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Acoustic and Explosive Impacts Analysis for Marine Mammals, Reptiles, and Fishes in the Atlantic Fleet Training and Testing Study Area

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TABLE OF CONTENTS

List of Figures

List of Tables

1 INTRODUCTION

This report analyzes acoustic and explosive impacts to marine mammals, sea turtles, and fishes from military readiness activities in the Atlantic Fleet Training and Testing (AFTT) Study Area. Impacts to these taxa are presented in separate sections below.

1.1 INFORMATION RELIED UPON FOR THIS ANALYSIS

The acoustic and explosive impact analysis provided here relies on information presented in other sections and appendices of this EIS, and relevant technical reports. The following lists contain abbreviated names for each of these supporting sections and briefly describes the content therein. The impact analysis refers to these supporting sections using the italicized names noted here.

Sections that provide details and descriptions of the Proposed Action include:

- The *Proposed Activities* section in Section 2.2 (Proposed Activities) of this AFTT Draft Supplemental EIS/OEIS provides the number of activities and the locations they would occur.
- The *Activity Descriptions* section in Appendix A (Activity Descriptions) of the AFTT Draft Supplemental EIS/OEIS describes for each activity: the primary mission area, details of the activity, typical components, acoustic/explosive bin categories, where they would occur, and any applicable mitigation measures.
- The *Acoustic Stressors* section in Sections 3.0.3.3.1 (Acoustic Stressors) and 3.0.3.3.2 (Explosive Stressors) of this AFTT Draft Supplemental EIS/OEIS describes the general categories and characteristics of each acoustic substressor and explosive, along with their general use and quantity (counts or hours, as applicable) of annual and seven-year total use. Information on characteristics of vessel, aircraft, and weapons noise produced during training and testing activities can be found in the 2018 Final EIS/OEIS.
- The *Vessel Movements* data in Section 3.0.3.3.4 (Physical Disturbance and Strike Stressors) of this AFTT Draft Supplemental EIS/OEIS quantifies the activities with vessels in each location in the Study Area, which is also relevant to where vessel noise would be generated in the Study Area.
- The *Munitions* data in Section 3.0.3.3.4 (Physical Disturbance and Strike Stressors) of this AFTT Draft Supplemental EIS/OEIS quantifies the number of non-explosive practice munitions and the number of explosives that may result in fragments at each location in the Study Area, which are also relevant to where weapon noise (other than noise due to in-water explosives) would be generated in the Study Area.

Sections that provide general background information:

- The *Marine Mammal Background* sections in Section 3.7.2 (Affected Environment) and Appendix H, Biological Resources Supplemental Information, of this AFTT Draft Supplemental EIS/OEIS describe species present in the Study Area, general biology, ecology, and status of each species, and descriptions of critical habitat, where applicable.
- The *Reptile Background* sections in Section 3.8.2 (Affected Environment) and Appendix H, Biological Resources Supplemental Information, of this AFTT Draft Supplemental EIS/OEIS describe the species present in the Study Area, general biology, ecology, and status of each species, and descriptions of critical habitat, where applicable.

- The *Fishes Background* sections in Section 3.7.2 (Affected Environment) and Appendix H, Biological Resources Supplemental Information, of this AFTT Draft Supplemental EIS/OEIS describe the species present in the Study Area, general biology, ecology, and status of each species, and descriptions of critical habitat, where applicable.
- The *Acoustic Primer* section in Appendix D, Acoustic and Explosive Impacts Supporting Information (Section D.1, Acoustic and Explosive Concepts / Primer) of the AFTT Draft Supplemental EIS/OEIS describes the basic concepts of sound and explosive energy transmission underwater and in air and introduces how animals perceive sound. The *Acoustic Primer* also describes acoustic metrics used in this analysis. Unless otherwise stated, sound pressure levels (SPL) in this analysis are root-mean-square values.
- The *Acoustic Habitat* section in Appendix D, Acoustic and Explosive Impacts Supporting Information (Section D.2, Acoustic Habitat) of this AFTT Draft Supplemental EIS/OEIS describes natural and anthropogenic sources that contribute to the ambient noise within the Study Area.
- The *Marine Mammal Acoustic Background* section in Appendix D, Acoustic and Explosive Impacts Supporting Information (Section D.8, Marine Mammals) of the AFTT Draft Supplemental EIS/OEIS summarizes the best available science on impacts to marine mammals from exposure to acoustic and explosive stressors.
- The *Reptile Acoustic Background* section located in the AFTT Draft Supplemental EIS/OEIS summarizes the best available science on impacts to reptiles from exposure to acoustic and explosive stressors.
- The *Fishes Acoustic Background* section Appendix D, Acoustic and Explosive Impacts Supporting Information (Section D.7, Fishes) of the AFTT Draft Supplemental EIS/OEIS summarizes the best available science on impacts to fishes from exposure to acoustic and explosive stressors.

Technical reports that provide details on the quantitative process and show specific data inputs to the models (all are available for download at https://www.nepa.navy.mil/aftteis/):

- The *Quantitative Analysis TR* refers to the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase IV Training and Testing* (U.S. Department of the Navy, 2024b) which describes the modeling methods used to quantify impacts to marine mammals and sea turtles from exposure to sonar, air guns, and explosives. Impacts due to pile driving were modeled outside of the Navy Acoustic Effects Model using a static area-density model and are also described in this technical report.
- The *Criteria and Thresholds TR* refers to the technical report titled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase IV) (U.S. Department of the Navy, 2024a)* which describes the development of criteria and thresholds used to predict impacts on marine mammals and sea turtles.
- The *Density TR* refers to the technical report titled *U.S. Navy Marine Species Density Database Phase IV for the Atlantic Fleet Training and Testing Study Area* (U.S. Department of the Navy, 2024c) which describes the spatial density distributions for each species or stock in the Study Area. The density models have been updated with new data since the prior analysis. The density technical report includes figures showing the change in spatial density for each species since the prior analysis. Any

substantial changes that are affecting the quantified impacts in this analysis are discussed for each stock below.

- The *Dive Profile and Group Size TR* refers to the technical report titled *Dive Distribution and Group Size Parameters for Marine Species Occurring in the U.S. Navy's Atlantic and Hawaii-California Training and Testing Study Areas* (Oliveira et al., 2024) which describes the dive profile and group size for each species. There are no substantive changes from the prior analysis.

Mitigation information includes:

- The *Mitigation* section refers to Sections 5.6.1 (Mitigation Specific to Acoustic Stressors, Explosives, and Non-Explosive Ordnance), Section 5.6.2 (Mitigation Specific to Vessels, Vehicles, and Towed In-Water Devices) and geographic mitigation in Section 5.7 (Geographic Mitigation) of this AFTT Draft Supplemental EIS/OEIS which describes the actions taken to avoid, reduce, or minimize potential impacts from acoustic and explosive stressors.

