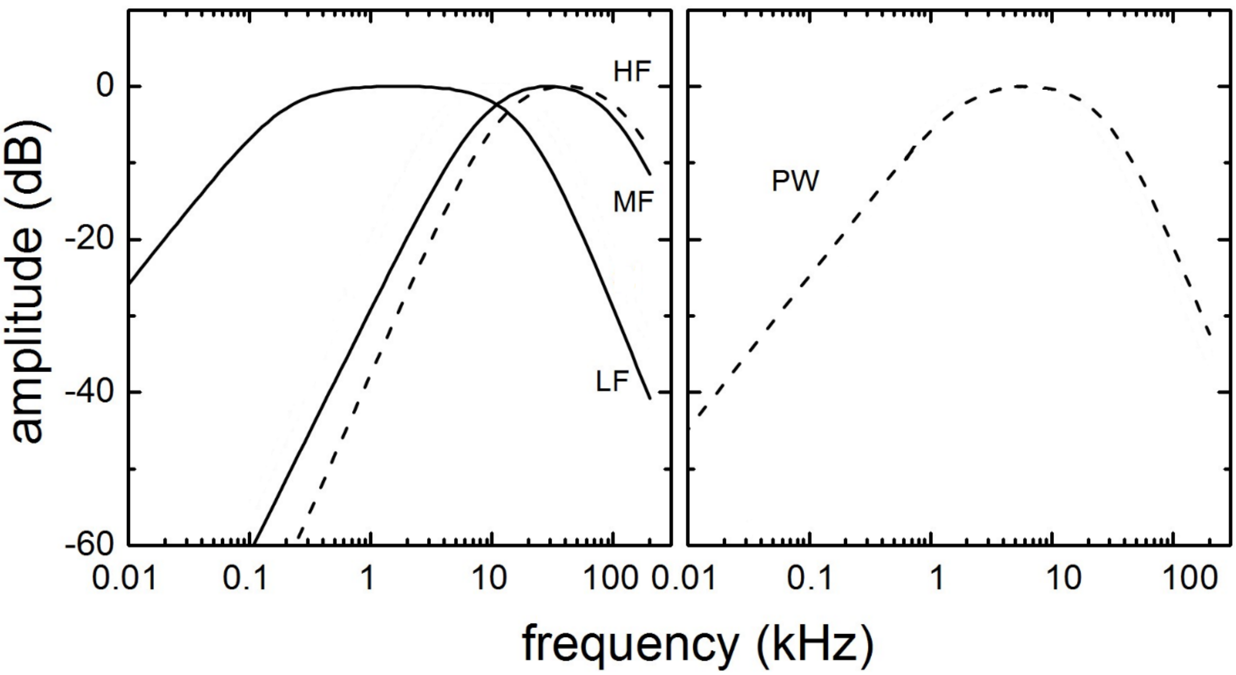
Criterion	*Threshold*
Onset Mortality (Impulse)	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury (Impulse)	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury (Peak Pressure)	237 dB re 1 µPa SPL peak

Notes: 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

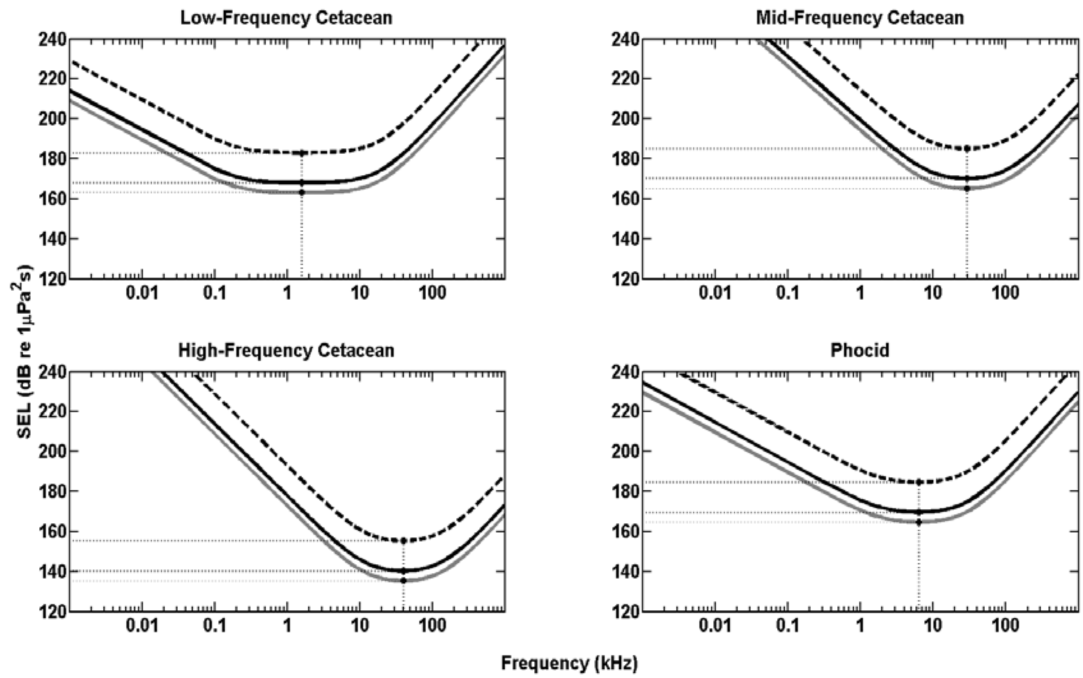
Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used. Auditory weighting functions are mathematical functions based on a generic band-pass filter and incorporate species-specific hearing 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.



Notes: 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; SI: Sirenean; PW: Phocid (in-water). 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 6.5-1: Navy Phase II Weighting Functions for All Species Groups

Criteria used to define threshold shifts from explosions is 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 6.5-2 and Table 6.5-3).



Notes: 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 6.5-2: Navy Phase III Behavioral, TTS and PTS Exposure Functions for Explosive

Table 6.5-3: Navy Phase III Weighted Sound Exposure 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
Phocid seal in water	165	170	212	185	218

Notes: dB: decibels; PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift

6.5.2.1.1.3 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, 2017). These caveats 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.

6.5.2.1.3 The Navy's Acoustic Effects Model

The Navy's Acoustic Effects Model calculates sound energy propagation from explosives 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.

- Navy 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.
- Many explosions from ordnances 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, 2017a).

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 or 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, 2017a).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation will be implemented, model-estimated mortality is considered mitigated to the level of injury. 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.

6.5.2.2 Impact Range 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 (Chapter 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 (Chapter 6.5.2.1.3, Navy Acoustic Effects Model). The range to effects are shown for a range of explosive bins, from E1 (up to 0.25 lb. net explosive weight) to E17 (up to 58,000 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.

Table 6.5-4 shows the minimum, average, and maximum ranges due to varying propagation conditions to non-auditory injury as a function of explosive bin (i.e., net explosive weight). Ranges to gastrointestinal tract injury typically exceed ranges to slights lung injury; therefore, the maximum range to effect is not mass-dependent. 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. Ranges to mortality, based on animal mass, are shown in Table 6.5-5.

The following tables (Table 6.5-14 to Table 6.5-15) show the minimum, average, and maximum ranges to onset of auditory and behavioral effects based on the thresholds described in Chapter 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* (U.S. Department of the Navy, 2017b).

Table 6.5-4: Ranges[1] to 50 % Non-Auditory Injury Risk for All Marine Mammal Hearing Groups

Bin	*Range (m)*
E1	22 (22—35)
E2	25 (25—30)
E3	46 (35—75)
E4	63 (0—130)
E5	75 (55—130)
E6	97 (65—390)
E7	232 (200—270)
E8	170 (0—490)
E9	215 (100—430)
E10	251 (110—700)
E11	604 (400—2,525)
E12	436 (130—1,025)
E16	1,844 (925—3,025)
E17	3,649 (1,000—14,025)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses. Modeled ranges based on peak pressure for a single explosion generally exceed the modeled ranges based on impulse (related to animal mass and depth).

Table 6.5-5: Ranges[1] to 50 % Mortality Risk for All Marine Mammal Hearing Groups as a Function of Animal Mass

Bin	*Representative Animal Mass (kg)*					
	10	*250*	*1,000*	*5,000*	*25,000*	*72,000*
E1	4 (3—5)	1 (0—3)	0 (0—0)	0 (0—0)	0 (0—0)	0 (0—0)
E2	5 (5—7)	3 (0—5)	0 (0—2)	0 (0—0)	0 (0—0)	0 (0—0)
E3	11 (9—15)	6 (3—11)	3 (2—4)	0 (0—2)	0 (0—0)	0 (0—0)
E4	20 (0—45)	11 (0—30)	5 (0—13)	3 (0—6)	1 (0—2)	0 (0—2)
E5	18 (14—50)	10 (5—35)	5 (3—11)	3 (2—6)	0 (0—3)	0 (0—2)
E6	26 (17—75)	14 (0—55)	7 (0—20)	4 (3—10)	2 (0—4)	1 (0—3)
E7	100 (75—130)	49 (25—95)	21 (17—30)	13 (11—15)	7 (6—7)	5 (4—6)
E8	69 (0—140)	36 (0—100)	16 (0—30)	12 (0—17)	6 (0—8)	5 (0—7)
E9	58 (40—200)	26 (17—55)	14 (11—18)	9 (8—11)	5 (4—5)	4 (3—5)
E10	107 (40—320)	39 (19—220)	18 (14—35)	12 (10—21)	6 (6—9)	5 (4—6)
E11	299 (230—675)	163 (90—490)	74 (55—150)	45 (35—85)	24 (21—40)	19 (15—30)
E12	194 (60—460)	82 (25—340)	22 (18—30)	15 (12—17)	8 (7—9)	6 (5—7)
E16	1,083 (925—1,525)	782 (500—1,025)	423 (350—550)	275 (230—300)	144 (130—150)	105 (90—120)
E17	1,731 (925—2,525)	1,222 (700—2,275)	857 (575—1,025)	586 (470—825)	318 (290—340)	244 (210—280)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-6: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for High-Frequency Cetaceans

Range to Effects for Explosives: High Frequency Cetaceans[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
E1	0.1	1	446 (180—975)	1,512 (525—3,775)	2,591 (800—6,775)
		20	1,289 (440—3,025)	4,527 (1,275—10,775)	6,650 (1,525—16,525)
E2	0.1	1	503 (200—1,025)	1,865 (600—3,775)	3,559 (1,025—6,775)
		2	623 (250—1,275)	2,606 (750—5,275)	4,743 (1,275—8,525)
E3	18.25	1	865 (525—2,525)	3,707 (1,025—6,775)	5,879 (1,775—10,025)
		50	4,484 (1,275—7,775)	10,610 (2,275—19,775)	13,817 (2,275—27,025)
E4	15	1	1,576 (1,025—2,275)	6,588 (4,525—8,775)	9,744 (7,275—13,025)
		5	3,314 (2,275—4,525)	10,312 (7,525—14,775)	14,200 (9,775—20,025)
	19.8	2	1,262 (975—2,025)	4,708 (1,775—7,525)	6,618 (2,025—11,525)
	198	2	1,355 (875—2,775)	4,900 (2,525—8,275)	6,686 (3,025—11,275)
E5	0.1	25	3,342 (925—8,025)	8,880 (1,275—20,525)	11,832 (1,525—25,025)
E6	0.1	1	1,204 (550—3,275)	4,507 (1,275—10,775)	6,755 (1,525—16,525)
	30	1	2,442 (1,525—5,025)	7,631 (4,525—10,775)	10,503 (4,775—15,025)
E7	15	1	3,317 (2,525—4,525)	10,122 (7,775—13,275)	13,872 (9,775—17,775)
E8	0.1	1	1,883 (675—4,525)	6,404 (1,525—14,525)	9,001 (1,525—19,775)
	45.75	1	2,442 (1,025—5,525)	7,079 (2,025—12,275)	9,462 (2,275—17,025)
	305	1	3,008 (2,025—4,025)	9,008 (6,025—10,775)	12,032 (8,525—14,525)
E9	0.1	1	2,210 (800—4,775)	6,088 (1,525—13,275)	8,299 (1,525—19,025)
E10	0.1	1	2,960 (875—7,275)	8,424 (1,525—19,275)	11,380 (1,525—24,275)
E11	18.5	1	4,827 (1,525—8,775)	11,231 (2,525—20,025)	14,667 (2,525—26,775)
	45.75	1	3,893 (1,525—7,525)	9,320 (2,275—17,025)	12,118 (2,525—21,525)
E12	0.1	1	3,046 (1,275—6,775)	7,722 (1,525—18,775)	10,218 (2,025—22,525)
E16	61	1	5,190	7,851	9,643

Table 6.5-6: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for High-Frequency Cetaceans

Range to Effects for Explosives: High Frequency Cetaceans[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
			(2,275—9,775)	(3,525—19,525)	(3,775—25,775)
E17	61	1	6,173 (2,525—12,025)	11,071 (3,775—29,275)	13,574 (4,025—37,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-7: Peak Pressure Based Ranges to Onset PTS and Onset TTS for High-Frequency Cetaceans

Range to Effects for Explosives: High Frequency Cetaceans[1]			
Bin	***Source Depth (m)***	***PTS***	***TTS***
E1	0.1	579 (200—975)	883 (300—3,025)
E2	0.1	493 (230—1,275)	879 (360—3,525)
E3	18.25	2,052 (950—5,025)	3,580 (1,025—8,275)
E4	15	3,324 (2,025—5,025)	7,679 (3,775—12,775)
	19.8	2,205 (1,275—4,275)	3,549 (2,275—5,525)
	198	2,841 (1,775—6,275)	4,009 (2,775—7,275)
E5	0.1	1,459 (490—7,775)	2,805 (875—17,775)
E6	0.1	1,956 (800—7,775)	4,071 (1,275—23,025)
	30	4,339 (2,025—10,025)	7,633 (3,025—17,025)
E7	15	9,900 (5,025—18,025)	15,456 (8,775—27,775)
E8	0.1	4,312 (1,025—26,775)	7,430 (1,525—53,275)
	45.75	6,941 (1,775—20,275)	11,610 (1,775—36,525)
	305	6,518 (3,275—10,775)	9,129 (4,525—18,025)
E9	0.1	4,129 (1,525—40,275)	6,770 (1,525—71,275)
E10	0.1	7,509 (1,525—53,775)	12,597 (1,775—76,775)
E11	18.5	14,627 (2,275—44,775)	22,673 (4,025—68,275)
	45.75	13,105 (2,025—41,775)	22,150 (2,775—65,775)
E12	0.1	6,551 (1,525—71,275)	11,162 (2,275—85,275)
E16	61	29,544 (17,525—59,275)	39,829 (24,525—92,775)
E17	61	39,317 (18,775—99,275)	52,954 (23,025—98,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-8: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Low-Frequency Cetaceans

Range to Effects for Explosives: Low Frequency Cetaceans[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
E1	0.1	1	54 (45—80)	259 (130—390)	137 (90—210)
		20	211 (110—320)	787 (340—1,525)	487 (210—775)
E2	0.1	1	64 (55—75)	264 (150—400)	154 (100—220)
		2	87 (70—110)	339 (190—500)	203 (120—300)
E3	18.25	1	211 (190—390)	1,182 (600—2,525)	588 (410—1,275)
		50	1,450 (675—3,275)	8,920 (1,525—24,275)	4,671 (1,025—10,775)
E4	15	1	424 (380—550)	3,308 (2,275—4,775)	1,426 (1,025—2,275)
		5	1,091 (950—1,525)	6,261 (3,775—9,525)	3,661 (2,525—5,275)
	19.8	2	375 (350—400)	1,770 (1,275—3,025)	1,003 (725—1,275)
	198	2	308 (280—380)	2,275 (1,275—3,525)	1,092 (850—2,275)
E5	0.1	25	701 (300—1,525)	4,827 (750—29,275)	1,962 (575—22,525)
E6	0.1	1	280 (150—450)	1,018 (460—7,275)	601 (300—1,525)
	30	1	824 (525—1,275)	4,431 (2,025—7,775)	2,334 (1,275—4,275)
E7	15	1	1,928 (1,775—2,275)	8,803 (6,025—14,275)	4,942 (3,525—6,525)
E8	0.1	1	486 (220—1,000)	3,059 (575—20,525)	1,087 (440—7,775)
	45.75	1	1,233 (675—3,025)	7,447 (1,275—19,025)	3,633 (1,000—9,025)
	305	1	937 (875—975)	6,540 (3,025—12,025)	3,888 (2,025—6,525)
E9	0.1	1	655 (310—1,275)	2,900 (650—31,025)	1,364 (500—8,525)
E10	0.1	1	786 (340—7,275)	7,546 (725—49,025)	3,289 (550—26,525)
E11	18.5	1	3,705 (925—8,775)	16,488 (2,275—40,275)	9,489 (1,775—22,775)
	45.75	1	3,133 (925—8,275)	16,365 (1,775—50,275)	8,701 (1,275—23,775)
E12	0.1	1	985 (400—6,025)	7,096 (800—72,775)	2,658 (625—46,525)
E16	61	1	10,155	35,790	25,946

Table 6.5-8: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Low-Frequency Cetaceans

Range to Effects for Explosives: Low Frequency Cetaceans[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
			(2,025—21,525)	(18,025—69,775)	(14,025—58,775)
E17	61	1	17,464 (8,275—39,525)	47,402 (21,025—93,275)	34,095 (16,275—86,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-9: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Low-Frequency Cetaceans

Range to Effects for Explosives: Low Frequency Cetaceans[1]			
Bin	***Source Depth (m)***	***PTS***	***TTS***
E1	0.1	127 (75—170)	226 (100—270)
E2	0.1	120 (85—150)	189 (110—270)
E3	18.25	336 (260—1,275)	674 (420—2,275)
E4	15	522 (410—875)	1,159 (775—2,025)
	19.8	431 (390—575)	892 (700—1,275)
	198	401 (360—490)	840 (650—1,775)
E5	0.1	387 (150—500)	622 (210—1,275)
E6	0.1	459 (230—625)	724 (370—1,525)
	30	871 (550—1,775)	1,519 (925—2,525)
E7	15	1,914 (1,525—2,275)	3,643 (3,025—4,525)
E8	0.1	703 (360—1,525)	1,062 (525—5,275)
	45.75	1,438 (675—3,525)	2,443 (975—7,025)
	305	1,153 (975—2,025)	3,210 (1,525—5,025)
E9	0.1	926 (480-3,525)	1,409 (600—5,025)
E10	0.1	997 (500—5,275)	1,993 (650—11,025)
E11	18.5	2,855 (950—7,525)	5,356 (1,025—15,525)
	45.75	2,642 (975—7,525)	4,485 (1,025—14,025)
E12	0.1	1,294 (575—4,775)	2,216 (750—17,275)
E16	61	5,118 (1,275—15,275)	12,416 (4,025—25,275)
E17	61	11,226 (3,525—22,775)	18,059 (8,275—37,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-10: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetaceans[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
E1	0.1	1	26 (25—50)	139 (95—370)	218 (120—550)
		20	113 (80—290)	539 (210—1,025)	754 (270—1,525)
E2	0.1	1	35 (30—45)	184 (100—300)	276 (130—490)
		2	51 (40—70)	251 (120—430)	365 (160—700)
E3	18.25	1	40 (35—45)	236 (190—800)	388 (280—1,275)
		50	304 (230—1,025)	1,615 (750—3,275)	2,424 (925—5,025)
E4	15	1	74 (60—100)	522 (440—750)	813 (650—1,025)
		5	192 (140—260)	1,055 (875—1,525)	1,631 (1,275—2,525)
	19.8	2	69 (65—70)	380 (330—470)	665 (550—750)
	198	2	48 (0—55)	307 (260—380)	504 (430—700)
E5	0.1	25	391 (170—850)	1,292 (470—3,275)	1,820 (575—5,025)
E6	0.1	1	116 (90—290)	536 (310—1,025)	742 (380—1,525)
	30	1	110 (85—310)	862 (600—2,275)	1,281 (975—3,275)
E7	15	1	201 (190—220)	1,067 (1,025—1,275)	1,601 (1,275—2,025)
E8	0.1	1	204 (150—500)	802 (400—1,525)	1,064 (470—2,275)
	45.75	1	133 (120—200)	828 (525—2,025)	1,273 (775—2,775)
	305	1	58 (0—110)	656 (550—750)	1,019 (900—1,025)
E9	0.1	1	241 (200—370)	946 (450—1,525)	1,279 (500—2,275)
E10	0.1	1	339 (230—750)	1,125 (490—2,525)	1,558 (550—4,775)
E11	18.5	1	361 (230—750)	1,744 (800—3,775)	2,597 (925—5,025)
	45.75	1	289 (230—825)	1,544 (800—3,275)	2,298 (925—5,025)
E12	0.1	1	382 (270—550)	1,312 (525—2,775)	1,767 (600—4,275)
E16	61	1	885	3,056	3,689

Table 6.5-10: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetaceans[1]					
Bin	*Source Depth (m)*	*Cluster Size*	*PTS*	*TTS*	*Behavioral*
			(650—1,775)	(1,275—5,025)	(1,525—6,525)
E17	61	1	1,398 (925—2,275)	3,738 (1,525—6,775)	4,835 (1,775—9,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-11: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetaceans[1]			
Bin	*Source Depth (m)*	*PTS*	*TTS*
E1	0.1	44 (35—75)	80 (60—110)
E2	0.1	52 (45—70)	82 (70—95)
E3	18.25	101 (95—220)	188 (170—600)
E4	15	139 (120—230)	278 (230—500)
	19.8	123 (120—130)	243 (230—300)
	198	113 (0—160)	229 (180—270)
E5	0.1	142 (85—170)	252 (110—320)
E6	0.1	175 (100—220)	306 (160—390)
	30	268 (190—575)	514 (370—1,275)
E7	15	415 (330—470)	924 (650—1,025)
E8	0.1	290 (140—350)	476 (230—925)
	45.75	433 (340—1,525)	890 (575—2,275)
	305	333 (250—420)	649 (575—800)
E9	0.1	418 (260—500)	676 (380—1,025)
E10	0.1	457 (220—775)	732 (370—2,025)
E11	18.5	904 (525—2,275)	1,686 (750—4,275)
	45.75	978 (600—2,525)	1,713 (675—5,525)
E12	0.1	608 (340—975)	940 (460—3,775)
E16	61	3,143 (1,000—7,525)	4,580 (1,025—11,025)
E17	61	4,035 (1,025—11,025)	6,005 (1,275—15,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-12: SEL-Based Ranges to Onset PTS, Onset 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	50 (45—85)	242 (120—470)	360 (160—650)
		20	197 (110—380)	792 (300—1,275)	1,066 (410—2,275)
E2	0.1	1	65 (55—85)	267 (140—430)	378 (190—675)
		2	85 (65—100)	345 (180—575)	476 (230—875)
E3	18.25	1	121 (110—220)	689 (500—1,525)	1,074 (725—2,525)
		50	859 (600—2,025)	4,880 (1,525—10,525)	7,064 (1,775—16,275)
E4	15	1	213 (190—260)	1,246 (1,025—1,775)	2,006 (1,525—3,025)
		5	505 (450—600)	2,933 (2,275—4,275)	4,529 (3,275—6,775)
	19.8	2	214 (210—220)	1,083 (900—2,025)	1,559 (1,025—2,525)
	198	2	156 (150—180)	1,141 (825—2,275)	2,076 (1,275—3,525)
E5	0.1	25	615 (250—1,025)	2,209 (850—9,775)	3,488 (1,025—15,275)
E6	0.1	1	210 (160—380)	796 (480—1,275)	1,040 (600—3,275)
	30	1	359 (280—625)	1,821 (1,275—2,775)	2,786 (1,775—4,275)
E7	15	1	557 (525—650)	3,435 (2,775—4,525)	5,095 (3,775—6,775)
E8	0.1	1	346 (230—600)	1,136 (625—4,025)	1,708 (850—6,025)
	45.75	1	469 (380—1,025)	2,555 (1,275—6,025)	3,804 (1,525—9,775)
	305	1	322 (310—330)	3,222 (1,775—4,525)	4,186 (2,275—5,775)
E9	0.1	1	441 (330—575)	1,466 (825—5,775)	2,142 (950—9,775)
E10	0.1	1	539 (350—900)	1,914 (875—8,525)	3,137 (1,025—15,025)
E11	18.5	1	1,026 (700—2,025)	5,796 (1,525—12,775)	8,525 (1,775—19,775)
	45.75	1	993 (675—2,275)	4,835 (1,525—13,525)	7,337 (1,775—18,775)
E12	0.1	1	651 (420—900)	2,249 (950—11,025)	3,349 (1,275—16,025)
E16	61	1	2,935 (1,775—5,025)	6,451 (2,275—16,275)	10,619 (3,275—24,025)
E17	61	1	3,583	12,031	18,396

Table 6.5-12: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Phocids

Range to Effects for Explosives: Phocids[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
			(1,775—7,525)	(3,275—29,275)	(7,275—41,025)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-13: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Phocids

Range to Effects for Explosives: Phocids[1]			
Bin	***Source Depth (m)***	***PTS***	***TTS***
E1	0.1	141 (80—200)	250 (100—310)
E2	0.1	129 (90—170)	204 (120—300)
E3	18.25	377 (290—1,275)	762 (575—2,025)
E4	15	591 (450—1,000)	1,280 (850—2,025)
	19.8	499 (460—625)	1,046 (775—2,025)
	198	458 (430—650)	1,011 (775—2,025)
E5	0.1	430 (150—725)	695 (220—1,275)
E6	0.1	509 (250—775)	791 (410—2,025)
	30	996 (575—2,025)	1,677 (975—2,775)
E7	15	2,109 (1,775—3,025)	3,803 (3,025—4,525)
E8	0.1	775 (390—2,025)	1,211 (575—5,275)
	45.75	1,630 (1,025—4,275)	2,814 (1,275—7,025)
	305	1,793 (1,025—3,275)	3,800 (2,025—5,775)
E9	0.1	1,045 (575—3,775)	1,626 (825—7,275)
E10	0.1	1,153 (525—5,275)	2,379 (750—15,775)
E11	18.5	3,232 (1,275—8,275)	5,978 (1,525—15,775)
	45.75	3,072 (1,525—7,775)	5,135 (1,525—14,525)
E12	0.1	1,499 (775—5,025)	2,603 (1,025—17,275)
E16	61	6,256 (2,025—14,775)	13,649 (8,525—25,775)
E17	61	12,665 (5,025—25,775)	19,689 (11,775—36,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-14: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Sirenians

Range to Effects for Explosives: Sirenians[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
E1	0.1	1	26 (25—45)	109 (85—300)	195 (120—550)
		20	90 (75—240)	385 (180—975)	646 (250—1,775)
E2	0.1	1	35 (30—40)	164 (100—250)	288 (140—500)
		2	48 (40—65)	218 (120—370)	375 (170—700)
E3	18.25	1	42 (40—45)	252 (200—460)	532 (370—1,275)
		50	326 (250—625)	1,595 (800—3,525)	2,985 (1,025—6,775)
E4	15	1	76 (65—100)	513 (450—700)	988 (825—1,275)
		5	191 (160—240)	1,080 (925—1,525)	2,118 (1,525—3,275)
	19.8	2	76 (75—80)	461 (400—550)	795 (675—900)
	198	2	0 (0—0)	303 (290—330)	640 (575—775)
E5	0.1	25	280 (150—750)	923 (330—2,775)	1,683 (390—5,525)
E6	0.1	1	95 (75—240)	402 (180—900)	634 (260—1,525)
	30	1	101 (85—120)	697 (550—925)	1,211 (950—2,025)
E7	15	1	199 (190—210)	1,143 (1,025—1,275)	2,254 (1,775—3,025)
E8	0.1	1	156 (100—410)	604 (240—1,525)	937 (340—2,025)
	45.75	1	142 (130—180)	754 (525—1,775)	1,299 (775—3,025)
	305	1	0 (0—12)	620 (600—650)	1,178 (1,025—1,275)
E9	0.1	1	162 (120—290)	638 (290—2,025)	1,033 (400—2,525)
E10	0.1	1	254 (140—625)	840 (310—2,275)	1,450 (410—4,025)
E11	18.5	1	383 (260—725)	1,728 (800—3,275)	3,231 (1,025—6,525)
	45.75	1	271 (240—400)	1,273 (750—3,025)	2,215 (1,025—5,025)
E12	0.1	1	258 (150—480)	909 (370—2,025)	1,561 (420—6,025)
E16	61	1	720	2,131	3,118

Table 6.5-14: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Sirenians

Range to Effects for Explosives: Sirenians[1]					
Bin	***Source Depth (m)***	***Cluster Size***	***PTS***	***TTS***	***Behavioral***
			(625—875)	(1,275—3,275)	(1,775—4,775)
E17	61	1	1,073 (800—1,275)	2,998 (1,525—4,525)	4,654 (2,275—14,525)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 6.5-15: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Sirenians

Range to Effects for Explosives: Sirenians[1]			
Bin	***Source Depth (m)***	***PTS***	***TTS***
E1	0.1	55 (50—75)	82 (70—150)
E2	0.1	67 (60—85)	110 (80—130)
E3	18.25	148 (120—160)	281 (210—450)
E4	15	200 (190—300)	422 (370—700)
	19.8	193 (190—200)	362 (320—400)
	198	56 (50—60)	293 (290—300)
E5	0.1	150 (100—240)	252 (130—550)
E6	0.1	201 (110—300)	328 (150—725)
	30	296 (250—360)	560 (410—1,000)
E7	15	569 (470—850)	1,740 (1,275—2,025)
E8	0.1	328 (150—525)	533 (210—2,275)
	45.75	509 (370—1,775)	897 (550—2,025)
	305	435 (430—440)	906 (875—950)
E9	0.1	419 (180—750)	713 (260—4,025)
E10	0.1	484 (200—2,025)	771 (280—5,275)
E11	18.5	1,165 (625—3,275)	2,106 (825—8,025)
	45.75	918 (550—2,525)	1,667 (850—5,025)
E12	0.1	655 (230—3,775)	949 (340—5,025)
E16	61	1,782 (1,025—2,775)	3,514 (1,275—10,025)
E17	61	3,009 (1,275—10,025)	9,174 (2,775—20,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

6.5.2.3 Impacts from Explosives Under the Proposed Action

As described in Section 1.3 (Overview of Training and Testing Activities), Table 1.3-2, and Section 1.4.2 (Explosive Stressors), training activities under the Proposed Action would use underwater detonations and explosive ordnance. Training activities involving explosions would be conducted throughout the Study Area but would be concentrated in the Virginia Capes Range Complex, followed in descending order of numbers of activities by Jacksonville, Navy Cherry Point, Gulf of Mexico, and the Northeast Range Complexes, although training activities could occur anywhere within the Study Area. 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 1.3 (Overview of Training and Testing Activities), Table 1.3-3 through Table 1.3-5, and Section 1.4.2 (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; the exception is the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is nearshore, partially within the surf zone. Testing activities under the Proposed Action also include Ship Shock Trials that could occur within offshore locations of the Virginia Capes Range Complex, Jacksonville Range Complex, and the Gulf of Mexico Range Complex.

6.5.2.3.1 Presentation of Estimated Impacts from the Quantitative Analysis

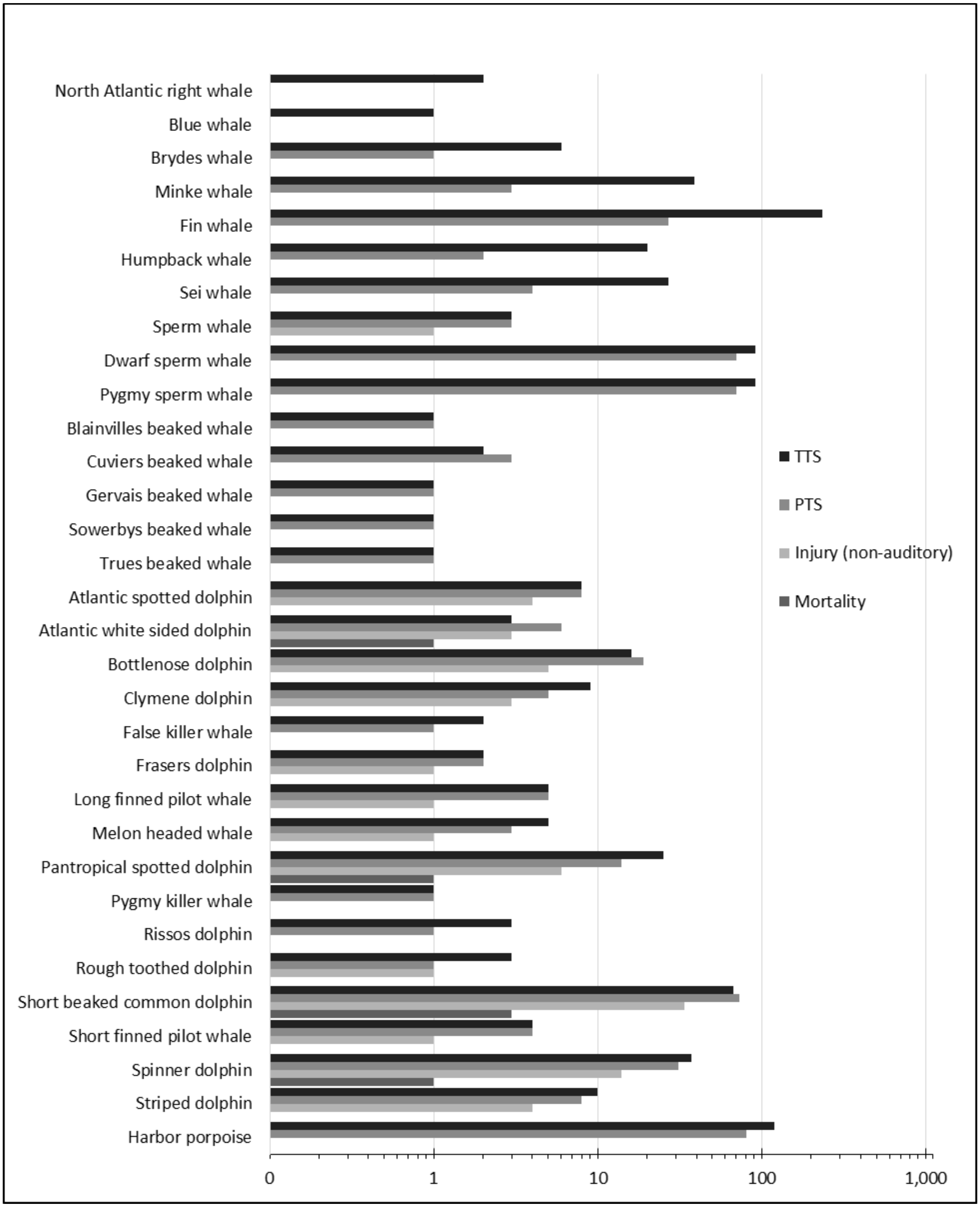
The results of the analysis of potential impacts to marine mammals from explosives (see above Section 6.4.2.1) are discussed below. The numbers of potential impacts estimated for individual species of marine mammals from exposure to explosive energy and sound for training activities under the Proposed Action are shown in Section 5.1 (Acoustic Impact Tables). Additionally, estimated numbers of potential impacts from the quantitative analysis for each species are presented below, with the exception of Ship Shock Trial results, which are presented separately, but discussed in each species discussion. The most likely regions and activity categories from which the impacts could occur are displayed in the impact graphics 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 regions or activity categories where 0.5 percent of the impacts, or greater, are estimated to occur are graphically represented below. All (i.e., grand total) estimated impacts are also included, regardless of region or category.

The numbers of activities planned under the Proposed Action can vary slightly from year-to-year. The Proposed Action results are presented for a maximum explosive-use year; however, during most years, explosive use would be less resulting in fewer potential impacts. The number of explosives used under the Proposed Action are described in Section 1.5.5 (Summary of Acoustic and Explosive Sources Analyzed for Training and Testing).

6.5.2.3.2 Estimated Impacts from Ship Shock Trials

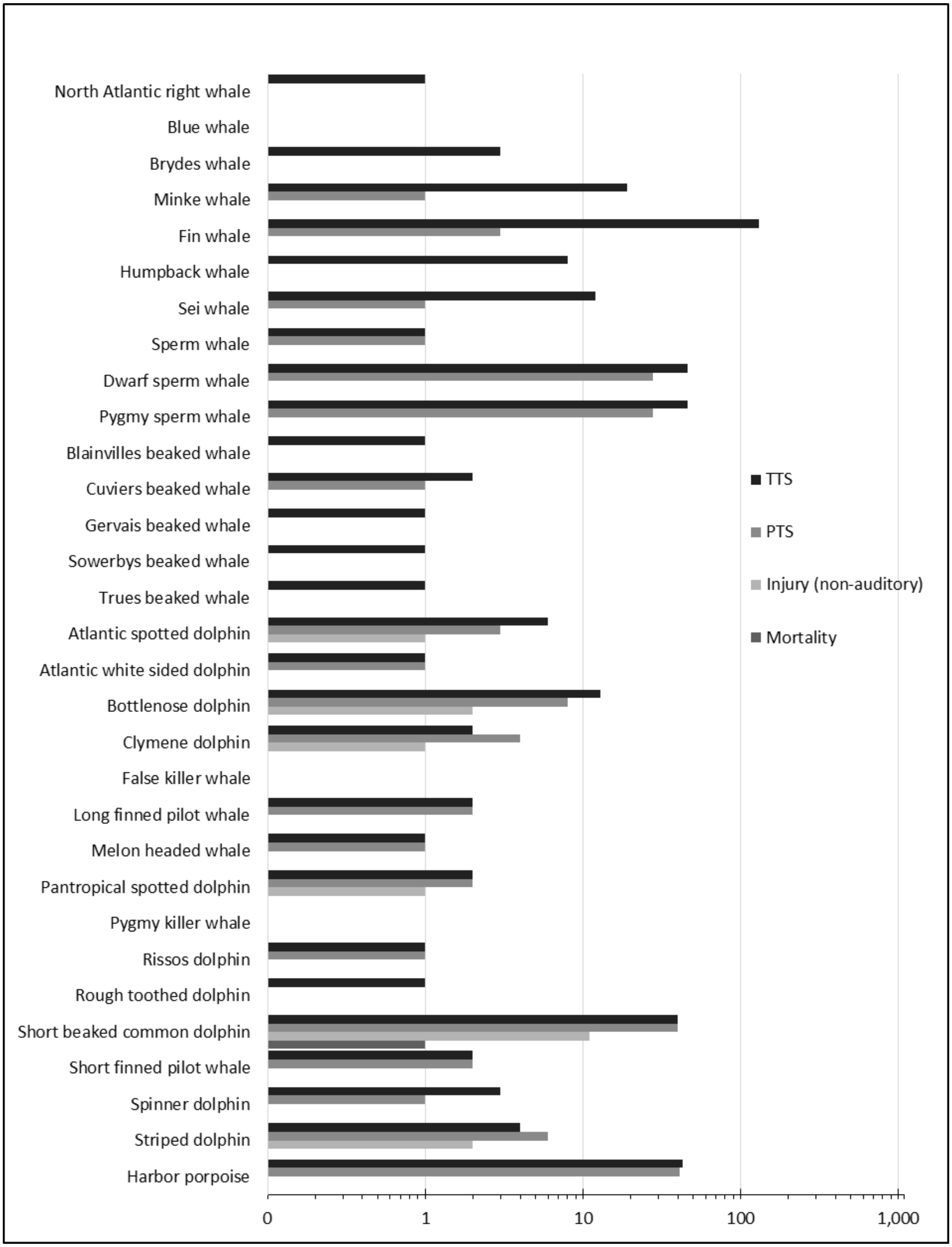
As described in Section 1.3 (Overview of Training and Testing Activities), Table 1.3-3, and Section 1.4.2 (Explosive Stressors), testing activities under the Proposed Action would use underwater detonations in Large and Small Ship Shock Trials. Results are presented per species in the graphics below (Figure 6.5-3 and Figure 6.5-4). Impacts per species are the maximum impacts for that species for any season and any area for either the large or small ship shock trial. Therefore, the results shown represent the maximum number of estimated impacts that could potentially occur to any species, but over-estimate the overall potential for impact.

Small Ship Shock Trials could take place any season within the deep offshore water of the Virginia Capes Range Complex or in the spring, summer, or fall within the Jacksonville Range Complex and could occur up to three times over a 5-year period. The Large Ship Shock Trial could take place in the Jacksonville Range Complex during the Spring, Summer, or Fall and during any season within the deep offshore water of the Virginia Capes Range Complex or within the Gulf of Mexico. The Large Ship Shock Trial could occur once over 5 years. Potential impacts and any consequences for individuals or populations are discussed below under testing for each species.



This event could occur once over a five-year period.

Figure 6.5-3: Estimated Maximum Impacts to Each Species Across All Seasons and Areas in which the Large Ship Shock Trial Could Occur



This event could occur up to three times over a five-year period.

Figure 6.5-4: Estimated Maximum Impacts to Each Species Across All Seasons and Areas in which Small Ship Shock Trials Could Occur

6.5.2.3.3 Mysticetes

Mysticetes may be exposed to sound and energy from explosives associated with training activities throughout the year. Explosives produce sounds that are within the hearing range of mysticetes (see Section 6.3, Hearing and Vocalization). Potential impacts from explosive energy and sound include non-auditory injury, behavioral reactions, physiological stress, masking, and hearing loss. The quantitative analysis estimates behavioral reactions, TTS, and PTS in mysticetes. 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 Behavioral Responses from Explosives) show that if mysticetes are exposed to the sound from impulsive sounds such as explosives, 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 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. 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.

6.5.2.3.3.1 North Atlantic Right Whales (Endangered Species Act-Listed)

As discussed in detail in Chapter 11 (Mitigation Measures), before transiting through or conducting any training or testing activities within the Southeast North Atlantic Right Whale Mitigation Area during calving season (November 15 to April 15), the Navy will initiate communication with the Fleet Area Control and Surveillance Facility, Jacksonville to obtain Early Warning System North Atlantic right whale sightings data. When transiting within the mitigation area, Navy vessels will use the obtained sightings information to reduce potential interactions with North Atlantic right whales during transits. This high level of awareness will further enhance the Navy's mitigation effectiveness for reducing potential explosive impacts to North Atlantic right whales. Additionally, training and testing activities that use underwater detonations and most other types of explosives would not occur within the Northeast North Atlantic Right Whale Mitigation Area or Southeast North Atlantic Right Whale Mitigation Area.

Impacts from Explosives Under the Proposed Action for Training Activities

North Atlantic right 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 6.5-5 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 from Explosives). Estimated impacts apply to the Western North Atlantic 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. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

As previously described in Section 6.3 (Hearing and Vocalization), a migratory corridor, a calving area, a mating area, and feeding areas for North Atlantic right whales have been identified by LaBrecque et al. (2015a, 2015b) that seasonally overlap with Virginia Capes, Navy Cherry Point, Jacksonville, and the Northeast Range Complexes within the Study Area. Navy training activities that use explosives could occur in these Range Complexes year round. Impacts to feeding and mating behaviors are not anticipated for North Atlantic right whales in the Northeast Range Complexes on identified feeding and mating areas due to explosive training activities because these activities within the Northeast Range Complexes are typically conducted within Narragansett Bay, which does not overlap the feeding or mating areas identified by LaBrecque et al. (2015a, 2015b). Estimated impacts to North Atlantic right whale migration and calving behaviors within the Navy Cherry Point Range Complex, which overlaps the identified migration and calving areas, are so low as to be unlikely in any given year. A few TTS exposures are estimated from training with explosives in the Virginia Capes Range Complex, which overlaps the migratory area, and within the Jacksonville Range Complex, which overlaps the identified migratory and calving areas, however significant impacts to migratory or calving behaviors within the identified areas are unlikely.

The Study Area does overlap North Atlantic right whale critical habitat and some limited use of explosives does take place within these areas; however, the sound and energy from explosions would not affect the biological or physical features that are essential for the reproduction, rest and refuge, health, continued survival, conservation and recovery of the northern right whale population.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of North Atlantic right whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Explosives Under the Proposed Action for Testing Activities

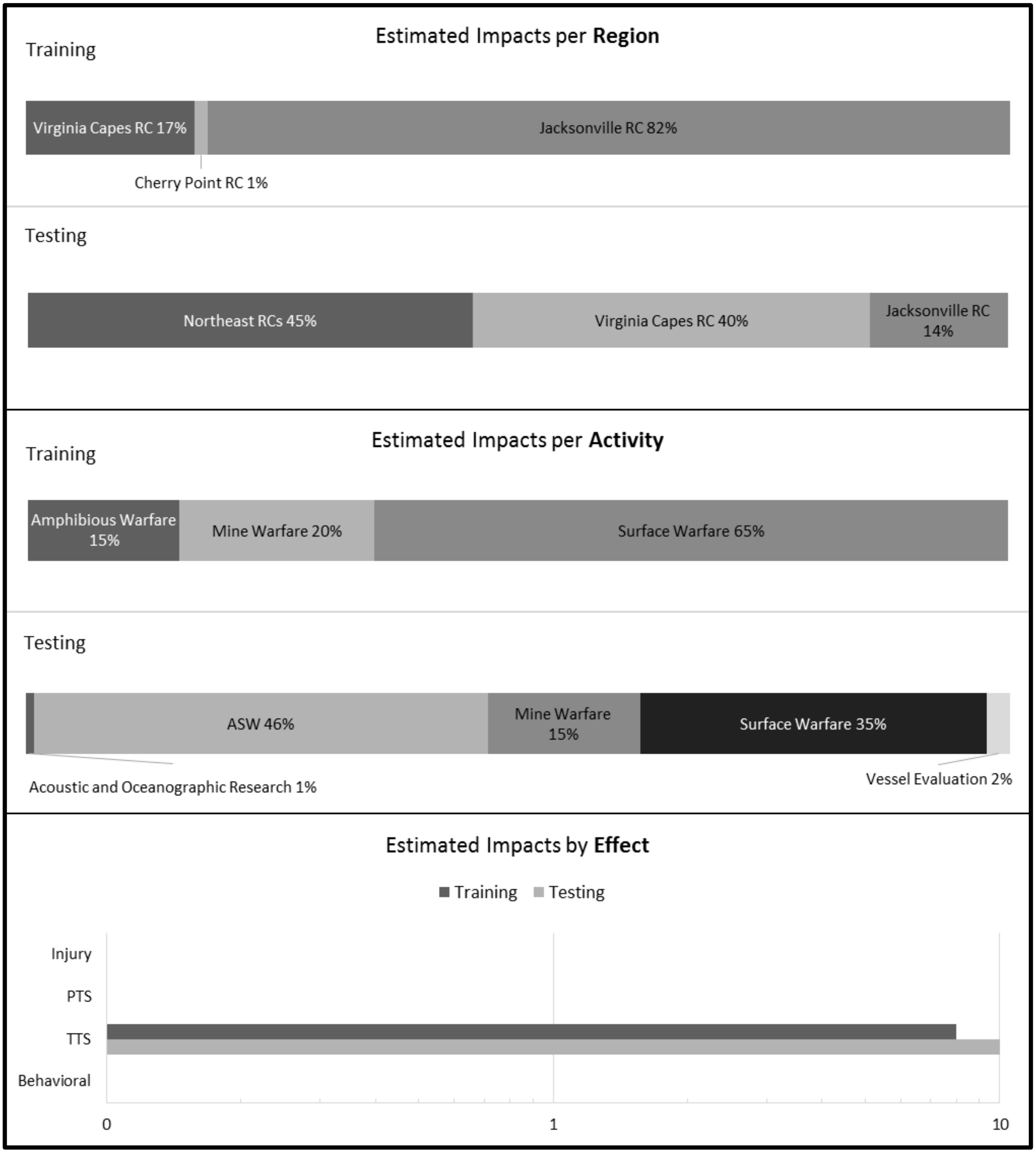
North Atlantic right whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6.5-5 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. The quantitative analysis also estimates TTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Western North Atlantic 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. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

As previously described in Sections 4.1.1.1 (North Atlantic Right Whale [*Eubalaena glacialis*]) a migratory corridor, a calving area, a mating area, and feeding areas for North Atlantic right whales have been identified by LaBrecque et al. (2015a, 2015b) that seasonally overlap with Virginia Capes, Navy Cherry Point, Jacksonville, and the Northeast Range Complexes within the Study Area. Navy testing activities that use explosives could occur in these range complexes year round. A few TTS exposures are estimated from testing with explosives in the Northeast Range Complexes on identified feeding and mating areas. Few impacts overall are predicted within the entire Study Area due to explosive testing activities; therefore significant impacts to feeding or mating behaviors within the feeding or mating areas identified by LaBrecque et al. (2015a, 2015b) are not anticipated. Estimated impacts to North Atlantic right whale migration and calving behaviors within the Navy Cherry Point Range Complex, which overlaps the identified migration and calving areas, are so low as to be unlikely in any given year. A few TTS exposures are estimated from testing with explosives in the Virginia Capes Range Complex, which overlaps the migratory area, and within the Jacksonville Range Complex, which overlaps the identified migratory and calving areas. However, since so few impacts are predicted overall within the Study Area from testing activities that use explosives, significant impacts to migratory or calving behaviors are not anticipated within the designated areas.

The Study Area does overlap North Atlantic right whale critical habitat and some limited use of explosives does take place within these areas; however, the sound and energy from explosives would not affect the biological or physical features that are essential for the reproduction, rest and refuge, health, continued survival, conservation and recovery of the northern right whale population.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of North Atlantic right whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-5: North Atlantic Right Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.3.2 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, although the quantitative analysis estimates that no blue whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

The use of explosives during training activities as described under the Proposed Action may not result in the unintentional taking of blue whale 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, although the quantitative analysis estimates that no blue whales would be impacted except for estimated TTS for Ship Shock Trials (See Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives).

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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of blue whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.

6.5.2.3.3.3 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 6.5-6 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 from Explosives).

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 implemented 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 Bryde's whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Gulf of Mexico Range Complex within the Study Area. Navy training activities that use explosives could occur year round within the Gulf of Mexico Range Complex; however, the quantitative analysis indicates no impacts to Bryde's whales. Bryde's whales residing in this area could be exposed to sound or energy from explosives; however, impacts to natural behavior patterns or abandonment would not be anticipated within the identified Bryde's whale small and resident population area.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of Bryde's whales incidental to those activities as outlined in Table 5.1-3.

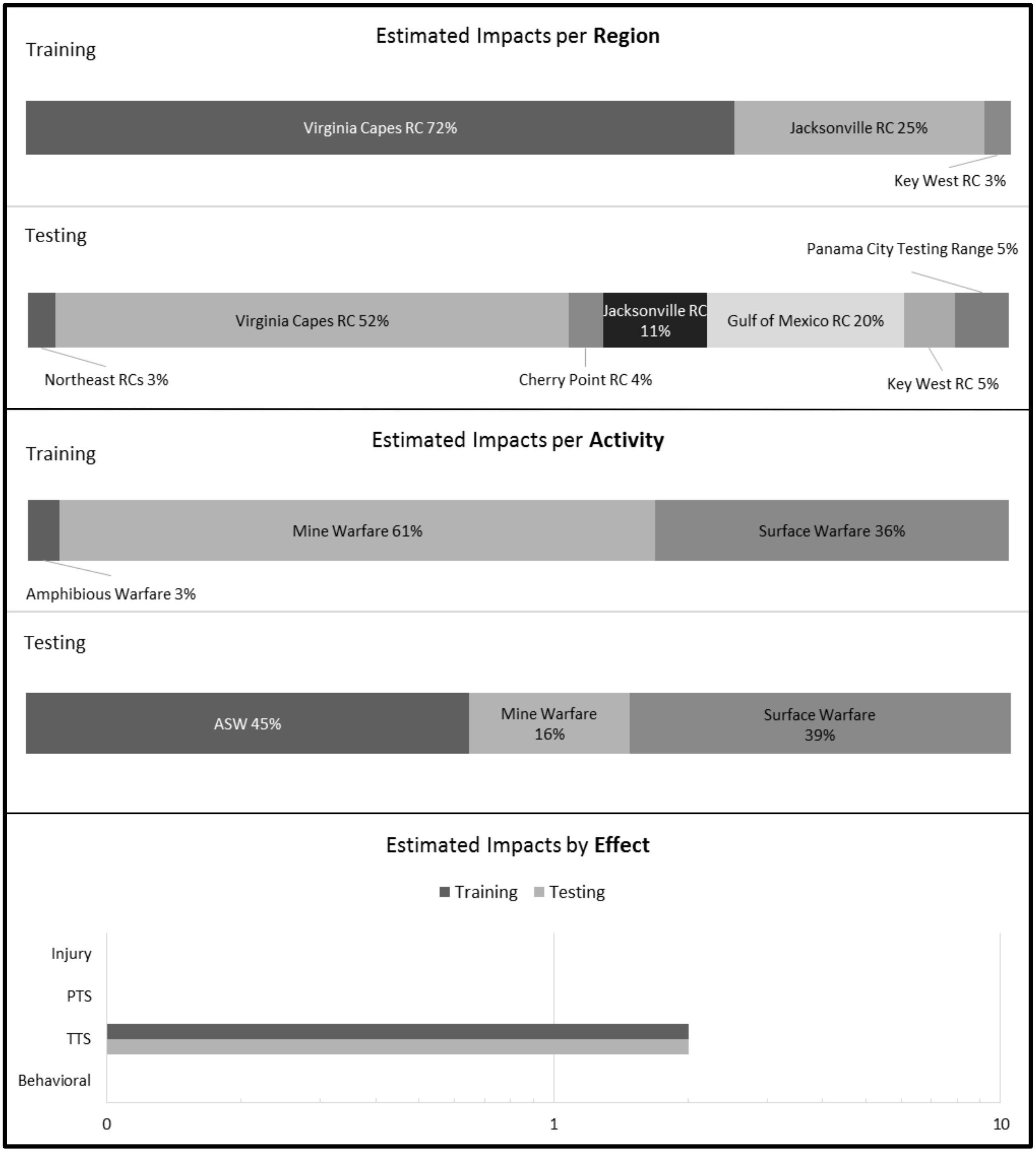
Impacts from Explosives Under the Proposed Action for Testing Activities

Bryde's 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 explosives per year under the Proposed Action, estimates TTS (see Figure 6.5-6 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives).

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 implemented 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 Bryde's whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Gulf of Mexico Range Complex within the Study Area. Navy testing activities that use explosives could occur year round within the Gulf of Mexico Range Complex; however, the quantitative analysis indicates impacts to Bryde's whales within the Bryde's whale small and resident population area identified by LaBrecque et al. (2015a, 2015b) are so low as to be unlikely in any given year. Significant impacts to natural behaviors or abandonment of the area by Bryde's whales in the small and resident population area identified by LaBrecque et al. (2015a, 2015b) are unlikely due to Navy testing activities that use explosives.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of Bryde's whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. 100% Northern Gulf of Mexico Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-6: Bryde's Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.3.4 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, estimates TTS and PTS (see Figure 6.5-7 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 from Explosives). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A feeding area for fin whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use explosives could occur year round within the Northeast Range Complex; however, within the Northeast Range Complex training with explosives typically occurs only within Narragansett Bay, which is outside the fin whale feeding area identified by LaBrecque et al. (2015a, 2015b). Fin whales within the identified feeding area would not be exposed to sound or energy from explosives; therefore, impacts to feeding behaviors would not be anticipated within the identified fin whale feeding area from training with explosives.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of fin whales incidental to those activities as outlined in Table 5.1-3.

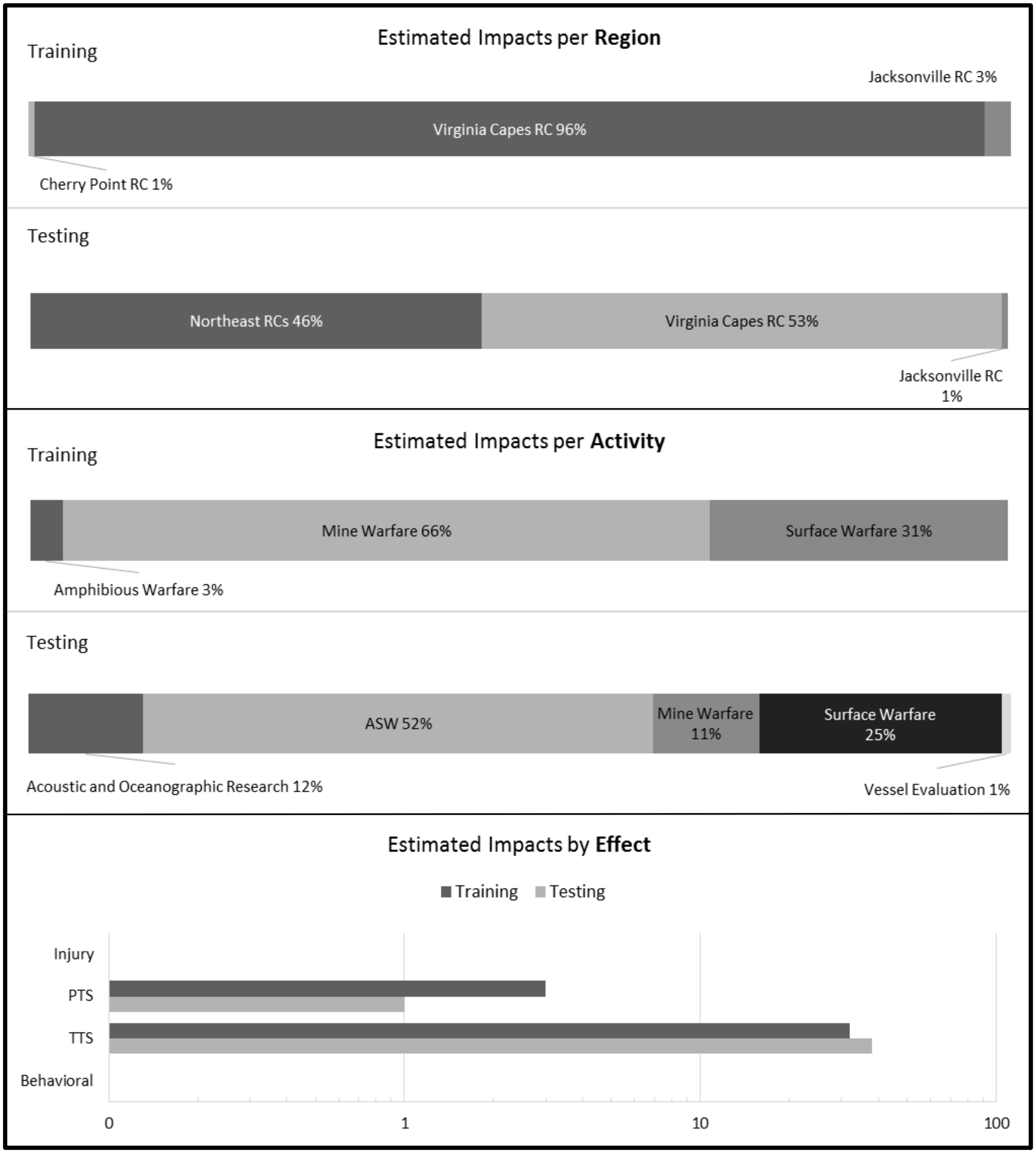
Impacts from Explosives Under the Proposed Action for Testing Activities

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 6.5-7 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Western North Atlantic 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for fin whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use explosives could occur year round within the Northeast Range Complexes. A small number of behavioral reactions or TTS could occur within the fin whale feeding area identified by LaBrecque et al. (2015a, 2015b). Few impacts overall are predicted within the entire Study Area due to explosive testing activities; therefore significant impacts to feeding behaviors within the fin whale feeding area identified by LaBrecque et al. (2015a, 2015b) are not anticipated.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of fin whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-7: Fin Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.3.5 Humpback Whales

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 6.5-8 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 from Explosives). Estimated impacts apply to the Gulf of Maine 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for humpback whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use explosives could occur year round within the Northeast Range Complexes; however, within the Northeast Range Complexes training with explosives typically occurs only within Narragansett Bay, which is outside the humpback whale feeding area identified by LaBrecque et al. (2015a, 2015b). Humpback whales within the identified feeding area would not be exposed to sound or energy; therefore, impacts to feeding behaviors would not be anticipated within the identified humpback whale feeding area from training with explosives.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of humpback whales incidental to those activities as outlined in Table 5.1-3.