1.2 Changes from Prior Analyses

Changes in the predicted acoustic impacts to protected species since the Navy's 2018 impact assessments are primarily due to the following:

- Updates to data on marine mammal and reptile presence, including estimated density of each species or stock (number of animals per unit area), group size, and depth distribution. For additional details, including maps showing the relative density changes between this analysis and the prior analysis for this Study Area, see the *Density TR* and *Dive Profile and Group Size TR*.

- Updates to criteria used to determine if an exposure to sound or explosive energy may cause auditory effects, non-auditory injuries, and behavioral responses. The changes in impact thresholds between this analysis and the prior analysis in the Study Area are shown in the applicable sections below. For additional details, see the technical report *Criteria and Thresholds TR*.

- Revisions to the modeling of acoustic effects due to proposed sound-producing activities in the Navy Acoustic Effects Model. An overview of notable changes is provided in relevant sections below. For additional details, see the technical report *Quantitative Analysis TR*.

Changes in the locations, numbers, and types of modeled military readiness activities as described in the *Proposed Action* section.

2 IMPACTS TO MARINE MAMMALS FROM ACOUSTIC AND EXPLOSIVE STRESSORS

This analysis is presented as follows:

- The impacts that would be expected due to each type of acoustic stressor and explosives used in the Proposed Action are described in Section 2.1 (Impacts due to each Acoustic Substressor and Explosives).
    - Incidental take is anticipated due to the following substressors: sonars and other transducers, air guns, pile driving, and explosives.
    - The following substressors are not anticipated to result in incidental take: vessel noise, aircraft noise, and weapons noise.
- The approach to modeling and quantifying impacts for stressors that may cause injury, auditory effects, or significant behavioral responses is summarized in Section 2.2 (Quantifying Impacts to Marine Mammals from Acoustic and Explosive Stressors).
- The approach to assessing the significance of responses for both individuals and populations is described in Section 2.3 (Assessing Impacts to Individuals and Populations).
- Impacts to individual species (stocks) in the Study Area, including predicted instances of harm or harassment, are presented in Section 2.4 (Species Impact Assessments). Mammal species that are extralimital to the Study Area, including bowhead whale, narwhal, beluga whale, ringed seal, bearded seal, walrus, and polar bear, are highly unlikely to be exposed to stressors under the Proposed Action. Thus, these species are not included in the detailed species impact assessments.

2.1 IMPACTS DUE TO EACH ACOUSTIC SUBSTRESSOR AND EXPLOSIVES

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; Southall et al., 2021b). 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 of the animal to the source of the sound. The *Marine Mammal Acoustic Background* section summarizes what is currently known about effects to marine mammals from all acoustic substressors and explosives. That section cites the best available science that is relied on for this impact assessment.

In this analysis, impacts are categorized as mortality, non-auditory injury, auditory injury (AINJ, including permanent threshold shift [PTS] and auditory neural injury), temporary hearing loss (temporary threshold shift [TTS]), other physiological response (including stress), masking (occurs when a noise interferes with the detection, discrimination, or recognition of other sounds), and behavioral responses. These effects are defined and explained in the *Acoustic Primer* and the *Marine Mammal Acoustic*

Background section. An "exposure" occurs when the received sound level is above the background ambient noise level within a similar frequency band; not all exposures are perceivable or result in impacts.

2.1.1 Impacts from Sonars and Other Transducers

Sonars and other transducers (collectively referred to as sonars in this analysis) emit sound waves into the water to detect objects, safely navigate, and communicate. Sonars are considered non-impulsive and vary in source level, frequency, duration (the total time that a source emits sound including any silent periods between pings), duty cycle (the portion of time a sonar emits sound when active, from infrequent to continuous), beam characteristics (narrow to wide, directional to omnidirectional, downward or forward facing), and movement (stationary or on a moving platform). Additional characteristics and occurrence of sonars used under the Proposed Action are described in the *Acoustic Stressors* and *Activity Descriptions* sections.

Although sonar use could occur throughout the Study Area, sonar use would typically occur within Navy training ranges, Navy testing ranges, associated inshore range locations, and specified ports and piers identified in the *Proposed Activities* section. Activities using sonar range from single source, limited duration events to multi-day events with multiple sound sources on different platforms. The types of sonars and the way they are used differ between primary mission areas. This in turn influences the potential for impacts to exposed marine mammals.

- Anti-submarine warfare typically relies on relatively high source level, mid-frequency sources including MF1 hull-mounted sonar, which is used on Navy combatants such as destroyers. Most anti-submarine warfare sonars use mid-frequency ranges (1 - 10 kHz), and some use low-frequency ranges (< 1 kHz). 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. Systems typically operate with low-duty cycles for most tactical sources, but some systems may operate nearly continuously or with higher duty cycles. The MF1 hull-mounted sonar is the predominant vessel-based anti-submarine warfare sonar. It nominally operates at 3 kilohertz (kHz) with a source level of 235 decibels (dB re 1 µPa) at 1 meter (m), pinging every 50 seconds. Due to their high source levels and low transmission loss (compared to higher frequency sources), anti-submarine warfare sonar sources have the largest zones of effects. The duration and duty cycle of different sources can vary greatly, from very low duty cycle submarine sonars that infrequently emit single pings, to helicopter dipping sonars that are active for minutes, to continuously active sources on vessels. Sonar on torpedoes would be higher frequency and used for shorter periods of time. Compared to the prior analysis, the Action Proponents propose to use fewer hours of hull-mounted surface ship sonar (greater than 40 percent fewer for regular duty cycle [MF1] greater than 20 percent fewer for high duty cycle sonar [MF1C]) in the Study Area during training and testing activities.
- The largest activities in terms of number of platforms using sonar and event duration are major training exercises. These are multi-day exercises that transition across large areas and involve multiple anti-submarine warfare assets. Although major training exercises tend to move to different locations as the event unfolds, some animals could be exposed to sonars over multiple days and across a large area. Integrated and coordinated training similarly involve multiple anti-submarine warfare platforms, but these activities are of shorter duration, smaller scale, and fewer participants than major training exercises. Unit-level training typically involves a single platform conducting anti-submarine warfare. Testing activities are often on the scale of unit-level training. These events

would be conducted across a smaller area and for a shorter period, usually within a few hours of a single day, although certain vessel evaluation activities using anti-submarine warfare sonars may extend over multiple days. On a similar scale, individual ships and submarines may use their anti-submarine warfare sonars during maintenance of these systems. These smaller scale events are less likely to repeatedly expose any marine mammals when these events are considered individually; however, these events may be concentrated in certain locations, such as sonar maintenance events at piers or unit-level training conducted near homeports, increasing the potential to repeatedly expose local populations. Except for nearshore maintenance activities and system checks, anti-submarine warfare sonars would typically be used in water deeper than approximately 200 m. Thus, in most locations near-shore populations would not be impacted by these activities.