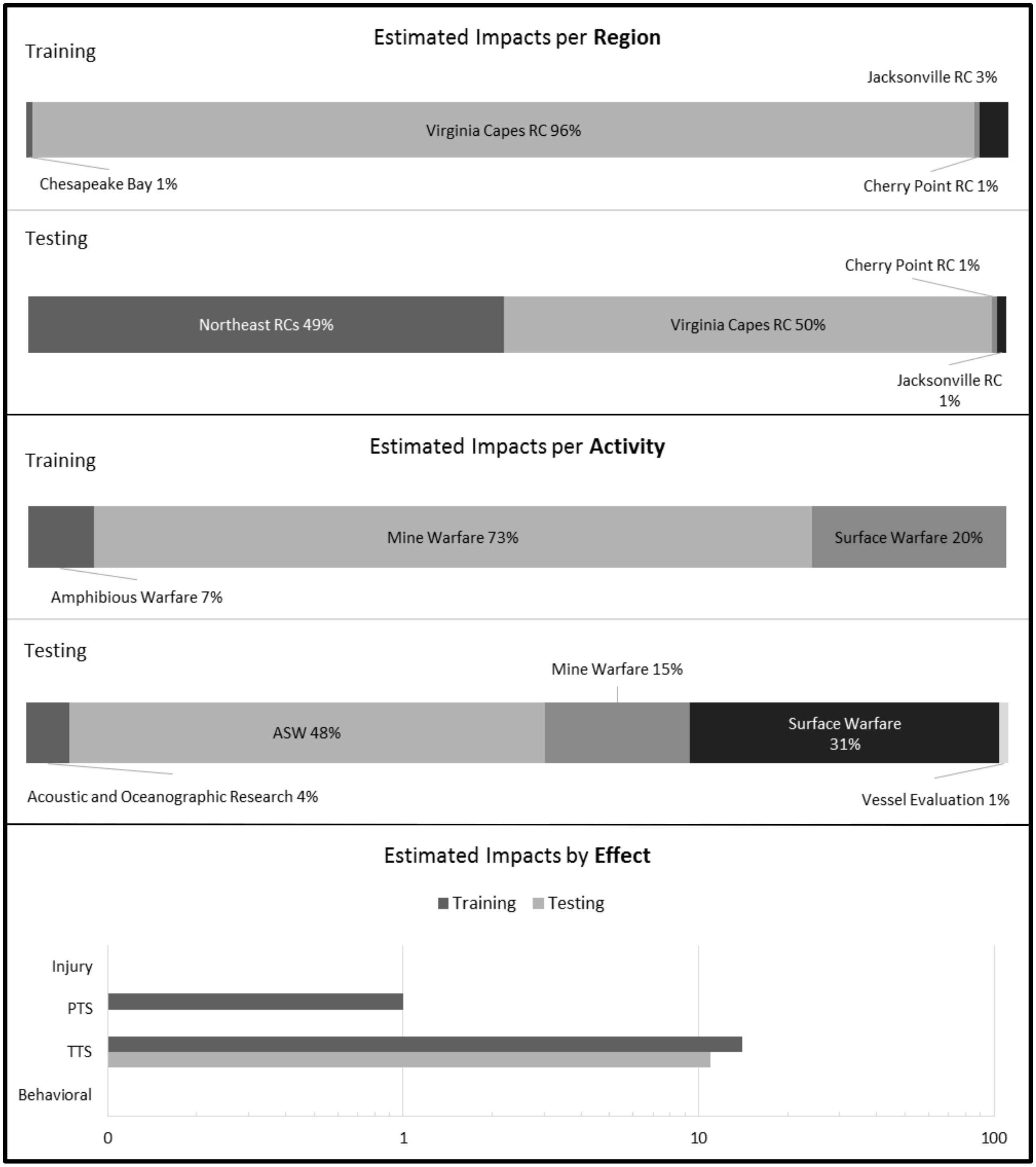
Impacts from Explosives Under the Proposed Action for Testing Activities

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 (see Figure 6.5-8 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Gulf of Maine 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for humpback whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use explosives could occur year round within the Northeast Range Complexes. A small number of behavioral reactions or TTS could occur within the humpback whale feeding area identified by LaBrecque et al. (2015a, 2015b). Few impacts overall are predicted within the entire Study Area due to explosive testing activities; therefore significant impacts to feeding behaviors within the humpback whale feeding area identified by LaBrecque et al. (2015a, 2015b) are not anticipated.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of humpback whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. 100% Gulf of Maine stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-8: Humpback Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.3.6 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 (see Figure 6.5-9 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 from Explosives). Estimated impacts apply to the Canadian East Coast 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. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A feeding area for minke whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use explosives could occur year round within the Northeast Range Complexes; however, within the Northeast Range Complexes training with explosives typically occurs only within Narragansett Bay, which is outside the minke whale feeding area identified by LaBrecque et al. (2015a, 2015b). Minke whales in the identified feeding area would not be exposed to sound or energy from explosives; therefore, impacts to feeding behaviors would not be anticipated within the identified minke whale feeding area from training with explosives.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of minke whales incidental to those activities as outlined in Table 5.1-3.

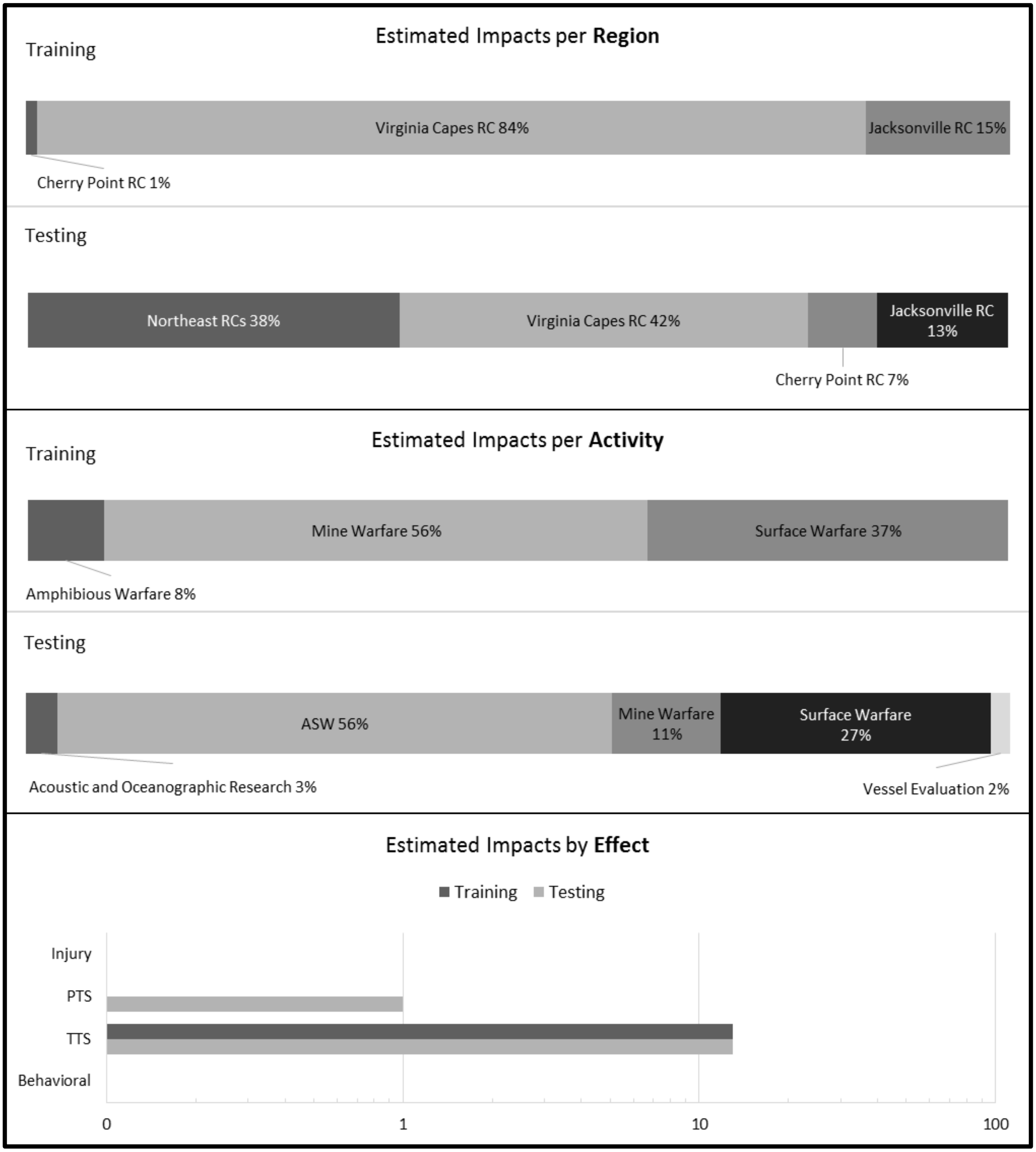
Impacts from Explosives Under the Proposed Action for Testing Activities

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 6.5-9 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Canadian East Coast 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for minke whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use explosives could occur year round within the Northeast Range Complexes. A small number of behavioral reactions or TTS could occur within the minke whale feeding area identified by LaBrecque et al. (2015a, 2015b). Few impacts overall are predicted within the entire Study Area due to explosive testing activities; therefore significant impacts to feeding behaviors within the minke whale feeding area identified by LaBrecque et al. (2015a, 2015b) are not anticipated.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of minke whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. 100% Canadian East Coast Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-9: Minke Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.3.7 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 6.5-10 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 from Explosives). Estimated impacts apply to the Nova Scotia 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. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A feeding area for sei whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that use explosives could occur year round within the Northeast Range Complexes; however, within the Northeast Range Complexes, training with explosives typically occurs only within Narragansett Bay, which is outside the sei whale feeding area identified by LaBrecque et al. (2015a, 2015b). Sei whales within the identified feeding area would not be exposed to sound or energy from explosives; therefore, impacts to feeding behaviors would not be anticipated within the identified sei whale feeding area from training with explosives.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of sei whales incidental to those activities as outlined in Table 5.1-3.

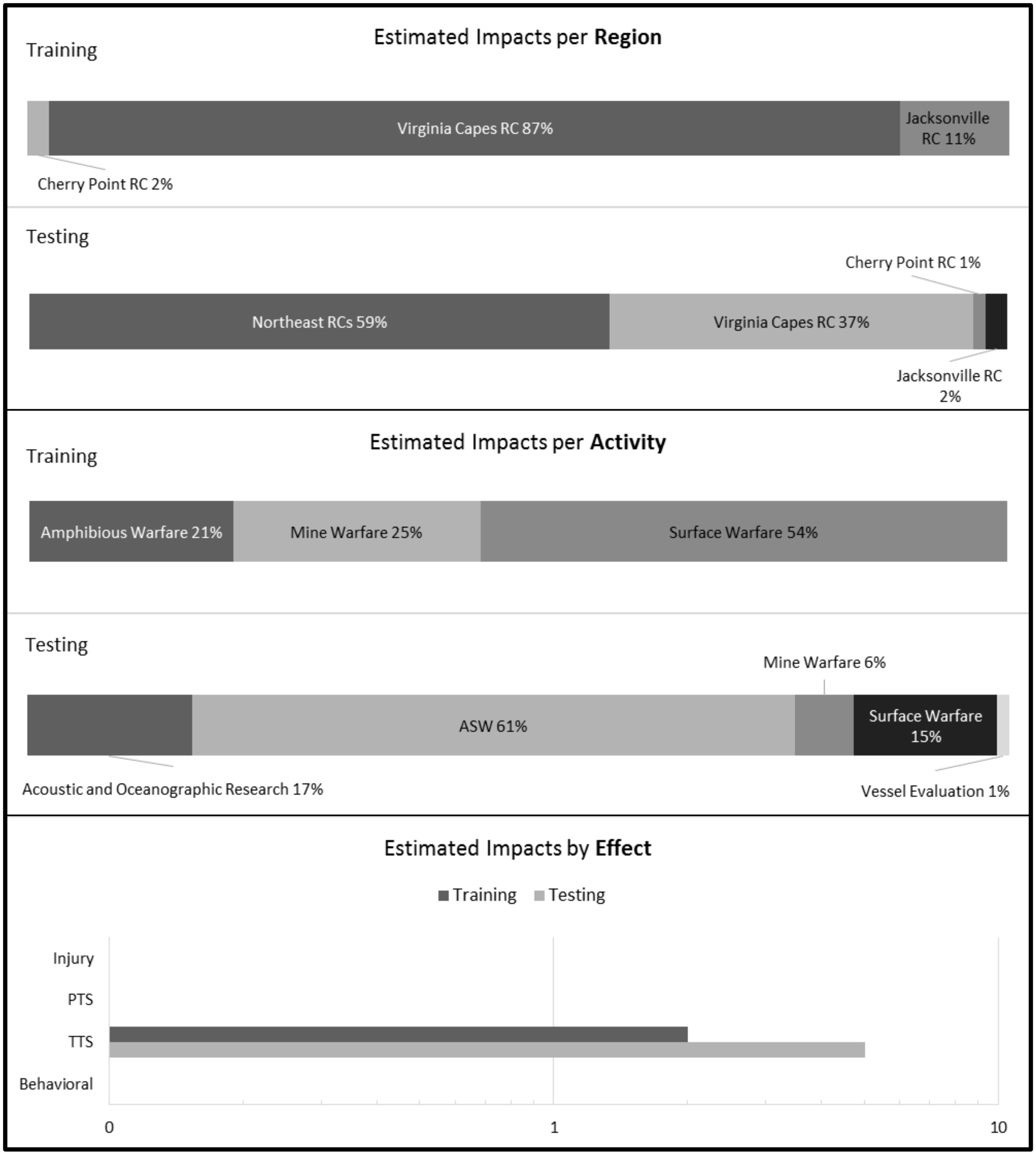
Impacts from Explosives Under the Proposed Action for Testing Activities

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 6.5-10 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Nova Scotia 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The feeding area for sei whales identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that use explosives could occur year round within the Northeast Range Complexes. A small number of behavioral reactions or TTS could occur within the sei whale feeding area identified by LaBrecque et al. (2015a, 2015b). Few impacts overall are predicted within the entire Study Area due to explosive testing activities; therefore significant impacts to feeding behaviors within the sei whale feeding area identified by LaBrecque et al. (2015a, 2015b) are not anticipated.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of sei whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. 100% Nova Scotia Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-10: Sei Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.4 Odontocetes

Odontocetes may be exposed to sound and energy from explosions associated with training activities throughout the year. Explosions produce sounds that are within the hearing range of odontocetes (see Section 6.3, 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 harbor 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 in a mitigation zone around an intended explosion impact area or target location to protect against injuries. Nevertheless, animals that did sustain injury could have long-term consequences for that individual. Considering that most 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 of time 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 (see Section 6.4.1.5, 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. 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.

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 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 activities 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.

6.5.2.3.4.1 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 6.5-11 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-16).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

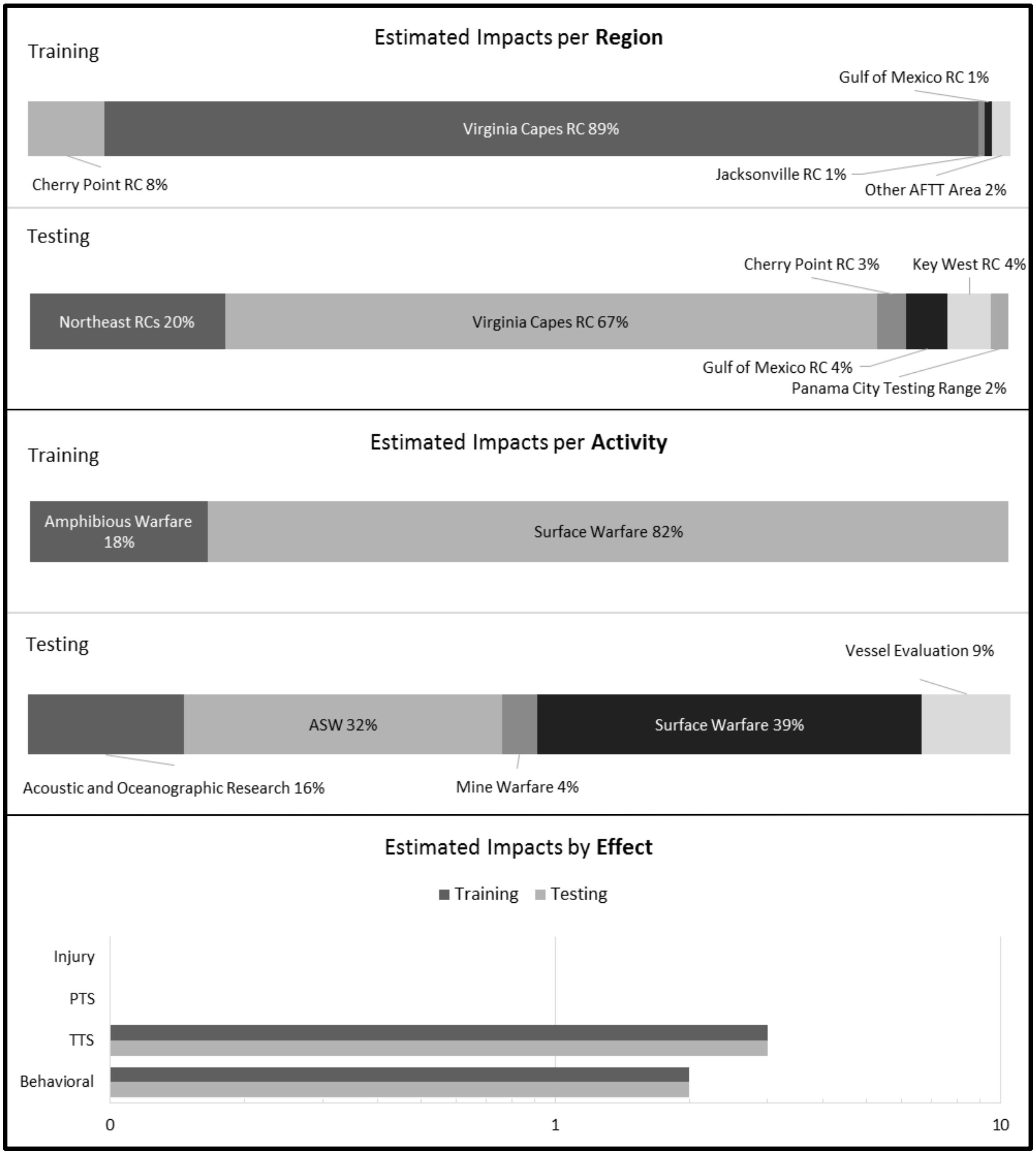
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of sperm whales incidental to those activities as outlined in Table 5.1-3.

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 behavioral reactions and TTS (see Figure 6.5-11 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-16).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of sperm whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-11: Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-16: 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***
Gulf of Mexico Oceanic	1%	7%
North Atlantic	99%	93%

6.5.2.3.4.2 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 6.5-12 and Figure 6.5-13 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-17 and Table 6.5-18: Estimated Impacts on Individual Pygmy Sperm Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

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As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of dwarf and pygmy sperm whales incidental to those activities as outlined in Table 5.1-3.

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 6.5-12 and Figure 6.5-13 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-17 and Table 6.5-18: Estimated Impacts on Individual Pygmy Sperm Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

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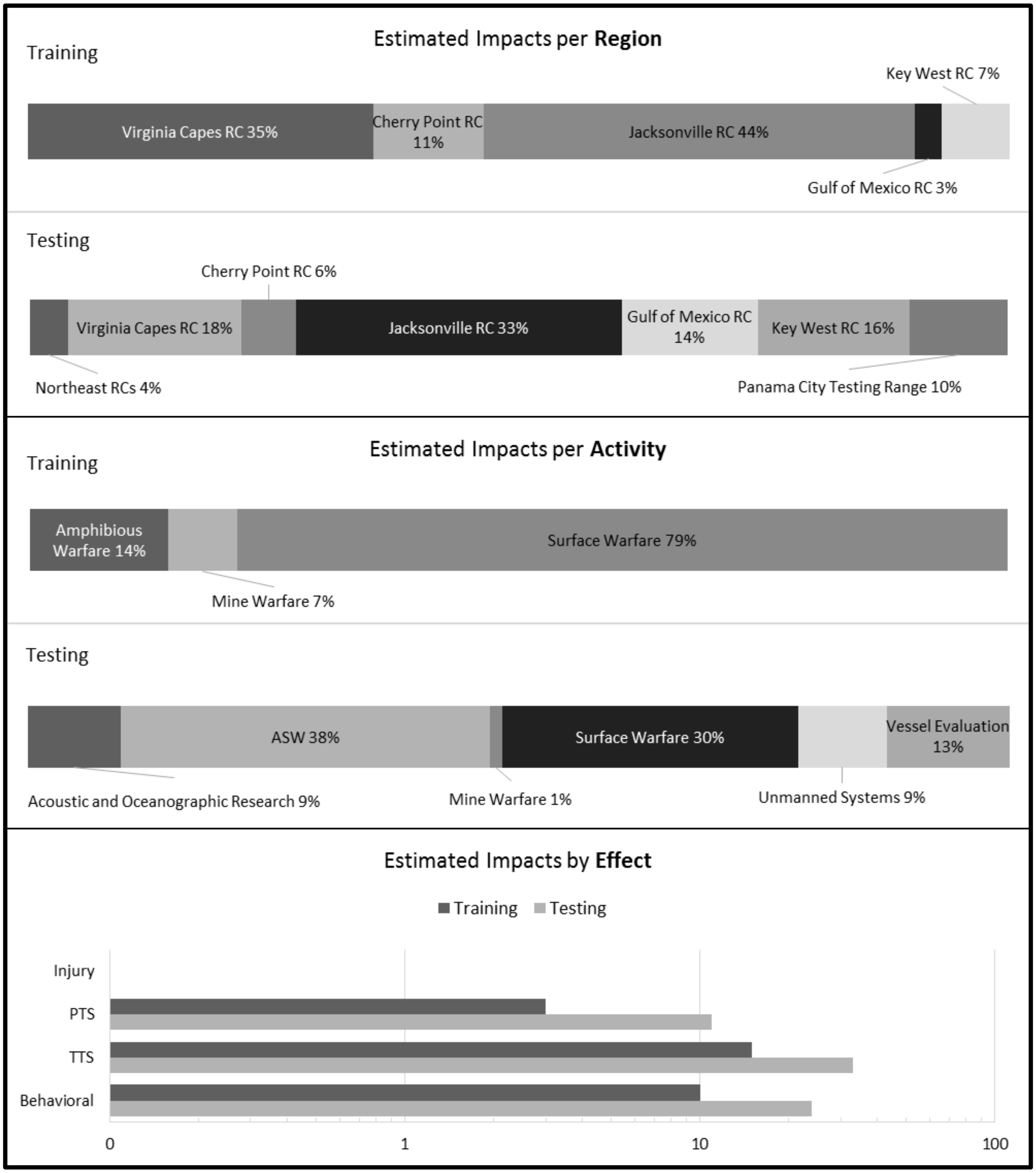
As described for odontocetes above, behavioral reactions or even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of dwarf and pygmy sperm whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.

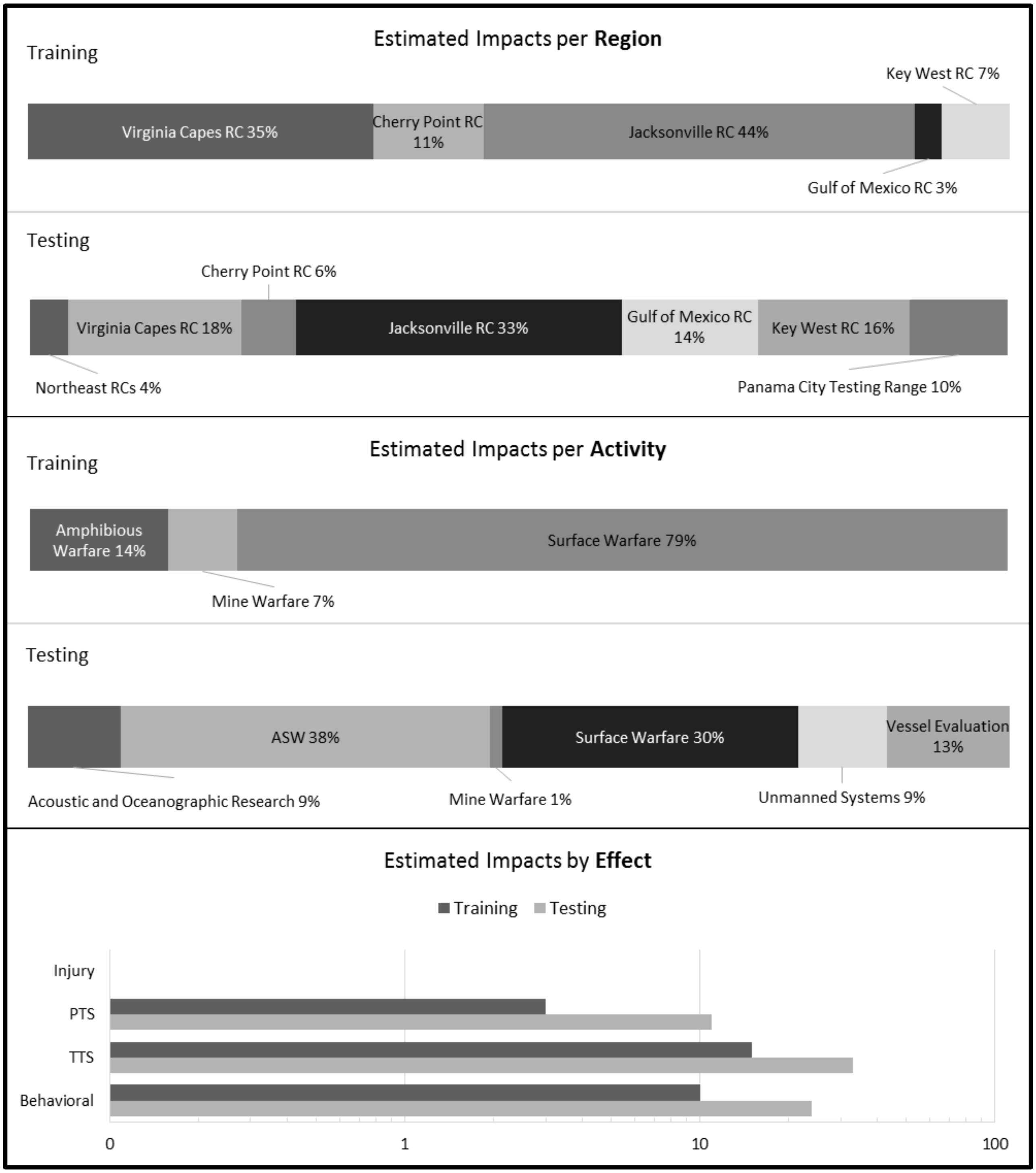


Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No Injury (Non-Auditory) is estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-12: Dwarf Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-17: Estimated Impacts on Individual Dwarf 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***
Gulf of Mexico Oceanic	5%	28%
Western North Atlantic	95%	72%



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 Injury (Non-Auditory) is Estimated for this Species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-13: Pygmy Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-18: Estimated Impacts on Individual Pygmy 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***
Northern Gulf of Mexico	5%	28%
Western North Atlantic	95%	72%

6.5.2.3.4.3 Beaked Whales

Beaked whales are a group of species within the AFTT Study Area that includes: Blainville's beaked whales, Cuvier's beaked whales, Gervais' beaked whales, Sowerby's beaked whales, True's beaked whales, and Northern bottlenose whales.

Northern bottlenose 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 Northern bottlenose whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

The use of explosives during training or testing activities under the Proposed Action may not result in the unintentional taking of Northern bottlenose whales incidental to those activities.

Research and observations (see 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 sounds or noise from explosions 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.

<u>Impacts from Explosives Under the Proposed Action for Training Activities</u>

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/or TTS (see Figure 6.5-14 through Figure 6.5-18 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 from Explosives). Estimated impacts apply to multiple stocks for Blainesville's, Cuvier's and Gervais' beaked whales (see Table 6.5-19 through Table 6.5-21), and to Sowerby's and True's beaked whale Western North Atlantic stocks.

As described above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

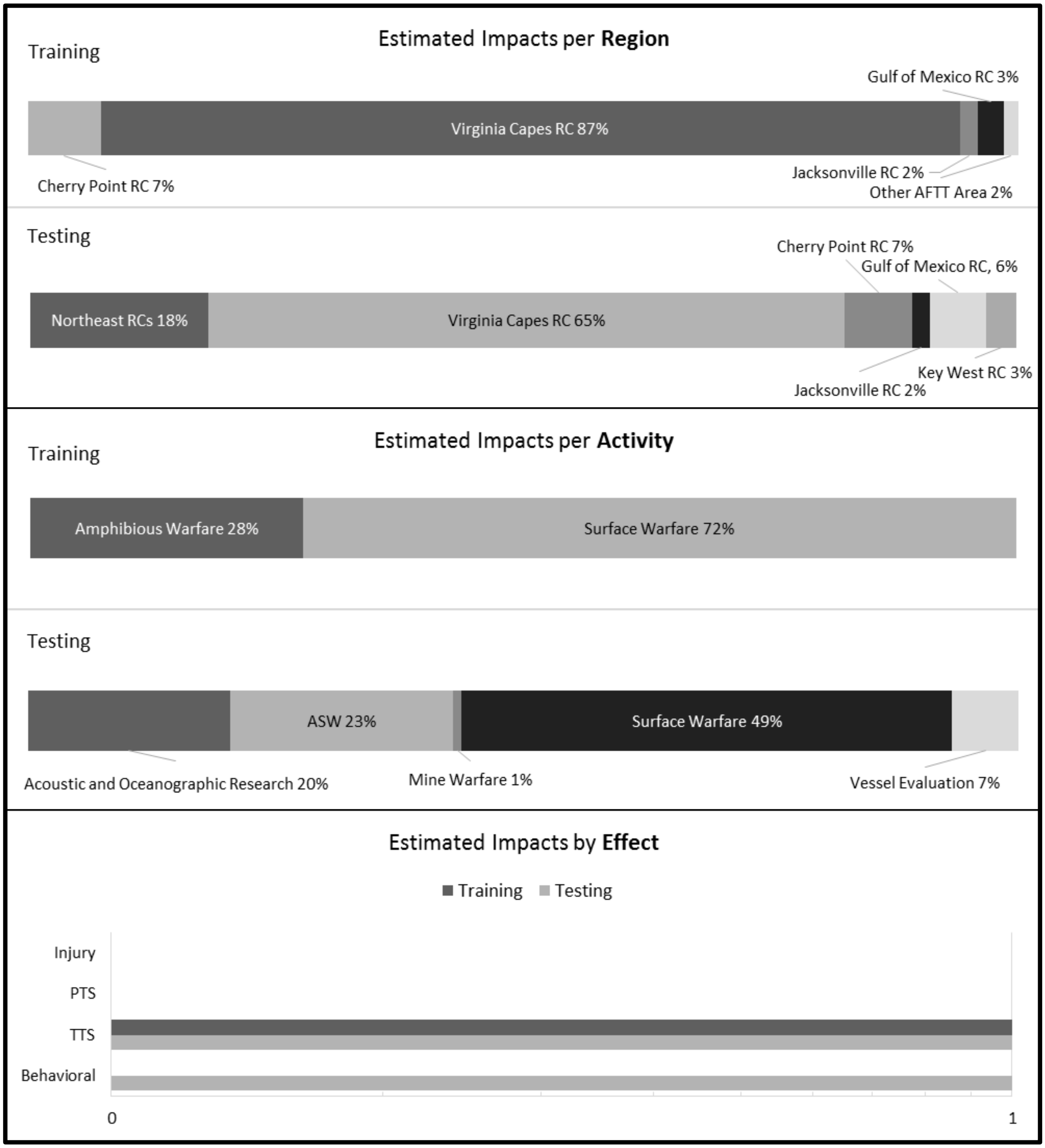
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of Blainville's, Cuvier's, Gervais', Sowerby's, and True's beaked whales incidental to those activities as outlined in Table 5.1-3.

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 behavioral reactions and TTS (see Figure 6.5-14 through Figure 6.5-18 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks for Blainesville's, Cuvier's and Gervais' beaked whales (see Table 6.5-19 through Table 6.5-21), and to Sowerby's and True's beaked whale Western North Atlantic stocks.

As described above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of Blainville's, Cuvier's, Gervais', Sowerby's, and True's beaked whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.

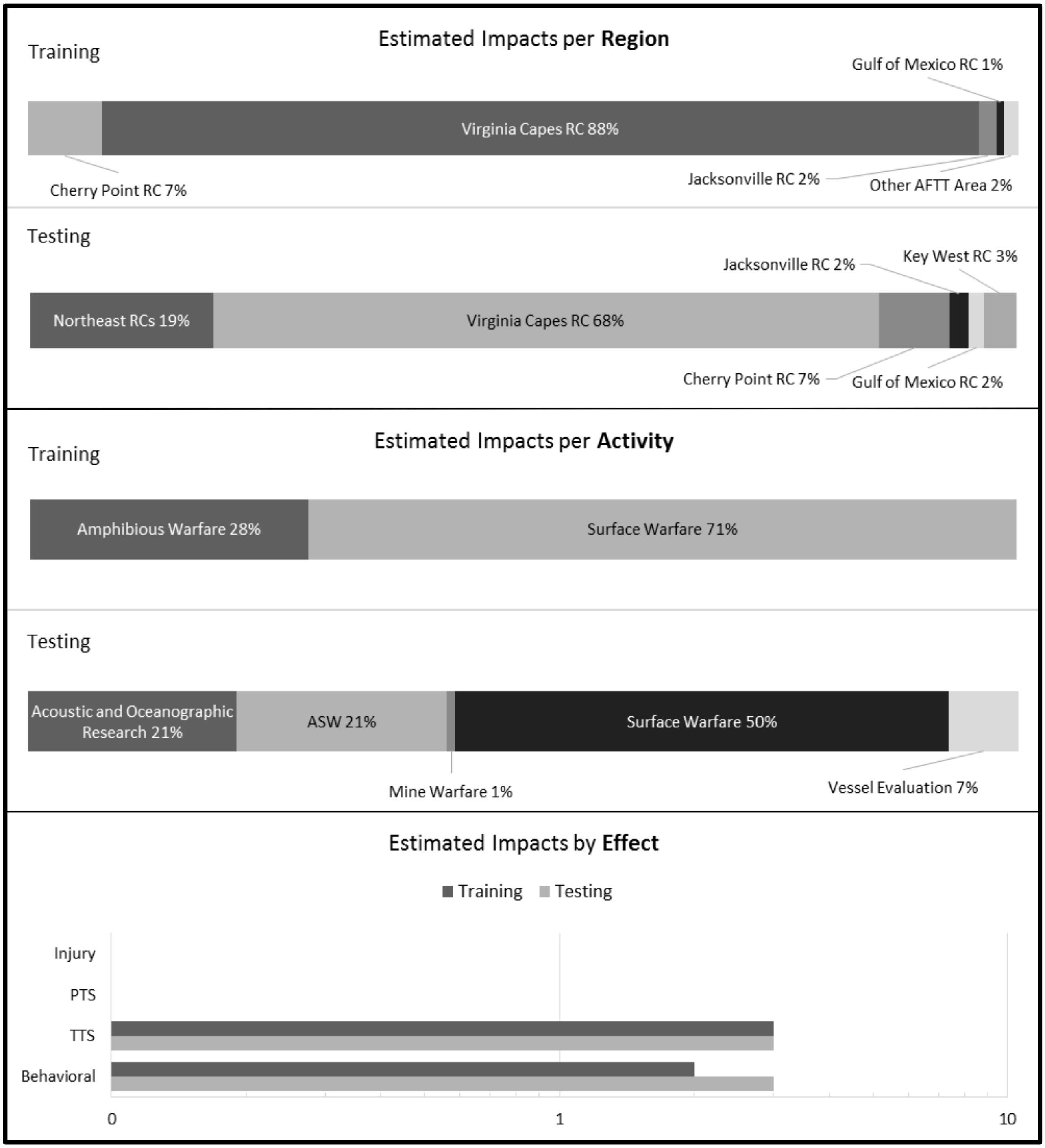


Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or Injury (Non-Auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-14: Blainville's Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-19: Estimated Impacts on Individual Blainesville's Beaked 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***
Northern Gulf of Mexico	3%	6%
Western North Atlantic	97%	94%



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 Injury (Non-Auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-15: Cuvier's Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-20: Estimated Impacts on Individual Cuvier's Beaked Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions.

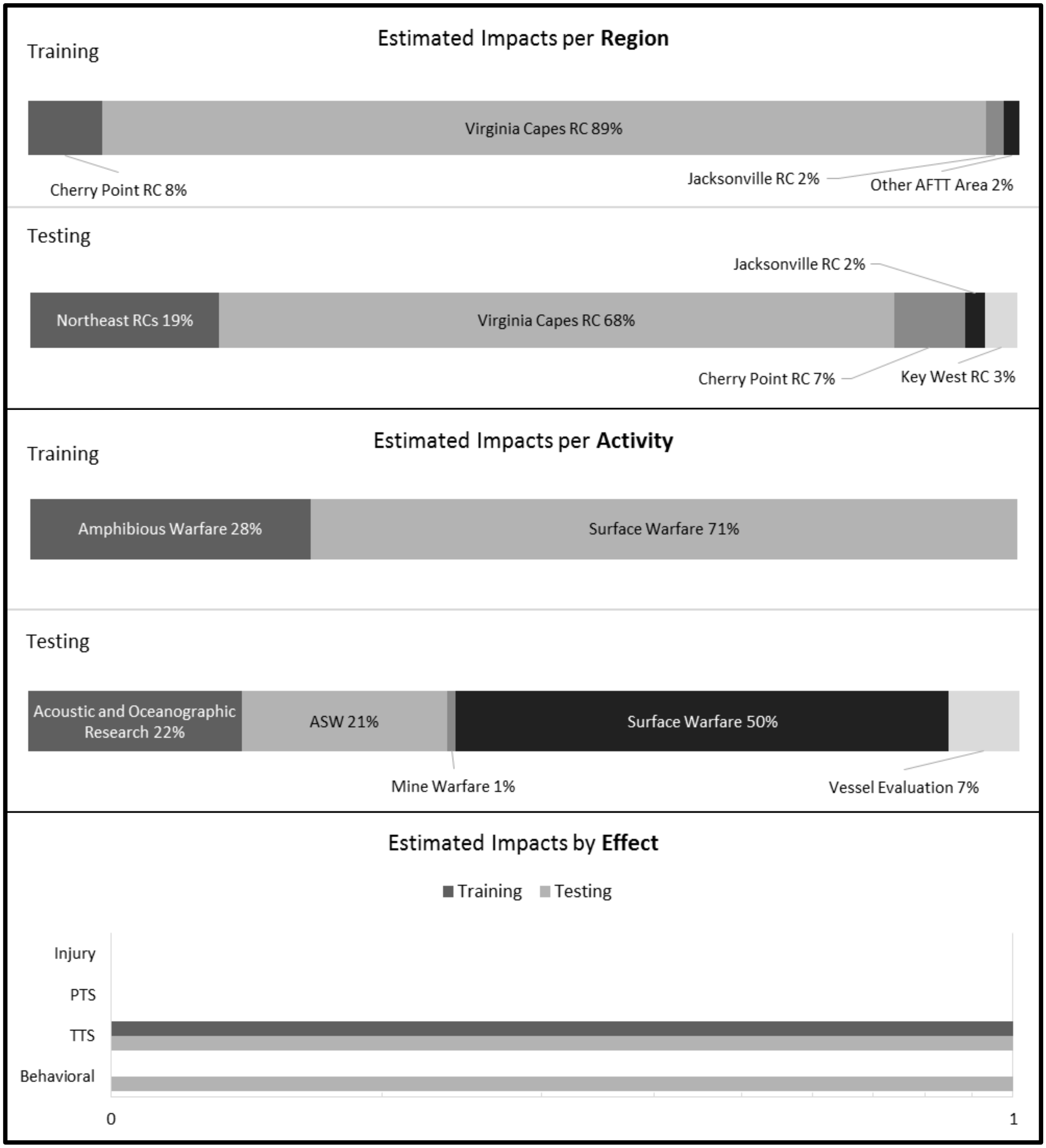
Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Northern Gulf of Mexico	1%	2%
Western North Atlantic	99%	98%

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 Injury (Non-Auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-16: Gervais' Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

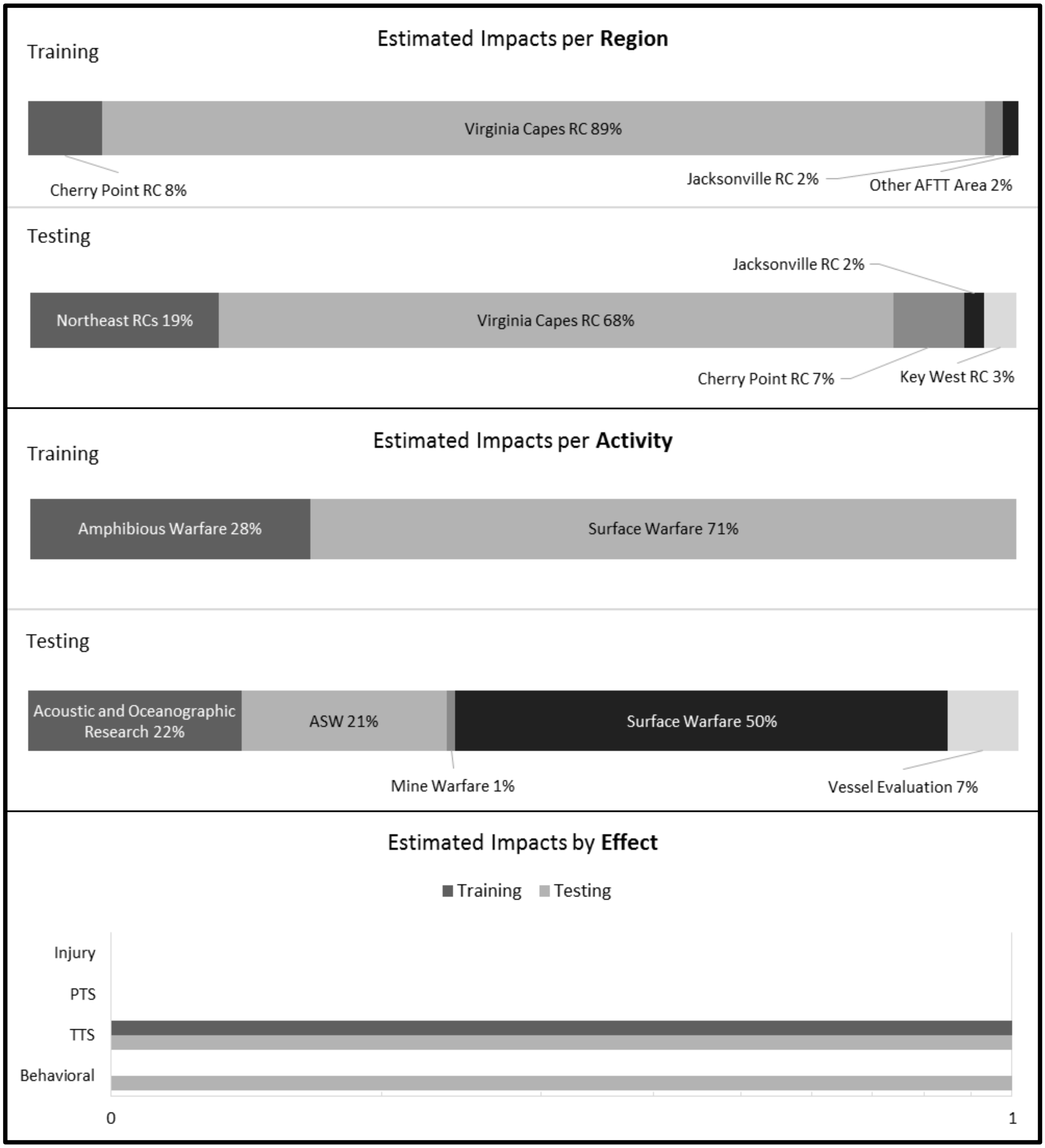
Table 6.5-21: Estimated Impacts on Individual Gervais' Beaked Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions.

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Northern Gulf of Mexico	3%	6%
Western North Atlantic	97%	94%



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 Injury (Non-Auditory) are estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-17: Sowerby's Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).



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 Injury (Non-Auditory) are estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-18: True's Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.4.4 Atlantic Spotted Dolphins

Impacts from Explosives Under the Proposed Action for Training Activities

Atlantic 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 behavioral reactions, TTS, PTS, and non-auditory injury (see Figure 6.5-19 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-22).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

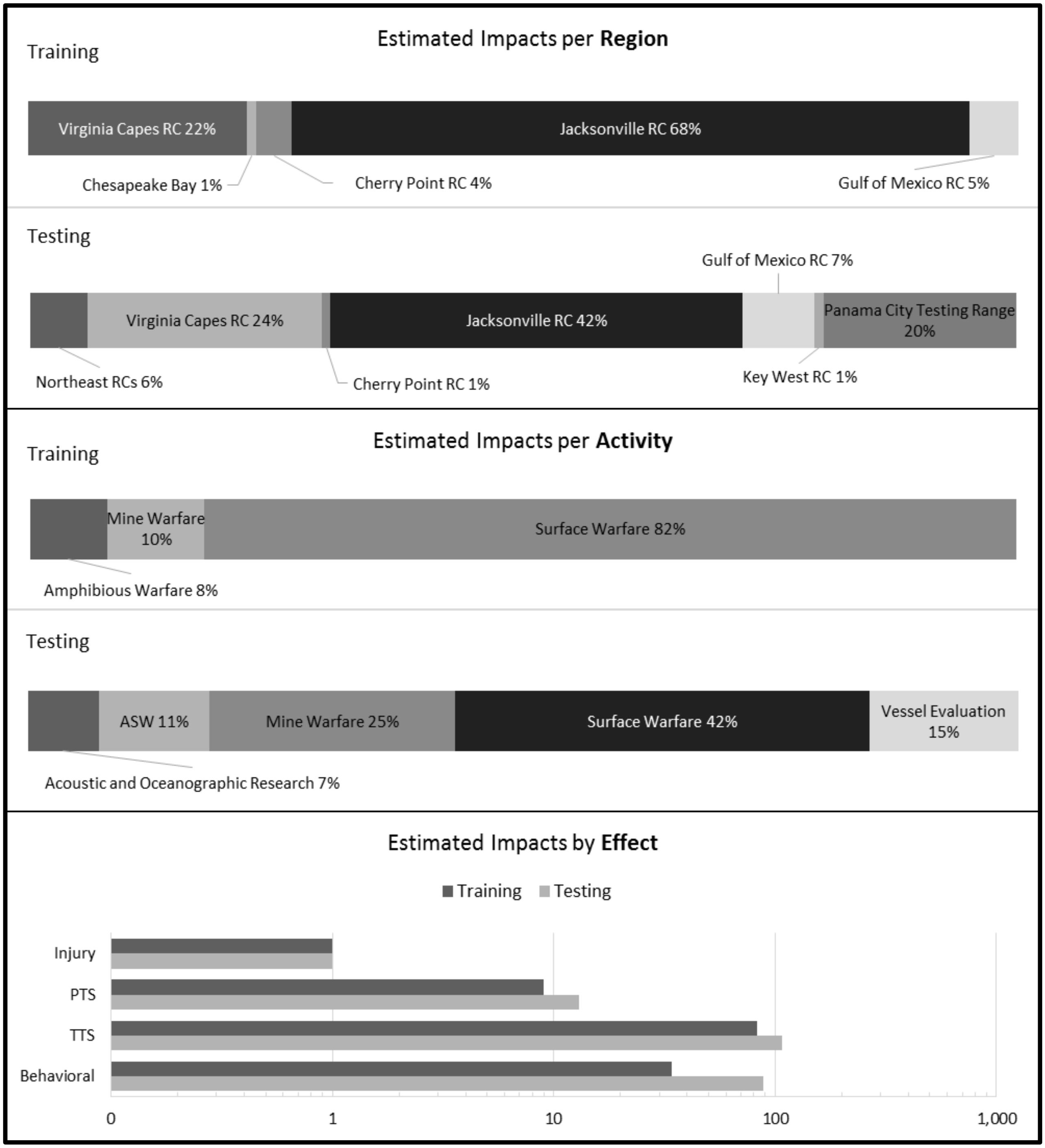
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of Atlantic spotted dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Explosives Under the Proposed Action for Testing Activities

Atlantic 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, TTS, PTS, and non-auditory injury (see Figure 6.5-19 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-22).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of Atlantic spotted dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-19: Atlantic Spotted Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-22: Estimated Impacts on Individual Atlantic 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***
Northern Gulf of Mexico	1%	2%
Western North Atlantic	99%	98%

6.5.2.3.4.5 Atlantic White-Sided Dolphins

Impacts from Explosives Under the Proposed Action for Training Activities

Atlantic 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 and TTS (see Figure 6.5-20 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 from Explosives). Estimated impacts apply to the Western North Atlantic stock.

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of Atlantic white-sided dolphins incidental to those activities as outlined in Table 5.1-3.

Impacts from Explosives Under the Proposed Action for Testing Activities

Atlantic 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 explosives per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6.5-20 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. The quantitative analysis also estimates TTS, PTS, non-auditory injury, and a single mortality for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Western North Atlantic stock.

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even in the event of a mortality or if an injury created long-term consequences for that individual or lead to mortality. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of Atlantic white-sided dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.

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 Injury (Non-Auditory) is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-20: Atlantic White-Sided Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.4.6 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, PTS, and non-auditory injury (see Figure 6.5-21 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-23).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

There are 21 small and resident population areas for common bottlenose dolphins identified by LaBrecque et al. (2015a, 2015b) which overlap, or are directly adjacent to the, AFTT Study Area. These identified areas are within bays and estuaries where the Navy does not train with explosives. Bottlenose dolphins in the identified small and resident population areas identified by LaBrecque et al. (2015a, 2015b) would not be exposed to sound or energy from explosions; therefore, impacts would not be anticipated from training with explosives.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of bottlenose dolphins incidental to those activities as outlined in Table 5.1-3.

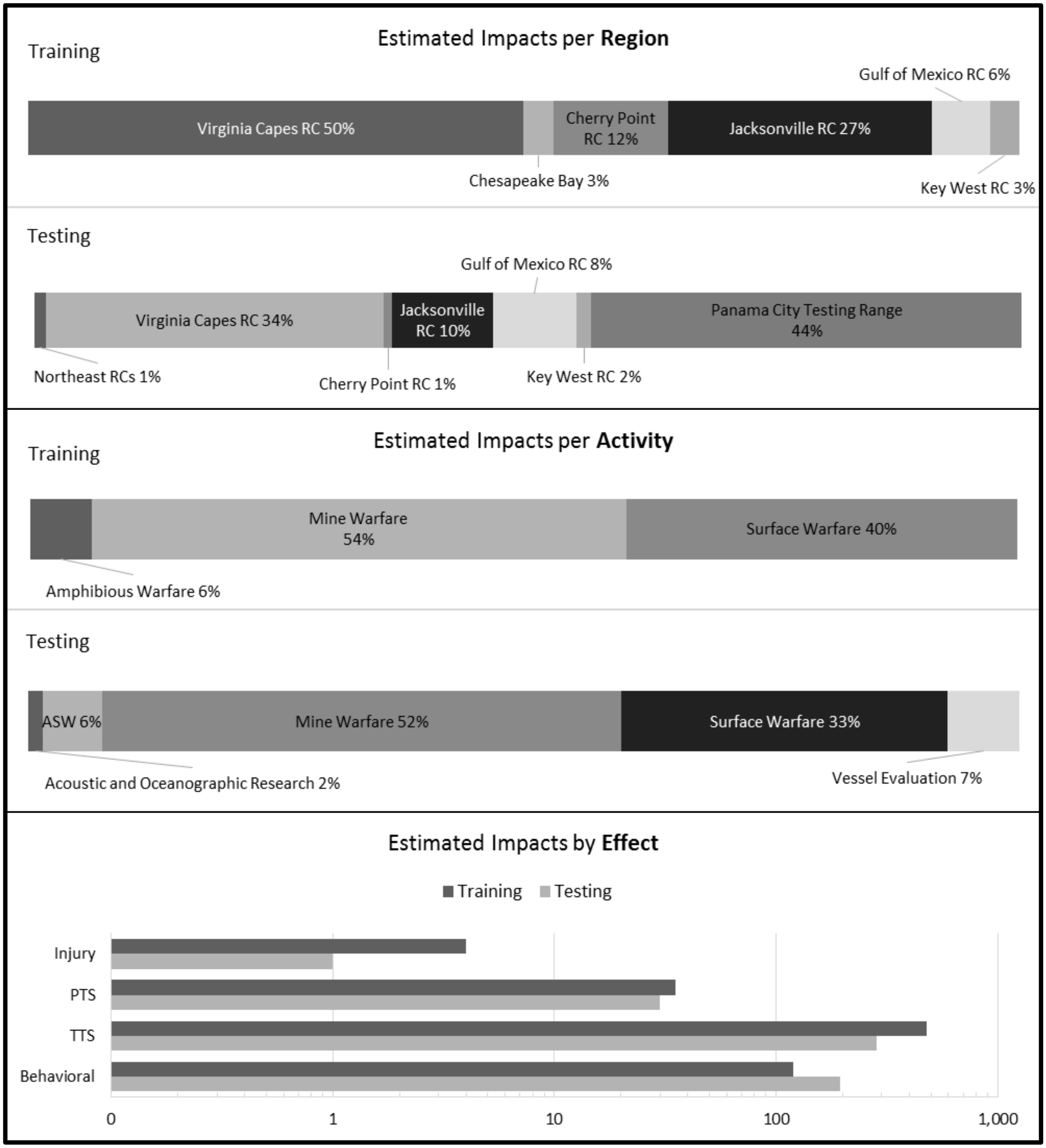
Impacts from Explosives Under the Proposed Action for Testing Activities

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, PTS, and non-auditory injury (see Figure 6.5-21 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-23).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

There are 21 small and resident population areas for common bottlenose dolphins identified by LaBrecque et al. (2015a, 2015b) which overlap, or are directly adjacent to the, AFTT Study Area. These identified areas are within bays and estuaries where the Navy does not test with explosives. Bottlenose dolphins in the identified small and resident population areas identified by LaBrecque et al. (2015a, 2015b) would not be exposed to sound or energy from explosions; therefore, impacts would not be anticipated from testing with explosives.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of bottlenose dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-21: Bottlenose Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-23: 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***
Gulf of Mexico Northern Coastal	1%	6%
Gulf of Mexico Western Coastal	0%	1%
Northern Gulf of Mexico Continental Shelf	4%	40%
Northern Gulf of Mexico Oceanic	1%	5%
Western North Atlantic Central Florida Coastal	1%	1%
Western North Atlantic Northern Migratory Coastal	9%	5%
Western North Atlantic Offshore	76%	41%
Western North Atlantic South Carolina/ Georgia Coastal	1%	1%
Western North Atlantic Southern Migratory Coastal	5%	1%

6.5.2.3.4.7 Clymene Dolphins

Impacts from Explosives Under the Proposed Action for Training Activities

Clymene 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 6.5-22 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 from Explosives). Estimated impacts apply to the Western North Atlantic stock.

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of Clymene dolphins incidental to those activities as outlined in Table 5.1-3.

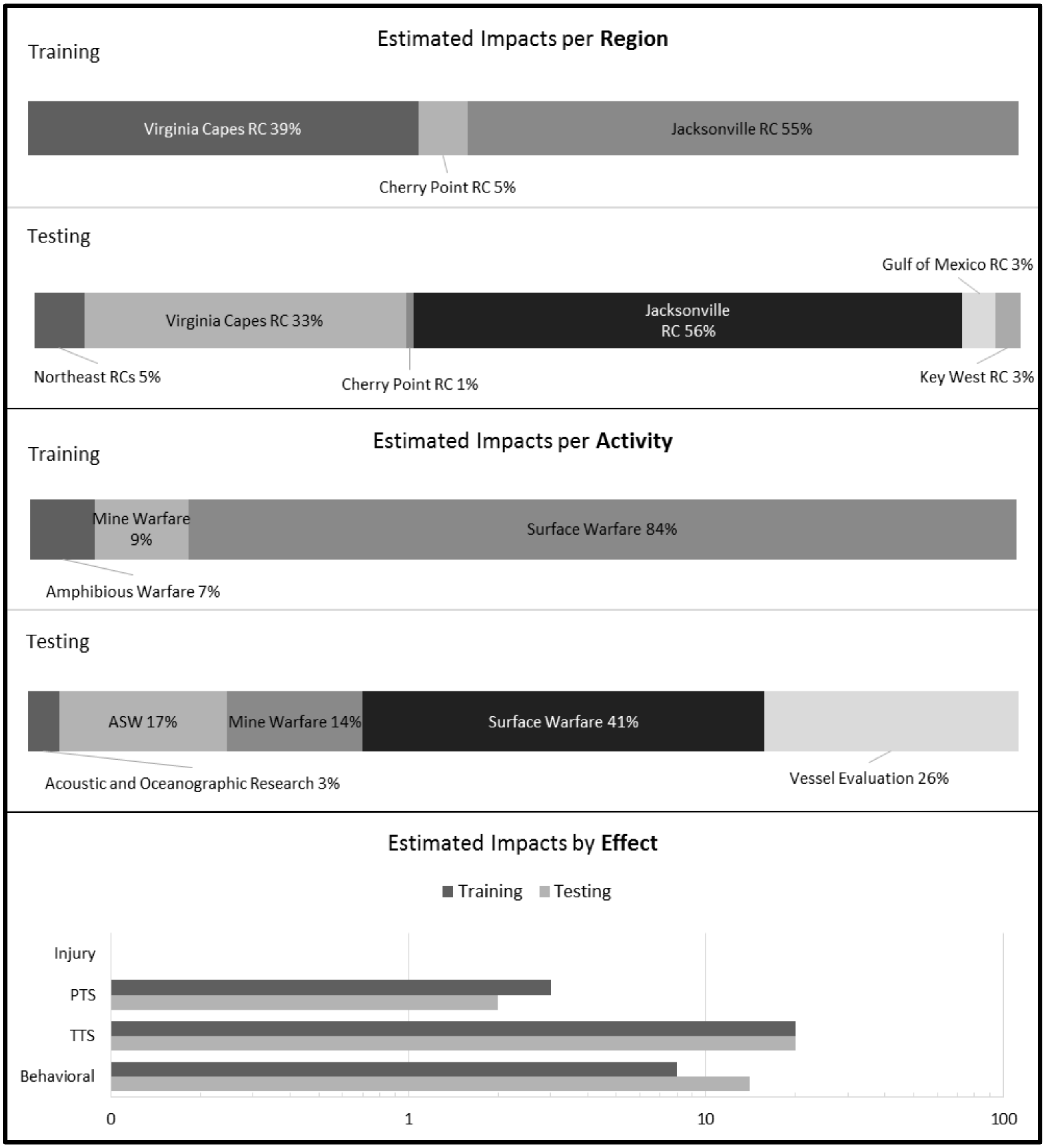
Impacts from Explosives Under the Proposed Action for Testing Activities

Clymene 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 6.5-22 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Western North Atlantic stock.

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of Clymene dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-22: Clymene Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

6.5.2.3.4.8 False Killer Whales

Impacts from Explosives Under 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 behavioral reactions and TTS (see Figure 6.5-23 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-24).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

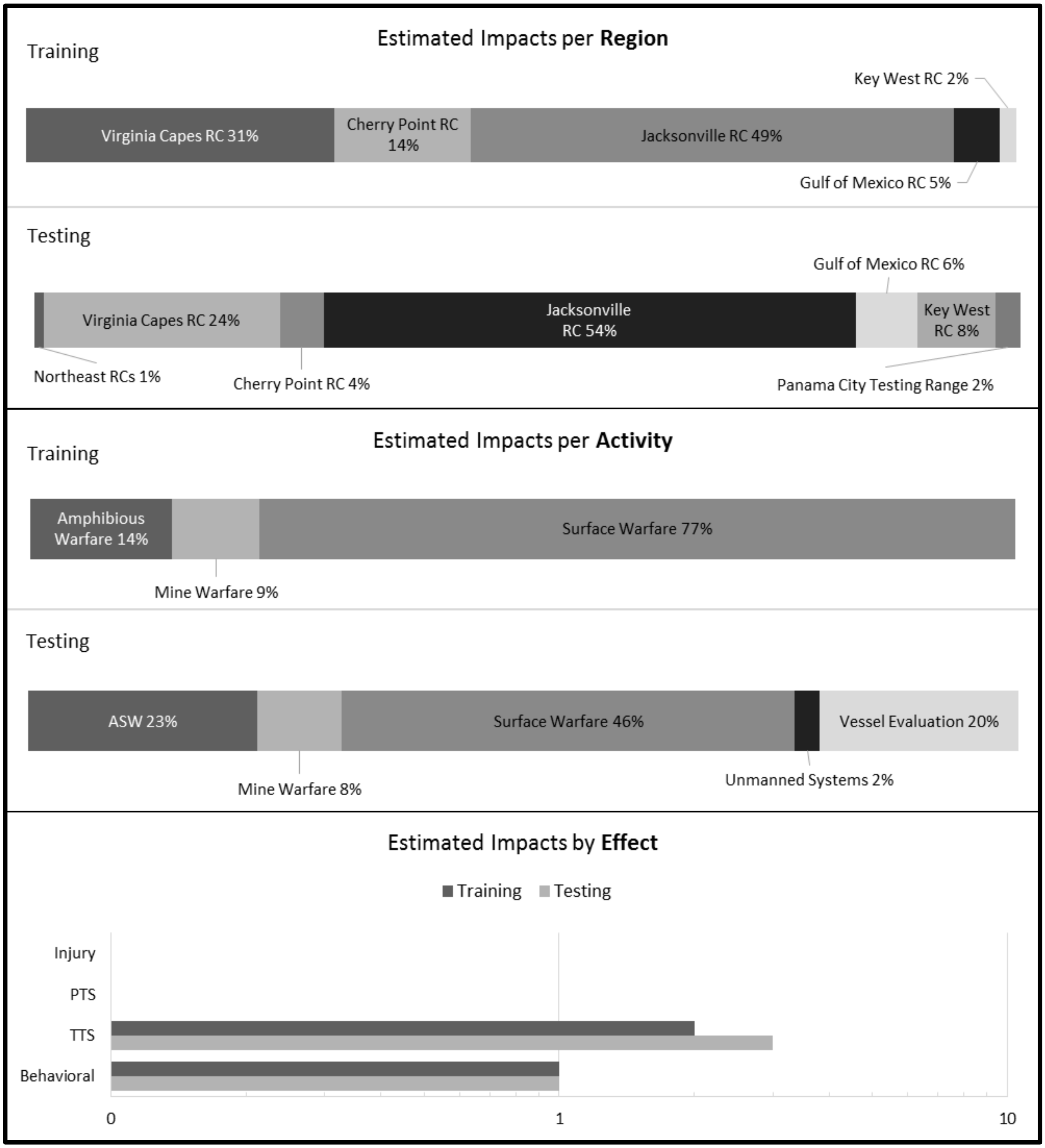
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of false killer whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Explosives Under the Proposed Action for Testing Activities

False 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 behavioral reactions and TTS (see Figure 6.5-23 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-24).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of false killer whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-23: False Killer Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-24: Estimated Impacts on Individual False 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***
Northern Gulf of Mexico	5%	11%
Western North Atlantic	95%	89%

6.5.2.3.4.9 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 under the Proposed Action throughout the year, although the quantitative analysis estimates that no Fraser's dolphin would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

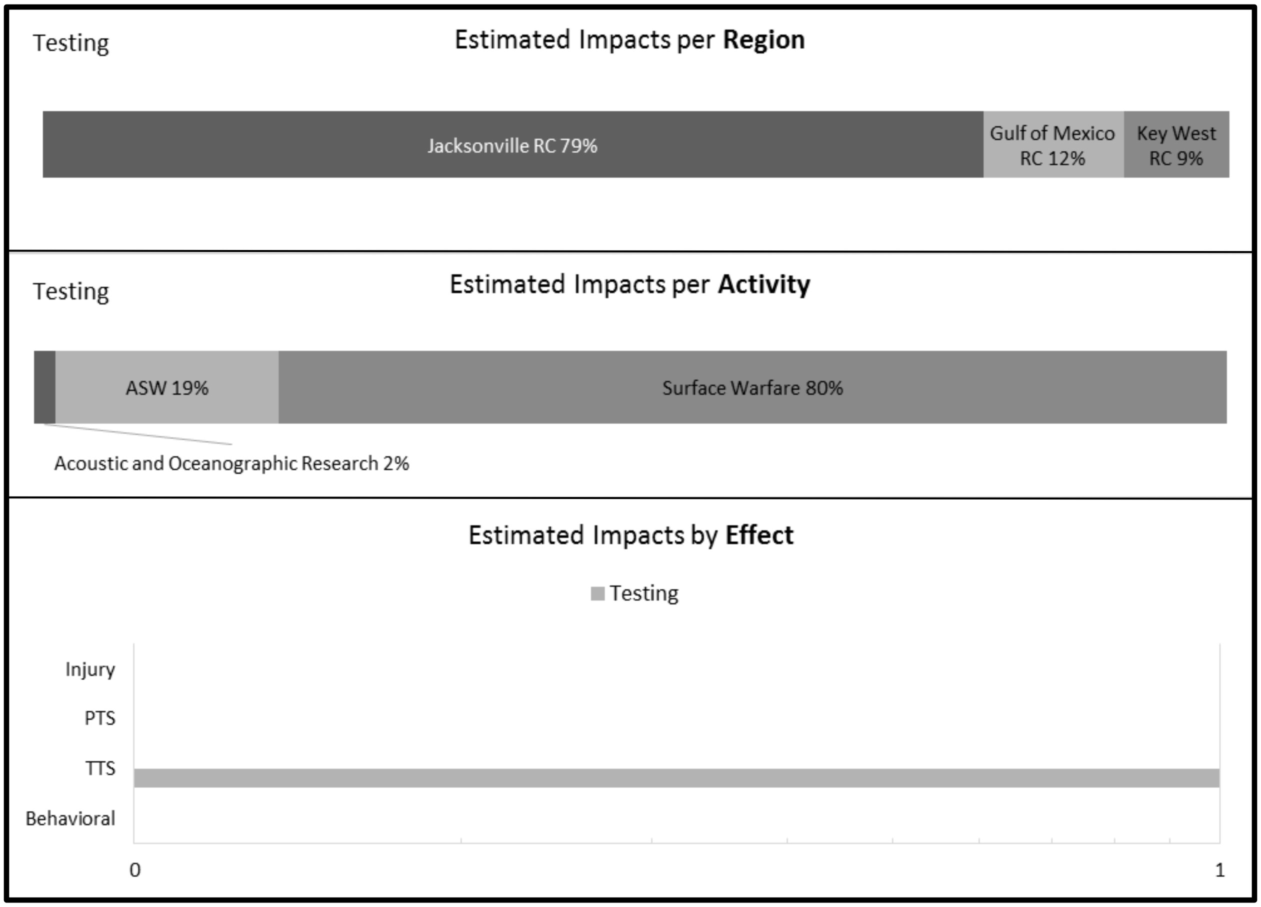
The use of explosives during training activities as described under the Proposed Action may not result in the unintentional taking of Fraser's dolphin incidental to those activities.