- Mine Warfare training and testing 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. Because of these factors, zones of effect for these systems tend to be relatively smaller. Mine Warfare activities may extend from hours to days. Despite relatively lower source levels, long duration events may still pose a risk of auditory effects due to accumulated exposure to any animal that remains in the vicinity. These activities would typically occur offshore in shallower waters than Anti-Submarine Warfare. These activities could also occur in certain inshore locations and ports. Mine Warfare activities occur in various locations, with training activities concentrated in the Virginia Capes Range Complex and testing activities concentrated in the Naval Surface Warfare Center Panama City Testing Range. Sonar use is limited for the Mine Warfare training activity Civilian Port Defense and is the only activity to which certain near-shore populations are exposed at certain Navy port locations.

- Navigation and object detection activities typically employ ship and submarine-based sonars to navigate and avoid underwater objects. Submarines will use their low duty cycle sonars to navigate near ports or train for simulated under ice conditions farther offshore. Surface ships will use hull-mounted sonar at higher frequencies (e.g., bin MF1K) to detect and avoid hazards both near ports. The activities would typically occur in range complexes adjacent to homeports.

- Unmanned underwater vehicles (UUV) typically employ sonars with higher frequencies and lower source levels. These activities therefore typically have a smaller zone of effect. Still, because some sonars on UUVs have high duty cycles and UUVs may be active for hours at a time, there is a risk of longer exposures for nearby animals. In addition, low-frequency and mid-frequency sonars may be used during some activities.

- A variety of sound sources are used in other testing activities. Acoustic and Oceanographic Research activities use a variety of sonars to conduct engineering tests of acoustic sources, validate ocean acoustic models, and characterize how sound travels and interacts with the ocean bottom, fish, and ocean surface. Other Testing activities include but are not limited to testing of communication sound sources and countermeasures. Most of these systems generate low to moderate sound levels and use higher frequencies. Some sources are stationary. Certain events may use sources over long durations (days) which may result in long duration exposures to animals that remain in the vicinity.

Sonars have the potential to affect marine mammals by causing hearing loss, masking, non-injurious physiological responses (such as stress), or behavioral reactions. Low- (less than 1 kHz), mid- (1–10 kHz), and some high- (10–100 kHz) frequency sonars are within the hearing range of all marine mammals, though odontocetes and sirenians hear poorly at low frequencies. Additionally, very high-frequency (100–200 kHz) sonars are in the hearing range of all odontocetes. See the section titled *Hearing* in the *Marine Mammal Background* for additional information.

Hearing Loss: Hearing loss, or threshold shift, is related to the received level of sound and the duration of the exposure. Proposed activities with more sound sources, louder sound sources, or that transmit sonar for longer durations increase the likelihood of auditory effects in marine mammals. For example, high-duty cycle hull-mounted sonar is more likely than other sonars to result in auditory effects. Research has shown that marine mammals are more susceptible to hearing loss within frequencies of best hearing. Hearing loss is most likely to occur at or above the dominant frequency of the sound source, not below. The recovery of hearing thresholds begins after an exposure. Any hearing loss that is recovered is called temporary threshold shift (TTS), whereas any remaining threshold shift after recovery is considered auditory injury (AINJ). See the section titled *Hearing Loss and Auditory Injury* in the *Marine Mammal Background* for additional information. TTS and AINJ are estimated using criteria developed for marine mammal hearing groups and modeling methods described below in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors).

Masking: Masking can reduce the ranges over which marine mammals can detect biologically relevant sounds in the presence of high-duty cycle sources. Lower-duty cycle sonars have less of a masking effect, as the listener can detect signals of interest during the quiet periods between cycles. The reduction in range over which marine mammals communicate is highly dependent on the frequencies of the sonar and biological signal of interest, as well as the source levels of the sonar. High-frequency (10–100 kHz) sonars, including those typically used for mine hunting, navigation, and object detection, fall within the best hearing and vocalization ranges of most marine mammals. However, high frequencies attenuate more rapidly in the water due to absorption than do lower frequency sounds, thus producing a smaller zone of potential masking than mid and low frequencies. While high-frequency sonar has the potential to mask marine mammal vocalizations under certain conditions, reduction in available communication space or ability to locate prey is unlikely because of the small zone of effect.

Masking effects of sonar are typically transient and temporary for hull-mounted sonars, as they are mobile, and masking is reduced as the spatial separation between the masker and signal of interest increases. Most Anti-Submarine Warfare activities are geographically dispersed and last for a few hours, often with intermittent sonar use, and have a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of masking due to sonar used in Anti-Submarine Warfare activities. In some cases, mammals can compensate for masking by changing their calls or moving away from the source.

For large mysticetes, the range of best hearing is estimated between 0.1 and 10 kHz, which overlaps with low- and mid-frequency sonar sources; however, their vocalizations are below 1 kHz, which overlaps with low-frequency sources. Any auditory impacts (TTS and INJ) or masking from mid-frequency sonars would be less likely to affect communication than impacts due to low-frequency sonars. For the other mysticetes, the range of best hearing and vocalizations is between 1 and 30 kHz, which overlaps with mid- and high-frequency sonar sources. Masking from high-frequency sonar sources would be less likely to affect communication for these mysticetes than impacts due to mid-frequency sonars.

Odontocetes that use echolocation to hunt may experience masking of the echoes needed to find their prey when foraging near low and mid-frequency sonar sources. Communication sounds could also be masked by these sources. This effect is likely to be temporary in offshore areas where these sources operate most often. However, when sonars operate in nearshore areas such as homeports with a high level of anthropogenic activity, the combined effect of masking due to sonar the opportunities for odontocetes to detect and interpret biologically relevant sounds may be reduced. Odontocete cetaceans with very high frequency hearing such as harbor porpoises may experience masking of echolocation and communication calls from close-proximity very-high-frequency sources, but these effects are likely to be transient and temporary.

Pinnipeds may also experience masking due to low and mid- frequency sources because their communication calls range from approximately 0.1 – 30 kHz. Some species of pinnipeds communicate primarily in air and would not experience masking due to sonar.

See the section titled *Masking* in the *Marine Mammal Acoustic Background* for additional information.

Physiological response (including stress): Marine mammals could experience a physiological change in heart rate, stress hormones, or immune system due to sound exposure. There has been limited study of physiological responses of marine mammals to sonar or other noise. Evidence suggests that behavioral responses by bottlenose dolphins to sonar were not accompanied by changes in stress hormones (Houser et al., 2020), although changes in heart rate and stress metabolites in dolphins and other species have been associated with sound exposure in a few studies. See the section titled *Physiological Response* in the *Marine Mammal Acoustic Background* for additional information.