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 TTS (see Figure 6.5-24 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-25).

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. 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of Fraser's dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species.
ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-24: Fraser's Dolphin Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

Table 6.5-25: Estimated Impacts on Individual Fraser's Dolphin Stocks Within the Study Area per Year from Testing Explosions Using the Maximum Number of Explosions.

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Northern Gulf of Mexico	16%	14%
Western North Atlantic	84%	86%

6.5.2.3.4.10 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.

The use of explosives during training or testing activities under the proposed action may not result in the unintentional taking of killer whales incidental to those activities.

6.5.2.3.4.11 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 behavioral reactions, TTS, and PTS (see Figure 6.5-25 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 from Explosives). Estimated impacts apply to the Western North Atlantic stock for Training (see Table 6.5-26).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of melon-headed whales incidental to those activities as outlined in Table 5.1-3.

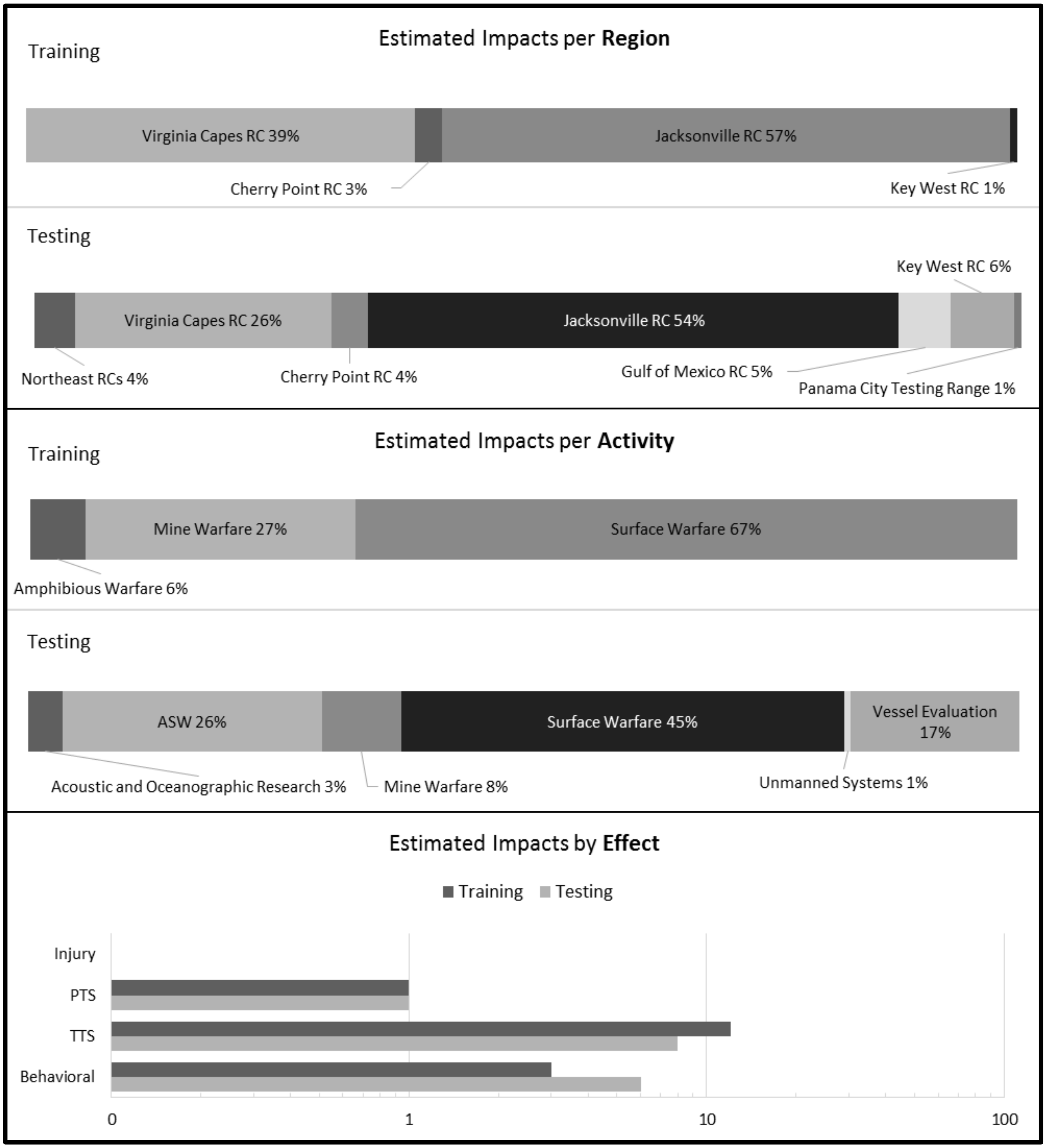
Impacts from Explosives Under the Proposed Action for Testing Activities

Melon-headed whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6.5-25 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-26).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in

Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of melon-headed whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-25: Melon-Headed Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-26: Estimated Impacts on Individual Melon-Headed 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***
Northern Gulf of Mexico	0%	8%
Western North Atlantic	100%	92%

6.5.2.3.4.12 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 behavioral reactions, TTS, and PTS (see Figure 6.5-26 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-27).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

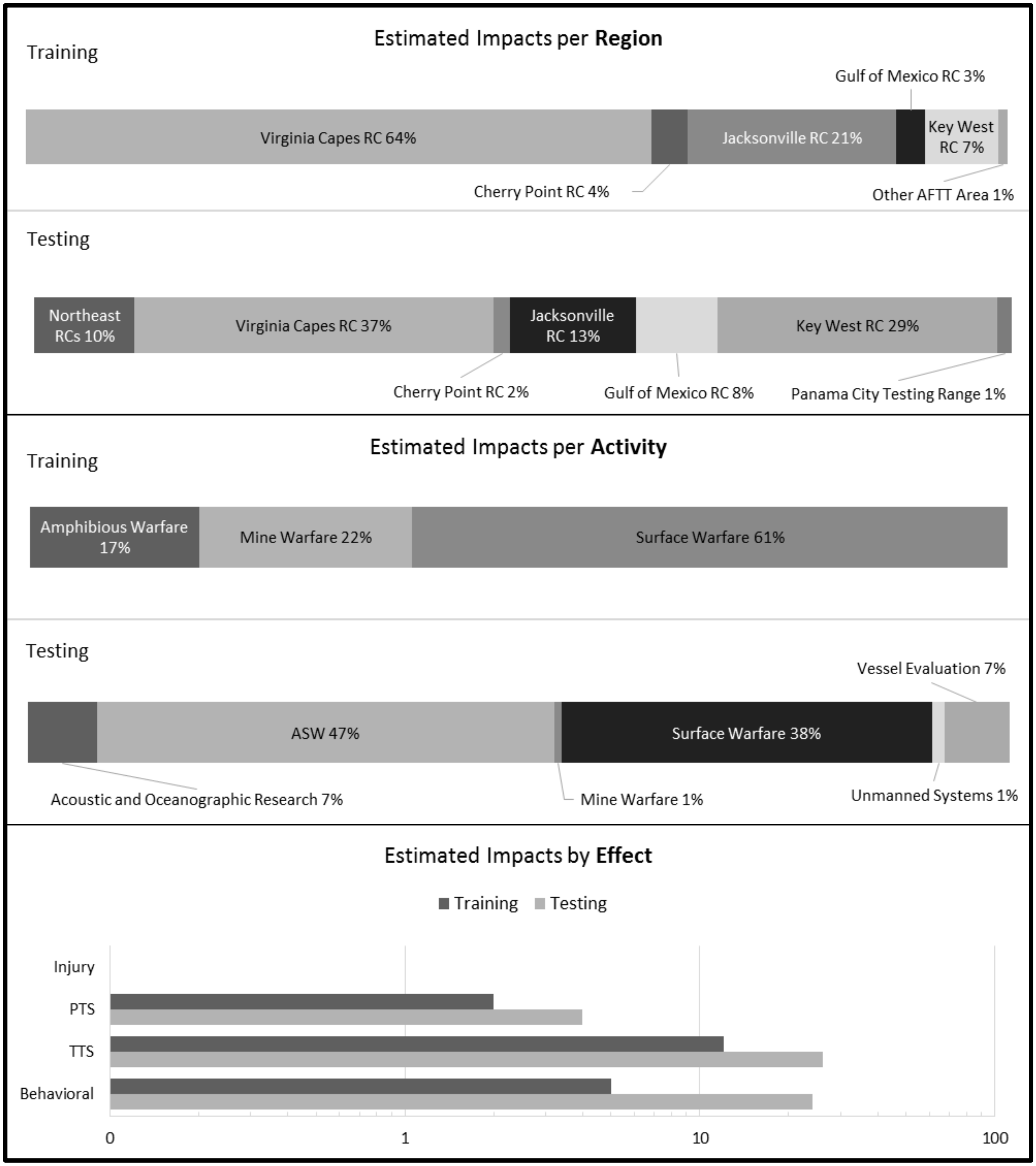
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of pantropical spotted dolphins incidental to those activities as outlined in Table 5.1-3.

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, TTS, and PTS (see Figure 6.5-26 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. The quantitative analysis also estimates TTS, PTS, non-auditory injury, and a single mortality for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-27).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even in the event of a mortality or if an injury created long-term consequences for that individual or lead to mortality. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of pantropical spotted dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-26: Pantropical Spotted Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-27: 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***
Northern Gulf of Mexico	5%	17%
Western North Atlantic	95%	83%

6.5.2.3.4.13 Pilot Whales

Pilot whales include two species that are often difficult to distinguish from one another: long-finned pilot whales and short-finned pilot whales.

Impacts from Explosives Under the Proposed Action for Training Activities

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 and TTS (see Figure 6.5-27 and Figure 6.5-28, 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 from Explosives). Estimated impacts apply to the Western North Atlantic stocks of long-finned and short-finned pilot whales.

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of long-finned and short-finned pilot whales incidental to those activities as outlined in Table 5.1-3.

Impacts from Explosives Under the Proposed Action for Testing Activities

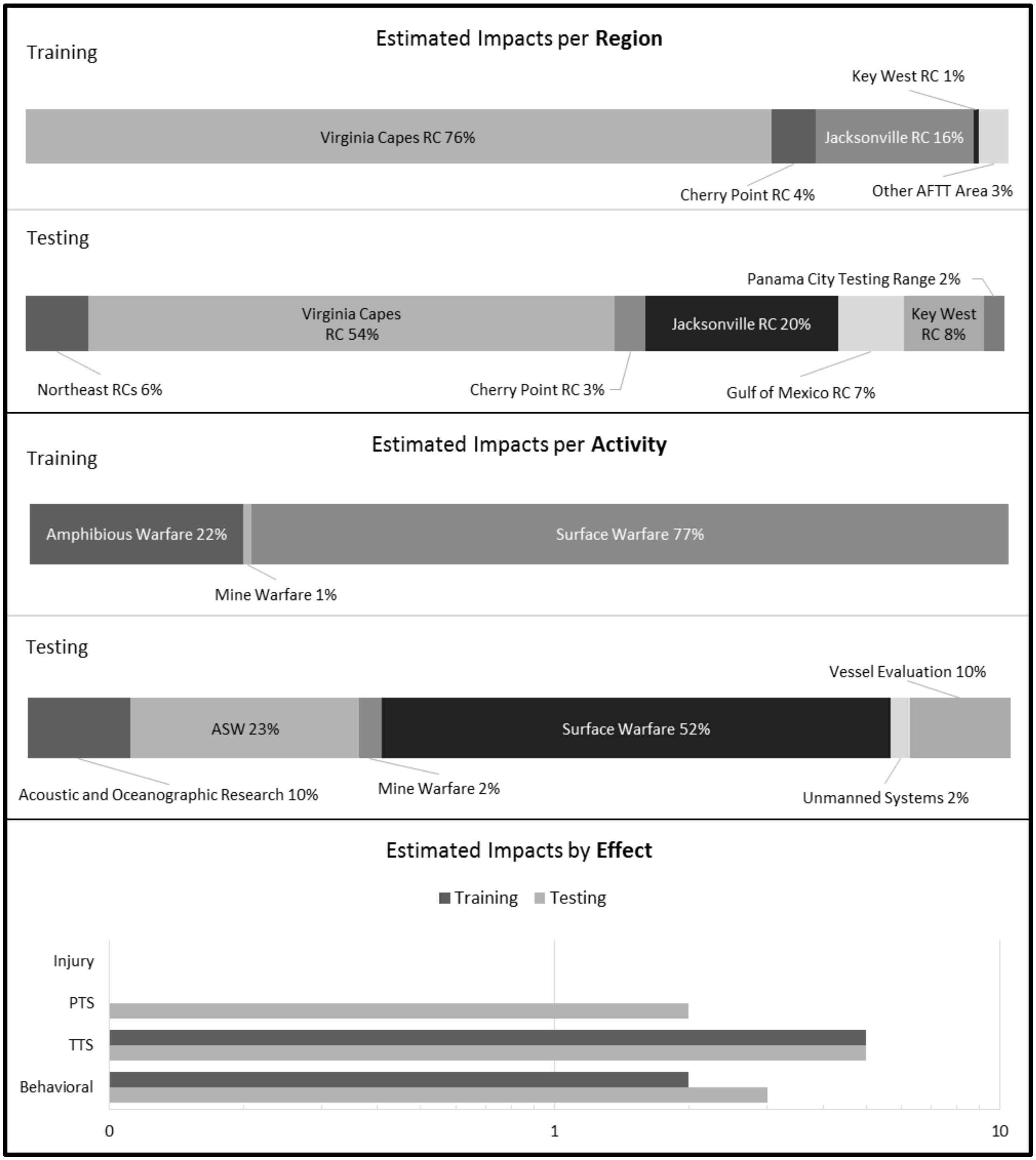
Pilot whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6.5-27 and Figure 6.5-28, 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Western North Atlantic stock of long-finned pilot whales and multiple stocks of short-finned pilot whales (see Table 6.5-28).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of long-finned and short-finned pilot whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.

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 Injury (Non-Auditory) is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-27: Long-Finned Pilot Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).



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 Injury (Non-Auditory) is estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-28: Short-Finned Pilot Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-28: 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***
Northern Gulf of Mexico	0%	11%
Western North Atlantic	100%	89%

6.5.2.3.4.14 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 behavioral reactions and TTS (see Figure 6.5-29 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-29).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

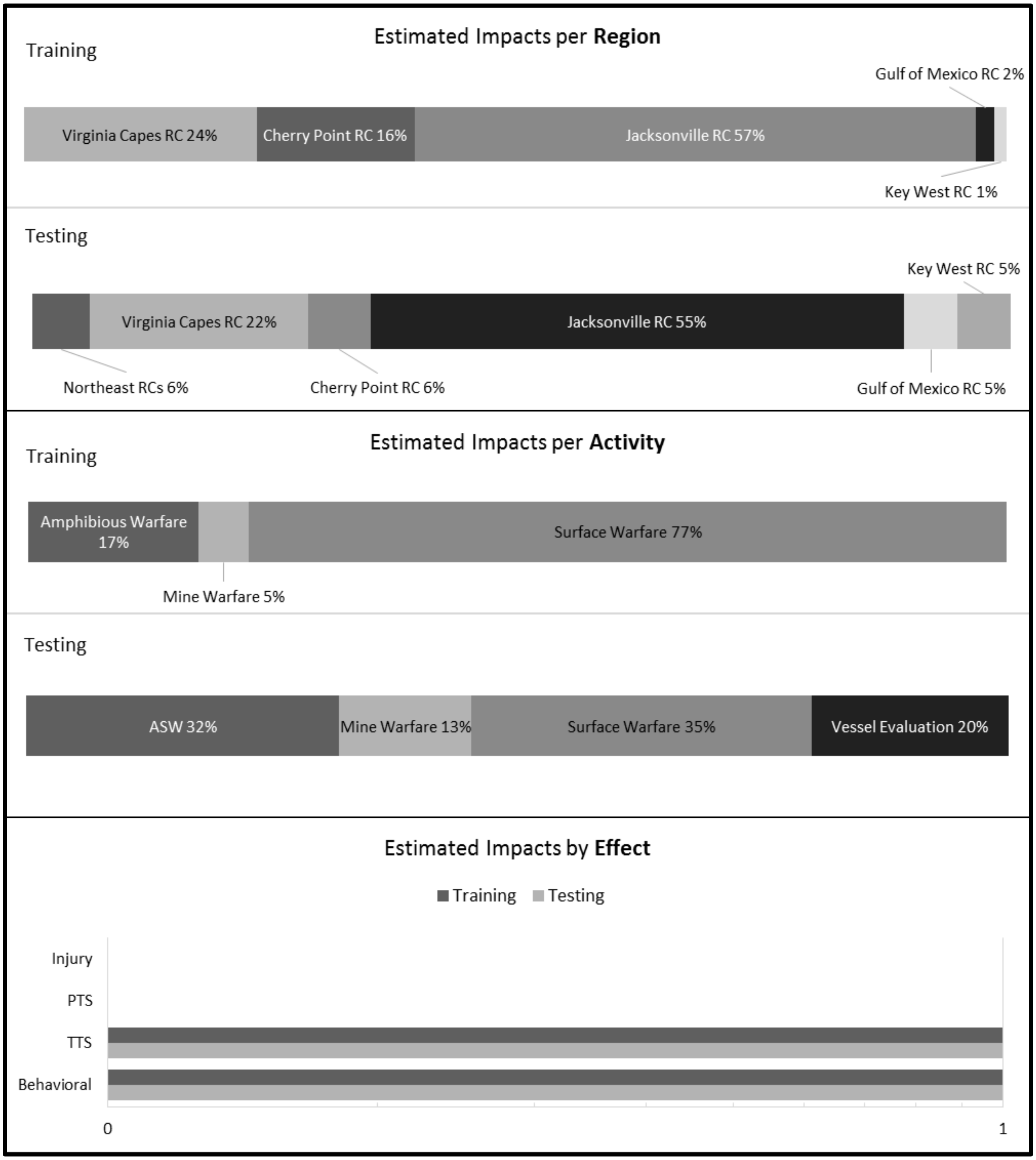
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of pygmy killer whales incidental to those activities as outlined in Table 5.1-3.

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 behavioral reactions and TTS (see Figure 6.5-29 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-29).

As described for odontocetes above, behavioral reactions 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of pygmy killer whales incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-29: Pygmy Killer Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing (Excluding Full Ship Shock Trials).

Table 6.5-29: 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***
Northern Gulf of Mexico	2%	7%
Western North Atlantic	98%	93%

6.5.2.3.4.15 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 and TTS (see Figure 6.5-30 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-30).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

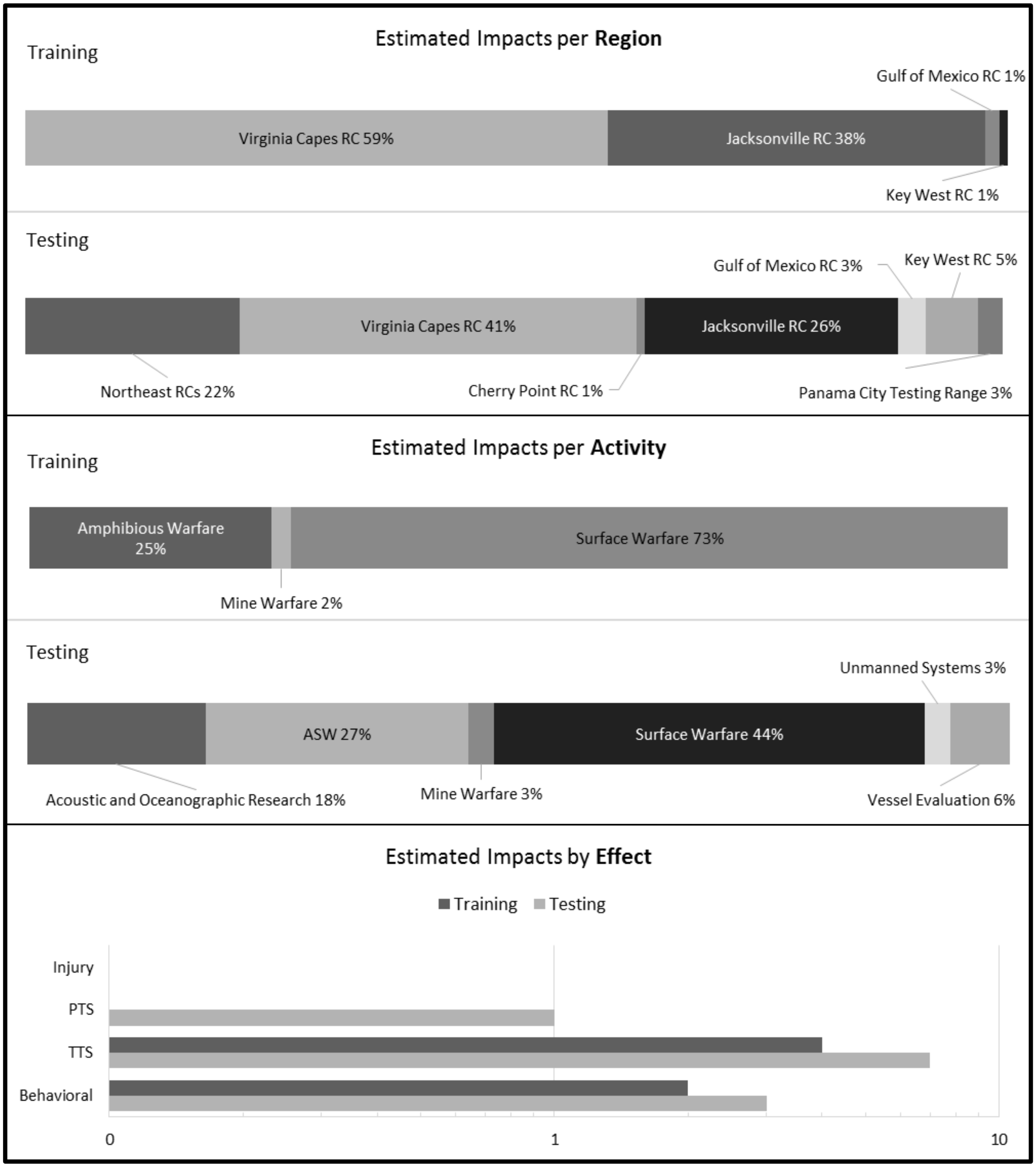
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of Risso's dolphins incidental to those activities as outlined in Table 5.1-3.

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 6.5-30 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-30

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of Risso's dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-30: Risso's Dolphin Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

Table 6.5-30: 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***
Northern Gulf of Mexico	2%	7%
Western North Atlantic	98%	93%

6.5.2.3.4.16 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. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions and TTS (see Figure 6.5-31 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-31).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

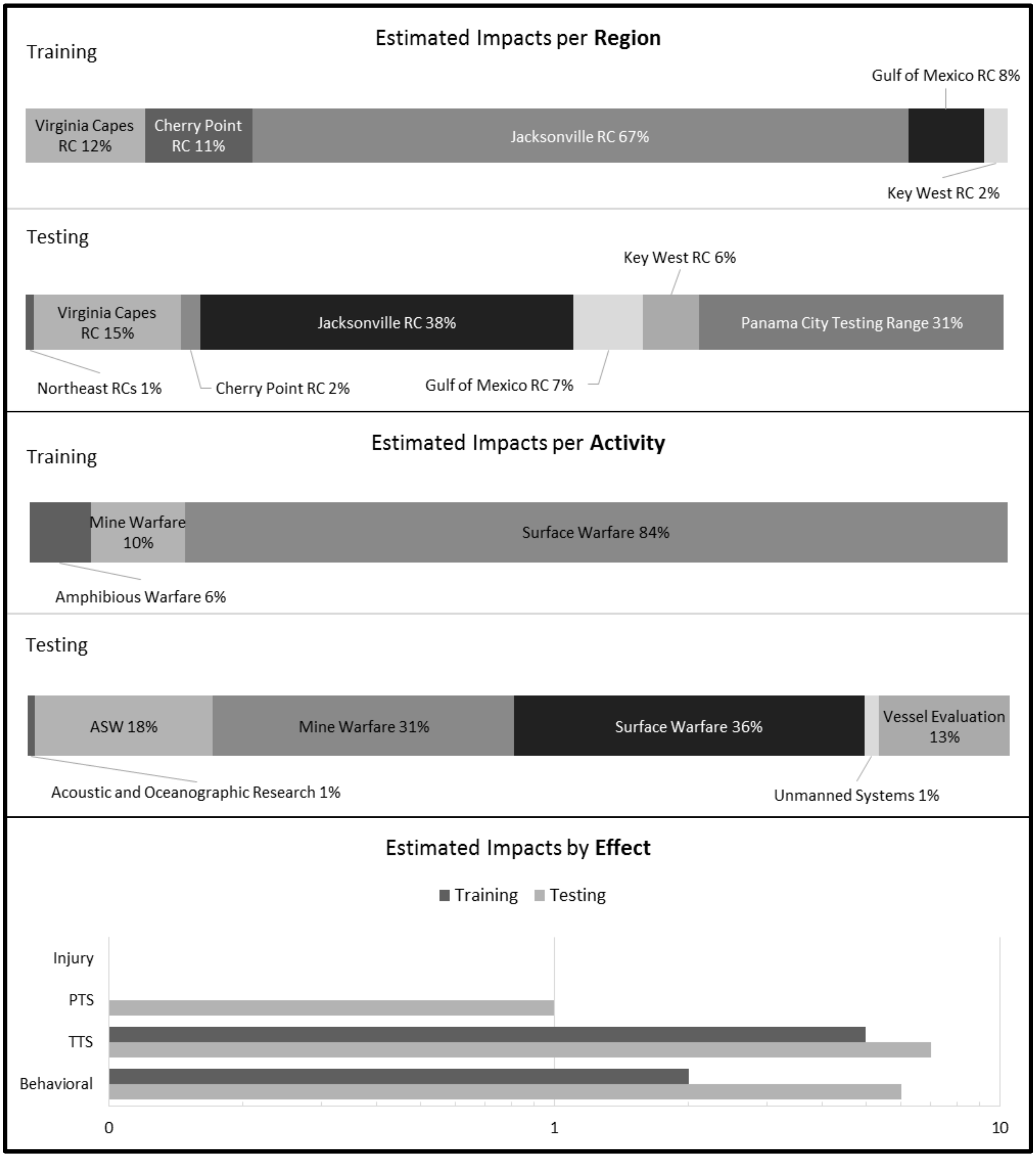
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of rough-toothed dolphins incidental to those activities as outlined in Table 5.1-3.

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, TTS, and PTS (see Figure 6.5-31 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-31

As described for odontocetes above, behavioral reactions or 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. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of rough-toothed dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-31: Rough-Toothed Dolphin Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

Table 6.5-31: Estimated Impacts on Individual Rough-Toothed 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***
Northern Gulf of Mexico	8%	40%
Western North Atlantic	92%	60%

6.5.2.3.4.17 Short-Beaked Common Dolphins

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 6.5-32 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 from Explosives). Estimated impacts apply to the Western North Atlantic stock.

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even in the event of a mortality or if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

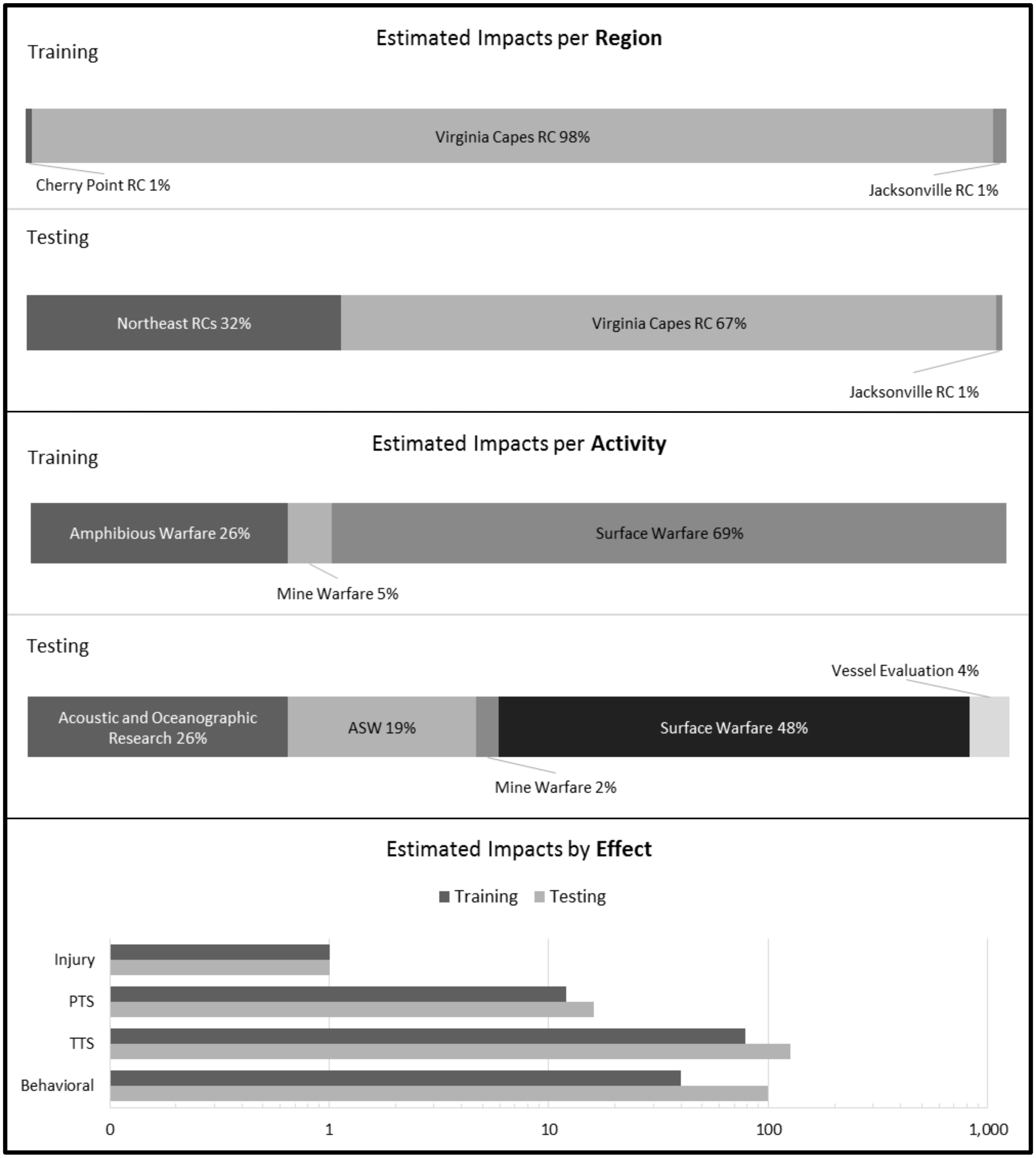
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of short-beaked common dolphins incidental to those activities as outlined in Table 5.1-3.

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 6.5-32 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. The quantitative analysis also estimates TTS, PTS, non-auditory injury, and mortality for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Western North Atlantic stock.

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of short-beaked common dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) are estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-32: Short-Beaked Common Dolphin Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

6.5.2.3.4.18 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 6.5-33 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-32).

As described for odontocetes above, behavioral reactions or 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

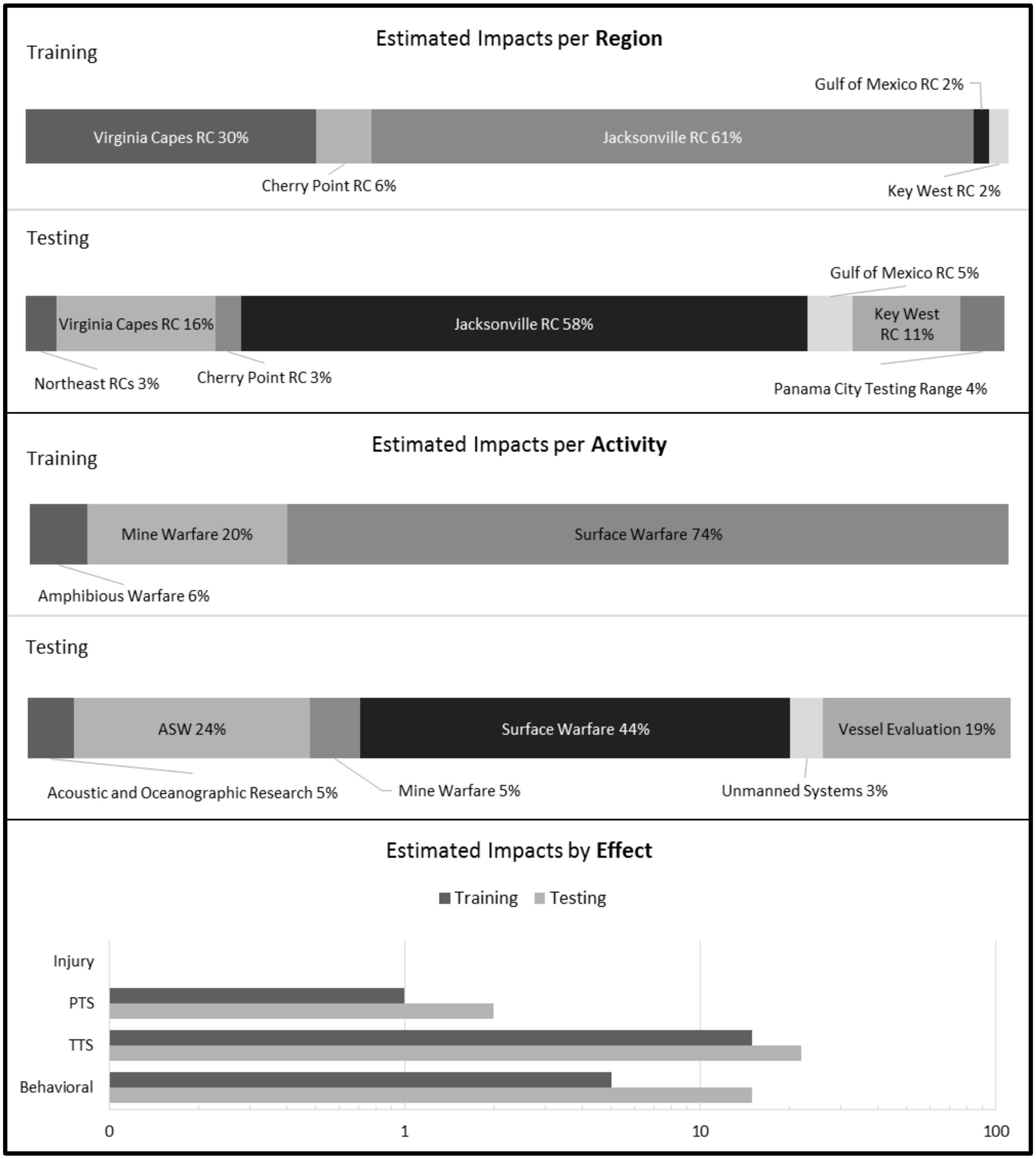
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of spinner dolphins incidental to those activities as outlined in Table 5.1-3.

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, TTS, and PTS (see Figure 6.5-33 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. The quantitative analysis also estimates TTS, PTS, non-auditory injury, and a single mortality for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-32

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of spinner dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-33: Spinner Dolphin Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

Table 6.5-32: 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***
Northern Gulf of Mexico	2%	12%
Western North Atlantic	98%	88%

6.5.2.3.4.19 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 6.5-34 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 from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-33).

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even in the event of a mortality or if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

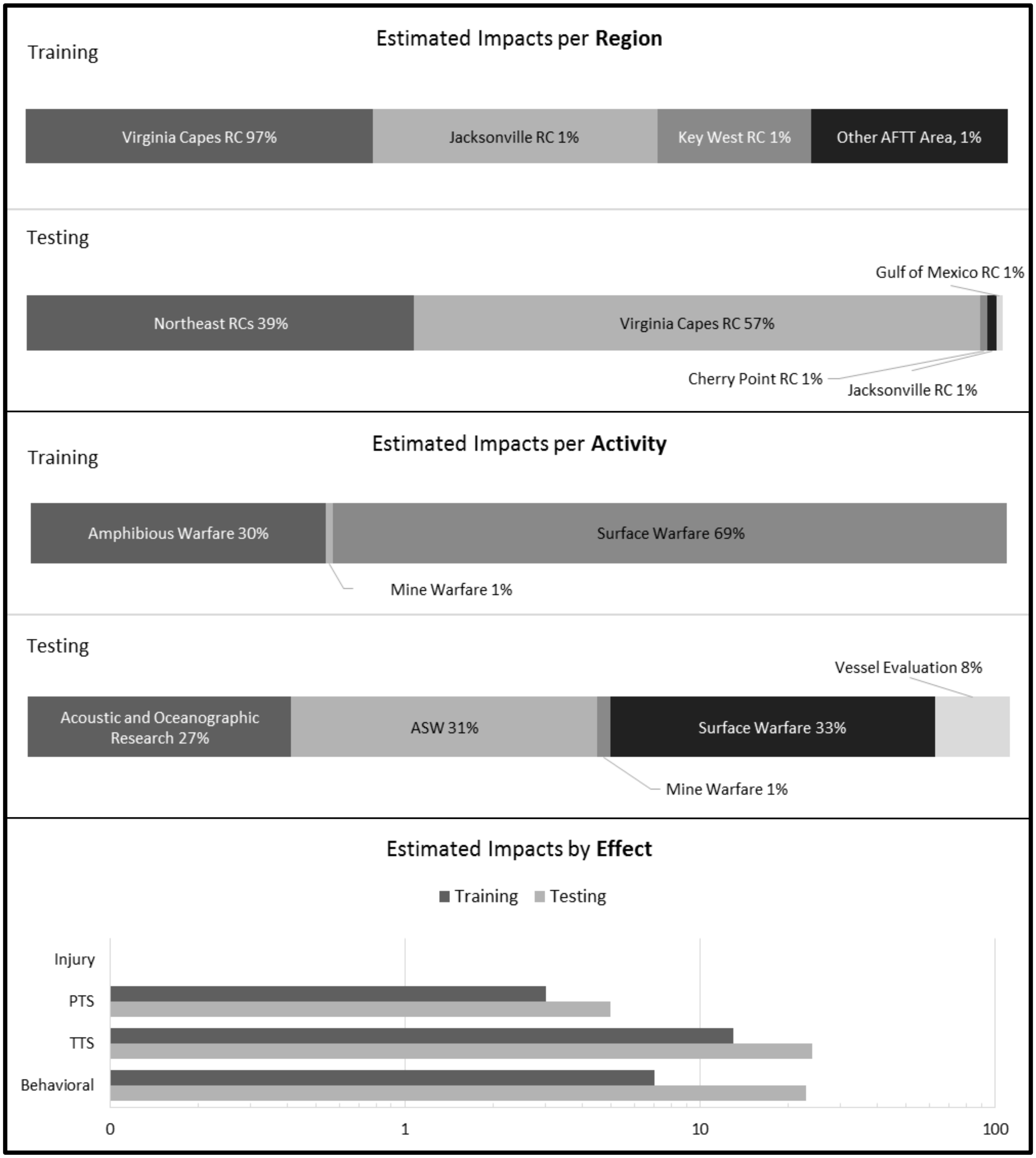
The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of striped dolphins incidental to those activities as outlined in Table 5.1-3.

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 6.5-34 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. The quantitative analysis also estimates TTS, PTS, and non-auditory injury for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to multiple stocks (see Table 6.5-33

As described for odontocetes above, behavioral reactions or 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. Non-auditory injury includes low severity injuries; following recovery, any long term consequences to an individual are expected to be minor. Long-term consequences for the population 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of striped dolphins incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-34: Striped Dolphin Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

Table 6.5-33: 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***
Northern Gulf of Mexico	0%	1%
Western North Atlantic	100%	99%

6.5.2.3.4.20 White-Beaked Dolphins

White-beaked dolphins 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 white-beaked dolphins would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

The use of explosives during training or testing activities as described under the Proposed Action may not result in the unintentional taking of white-beaked dolphins incidental to those activities.

6.5.2.3.4.21 Harbor Porpoises

TTS and PTS thresholds for high-frequency cetaceans, such as harbor 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 harbor porpoise had hearing loss, vocalizations from conspecifics could be more difficult to detect or interpret, however harbor 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 harbor porpoise, use echolocation clicks to find and capture prey. These echolocation clicks and vocalizations are at frequencies above 100 kHz for harbor porpoises and are therefore unlikely to be affected by threshold shift at lower frequencies. This should not affect harbor porpoise’s ability to locate prey or rate of feeding.

Research and observations (see Behavioral Responses from Explosives) show that harbor 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 harbor 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 harbor 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. Considering these factors, and the low number of overall estimated impacts, long-term consequences for the population would not be expected.

Impacts from Explosives Under the Proposed Action for Training Activities

Harbor 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 6.5-35 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 from Explosives). Estimated impacts apply to the Gulf of Main/Bay of Fundy stock.

As described above, behavioral reactions or 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 implemented 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 harbor porpoises identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy training activities that involve the use of explosives could occur year round within the Northeast Range Complexes; however, training with explosives typically occurs only within Narragansett Bay, which is outside the harbor porpoise small and resident population area identified by LaBrecque et al. (2015a, 2015b). The identified harbor porpoise area would not be exposed to sound or energy from explosives; therefore, impacts would not be anticipated within the identified small and resident population area for harbor porpoises.

The use of explosives during training activities as described under the Proposed Action may result in the unintentional taking of harbor porpoises incidental to those activities as outlined in Table 5.1-3.

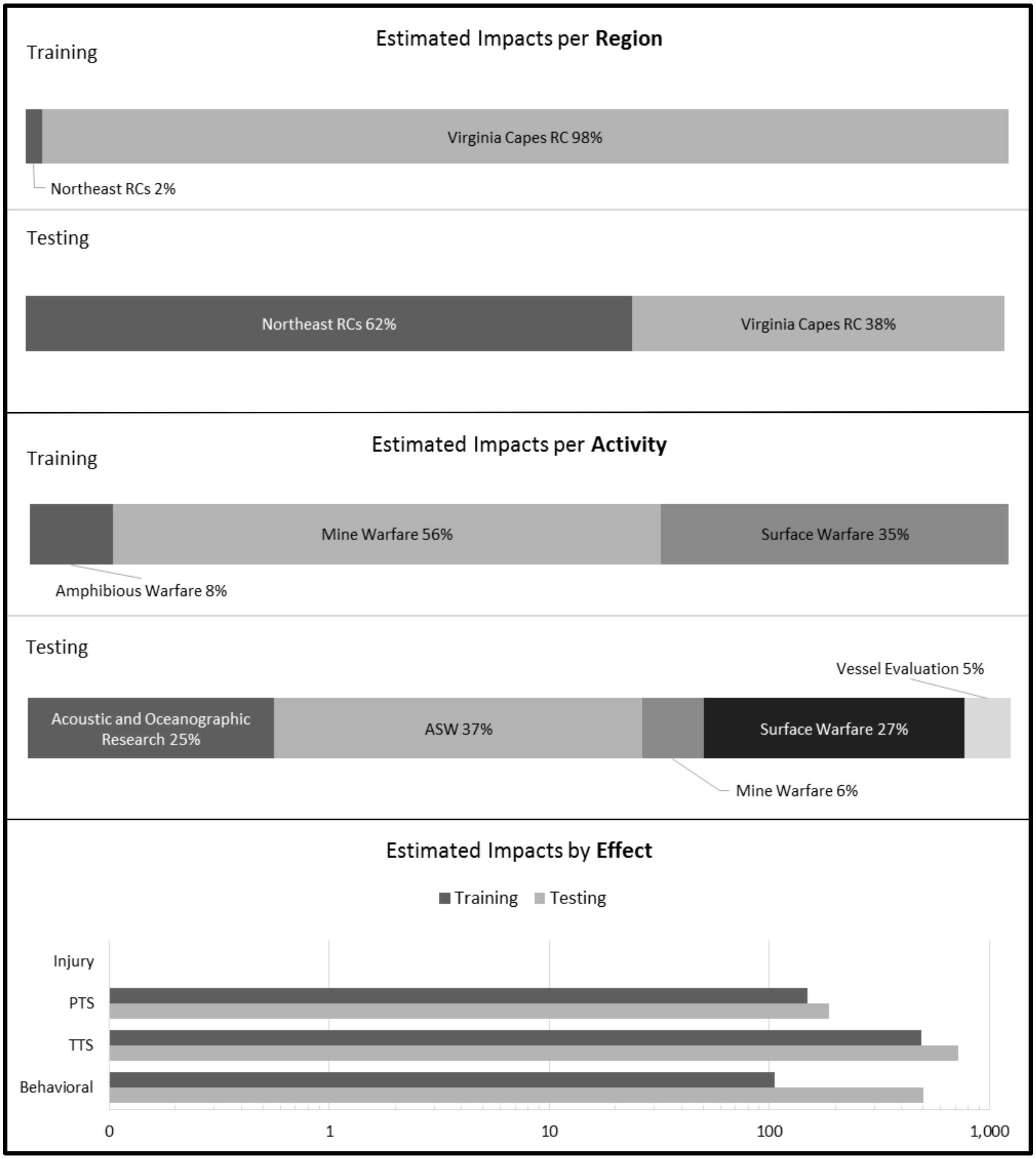
Impacts from Explosives Under the Proposed Action for Testing Activities

Harbor 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 6.5-35 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. The quantitative analysis also estimates TTS and PTS for Ship Shock Trials (Figure 6.5-3 and Figure 6.5-4). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Gulf of Main/Bay of Fundy stock.

As described for other mysticetes above, behavioral reactions or 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 implemented 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 harbor porpoises identified by LaBrecque et al. (2015a, 2015b) overlaps the Northeast Range Complexes within the Study Area. Navy testing activities that involve the use of explosives could occur year round within the Northeast Range Complexes including the harbor porpoise small and resident population area identified by LaBrecque et al. (2015a, 2015b). A small number of behavioral reactions, TTS, or PTS could occur within this identified area, although this area only overlaps a small portion of the Northeast Range Complexes. This leads to a lower likelihood that impacts estimated for harbor porpoises in the Northeast Range Complexes would occur within the small and resident population area for harbor porpoises identified by LaBrecque et al. (2015a, 2015b). Due the low number of estimated impacts overall and the intermittent nature of explosive activities that could take place within the identified harbor porpoise area, significant impacts to natural behaviors within or abandonment of the small and resident population area for harbor porpoises identified by LaBrecque et al. (2015a, 2015b) are not anticipated.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of harbor porpoises incidental to those activities as outlined in Table 5.1-4 and Table 5.1-5.



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 Injury (Non-Auditory) is estimated for this species. 100% Gulf of Main/Bay of Fundy Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-35: Harbor Porpoise Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

6.5.2.3.5 Phocid Seals

Phocid seals in AFTT Study Area include harbor seals, gray seals, harp seals, hooded seals, bearded seals and ringed seals. Most of these species primary ranges are north of the AFTT Study Area.

Phocid seals 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 phocid seal had TTS, social calls from conspecifics could be more difficult to detect or interpret, however most phocid vocalizations ay be above the frequency of TTS induced by an explosion. Killer whales are one of the phocid seals 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 phocid seals due to sound from explosions is unlikely to reduce detection of killer whale calls. Phocid seals probably 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 phocid seals 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 seals in the area over the short duration of the event. Potential costs to seals 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 (including phocid seals) 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.

<u>**Impacts from Explosives Under the Proposed Action for Training Activities**</u>

Phocid seals may be exposed to sound or energy from explosions associated with training activities under the Proposed Action throughout the year, although the quantitative analysis estimates that no phocid seals would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

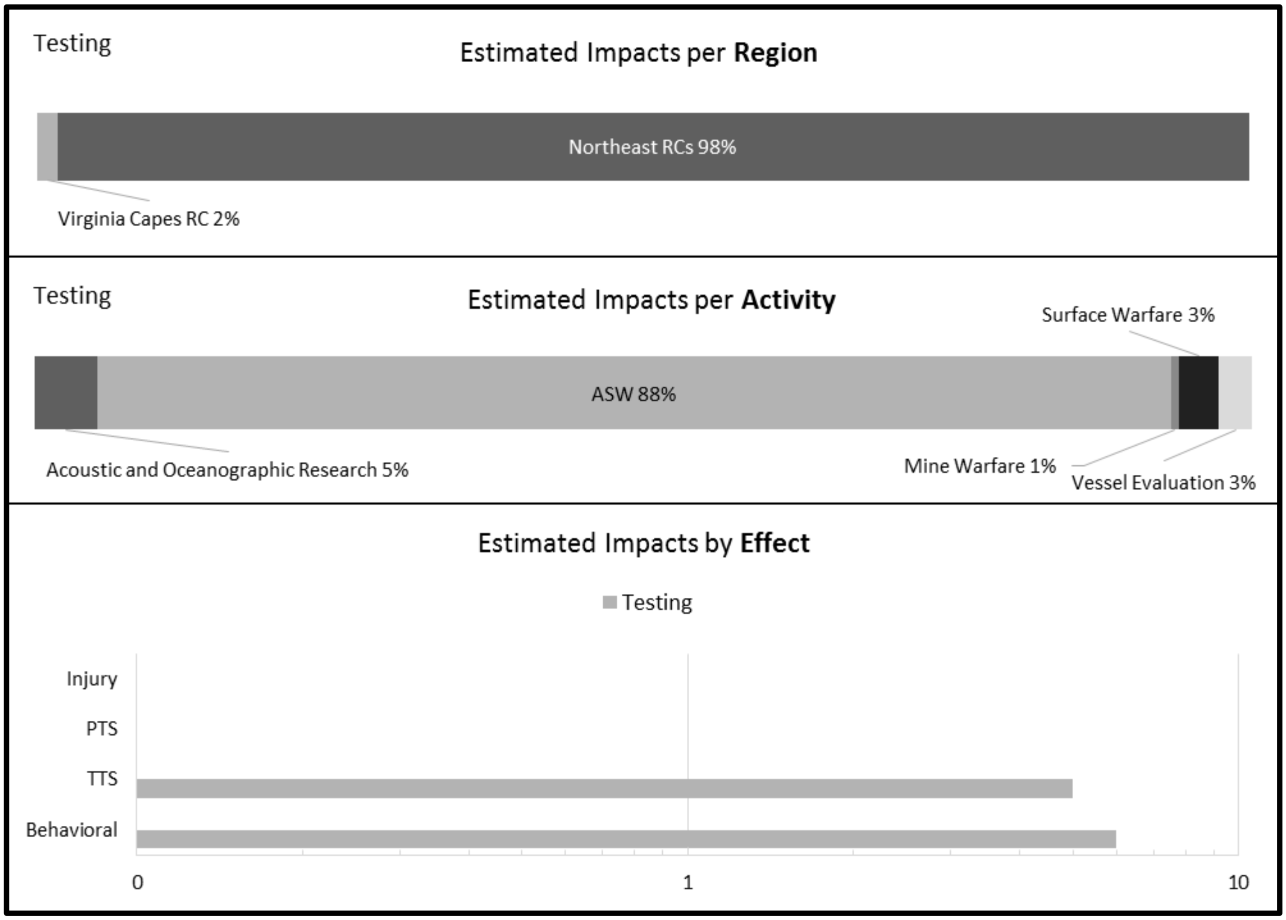
The use of explosives during training activities as described under the Proposed Action may not result in the unintentional taking of phocid seals incidental to those activities.

Impacts from Explosives Under the Proposed Action for Testing Activities

Phocid 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 and TTS for gray and hooded seals and behavioral reactions, TTS, and PTS for harbor and harp seals (see Figure 6.5-36 through Figure 6.5-39 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. No impacts are estimated for ringed or bearded seals. No impacts are estimated from Ship Shock Trials. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges from Explosives). Estimated impacts apply to the Western North Atlantic stocks of gray, harbor, harp, and hooded seals.

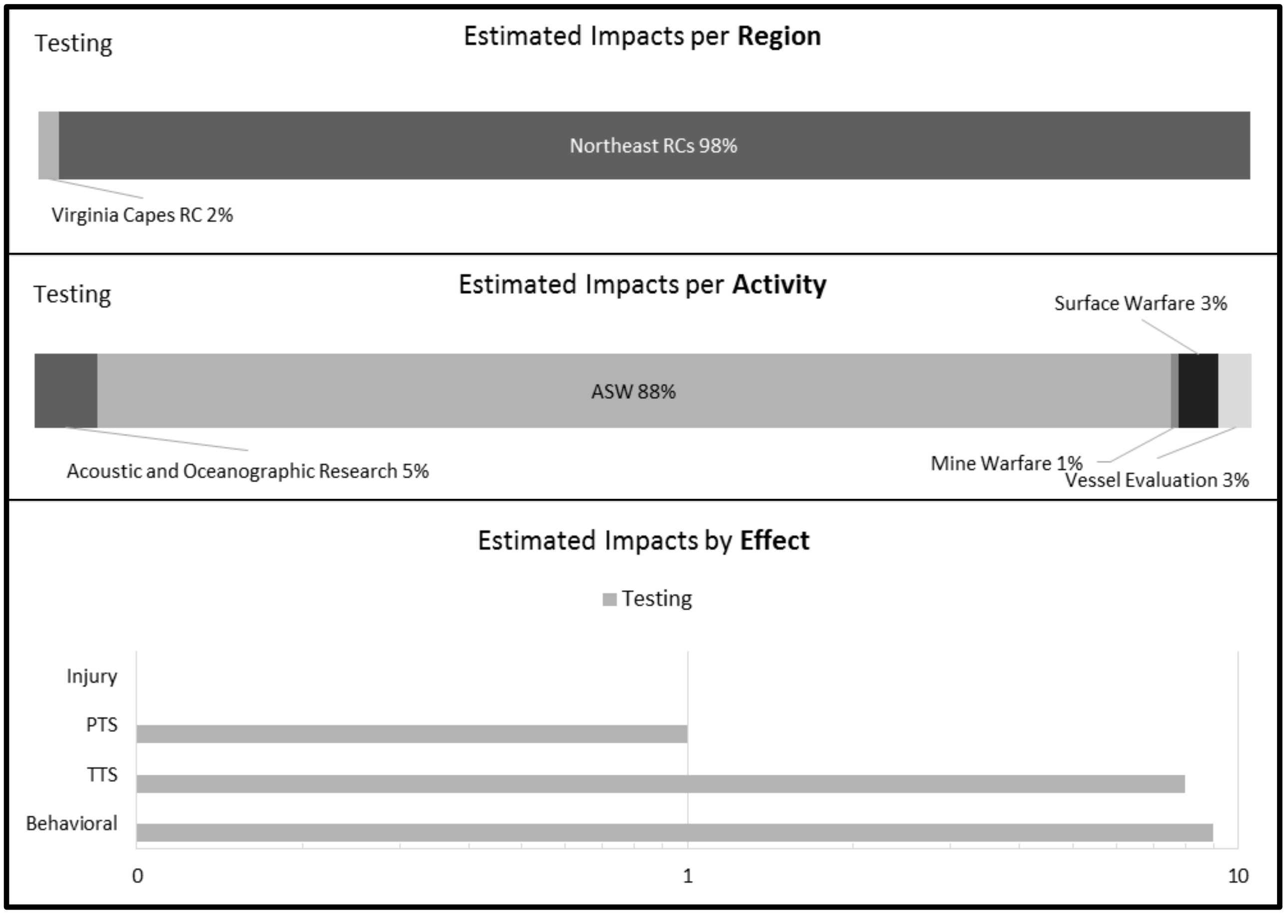
As described above, behavioral reactions or even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although 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 implemented as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The use of explosives during testing activities as described under the Proposed Action may result in the unintentional taking of gray, harbor, harp and hooded seals incidental to those activities as outlined in Table 5.1-4.



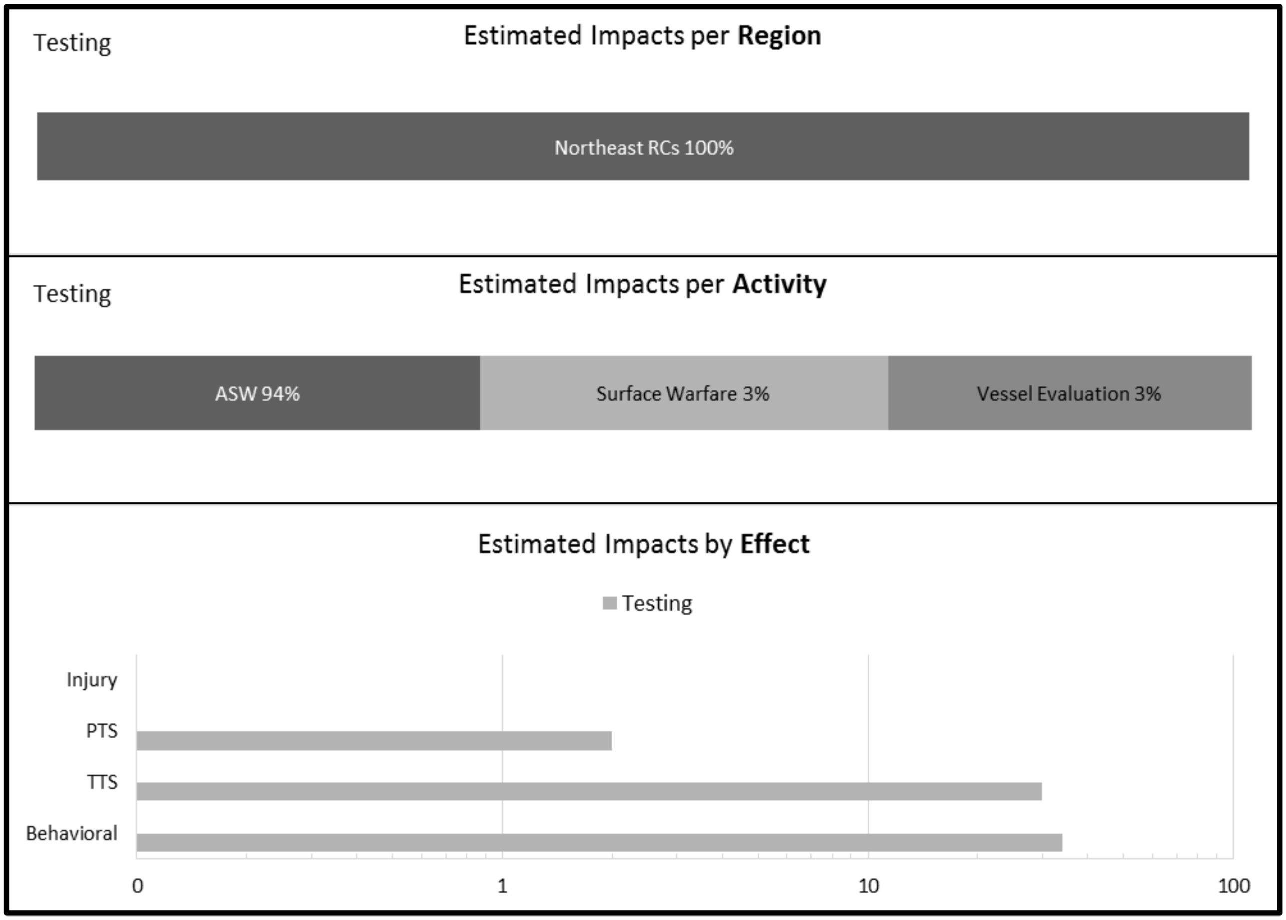
Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or Injury (Non-Auditory) are estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-36: Gray Seal Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).