Behavioral response: Marine mammals only behaviorally respond to sounds they can hear or otherwise perceive. Marine mammals may react in several ways depending on the sound's characteristics, their experience with the sound source, and whether they are migrating, breeding, or feeding. Behavioral responses may include alerting, breaking off feeding dives and surfacing, diving, or swimming away. While marine mammals' reaction to sonar can vary based on the individual, species, and context, animals disturbed during activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. See the section titled *Behavioral Reactions* in the *Marine Mammal Acoustic Background* for additional information. Behavioral responses to sonars are estimated using criteria developed for marine mammal behavioral groups and modeling methods described below in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors). The sensitivity to behavioral disturbance due to sonars differs among marine mammal groups as follows: Marine mammals only behaviorally respond to sounds they can hear or otherwise perceive. Marine mammals may react in several ways depending on the sound's characteristics, their experience with the sound source, and whether they are migrating, breeding, or feeding. Behavioral responses may include alerting, breaking off feeding dives and surfacing, diving, or swimming away. While marine mammals' reaction to sonar can vary based on the individual, species, and context, animals disturbed during activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. See the section titled *Behavioral Reactions* in the *Marine Mammal Acoustic Background* for additional information. Behavioral responses to sonars are estimated using criteria developed for marine mammal behavioral groups and modeling methods described below in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors). The sensitivity to behavioral disturbance due to sonars differs among marine mammal groups as follows:

- Mysticetes are the least behaviorally sensitive group. Behavioral reactions in mysticetes are much more likely within a few kilometers of a sound source. Mysticetes have been observed to route around sound sources placed in their migration path.
- Large odontocetes such as killer whales and pilot whales have been observed to temporarily cease natural behaviors such as feeding, avoid the sonar source, or even move towards the sound source, as seen in pilot whales. These same behavioral responses have been observed in delphinids, both in captivity and in the field; however, this group appears to be less sensitive to sound and anthropogenic disturbance than other cetacean species.
- Beaked whales exposed to sonar or other active acoustic sources may startle, discontinue feeding dives, and avoid the area of the sound source. Because they are highly sensitive to anthropogenic activity including sonars, behavioral responses of beaked whales have been carefully studied on Navy ranges, as well as using tagging technology and controlled exposures. These studies are detailed in the *Marine Mammal Acoustic Background* subsection *Behavioral Responses of Odontocetes*. In areas where Anti-Submarine Warfare training exercises occur with some regularity, beaked whales leave the area but return within a few days after the event ends (e.g., Henderson et al., 2015; Henderson et al., 2016; Jacobson et al., 2022; Manzano-Roth et al., 2016; Tyack et al., 2011). Population levels of beaked whales and other odontocetes on Navy fixed ranges that have been operating for decades appear to be stable. In areas where beaked whales are unlikely to regularly encounter naval sonar activity, beaked whales may be more likely to be displaced for longer periods of time. For example, *Mesoplodon* species and Cuvier's beaked whales reduced foraging for up to a week after a multi-day, multi-platform Anti-Submarine Warfare training exercise (Stanistreet et al., 2022). Beaked whale detections remained low seven days after the exercise, indicating that these whales were likely displaced. Significant behavioral reactions to sonar are likely when beaked whales are exposed to anti-submarine sonar within a few tens of kilometers, especially for prolonged periods (a few hours or more). Conversely, the behavioral avoidance of Navy activities exhibited by beaked whales is likely to also decrease the probability of hearing loss for these species.
- Harbor porpoises are a small species that is sensitive to anthropogenic activity and avoid anthropogenic sound sources at low received levels. Behavioral reactions are 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.
- Research shows that pinnipeds in the water are generally tolerant of anthropogenic sound and activity. They 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, diving, or hauling out.
- Manatees typically live in shallow inshore areas with limited open water. Research shows that manatees are generally tolerant, or perhaps habituated, to high levels of anthropogenic noise and activity. Manatees that have been observed reacting have done so by alerting and swimming to deeper water. Manatees may not react at all or may not react until the sound source is approaching within a few hundred meters.

For sonars with applicable visual observation mitigation (see *Mitigation*), trained Lookouts observe defined mitigation zones for marine mammals and indicators that marine mammals may be present.

The mitigation zones encompass the ranges to auditory injury for all marine mammals for all sonars shown in 2.5.1 (Ranges to Effects for Sonars and Other Transducers), including the ship hull-mounted sonars, MF1 and MF1C.

Because sonars may result in the incidental take of marine mammals (auditory impacts and significant behavioral responses), sonar impacts are modeled per the methods presented in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors). Impacts on each marine mammal stock are quantified below in Section 2.4 (Species Impact Assessments).

Conclusions regarding impacts from sonars used during military readiness activities for ESA-listed species are provided in Section 2.4 (Species Impact Assessments).

2.1.2 Impacts from Air Guns

Air guns use bursts of pressurized air to create intermittent, broadband, impulsive sounds. Air gun use during military readiness activities is limited and unlike large-scale seismic surveys that use multiple air guns. Rather, small air guns would be fired over a limited period within a single day. Air gun use would only occur in two testing activities: Semi-Stationary Equipment Testing and Acoustic and Oceanographic Research. While air gun use during Semi-Stationary Equipment Testing could occur near shore at Newport, RI, air gun use during Acoustic and Oceanographic Research would occur in the Northeast, Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes greater than 3 NM from shore.

Air gun sounds are within the hearing range of all marine mammals. Potential impacts from air guns could include temporary hearing loss, behavioral reactions, physiological response, and masking.

All marine mammals are susceptible to auditory effects from impulsive sounds such as those from air guns. Ranges to auditory effects for marine mammals exposed to air guns are in Section 2.5 (Ranges to Effects). The visual observation distances described in the section *Mitigation* are designed to avoid or substantially reduce the potential for AINJ due to air guns.

If marine mammals are exposed to sounds from air guns they may experience masking and could potentially react with short-term behavioral reactions and physiological response (see the *Marine Mammal Acoustic Background* section for details). 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. Military readiness activities, in contrast, only use single air guns over a much shorter period and 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.

Impacts from seismic air guns has been studied in several mysticete species, including bowhead whales, grey whales, humpback whales, and blue whales. Mysticetes react to air guns in a variety of ways, ranging from startle responses, changing respiration, vocal, dive, or surface behaviors (e.g., tail slapping), and strong avoidance responses (e.g., swimming rapidly away from the seismic vessels, habitat displacement). Exposed mysticetes will sometimes tolerate the disturbance and continue their natural behavior patterns or return to the area once the air gun activity ceases. Certain factors (e.g., activity intensity, proximity, behavioral context, species) may influence whether a mysticete tolerates air gun noise or leaves the area until the seismic activity ceases, as in the case of the more sensitive bowhead whales.

Impacts from air guns have been studied in several odontocete species, including sperm whales, beluga whales, and harbor porpoises. Odontocetes may react in a variety of ways to air guns, which include changes in feeding, dive, and vocal behavior, habitat displacement, or showing no response at all. If disturbed while engaged in activities such as feeding or reproductive behaviors, odontocetes may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns, as seen in sperm whales.

Impacts from air guns have not been studied in many species of pinnipeds, but there is evidence of wild ringed seals avoiding a seismic vessel by a short distance (less than 250 m). Research in captive ringed seals and California sea lions shows mild to evasive behavioral responses. 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). If disturbed while engaged in activities such as feeding or reproductive behaviors, pinnipeds may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns.

Because noise from air guns may result in the incidental take of marine mammals (auditory impacts and significant behavioral responses), air gun impacts are modeled per the methods presented in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors). Impacts on each marine mammal stock are quantified below in Section 2.4 (Species Impact Assessments).