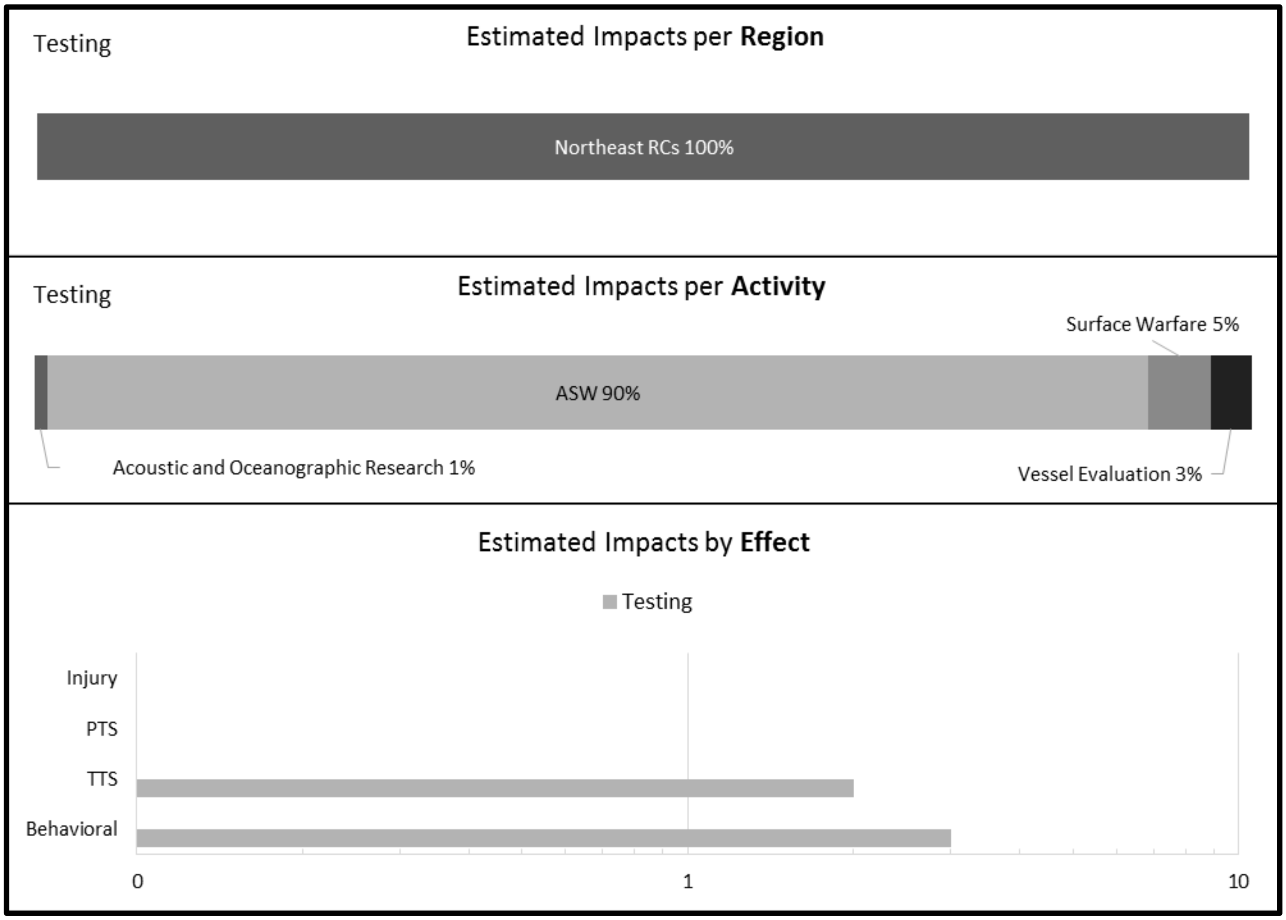
Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No Injury (Non-Auditory) is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-37: Harbor Seal Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).



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 Injury (Non-Auditory) is estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-38: Harp Seal Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).



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 Injury (Non-Auditory) are estimated for this species. 100% Western North Atlantic Stock. ASW: Anti-Submarine Warfare; RC: Range Complex

Figure 6.5-39: Hooded Seal Impacts Estimated per Year from Testing Explosions Using the Maximum Number of Explosions (Excluding Full Ship Shock Trials).

6.6 ESTIMATED TAKE OF MARINE MAMMALS BY VESSEL STRIKE

6.6.1 BACKGROUND ON VESSEL STRIKES

Vessel strikes from commercial, recreational, and military vessels are known to seriously injure and occasionally kill cetaceans (Abramson et al., 2011; Berman-Kowalewski et al., 2010; Calambokidis, 2012; Douglas et al., 2008; Laggner, 2009; Lammers et al., 2003; Van der Hoop et al., 2012; Van der Hoop et al., 2013), although reviews of the literature on ship strikes mainly involve collisions between commercial vessels and whales (Jensen & 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 conducted by Silber et al. (2010), researchers 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 AFTT Study Area, commercial traffic is heaviest in the nearshore waters, near major ports and in the shipping lanes along the entire United States East Coast and along the northern coast of the Gulf of Mexico while Navy vessel traffic is primarily concentrated between the mouth of the Chesapeake Bay, Virginia and Jacksonville, Florida (Mintz, 2012). An examination of vessel traffic within the AFTT Study Area determined that Navy vessel occurrence is two orders of magnitude lower than that of commercial traffic. The study also revealed that while commercial traffic is relatively steady throughout the year, Navy vessel usage within the range complexes is episodic, based on specific exercises being conducted at different times of the year (Mintz, 2012), however Navy vessel use within inland waters occurs regularly and routinely consists of high speed small craft movements.

Large Navy vessels (greater than 18 m in length) within the offshore areas of range complexes and testing ranges 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 and submarines generally operate at speeds in the range of 8-13 knots, while a few specialized vessels can travel at faster speeds. 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 considered “extra slow”; and 15 knots is considered “super slow” (Bonney & Leach, 2010). Small craft (less than 50 ft. in length), have much more variable speeds (0–50+ knots, dependent on the mission). While these speeds are considered averages and representative of most events, some vessels need to operate outside of these parameters during certain situations.

In addition, surface ships operated by or for the Navy have multiple personnel assigned to stand watch at all times, when a ship or surfaced submarine is moving through the water (underway). A primary duty of personnel standing watch on surface ships is to detect and report all objects and disturbances sighted in the water that may indicate a threat to the vessel and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per vessel safety requirements, personnel standing watch also report any marine mammals sighted in the path of the vessel as a standard collision avoidance procedure. All vessels use extreme caution and proceed at a safe speed so they can take proper and effective action to avoid a collision with any sighted object or disturbance, and can be stopped within a distance appropriate to the prevailing circumstances and conditions. Other differences between most large 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 1.5.3 (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.
- 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.
- 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), requiring vessels to maneuver to maintain a specified distance from marine mammals during vessel movements, and implementing additional mitigation related to vessel movements within the Northeast North Atlantic Right Whale Mitigation Area and Southeast North Atlantic Right Whale Mitigation Area

6.6.1.1 Mysticetes

Vessel strikes have been documented for almost all of the mysticete species (Van der Hoop et al., 2012). 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), North Atlantic right whales (Firestone, 2009; Fonnesbeck et al., 2008; Vanderlaan et al., 2009; Wiley et al., 2016), 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 (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). Some individuals may become habituated to low-frequency sounds from shipping and fail to respond to an approaching vessel (National Marine Fisheries Service, 2008b). For example, North Atlantic 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). Because surface activity includes feeding, breeding, and resting, whales may be engaged in this activity and not notice an approaching vessel. 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 meter wooden sailboat, and another instance a humpback whale rammed a powered down 10 meter 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. 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).

Vessel strikes are considered a primary threat to North Atlantic right whale survival (Firestone, 2009; Fonnesbeck et al., 2008; Knowlton & Brown, 2007; Nowacek et al., 2004; Vanderlaan et al., 2009). Studies of North Atlantic right whales tagged in April 2009 on the Stellwagen Bank feeding grounds found that right whales spent most of their time at a depth of 6.5 ft., which makes them less visible at the water's surface (Bocconcelli, 2009; Parks & Wiley, 2009). Also, North Atlantic right whales have been documented to show little overall reaction to the playback of sounds of approaching vessels, but they did respond to an alert signal by swimming strongly to the surface, which may increase their risk of collision (Nowacek et al., 2004).

In addition to procedural mitigation for vessel movement, the Navy will implement mitigation measures in mitigation areas used by North Atlantic right whales for foraging, calving, and migration (Chapter 11, Mitigation Measures). These measures include funding of and communication with sightings systems, and implementation of speed reductions during applicable circumstances in certain areas (Chapter 11, Mitigation Measures). Generally, mysticetes are larger than odontocetes and are not able 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 AFTT 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 potentially avoid collision (Ketten, 1998). Sperm whales may be particularly vulnerable to vessel strikes as they spend extended periods of time "rafting" at the surface 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). There were also instances in which sperm whales approached vessels too closely and were cut by the propellers (Aguilar de Soto et al., 2006).

Odontocetes that occur within the AFTT 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 small and medium odontocete species (e.g. dolphins and small whales) are not as likely to be struck by a Navy vessel as sperm whales and 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.

6.6.2 Probability of Vessel Strike of Large Whale species

Most vessel strikes of marine mammals reported 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. Figure 6.6-1 provides the history of Navy vessel strikes reported in the AFTT Study Area for the eight-year period from 2009 through 2016.

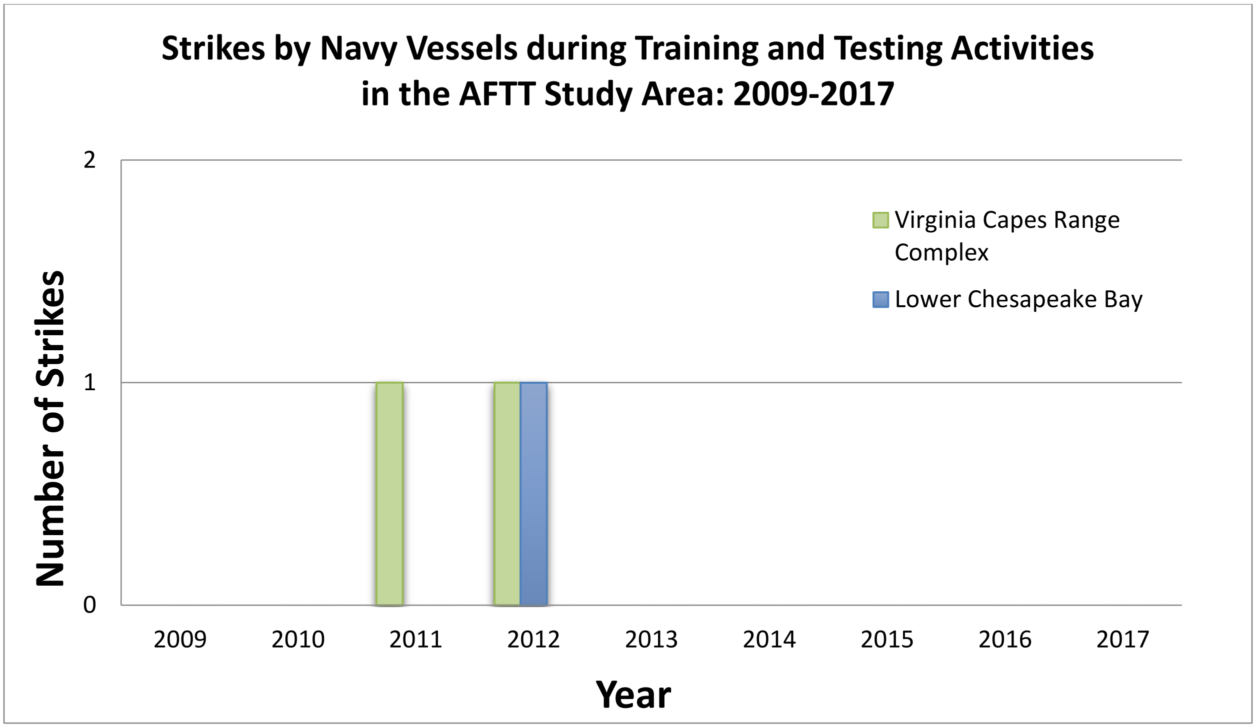


Figure 6.6-1: Navy Vessel Strikes Reported by Year (2009 - April 2017)

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 eight 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 is expected to be consistent with this time period.

Since the probability of a Navy vessel strike to whales is influenced by the amount of time at sea for Navy vessels within the AFTT Study Area during future training and testing activities, historical vessel use (i.e. steaming days) and reported ship strike data from 2009- 2016 were used to calculate the probability of a direct strike during proposed training and testing activities in the offshore portion of the AFTT Study Area over the next seven years. The Navy determined that data beginning in 2009 would be the most representative for predicting the potential for future vessel strikes, because this coincided with when the Navy's mitigation, monitoring, and reporting requirements became standardized across the Navy with the issuance of MMPA Authorizations for sonar and explosive usage in at-sea Navy ranges, as discussed above.

There were a total of three reported vessel strikes of whales by Navy vessels from 2009-2016 in the AFTT Study Area. During this same time period there was a total of 39,040 steaming days by Navy vessels use within the Study Area. Therefore, there was an average strike rate of 0.00008 strikes per steaming day. Based on the annual average from 2009-2016, the Navy estimates that 34,160 steaming days will occur between 2017 and 2023, extending through the end of the requested LOAs. These values were used to determine the rate parameters to calculate a series of probabilities based on 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, are often described as a Poisson or over-dispersed Poisson distribution). In modeling strikes as a Poisson process, we assume this strike rate for the future and we use the Poisson distribution to estimate the probability of a number of strikes over a defined time period in the future:

$$P\left\langle n \middle| \mu \right\rangle = \frac{e^{-\mu} \bullet \mu^{n}}{n!}$$

$P(n|\mu)$ is the probability of observing n events in some time interval, when the expected number of events in that time interval is μ. As stated previously, the Navy estimates that 34,160 steaming days would occur from 2017-2023, covering through the end of the anticipated MMPA authorization; given a strike rate of 0.00008 strikes per steaming day, the expected number of strikes (μ) over the period 2017- is 2.63. The Poisson distribution can then be used to estimate the probability of n where n=0 (no strikes), 1 strike, 2 strikes, etc., over the time period. For example, the equation yields a value of $P(0) = 0.0721$, indicating a 7% probability of not striking any whales over the 7-year period. The resulting probabilities of one through five strikes over the next 7 years covering through the end of the anticipated MMPA authorization are:

- 19 percent probability of striking one whale over the next 7 years
- 25 percent probability of striking two whales over the next 7 years
- 22 percent probability of striking three whales over the next 7 years
- 14 percent probability of striking four whales over the next 7 years
- 8 percent probability of striking five whales over the next 7 years

Based on the resulting probabilities presented in this analysis and the cumulative low history of Navy vessel strikes since 2009 and introduction of the Marine Species Awareness Training and adaptation of additional mitigation measures, the Navy estimates that it may strike, and take by injury or mortality, up to three large whales incidental to training and testing activities within the AFTT Study Area over the course of the 5 years of the AFTT regulations. Most Navy-reported whale strikes are not identified to the species level, however, large whales (i.e. mysticetes and sperm whales) are the most likely to be struck by a large vessel as a result of training and testing activities, primarily in the offshore portion of the Study Area.

Because of the number of incidents in which the struck animal has remained unidentified to species, the Navy cannot quantifiably predict that the proposed takes will be of any particular species, and therefore seeks take authorization for any of the following species: humpback whale, fin whale, sei whale, minke whale, blue whale, and sperm whale. Based on the broad distribution of training and testing activities and the relative distribution and abundances of these species within the AFTT study area, it is not anticipated that vessel strikes would exceed two (2) of any individual stock.

The Navy does not anticipate it will strike a North Atlantic right whale as a result of training or testing activities because of the extensive measures in place to reduce the risk of a strike to this species. Refer to Chapter 11 (Mitigation Measures) for a full list of these measures. Although vessels may transit into bowhead whale habitat during training and testing activities, these transits are expected to be very infrequent and it is therefore extremely unlikely that this species will be struck by Navy vessels in the AFTT study area.

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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. By definition, 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 the proposed training and testing activities in the AFTT study area would result in Level B, Level A, or mortality 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 to the proposed training and testing activities would result in only short-term effects on most individuals exposed and would not affect annual rates of recruitment or survival for the following reasons:

- Most acoustic 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 takes under the MMPA, they are conservative (i.e., over-predictions) estimates 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. The quantitative analysis process estimates harassment taking into consideration mitigation measures.
- Range complexes and testing ranges 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. This overestimates reactions qualifying as harassment under MMPA because there is no established scientific correlation between short-term use of sonar and other transducers, explosives, and pile driving/extraction, air guns, and long term abandonment or significant alteration of behavioral patterns in marine mammals.

An analysis of the potential impacts of the proposed activities on recruitment or survival is presented in Chapter 6 (Take Estimates for Marine Mammals) for each individual species, species group, or stock based on life history information, estimated take levels, an analysis of estimated take levels in comparison to the overall population, and identified geographic areas that may be particularly important for activities such as feeding and breeding. The species-specific analyses, in combination with the mitigation measures provided in Chapter 11 (Mitigation Measures) support the conclusion that proposed training and testing activities would have a negligible impact on marine mammal species or stocks within the Study Area.

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. The acoustic stimuli can cause a stress reaction (i.e., 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 importance of the disruption and degree of consequence for individual marine mammals often has much to do with the frequency, intensity, and duration of the disturbance. Isolated acoustic disturbances such as sonar use, underwater detonation, and pile driving and pile removal events within the Study Area usually have minimal consequences or no lasting effects for marine mammals. Marine mammals regularly cope with occasional disruption of their activities by predators, adverse weather, and other natural phenomena. It is reasonable to assume that they can tolerate occasional or brief disturbances by anthropogenic sound without significant consequences. However, prolonged disturbance, as might occur if a stationary and noisy activity were established near a concentrated area, is a more important concern. The long-term implications would depend on the degree of habituation within the population. If the marine mammals fail to habituate or become sensitized to disturbance and, as a consequence, are excluded from an important area or are subject to stress while at the important area, long-term effects could occur to individuals or the population.

The potential costs to a marine animal 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.

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 predict a short-term, immediate response of an individual based on established criteria. Consequences to populations are much more difficult to predict and empirical measurement of population effects from anthropogenic stressors is limited (National Research Council, 2005). 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. 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 implementation of the mitigation measures outlined in Chapter 11 (Mitigation Measures), AFTT training and testing activities are anticipated to have a negligible impact on marine mammal stock or populations within the Study Area.

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8 ANTICIPATED IMPACTS ON SUBSISTENCE USE

Potential marine mammal impacts resulting from the Proposed Action will be limited to individuals located in the Study Area that have no subsistence requirements. 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 AFTT 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 North Atlantic right whale, 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 assumed primary constituent elements of the North Atlantic right whale critical habitat (i.e., water temperature and depth in the southeast and copepods in the northeast).

Water Quality. The AFTT 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 AFTT 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. (0.15–0.3 m) away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3–6 ft. (1–2 m) 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. [0.3–2 m]).

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 attributable to 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 improved extended echo ranging sonobuoys; anti-swimmer grenades; mine countermeasure and neutralization activities; ordnance testing; gunnery, missile, and bombing exercises; torpedo testing, sinking exercises; ship shock trials; vessels; and aircraft. Sound produced from training and testing activities in the Study Area is temporary and transitory. The sounds produced during training and testing activities can be widely dispersed or concentrated in small areas for varying periods. Any anthropogenic noise attributed to 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. If fish are exposed to explosions and impulsive sound sources, they may show no response at all or may have a behavioral reaction. Occasional behavioral reactions to intermittent explosions and impulsive sound sources are unlikely to cause long-term consequences for individual fish or populations. Animals that experience hearing loss (PTS or TTS) 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. It is uncertain whether some permanent hearing loss over a part of a fish's hearing range would have long-term consequences for that individual. It is possible for fish to be injured or killed by an explosion. 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 higher mortality than those without them (Continental Shelf Associates Inc., 2004; 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). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation. The abundances of various fish and invertebrates near the detonation point could be altered for a few hours before animals from surrounding areas repopulate the area; however these populations would likely be replenished as waters near the detonation point are mixed with adjacent waters. Repeated exposure of individual fish to sounds from underwater explosions is not likely and most acoustic effects are expected to be short-term and localized. Long-term consequences for fish populations would not be expected.

Vessels and in-water devices do not normally collide with adult fish, most of which can detect and avoid them. Exposure of fishes is to vessel strike stressors is limited to those fish groups that are large, slow-moving, and may occur near the surface, such as sturgeon, ocean sunfish, whale sharks, basking sharks, and manta rays. With the exception of sturgeon, 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 would likely 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. Therefore, 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.

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10 ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

The Proposed Action is 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 (Impacts on Marine Mammal Habitat and the Likelihood of Restoration), 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 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 AFTT EIS/OEIS. The following sections summarize the mitigation measures that will be implemented in association with the training and testing activities analyzed in this document.

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 11.1-1) 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 11.1-1: 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 that are relevant to Navy training and testing activities. 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 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. 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.

11.1.1 Acoustic Stressors

Mitigation measures for acoustic stressors are provided in Tables 11.1-2 through 11.1-5.

Table 11.1-2: 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 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 o Pierside sonar testing activities at Port Canaveral, Florida and Kings Bay, Georgia: 4 Lookouts • 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 or above 200 dB 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 ship 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). • The Navy will notify the Port Authority prior to the commencement of pierside sonar testing activities at Port Canaveral, Florida and Kings Bay, Georgia. At these locations, the Navy will conduct active sonar activities during daylight hours to ensure adequate sightability of manatees, and will equip Lookouts with polarized sunglasses. After completion of pierside sonar testing activities at Port Canaveral and Kings Bay, the Navy will continue to observe for marine mammals for 30 min within the mitigation zone. The Navy will implement a reduction of at least 36 dB from full power for mid-frequency active sonar transmissions at Kings Bay. The Navy will communicate sightings of manatees made during or after pierside sonar testing activities at Kings Bay to the Georgia Department of Natural Resources sightings hotline, Base Natural Resources Manager, and Port Operations. Communications will include information on the time and location of a sighting, the number and size of animals sighted, a description of any research tags (if present), and the animal's direction of travel. Port Operations will disseminate the sightings information to other vessels operating near the sighting and will keep logs of all manatee sightings.

Table 11.1-3: Procedural Mitigation for Air Guns

Procedural Mitigation Description
<u>Stressor or Activity</u> • Air guns
<u>Number of Lookouts and Observation Platform</u> • 1 Lookout positioned on a ship or pierside
<u>Mitigation Zone Size and Mitigation Requirements</u> • 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 11.1-4: Procedural Mitigation for Pile Driving

Procedural Mitigation Description
<u>Stressor or Activity</u> • Pile driving and pile extraction sound during Elevated Causeway System training
<u>Number of Lookouts and Observation Platform</u> • 1 Lookout positioned on the shore, the elevated causeway, or a small boat
<u>Mitigation Zone Size and Mitigation Requirements</u> • 100 yd. around the pile driver: o 30 min. 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. • In the Navy Cherry Point Range Complex, the Navy will maintain a log detailing any sightings and injuries to manatees during pile driving. If a manatee was sighted during the activity, upon completion of the activity, the Navy project manager or civilian equivalent will prepare a report that summarizes all information on manatees encountered and submit the report to the USFWS, Raleigh Field Office. The Navy will report any injury of a manatee to the USFWS, NMFS, and the North Carolina Wildlife Resources Commission.

Table 11.1-5: 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 11.1-8 for Explosive Medium-Caliber and Large-Caliber Projectiles or in Table 11.1-19 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 Tables 11.1-6 through 11.1-16.

Table 11.1-6: 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 11.1-7: Procedural Mitigation for Explosive Torpedoes

Procedural Mitigation Description
<u>Stressor or Activity:</u> • Explosive torpedoes
<u>Number of Lookouts and Observation Platform</u> • 1 Lookout positioned in an aircraft
<u>Mitigation Zone Size and Mitigation Requirements</u> • 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 11.1-8: Procedural Mitigation for Explosive Medium-Caliber and Large-Caliber Projectiles

Procedural Mitigation Description
<u>Stressor or Activity</u> • Gunnery activities using explosive medium-caliber and large-caliber projectiles • Mitigation applies to activities using a surface target
<u>Number of Lookouts and Observation Platform</u> • 1 Lookout on the vessel or aircraft conducting the activity • For activities using explosive large-caliber projectiles, depending on the activity, the Lookout could be the same as the one described in Table 11.1-5 for Weapons Firing Noise
<u>Mitigation Zone Size and Mitigation Requirements</u> • 200 yd. around the intended impact location for air-to-surface activities using explosive medium-caliber projectiles, • 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 11.1-9: 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 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 11.1-10: 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 11.1-11: 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 11.1-12: 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 using up to 5 lb. net explosive weight charges • 2 Lookouts (one in an aircraft and one on a small boat) when using up to 650 lb. net explosive weight charges
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 activities using 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 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 and sea turtles (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 11.1-13: Procedural Mitigation for Explosive Mine Neutralization Activities Involving Navy Divers

Procedural Mitigation Description
Stressor or Activity • 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 (0.1–20 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 (0.1–20 lb. net explosive weight) and during activities under positive control using 21–60 lb. net explosive weight charges: 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 marine mammal 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; or (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. • 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 11.1-14: 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.

Table 11.1-15: Procedural Mitigation for Line Charge Testing

Procedural Mitigation Description
Stressor or Activity • Line charge testing
Number of Lookouts and Observation Platform • 1 Lookout positioned on a vessel
Mitigation Zone Size and Mitigation Requirements • 900 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. 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 intended detonation location; or (3) the mitigation zone has been clear from any additional sightings for 30 min.

Table 11.1-16: Procedural Mitigation for Ship Shock Trials

Procedural Mitigation Description
Stressor or Activity • Ship shock trials
Number of Lookouts and Observation Platform • At least 10 Lookouts or trained marine species observers (or a combination thereof) positioned either in an aircraft or on multiple vessels (i.e., a Marine Animal Response Team boat and the test ship) • If aircraft are used, Lookouts or trained marine species observers will be in an aircraft and on multiple vessels • If aircraft are not used, a sufficient number of additional Lookouts or trained marine species observers will be used to provide vessel-based visual observation comparable to that achieved by aerial surveys
Mitigation Zone Size and Mitigation Requirements • The Navy will not conduct ship shock trials in the Jacksonville Operating Area during North Atlantic right whale calving season from November 15 through April 15. • The Navy develops detailed ship shock trial monitoring and mitigation plans approximately 1-year prior to an event and will continue to provide these to NMFS for review and approval. • Pre-activity planning will include selection of one primary and two secondary areas where marine mammal populations are expected to be the lowest during the event, with the primary and secondary locations located more than 2 NM from the western boundary of the Gulf Stream for events in the Virginia Capes Range Complex or Jacksonville Range Complex. • If it is determined during pre-activity surveys that the primary area is environmentally unsuitable (e.g., observations of marine mammals or presence of concentrations of floating vegetation), the shock trial could be moved to a secondary site in accordance with the detailed mitigation and monitoring plan provided to NMFS. • 3.5 NM around the ship hull: o Prior to the detonation (at the primary shock trial location) in intervals of 5 hours, 3 hours, 40 min., and immediately before the detonation, observe for floating vegetation and marine mammals; if resource is observed, do not trigger the detonation. o During the activity, observe for marine mammals, large schools of fish, jellyfish aggregations, and flocks of seabirds; if resource is observed, cease triggering the detonation. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence the triggering of a detonation 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 ship hull; or (3) the mitigation zone has been clear from any additional sightings for 30 min. o After completion of each detonation, observe for marine mammals; if any injured or dead resources are observed, follow established incident reporting procedures and halt any remaining detonations until the Navy can consult with NMFS and review or adapt the mitigation, if necessary. o After completion of the ship shock trial, conduct additional observations during the following 2 days (at a minimum) and up to 7 days (at a maximum); if any injured or dead resources are observed, follow established incident reporting procedures.

11.1.3 Physical Disturbance and Strike Stressors

Mitigation measures for physical disturbance and strike stressors are provided in Table 11.1-17 through Table 11.1-21.

Table 11.1-17: Procedural Mitigation for Vessel Movement

Procedural Mitigation Description
Stressor or Activity • 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.), or (3) the vessel is operated autonomously
Number of Lookouts and Observation Platform • 1 Lookout on the vessel that is underway

Mitigation Zone Size and Mitigation Requirements
• 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.
• While underway in the turning basins, channels, and waterways adjacent to Naval Station Mayport, the Navy will comply with all federal, state, and local Manatee Protection Zones and reduce speed in accordance with established operational safety and security procedures. The Navy will ensure that small boats operating out of Naval Station Mayport will be fitted with manatee propeller guards. Pursuant to the Naval Station Mayport Integrated Natural Resource Management Plan, the Navy will provide manatee awareness education to Harbor Operations personnel, require that manatee sightings are communicated to other vessels in the vicinity, and maintain signage at select locations that will alert personnel of the potential presence of manatees and the requirements and procedures for reporting manatee sightings. For information on protective measures pertaining to activities not conducted under the Proposed Action, see the Integrated Natural Resources Management Plan for Naval Station Mayport.
• When mooring pierside at Kings Bay, Georgia, the Navy will ensure proper tendering techniques (e.g., the use of buoys that keep submarines 20 ft. off the quay wall) to prevent submarines from injuring a manatee.

Table 11.1-18: Procedural Mitigation for Towed In-Water Devices

Procedural Mitigation Description
Stressor or Activity • 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 is threatened
Number of Lookouts and Observation Platform • 1 Lookout positioned on a manned towing platform
Mitigation Zone Size and Mitigation Requirements • 250 yd. around marine mammals: o When towing an in-water device, observe for marine mammals; if resource is observed, maneuver to maintain distance.

Table 11.1-19: Procedural Mitigation for Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions

Procedural Mitigation Description
<u>**Stressor or Activity**</u> • Gunnery activities using small-, medium-, and large-caliber non-explosive practice munitions • Mitigation applies to activities using a surface target
<u>**Number of Lookouts and Observation Platform**</u> • 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 11.1-5 for Weapons Firing Noise
• Mitigation Zone Size and Mitigation Requirements: o 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 11.1-20: Procedural Mitigation for Non-Explosive Missiles and Rockets

Procedural Mitigation Description
<u>**Stressor or Activity**</u> • Aircraft-deployed non-explosive missiles and rockets • Mitigation applies to activities using a surface target
<u>**Number of Lookouts and Observation Platform**</u> • 1 Lookout positioned in an aircraft
<u>**Mitigation Zone Size and Mitigation Requirements**</u> • 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 11.1-21: Procedural Mitigation for Non-Explosive Bombs and Mine Shapes

Procedural Mitigation Description
Stressor or Activity • Non-explosive bombs • Non-explosive mine shapes during mine laying activities
Number of Lookouts and Observation Platform • 1 Lookout positioned in an aircraft
Mitigation Zone Size and Mitigation Requirements • 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 potential impacts on marine mammals (Figures 11.2-1 through 11.2-3), as well as seafloor resources that serve valuable ecosystem functions and could provide habitat for marine mammal prey species. The Navy considered a mitigation area to be effective if it met all three of 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 particularly 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);
- **The mitigation would result in an avoidance or substantial reduction of impacts:** Implementing the mitigation would likely result in an avoidance or substantial 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 the distribution and physical properties of the resource; and
- **The mitigation area would result in a net benefit to the biological or cultural resource:** Implementing the mitigation would not simply shift impacts from one area or species to another, resulting in a similar or worse level of effect.