Conclusions regarding impacts from air guns used during military readiness activities for ESA-listed species are provided in Section 2.4 (Species Impact Assessments).

2.1.3 Impacts from Pile Driving

Marine mammals[1] could be exposed to sounds from impact (installation only) and vibratory (installation and removal) pile driving during Port Damage Repair training at Gulfport, Mississippi (pile driving would not occur during testing activities).

Port Damage Repair training would occur over five days and up to four times per year (20 days total). At most, sound from pile driving activities could occur over a maximum estimated duration of several hours in each day, though breaks in pile driving are taken frequently to reposition the drivers between piles and not all piles would be driven to completion, minimizing the total time pile driving noise is produced during this activity. Depending on where the activity occurs at Gulfport, transmission of pile driving noise may be reduced by earthen pier structures. As discussed in *Activities Description* section, as a standard operating procedure, the Navy performs soft starts at reduced energy during an initial set of strikes from an impact hammer. Soft starts may "warn" marine mammals and cause them to move away from the sound source before impact pile driving increases to full operating capacity. Soft starts were not considered when calculating the number of marine mammals that could be impacted, nor was the possibility that marine mammals could avoid the training area. Therefore, absent these considerations, the impact determination is overly conservative.

[1] Only two species of marine mammals are anticipated to be present in the nearshore waters by Gulfport: West Indian manatees (managed by U.S. Fish and Wildlife Service) and two stocks of bottlenose dolphins (managed by NMFS).

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, especially when extracting piles from sandy, nearshore ground, and the sound is continuous while operating.

Ranges to effects for marine mammals exposed to impact and vibratory pile driving are shown in Section 2.5 (Ranges to Effects). The mitigation zone (100 yd.) extends beyond the relatively short ranges to auditory effects for hearing groups present near Gulfport. After a sighting, the 15-min. recommencement wait period would cover the average dive times of the marine mammal species that could be present in the mitigation zone. If impacts occur, it would be more likely that marine mammals may experience brief periods of masking, physiological responses, or behavioral reactions.

Vibratory and impact pile driving (at 60 strikes per minute) may cause masking. The effect would be temporary, lasting the amount of time it would take to drive a pile, with pauses before the next pile is driven. Furthermore, Port Damage Repair activities occur in shallow, nearshore areas where ambient noise levels are already typically high. Gulfport is a commercial port with potentially high ambient noise levels due to vessel traffic and port activities. Most of the pile driving would occur within the port. Given these factors, significant masking is unlikely to occur in marine mammals due to exposure to sound from impact pile driving or vibratory pile driving/extraction.

If marine mammals are exposed to sounds from pile driving or extraction, they could potentially react with short-term behavioral reactions and physiological (stress) responses (see the *Marine Mammal Acoustic Background* section).

Because noise from pile driving may result in the incidental take of marine mammals (auditory impacts and significant behavioral responses), pile driving impacts are modeled per the methods presented in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors). Impacts on each marine mammal stock present in the affected area are quantified below in Section 2.4 (Species Impact Assessments).

Conclusions regarding impacts from pile driving during military readiness activities for ESA-listed species are provided in Section 2.4 (Species Impact Assessments).

2.1.4 IMPACTS FROM VESSEL NOISE

Marine mammals may be exposed to vessel-generated noise throughout the Study Area. Military readiness activities with vessel-generated noise would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Specifically, a study of Navy vessel traffic found that traffic was heaviest just offshore of Norfolk and Jacksonville, as well as along the coastal waters between the two ports (Mintz, 2012a; Mintz, 2016; Mintz & Filadelfo, 2011) as described in the *Acoustic Habitat* section, though these activities could occur throughout the Study Area. Vessel movements involve transits to and from ports to various locations within the Study Area. Many ongoing and proposed military readiness activities involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels), as well as Unmanned Systems. During training, combatant 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. A variety of smaller craft can be operated within the Study Area. Small craft types, sizes, and speeds vary. In all cases, the vessels will be operated in a safe manner consistent with the local conditions. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to multiple weeks.

Noise from vessels generally lacks the amplitude and duration to cause any hearing loss in marine mammals under realistic conditions. Noise from vessels is generally low-frequency (10 to hundreds of Hertz), although at close range or in shallow water some sound energy can extend above 100 kHz at received levels above 100 dB re 1 µPa (Hermannsen et al., 2014). Although periods of broadband noise tend to be brief, occurring only as a vessel is passing within a few hundred meters, vessel noise could lead to short-term masking for all marine mammal species. Vessels have been linked to minor behavioral responses, although it is difficult to separate responses to the noise from reactions to the physical presence of the vessel. Physiological response has also been linked to chronic vessel noise, such as that in shipping lanes or heavily trafficked whale-watch areas. However, based on the relatively low source levels of many vessels, and the transient nature of vessel noise during military readiness activities, any responses by marine mammals to vessels and associated noise are unlikely to be significant. Best available science on responses to vessel noise, including behavioral responses, stress, and masking, is summarized in the *Marine Mammal Acoustic Background* section.

Vessel traffic related to the proposed activity would pass near marine mammals only on an incidental basis. Ports such as Mayport and Norfolk are heavily trafficked with private and commercial vessels in addition to naval vessels. Because ships taking part in military readiness activities make up only a small proportion of the total ship traffic, even in the most concentrated port and inshore areas, proposed vessel transits are unlikely to cause significant behavioral responses or long-term abandonment of habitat by a marine mammal. The Action Proponents will implement mitigation for vessel movement to avoid the potential for marine mammal vessel strikes, as discussed in the *Mitigation* section. The mitigation for vessel movements (i.e., maneuvering to maintain a specified distance from a marine mammal) will also help the Navy avoid or reduce potential impacts from vessel noise on marine mammals.

When the level of vessel noise is above the sound of interest, and in a similar frequency band, masking could occur. Vessel noise can mask vocalizations and other biologically relevant sounds (e.g., sounds of prey or predators) that marine mammals rely on. Potential masking can vary depending on the ambient noise level within the environment, the received level and frequency of the vessel noise, and the received level, frequency, and relative position of the sound of biological interest. In the open ocean, ambient noise levels are between about 60 and 80 dB re 1 µPa in the band between 10 Hz and 10 kHz due to a combination of natural (e.g., wind) and anthropogenic sources (Urick, 1983), while inshore noise levels, especially around busy ports, can exceed 120 dB re 1 µPa. This analysis assumes that any sound that is above ambient noise levels and within an animal's hearing range may potentially cause masking. However, the degree of masking increases with increasing noise levels; a noise that is just detectable over ambient levels is unlikely to cause any substantial masking. Masking by passing ships or other sound sources transiting the Study Area would be short term and intermittent, and therefore unlikely to result in any substantial costs or consequences to individual animals or populations. Areas with increased levels of ambient noise from anthropogenic noise sources such as areas around busy shipping lanes and near harbors and ports may cause sustained levels of masking for marine mammals, which could reduce an animal's ability to find prey, find mates, socialize, avoid predators, or navigate. However, Navy vessels make up a very small percentage of the overall traffic (two orders of magnitude lower than commercial ship traffic in the Study Area), and the rise of ambient noise levels in these areas is related to all ocean users, including commercial and recreational vessels and shoreline development and industrialization.

Surface combatant ships (e.g., guided missile destroyer, guided missile cruiser, and Littoral Combat Ship) and submarines are designed to be very quiet to evade enemy detection and typically travel at speeds of 8 - 15 knots. Actual acoustic signatures and source levels of combatant ships and submarines are classified; however, they are quieter than most other motorized ships. Still, these surface combatants and submarines are likely to be detectable by marine mammals over open-ocean ambient noise levels at distances of up to a few kilometers, which could cause masking for a few minutes as the vessel passes by. Other ships and small vessels have higher source levels, like equivalently sized commercial ships and private vessels, however many of these are concentrated in homeports, which are typically industrialized areas with elevated ambient noise levels.

Ship noise tends to be low-frequency and broadband; therefore, it may have the largest potential to mask mysticetes that vocalize at lower frequencies compared to other marine mammals. Noise from large vessels and outboard motors on small craft can produce source levels of 160 to over 200 dB re 1 µPa at 1 m. Therefore, in the open ocean, noise from noncombatant vessels may be detectable over ambient levels for tens of kilometers, and some masking, especially for mysticetes, is possible. In noisier inshore areas around ports and ranges, vessel noise may be detectable above ambient for only several hundred meters. Some masking of mysticete communication is likely from noncombatant vessels, on par with similar commercial and recreational vessels, especially in quieter, open-ocean environments.

Vessel noise has the potential to disturb marine mammals and elicit an alerting, avoidance, or other behavioral reaction. Most studies have reported that marine mammals react to vessel sounds and traffic with short-term interruption of feeding, resting, or social interactions (Magalhães et al., 2002; Richardson et al., 1995; Watkins, 1981). Some species respond negatively by retreating or responding to the vessel antagonistically, while other animals seem to ignore vessel noises altogether or are attracted to the vessel (Watkins, 1986). Marine mammals are frequently exposed to vessels due to research, ecotourism, commercial and private vessel traffic, and government activities. It is difficult to differentiate between responses to vessel sound and visual cues associated with the presence of a vessel; thus, it is assumed that both play a role in prompting reactions from animals.

Based on studies of several species, mysticetes are not expected to be disturbed by vessels that maintain a reasonable distance from them, which varies with vessel size, geographic location, and tolerance levels of individuals. Pinniped data largely indicates tolerance of vessel approaches, especially for animals in the water.

Odontocetes could have a variety of reactions to passing vessels, including attraction, increased traveling time, decreased feeding behaviors, diving, or avoidance of the vessel, which may vary depending on their prior experience with vessels. Kogia species, harbor porpoises, and beaked whales have been observed avoiding vessels. Some masking to odontocete communication is likely from noncombatant vessels, on par with similar commercial and recreational vessels, especially in quieter, open-ocean environments.

Most activities occur more than 3 NM offshore, where manatees are uncommon; however, at pierside locations and within inshore locations along the southeastern United States and in the Gulf of Mexico, manatees could co-occur with vessels used in military readiness activities. In studies, manatees have reacted to vessels by moving away from the approaching vessel, increasing their swimming speed, and moving toward deeper water.

Vessels operated by the Action Proponents do not purposefully approach marine mammals and are not expected to elicit significant behavioral responses. Marine mammal reactions to vessel noise associated with proposed activities are likely to be minor and short term, leading to no significant reactions and no long-term consequences.

Pursuant to the MMPA, vessel noise during military readiness activities as described under the Proposed Action will not result in the unintentional taking of marine mammals incidental to those activities.

Conclusions regarding impacts from activities that produce vessel noise during military readiness activities for ESA-listed species are provided in Section 2.4 (Species Impact Assessments).

2.1.5 IMPACTS FROM AIRCRAFT NOISE

Marine mammals may be exposed to aircraft-generated noise throughout the Study Area. Military readiness activities with aircraft would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Fixed- and rotary-wing (helicopters) aircraft are used for a variety of military readiness activities throughout the Study Area. Tilt-rotor impacts would be like fixed-wing or helicopter impacts depending which mode the aircraft is in. Most of these sounds would be concentrated around airbases and fixed ranges within each of the range complexes. Aircraft noise could also occur in the waters immediately surrounding aircraft carriers at sea during takeoff and landing or directly below hovering helicopters that are near the water's surface.

Aircraft produce extensive airborne noise from either turbofan or turbojet engines. An infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Rotary-wing aircraft produce low-frequency sound and vibration (Pepper et al., 2003). Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors, but significant acoustic energy is primarily transmitted into the water directly below the craft in a narrow cone, as discussed in detail in the *Acoustic Primer* section. Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Additional characteristics of aircraft noise are described in the *Acoustic Stressors* section.

Sound from aircraft noise, including occasional sonic booms, lack the amplitude or duration to cause any hearing loss in marine mammals underwater. Aircraft would pass quickly overhead and rotary-wing aircraft (e.g., helicopters) may hover at lower altitudes for longer durations, though still for relatively brief periods, considering the transient nature of both the aircraft and marine mammals. Potential impacts from aircraft noise are limited to masking of other biologically relevant sounds, and brief behavioral and physiological response reactions as aircraft passes overhead. Based on the short duration of potential exposure to aircraft noise, behavioral and physiological response reactions, if they did occur, are unlikely to be significant. The duration of masking due to hovering rotary-wing aircraft would be limited to the short duration of hovering events.

Marine mammals may respond to both the physical presence and to the noise generated by aircraft, making it difficult to attribute causation to one or the other stimulus. In addition to noise produced, all low-flying aircraft make shadows, which can cause animals at the surface to react. Helicopters may also produce strong downdrafts, a vertical flow of air that becomes a surface wind, which can also affect an animal's behavior at or near the surface.

Many of the observations of marine mammal reactions are to aircraft flown for whale-watching and marine research purposes. Marine mammal survey aircraft are typically used to locate, photograph, track, and sometimes follow animals for long distances or for long periods of time, all of which results in the animal being much more frequently located directly beneath the aircraft (in the cone of the loudest noise and potentially in the shadow of the aircraft) for extended periods. Aircraft would not follow marine mammals. In contrast to whale-watching excursions or research efforts, overflights would not result in prolonged exposure of marine mammals to overhead noise or encroachment.

In most cases, exposure of a marine mammal to fixed-wing aircraft presence and noise would be brief as the aircraft quickly passes overhead. Animals would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. Takeoffs and landings occur at established airfields as well as on vessels at sea at unspecified locations across the Study Area. Takeoffs and landings from vessels could startle marine mammals; however, these events only produce in-water noise at any given location for a brief period as the aircraft climbs to cruising altitude. Some sonic booms from aircraft could startle marine mammals, but these events are transient and happen infrequently at any given location within the Study Area. Repeated exposure to most individuals over short periods (days) is extremely unlikely, except for animals that are resident in inshore locations around ports, on fixed ranges (e.g., the Undersea Warfare Training Range), or during major training exercises. These animals could be subjected to multiple overflights per day; however, aircraft would pass quickly overhead, typically at altitudes above 3,000 ft., which would make marine mammals unlikely to respond. No long-term consequences for individuals or populations would be expected.