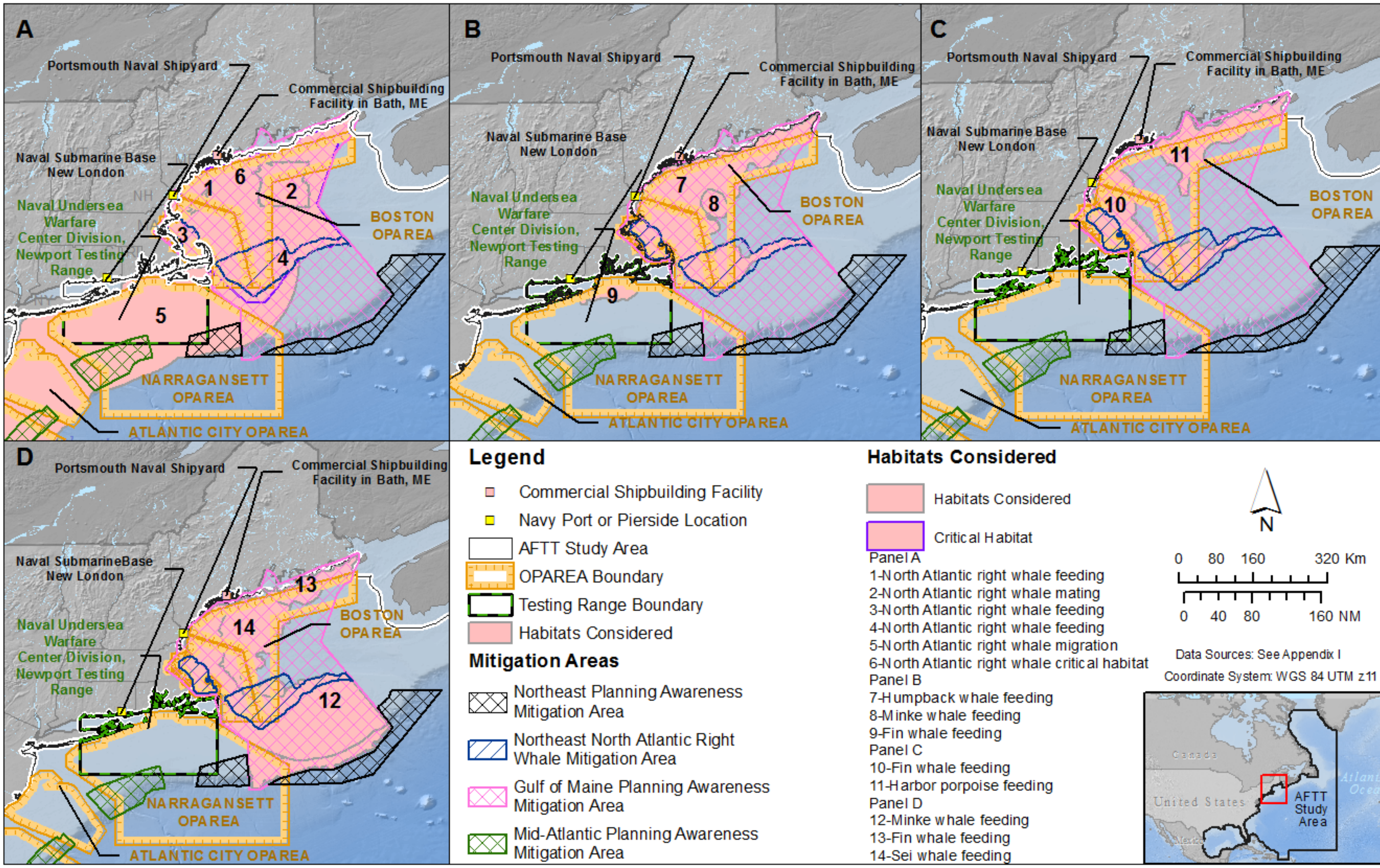
Information on the mitigation measures that the Navy will implement within mitigation areas is provided in Table 11.2-1 through Table 11.2-4. The mitigation applies year-round unless specified otherwise in the tables.

Table 11.2-1: Mitigation Areas for Seafloor Resources

Mitigation Area Description
Resource Protection Focus • Shallow-water coral reefs • Live hard bottom • Artificial reefs • Shipwrecks
Stressor or Activity • Explosives • Physical disturbance and strikes
Mitigation Area Requirements • **Within the anchor swing circle of shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks:** o The Navy will not conduct precision anchoring (except in designated anchorages). • **Within a 350-yd. radius of shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks:** o The Navy will not conduct explosive mine countermeasure or mine neutralization activities, or explosive mine neutralization activities involving Navy divers. • **Within a 350-yd. radius of shallow-water coral reefs:** 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. • **Within the South Florida Ocean Measurement Facility Testing Range:** o The Navy will use real-time geographic information system and global positioning system (along with remote sensing verification) during deployment, installation, and recovery of anchors and mine-like objects and during deployment of bottom-crawling unmanned underwater vehicles in waters deeper than 10 ft. to avoid shallow-water coral reefs and live hard bottom. o Vessels deploying anchors, mine-like objects, and bottom-crawling unmanned underwater vehicles will aim to hold a relatively fixed position over the intended mooring or deployment location using a dynamic positioning navigation system with global positioning system. o The Navy will minimize vessel movement and drift in accordance with mooring installation and deployment plans, and will conduct activities during sea and wind conditions that allow vessels to maintain position and speed control during deployment, installation, and recovery of anchors, mine-like objects, and bottom-crawling unmanned underwater vehicles. o Vessels will operate within waters deep enough to avoid bottom scouring or prop dredging, with at least a 1-ft. clearance between the deepest draft of the vessel (with the motor down) and the seafloor at mean low water. o The Navy will not anchor vessels or spud over shallow-water coral reefs and live hard bottom. o The Navy will use semi-permanent anchoring systems that are assisted with riser buoys over soft bottom habitats to avoid contact of mooring cables with shallow-water coral reefs and live hard bottom.

Table 11.2-2: Mitigation Areas off the Northeastern United States

Mitigation Area Description
Stressor or Activity • Sonar • Explosives • Physical disturbance and strikes
Mitigation Area Requirements • **Northeast North Atlantic Right Whale Mitigation Areas (year-round):** o The Navy will minimize the use of low-frequency active sonar, mid-frequency active sonar, and high-frequency active sonar to the maximum extent practicable. o The Navy will not use Improved Extended Echo Ranging sonobuoys (within 3 NM of the mitigation area), explosive and non-explosive bombs, in-water detonations, and explosive torpedoes. o For activities using non-explosive torpedoes, the Navy will conduct activities during daylight hours in Beaufort sea state 3 or less. The Navy will use three Lookouts (one positioned on a vessel and two in an aircraft during dedicated aerial surveys) to observe the vicinity of the activity. An additional Lookout will be positioned on the submarine, when surfaced. Immediately prior to the start of the activity, Lookouts will observe for floating vegetation and marine mammals; if the resource is observed, the activity will not commence. During the activity, Lookouts will observe for marine mammals; if observed, the activity will cease. To allow a sighted marine mammal to leave the area, the Navy will not recommence the activity until one of the recommencement conditions has been met: (1) the animal is observed exiting the vicinity of the activity; (2) the animal is thought to have exited the vicinity of the activity based on a determination of its course, speed, and movement relative to the activity location; or (3) the area has been clear from any additional sightings for 30 min. During transits and normal firing, ships will maintain a speed of no more than 10 knots. During submarine target firing, ships will maintain speeds of no more than 18 knots. During vessel target firing, ship speeds may exceed 18 knots for brief periods of time (e.g., 10–15 min.). o For all activities, before vessel transits, the Navy will conduct a web query or email inquiry to the National Oceanographic and Atmospheric Administration Northeast Fisheries Science Center's North Atlantic Right Whale Sighting Advisory System to obtain the latest North Atlantic right whale sighting information. Vessels will use the obtained sightings information to reduce potential interactions with North Atlantic right whales during transits. Vessels will implement speed reductions after they observe a North Atlantic right whale, if they are within 5 NM of a sighting reported to the North Atlantic Right Whale Sighting Advisory System within the past week, and when operating at night or during periods of reduced visibility. • **Gulf of Maine Planning Awareness Mitigation Area (year-round):** o The Navy will not plan major training exercises (Composite Training Unit Exercises or Fleet Exercises/Sustainment Exercises), and will not conduct more than 200 hours of hull-mounted mid-frequency active sonar per year. o If the Navy needs to conduct major training exercises or more than 200 hours of hull-mounted mid-frequency active sonar per year for national security, it will provide NMFS with advance notification and include the information in any associated training activity or monitoring reports. • **Northeast Planning Awareness Mitigation Areas (year-round):** o The Navy will avoid planning major training exercises (Composite Training Unit Exercises or Fleet Exercises/Sustainment Exercises) to the maximum extent practicable. o The Navy will not conduct more than four major training exercises per year (all or a portion of the exercise). o If the Navy needs to conduct additional major training exercises for national security, it will provide NMFS with advance notification and include the information in any associated training activity or monitoring reports.

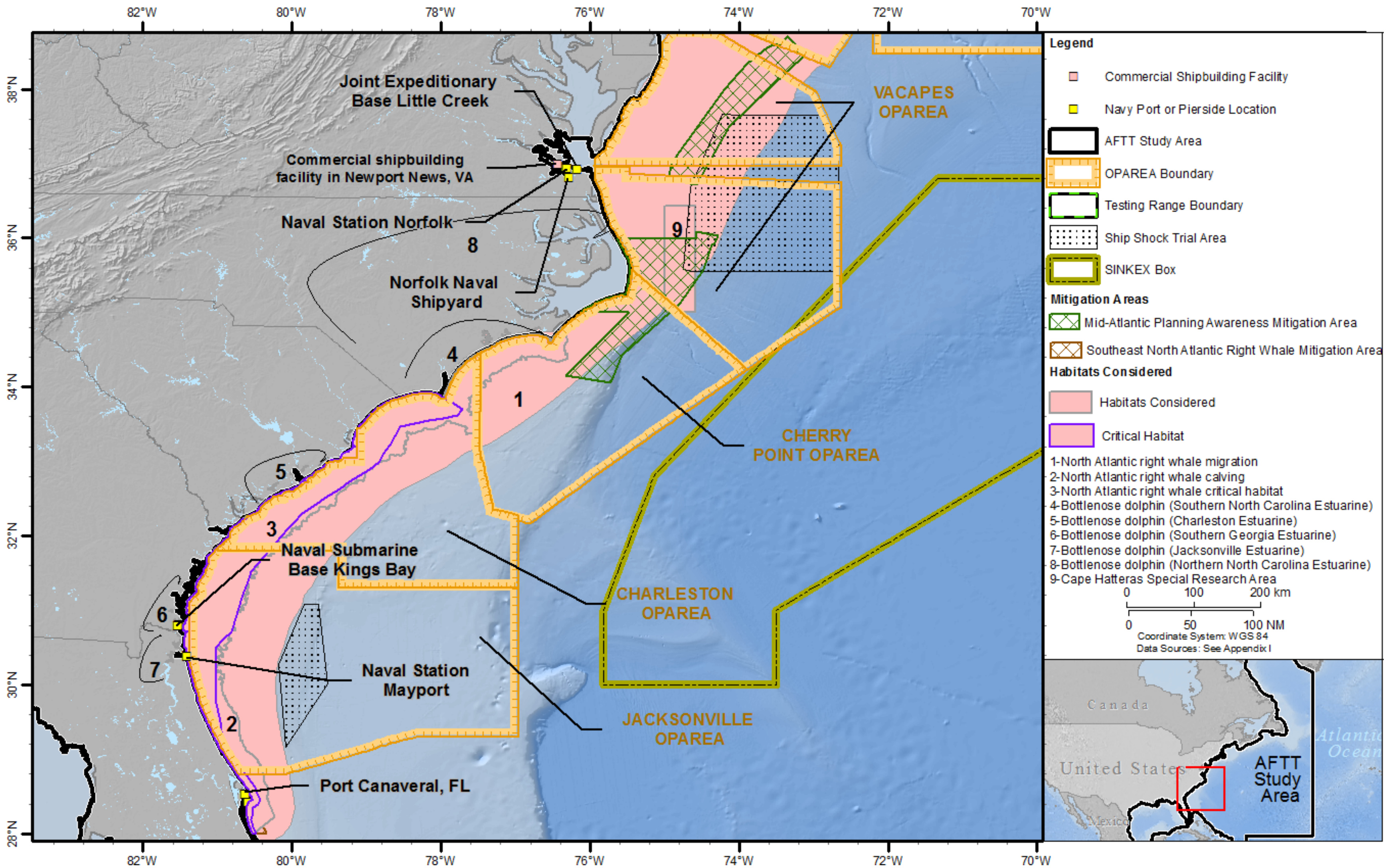


Notes: AFTT: Atlantic Fleet Training and Testing; ME: Maine; OPAREA: Operating Area

Figure 11.2-1: Mitigation Areas and Habitats Considered off the Northeastern United States

Table 11.2-3: Mitigation Areas off the Mid-Atlantic and Southeastern United States

Mitigation Area Description
Stressor or Activity • Sonar • Explosives • Physical disturbance and strikes
Mitigation Area Requirements • **Southeast North Atlantic Right Whale Mitigation Area (November 15 through April 15):** o The Navy will not conduct: (1) low-frequency active sonar (except as noted below), (2) mid-frequency active sonar (except as noted below), (3) high-frequency active sonar, (4) missile and rocket activities (explosive and non-explosive), (5) small-, medium-, and large-caliber gunnery activities, (6) Improved Extended Echo Ranging sonobuoy activities, (7) explosive and non-explosive bombing activities, (8) in-water detonations, and (9) explosive torpedo activities. o To the maximum extent practicable, the Navy will minimize the use of: (1) helicopter dipping sonar, (2) low-frequency active sonar and hull-mounted mid-frequency active sonar used for navigation training, and (3) low-frequency active sonar and hull-mounted mid-frequency active sonar used for object detection exercises. o Before transiting or conducting training or testing activities, the Navy will initiate communication with the Fleet Area Control and Surveillance Facility, Jacksonville to obtain Early Warning System North Atlantic right whale sightings data. The Fleet Area Control and Surveillance Facility, Jacksonville will advise vessels of all reported whale sightings in the vicinity to help vessels and aircraft reduce potential interactions with North Atlantic right whales. Commander Submarine Force U.S. Atlantic Fleet will coordinate any submarine operations that may require approval from the Fleet Area Control and Surveillance Facility, Jacksonville. Vessels will use the obtained sightings information to reduce potential interactions with North Atlantic right whales during transits. Vessels will implement speed reductions after they observe a North Atlantic right whale, if they are within 5 NM of a sighting reported within the past 12 hours, or when operating at night or during periods of poor visibility. To the maximum extent practicable, vessels will minimize north-south transits. • **Mid-Atlantic Planning Awareness Mitigation Areas (year-round):** o The Navy will avoid planning major training exercises (Composite Training Unit Exercises or Fleet Exercises/Sustainment Exercises) to the maximum extent practicable. o The Navy will not conduct more than four major training exercises per year (all or a portion of the exercise). o If the Navy needs to conduct additional major training exercises for national security, it will provide NMFS with advance notification and include the information in any associated training activity or monitoring reports.

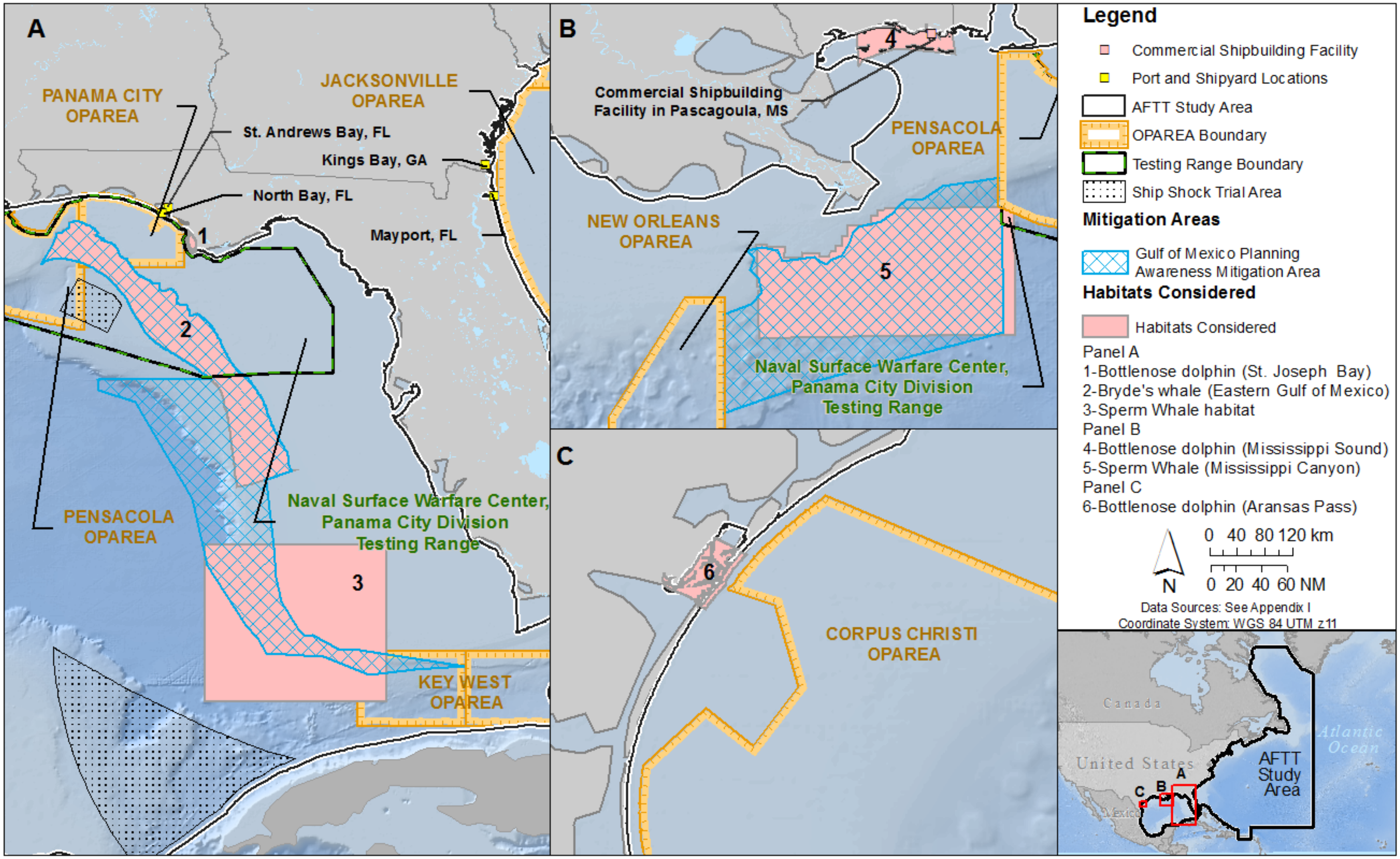


Notes: AFTT: Atlantic Fleet Training and Testing; FL: Florida; OPAREA: Operating Area; SINKEX: sinking exercise; VA: Virginia

Figure 11.2-2: Mitigation Areas and Habitats Considered off the Mid-Atlantic and Southeastern United States

Table 11.2-4: Mitigation Areas in the Gulf of Mexico

Mitigation Area Description
Stressor or Activity • Sonar
Mitigation Area Requirements • **Gulf of Mexico Planning Awareness Mitigation Areas (year-round):** o The Navy will avoid planning major training exercises (i.e., Composite Training Unit Exercises or Fleet Exercises/Sustainment Exercises) involving the use of active sonar to the maximum extent practicable. o The Navy will not conduct any major training exercises in the Gulf of Mexico Planning Awareness Mitigation Areas under the Proposed Action. o If the Navy needs to conduct additional major training exercises in these areas for national security, it will provide NMFS with advance notification and include the information in any associated training activity or monitoring reports.



Notes: AFTT: Atlantic Fleet Training and Testing; FL: Florida; GA: Georgia; MS: Mississippi; OPAREA: Operating Area

Figure 11.2-3: Mitigation Areas and Habitats Considered in the Gulf of Mexico

11.3 Mitigation Summary

The Navy's mitigation measures are summarized in Table 11.3-1 and 11.3-2. Figure 11.3-1 depicts the mitigation areas that the Navy developed for marine mammals in the Study Area.

Table 11.3-1: Summary of Procedural Mitigation

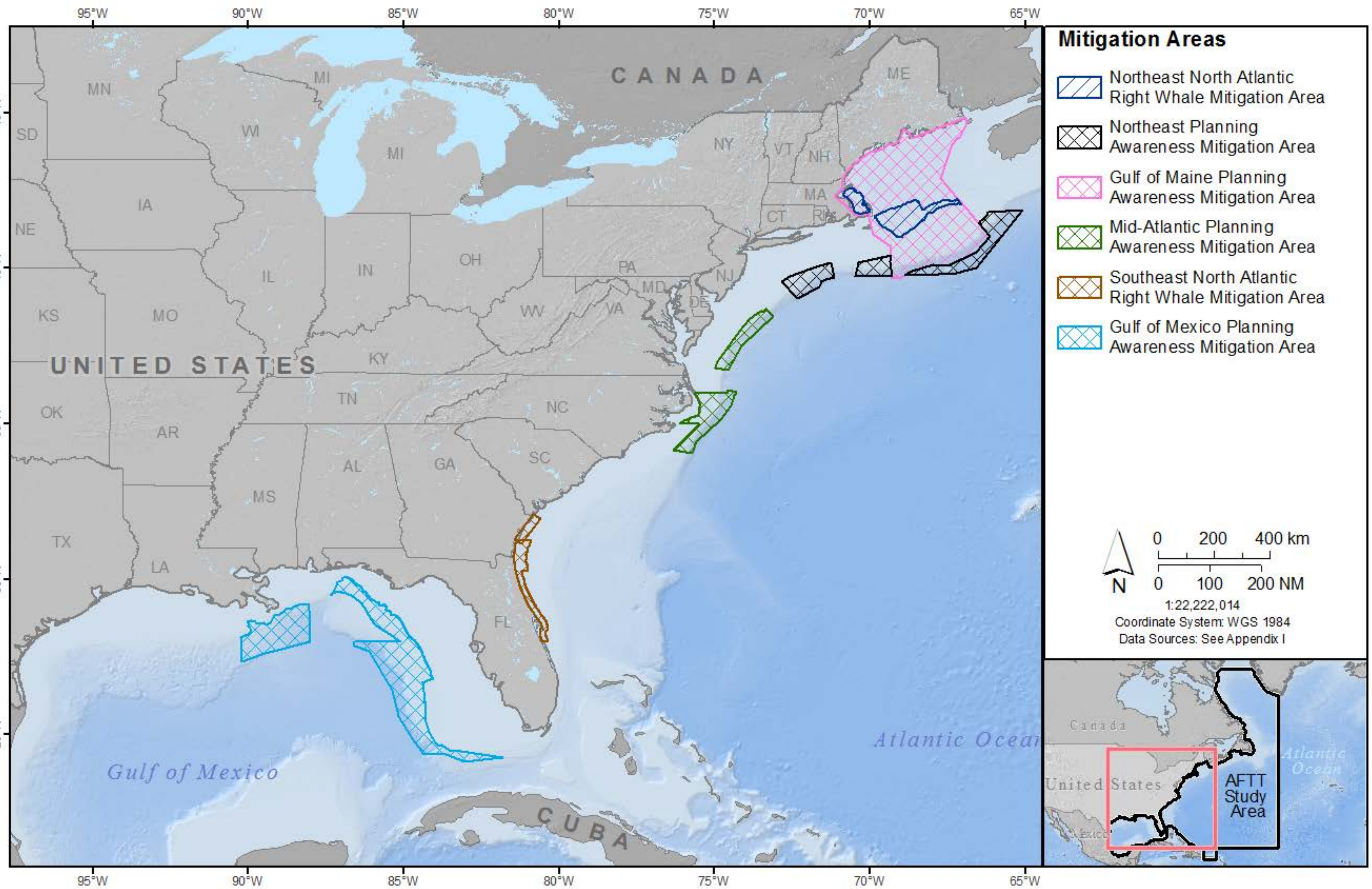
Stressor or Activity	*Summary of Mitigation Zone or Other Mitigation*
Environmental Awareness and Education	Afloat Environmental Compliance Training for applicable personnel
Active Sonar	Depending on sonar source: 1,000 yd. power down, 500 yd. power down, and 200 yd. shut down; or 200 yd. shut down
Air 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)
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)
Maritime Security Operations – Anti-Swimmer Grenades	200 yd.
Line Charge Testing	900 yd.
Ship Shock Trials	3.5 NM
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.

Notes: lb.: pounds; NM: nautical miles; yd.: yards

Table 11.3-2: Summary of Mitigation Areas

Mitigation Area	*Summary of Mitigation Requirements*
Mitigation Areas for Seafloor Resources	
Shallow-water coral reefs	• 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. • Within the South Florida Ocean Measurement Facility Testing Range, the Navy will implement additional measures, such as using real-time positioning and remote sensing information to avoid shallow-water coral reefs during deployment, installation, and recovery of anchors and mine-like objects, and during deployment of bottom-crawling unmanned underwater vehicles.
Live hard bottom	• 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. • Within the South Florida Ocean Measurement Facility Testing Range, the Navy will implement additional measures, such as using real-time positioning and remote sensing information to avoid live hard bottom during deployment, installation, and recovery of anchors and mine-like objects, and during deployment of bottom-crawling unmanned underwater vehicles.
Artificial reefs, Shipwrecks	• 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	
Northeast North Atlantic Right Whale Mitigation Area	• The Navy will minimize use of active sonar to the maximum extent practicable. • The Navy will not use explosives that detonate in the water. • Non-explosive torpedo testing will be conducted during daylight hours in Beaufort sea state 3 or less; three Lookouts (one on a vessel and two in an aircraft during dedicated aerial surveys) and an additional Lookout on the submarine (when surfaced) will be used; during transits, ships will maintain a speed of no more than 10 knots; during firing, ships will maintain a speed of no more than 18 knots except for brief periods of time (e.g., 10–15 min.) during vessel target firing. • Navy will obtain the latest North Atlantic right whale sightings data. • Vessels will implement speed reductions after they observe a North Atlantic right whale, if they are within 5 NM of a sighting reported within the past week, and when operating at night or during periods of reduced visibility.
Gulf of Maine Planning Awareness Mitigation Area	• The Navy will not plan major training exercises. • The Navy will not conduct more than 200 hours of hull-mounted mid-frequency active sonar per year.
Northeast Planning Awareness Mitigation Areas, Mid-Atlantic Planning Awareness Mitigation Areas	• The Navy will avoid planning major training exercises to the maximum extent practicable. • The Navy will not conduct more than four major training exercises per year (all or a portion of the exercise).
Southeast North Atlantic Right Whale Mitigation Area (November 15 through April 15)	• The Navy will not conduct active sonar except as necessary for navigation and object detection training, and dipping sonar. • The Navy will not expend explosive or non-explosive ordnance. • The Navy will obtain the latest North Atlantic right whale sightings data. • Vessels will implement speed reductions after they observe a North Atlantic right whale, if they are within 5 NM of a sighting reported within the past 12 hours, and when operating at night or during periods of reduced visibility. • To the maximum extent practicable, vessels will minimize north-south transits.
Gulf of Mexico Planning Awareness Mitigation Areas	• The Navy will avoid planning major training exercises to the maximum extent practicable. • The Navy will not conduct any major training exercises (all or a portion of the exercise) in each area under the Proposed Action.

Notes: min.: minutes; NM: nautical miles



Notes: AFTT: Atlantic Fleet Training and Testing

Figure 11.3-1: Mitigation Areas for Marine Mammals in the Study Area

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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 request for Letters of Authorization, 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

The Navy is committed to demonstrating environmental stewardship while executing its National Defense Mission and complying with the suite of Federal environmental laws and regulations. As a complement to the Navy's commitment to avoiding and reducing impacts of the Proposed Action through mitigation (Chapter 11, Mitigation Measures), the Navy will undertake reporting efforts to track compliance with take authorizations and help investigate the effectiveness of implemented mitigation measures. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing and understanding 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. Since monitoring will be required for compliance with the final rule issued for the Proposed Action under the MMPA, details of the monitoring program will be developed in coordination with NMFS through the regulatory process.

13.1 ADAPTIVE MANAGEMENT

Adaptive management is an iterative process of decision-making that accounts for changes in the environment and scientific understanding over time through a system of monitoring and feedback. Within the natural resource management community, adaptive management involves ongoing, real-time learning and knowledge creation, both in a substantive sense and in terms of the adaptive process itself. Adaptive management focuses on learning and adapting, through partnerships of natural resource managers, scientists, and other stakeholders. Adaptive management helps managers maintain flexibility in their decisions and provides them the latitude to change direction to improve understanding of ecological systems to achieve management objectives. Taking action to improve progress toward desired outcomes is another function of adaptive management.

The adaptive management review process and reporting requirments serve as the basis for evaluating performance and compliance. The adaptive management review process involves technical review meetings and ongoing discussions between the Navy, NMFS, the Marine Mammal Commission, and other experts in the scientific community. Revisions to the compliance monitoring structure as a result of adaptive management review include the further development of the Strategic Planning Process (U.S. Department of the Navy, 2013b), which is a planning tool for selection of monitoring investments, and its incorporation into the Integrated Comprehensive Monitoring Program for future 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.

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 study area 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 a planning tool, the Integrated Comprehensive Monitoring Program will be routinely updated as the program evolves and progresses. The Strategic Planning Process (U.S. Department of the Navy, 2013b) serves to guide the investment of resources to most efficiently address Integrated Comprehensive Monitoring Program objectives and intermediate scientific objectives developed through this process.

Under the Integrated Comprehensive Monitoring Program, Navy-funded monitoring relating to the effects of Navy training and testing activities on protected marine species should be designed to accomplish one or more top-level goals as described in the current version of 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 military 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.

The Navy established the Scientific Advisory Group in 2011 with the initial task of evaluating current Navy monitoring approaches under the Integrated Comprehensive Monitoring Plan and existing MMPA Letters of Authorization and developing objective scientific recommendations that would form the basis for the Strategic Plan. While recommendations were fairly broad and not specifically prescriptive, the Scientific Advisory Group did provide specific programmatic recommendations that 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.
- Striving to move away from effort-based compliance metrics (e.g., completing a pre-determined amount of survey hours or days, or number of surveys). Monitoring studies should be designed and conducted according to scientific objectives, rather than on effort expended.
- 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 U.S. Navy marine species monitoring program has evolved and improved as a result of the adaptive management review process through changes including:

- Recognizing the limitations of effort-based compliance metrics;
- Developing a strategic approach to monitoring based on recommendations from the Scientific Advisory Group (U.S. Department of the Navy, 2013b);
- 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, and has 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 response 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 of Navy training and testing
- 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.

13.4 Annual Monitoring, and Exercise and Testing Reports

Reports from individual monitoring events, results of analyses, publications, and periodic progress reports for specific monitoring projects will be posted to the U.S. Navy Marine Species Monitoring Program website as they become available. Progress and results from all monitoring activity conducted within the AFTT Study Area, as well as required Major Training Event exercise activity, will be summarized in an annual report. A draft of these annual reports will be submitted to NMFS for review in April of each year prior to being finalized and made available to the public within 3 months.

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14 SUGGESTED MEANS OF COORDINATION

The Navy provides a significant amount of funding and support to marine research. Over the past 5 years the U.S. Navy has provided over $100 million to universities, research institutions, Federal laboratories, private companies, and independent researchers around the world to study marine mammals, including approximately 70 percent of all United States research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. This research is directly applicable to the AFTT activities analysis, particularly with respect to the investigations of the potential impacts of underwater noise sources on marine mammals and other protected marine resources.

Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas;
- Developing methods to detect and monitor marine species before and during training and testing;
- Understanding the impacts of sound on marine mammals, sea turtles, fish, and birds; and
- Developing tools to model and estimate potential impacts of sound.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the impacts of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are:

- Environmental Consequences of Underwater Sound;
- Non-Auditory Biological Effects of Sound on Marine Mammals;
- Effects of Sound on the Marine Environment;
- Sensors and Models for Marine Environmental Monitoring;
- Effects of Sound on Hearing of Marine Animals; and
- Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

Overall, the U.S. Navy will continue to support and fund ongoing marine mammal research and long-term monitoring and research of marine mammals throughout the AFTT Study Area. The Navy will continue to research and contribute to university and external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts; and future research as described previously.

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