Daytime and nighttime activities involving helicopters may occur for extended periods of time, typically 1 to 3 hours in some areas. During these activities, helicopters would typically transit throughout an area and may hover over the water. Longer activity durations and periods of time where helicopters hover may increase the potential for behavioral reactions, startle reactions, and physiological response. Low-altitude flights of helicopters during some activities, often under 100 ft., may elicit a somewhat stronger behavioral response due to the proximity to marine mammals, the slower airspeed and therefore longer exposure duration, and the downdraft created by the helicopter’s rotor. Marine mammals would likely avoid the area under the helicopter.

Most fixed-wing aircraft and helicopter activities are transient in nature, although helicopters could also hover for extended periods (5 to 15 minutes). The likelihood that marine mammals would occur or remain at the surface while an aircraft or helicopter transits directly overhead would be low. Helicopters that hover in a fixed location for an extended period could increase the potential for exposure. However, impacts from military readiness activities would be highly localized and concentrated in space and duration.

The consensus of all the studies reviewed is that aircraft noise would cause only small temporary changes in the behavior of marine mammals. Specifically, marine mammals at or near the surface when an aircraft flies overhead at low altitude may startle, divert their attention to the aircraft, or avoid the immediate area by swimming away or diving. No more than short-term reactions are likely. No long-term consequences for individuals, species, or stocks would be expected.

Pursuant to the MMPA, aircraft noise during military readiness activities as described under the Proposed Action will not result in the unintentional taking of marine mammals incidental to those activities.

Conclusions regarding impacts from activities that produce aircraft noise during military readiness activities for ESA-listed species are provided in Section 2.4 (Species Impact Assessments).

2.1.6 Impacts from Weapons Noise

Marine mammals may be exposed to sounds caused by the firing of weapons, objects in flight, and inert impact of non-explosive munitions on the water's surface. Military readiness activities using gunnery and other weapons that generate firing noise would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. The locations where gunnery and other munitions may be used are shown in the *Munitions* data section. Most weapons noise is attributable to gunnery activities. The overall proposed use of large and medium caliber gunnery has decreased since the prior analysis. Proposed use of large caliber gunnery has decreased in all range complexes since the prior analysis, except for an increase in the Virginia Capes range complex. The proposed use of medium caliber gunnery has remained the same or decreased since the prior analysis in most range complexes, except for increases in the Northeast and Virginia Capes range complexes.

Generally, the use of weapons during proposed activities would occur in the range complexes, with greatest use of most types of munitions in the Virginia Capes and Jacksonville Range Complexes. Most activities involving large caliber naval gunfire, or the launching of targets, missiles, bombs, or other munitions are conducted more than 12 NM from shore. The Action Proponents will implement mitigation to avoid or reduce potential impacts from weapon firing noise during large-caliber gunnery activities, as discussed in the *Mitigation* section. For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the underwater detonation of explosive weapons is analyzed in Section 2.1.7 (Impacts from Explosives).

The firing of a weapon may have several components of associated noise. Firing of guns could include sound generated in air by firing a gun (muzzle blast) and a crack sound due to a low amplitude shock wave generated by a supersonic projectile. Most in-air sound would be reflected at the air-water interface. Underwater sounds would be strongest just below the surface and directly under the firing point. Any sound that enters the water only does so within a narrow cone below the firing point or path of the projectile. Vibration from the blast propagating through a ship’s hull, the sound generated by the impact of an object with the water surface, and the sound generated by launching an object underwater are other sources of impulsive sound in the water. Sound due to missile and target launches is typically at a maximum at initiation of the booster rocket and rapidly fades as the missile or target travels downrange.

A gun fired from a ship on the surface of the water propagates a blast wave away from the gun muzzle into the water. Average peak sound pressure in the water measured directly below the muzzle of the gun and under the flight path of the shell (assuming it maintains an altitude of only a few meters above the water’s surface) was approximately 200 dB re 1 µPa. Animals at the surface of the water, in a narrow footprint under a weapons trajectory, could be exposed to naval gunfire noise and may exhibit brief startle reactions, avoidance, diving, or no reaction at all. Due to the short term, transient nature of gunfire noise, animals are unlikely to be exposed multiple times within a short period. Behavioral reactions would likely be short term (minutes) and are unlikely to lead to substantial costs or long-term consequences for individuals, species, or stocks.

Sound due to missile and target launches is typically at a maximum at initiation of the booster rocket and rapidly fades as the missile or target travels downrange. These sounds would be transient and of short duration, lasting no more than a few seconds at any given location. Many missiles and targets are launched from aircraft, which would produce minimal noise in the water due to the altitude of the aircraft at launch. Missiles and targets launched by ships or near the water’s surface may expose marine mammals to levels of sound that could produce brief startle reactions, avoidance, or diving. Due to the short-term, transient nature of launch noise, animals are unlikely to be exposed multiple times within a short period. Reactions by marine mammals to these specific stressors have not been recorded; however, marine mammals would be expected to react to weapons noise as they would other transient sounds. Behavioral reactions would likely be short term (minutes) and are unlikely to lead to long-term consequences for individual, species, or stocks.

Some objects, such as certain non-explosive practice munitions, could impact the water with great force. Animals within the area may hear the impact of non-explosive ordnance on the surface of the water and would likely alert, startle, dive, or avoid the immediate area. Significant behavioral reactions from marine mammals would not be expected due to non-explosive ordnance impact noise; therefore, long-term consequences for the individual, species, or stocks are unlikely.

Weapons firing noise is not expected to result in injury, masking, or significant behavioral reactions under the Proposed Action.

Pursuant to the MMPA, weapons noise during military readiness activities as described under the Proposed Action will not result in the unintentional taking of marine mammals incidental to those activities.

Conclusions regarding impacts from activities that produce weapons noise during military readiness activities for ESA-listed species are provided in Section 2.4 (Species Impact Assessments).

2.1.7 Impacts from Explosives

Marine mammals may be exposed to sound and energy from explosions in the water and near the water surface associated with the proposed activities. Activities using explosives would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Most explosive activities would occur in the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes, although activities with explosives would also occur in other areas as described in *Activity Descriptions*. Most activities involving in-water explosives associated with large caliber naval gunfire, or the launching of targets, missiles, bombs, or other munitions, are conducted more than 12 NM from shore. Small Ship Shock Trials could occur in Virginia Capes, Jacksonville, or the Gulf of Mexico Range Complexes greater than 12 NM from shore as shown in the *Proposed Activities* section. Sinking Exercises are conducted greater than 50 NM from shore as shown in the *Proposed Activities* section. Certain activities with explosives may be conducted closer to shore at locations identified in *Activity Descriptions*, including the training activity Mine Neutralization Explosive Ordnance Disposal and testing activities Semi-Stationary Equipment Testing and line charge testing.

Characteristics, quantities, and net explosive weights of in-water explosives used during military readiness activities are provided in the *Acoustic Stressors* section. The use of in-water explosives would generally decrease from the prior analysis for both training and testing activities. There is a reduction in the use of most of the largest explosive bins for both training and testing, and an extremely large decrease in in-water explosives associated with medium-caliber gunnery (bin E1 [0.1–0.25 pounds (lb.) net explosive weight (NEW)]). There would be notable increases in three bins (E4 [> 2.5–5 lb. NEW], E7 [> 20–60 lb. NEW], and E9 [> 100–250 lb. NEW]). For testing, there would be no use of bin E17 (> 14,500–58,000 lb. NEW) because no Large Ship Shock Trials are proposed, and there would be reduced use of bin E16 (> 7,250–14,500 lb. NEW) for Small Ship Shock Trials.

The majority (96%) of explosive munitions used during military readiness activities would occur at or above the water's surface including those used during Surface Warfare activities which would typically detonate at or within 9 m (30 ft) above the water surface. The only detonations that would occur exclusively in-water would be from Mine Countermeasures (E4 [> 2.5–5 lb. NEW]), Torpedo Testing (E11 [> 500–675 lb. NEW]) and Ship Shock Trials (E16 [> 7,250–14,500 lb. NEW)]. Therefore, impacts to marine mammals are over-estimated in this analysis by modeling in-air or near surface explosions as underwater explosions. In-air explosives, especially those detonating at higher altitudes, are unlikely to result in any significant effects because the received levels would be low and would be reflected at the water surface.

Explosions produce loud, impulsive, broadband sounds that are within the hearing range of all marine mammals. Potential impacts from explosive energy and sound include mortality, non-auditory injury, behavioral reactions, physiological response, masking, and hearing loss. Impact ranges for marine mammals exposed to explosive sound and energy are shown in Section 2.5 (Ranges to Effects). As discussed in the *Mitigation* section, the Action Proponents will implement mitigation to relocate, delay, or cease detonations when a marine mammal is sighted within or entering a mitigation zone to avoid or reduce potential explosive impacts. The visual observation distances described in the section *Mitigation* are designed to cover the distance to mortality and reduce the potential for injury due to explosives.

Assessing whether an explosive detonation may disturb or injure a marine mammal involves understanding the characteristics of the explosive sources, the marine mammals that may be present near the sources, the physiological effects of a close explosive exposure, and the effects of impulsive sound on marine mammal hearing and behavior. Many other factors besides just the received level or pressure wave of an explosion such as the animal's physical condition and size; prior experience with the explosive sound; and proximity to the explosion may influence physiological effects and behavioral reactions.

Explosions introduce low-frequency, broadband sounds into the environment, which could mask hearing thresholds in marine mammals that are nearby, although sounds from explosions last for only a few seconds at most. Sounds from explosions could also mask biologically relevant sounds; however, the duration of individual sounds is very short, reducing the likelihood of substantial auditory masking. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for marine mammals in the area over the short duration of the event.

If marine mammals are exposed to impulsive sounds such as those from 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, marine mammals have been observed to be more reactive to acoustic disturbance when a noise source is located directly on their migration route. Marine mammals 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 marine mammals 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. Due to the short-term and intermittent use of explosives, physiological stress is also likely to be short term and intermittent.

Because in-water explosives may result in the incidental take of marine mammals (mortality, non-auditory injury, auditory effects, and significant behavioral responses), explosive impacts are modeled per the methods presented in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors). Impacts on each marine mammal stock are quantified below in Section 2.4 (Species Impact Assessments).

Conclusions regarding impacts from explosives used during military readiness activities for ESA-listed species are provided in Section 2.4 (Species Impact Assessments).

2.2 Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors

The following section provides an overview of key components of the modeling methods used in this analysis to estimate the number and types of acoustic and explosive impacts to marine mammals. The *Quantitative Analysis TR, Criteria and Thresholds TR, Density TR,* and *Dive Profile and Group Size TR* detail the quantitative process and show specific data inputs to the models. With the exception of pile driving, impacts are modeled using the Navy Acoustic Effects Model. Pile driving is modeled using methods described in the *Quantitative Analysis TR.*

2.2.1 The Navy Acoustic Effects Model

The Navy Acoustic Effects Model was developed to conduct a comprehensive acoustic impact analysis for use of sonars, air guns, and explosives[2] in the marine environment. This model considers the physical environment, including bathymetry, seafloor composition/sediment type, wind speed, and sound speed profiles, to estimate propagation loss. The propagation information combined with data on the locations, numbers, and types of military readiness activities and marine resource densities provides estimated numbers of effects to each stock.

Individual animals are represented as "animats," which function as dosimeters and record acoustic energy from all active underwater sources during a simulation of a training or testing event. Each animat's depth changes during the simulation according to the typical depth pattern observed for each species. During any individual modeled event, impacts on individual animats are considered over 24-hour periods.

The model estimates the number of instances in which an effect threshold was exceeded over the course of a year, it does not estimate the number of times an individual in a population may be impacted over a year. Some individuals could be impacted multiple times, while others may not experience any impact.

The Navy Acoustic Effects Model (described in the *Quantitative Analysis TR*) underwent several notable changes from the prior analysis that influence estimates of the number of marine mammals that could be impacted in each training or testing event.

- Broadband sonar bins are split into one octave sub-bins, propagation calculations performed, and then the energy in each one-octave bin is summed at the receiver (i.e., animat). Broadband sources

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[2] Explosives analyzed in NAEMO include those that are expected to occur in air within 30 ft. (9 m) of the water surface (e.g., those that detonate at a surface target). These explosives are modeled at 0.1 m depth with no release at the surface.

were represented and modeled in previous analyses using only the source's center frequency. Using the full frequency spectrum of the source, as opposed to only the center frequency, may lead to higher weighted received levels for some hearing groups, dependent on the overlap of source frequencies with the auditory range of the hearing group. This will increase sound exposure level (SEL)-based impacts (i.e., TTS and AINJ) for broadband sources in this analysis versus prior analyses for the same event. Sometimes in prior analyses, broadband sonar sources were not analyzed for some hearing groups if the center frequency was beyond the group's frequency cutoffs. Now considering the full broadband frequency spectra of the signal, some previously discounted hearing groups are now assessed for impacts from those sources.

- The impulsive propagation model was updated to use an equation that was more suitable for use in water. The total peak pressure and overall energy of both equations is the same and not expected to result in significant differences in estimates for the number of non-auditory injury, AINJ, TTS, or behavioral effects. However, because of the slower decay time of the updated equation, there would be a slight increase in modeled non-auditory injury and mortality as compared to prior analyses.
- Animal avoidance of high sources levels was incorporated into the Navy Acoustic Effects Model, with marine mammal avoidance thresholds based on their sensitivity to behavioral response. Some species that are less sensitive to behavioral response (i.e., most odontocetes and mysticetes) had less reduction in AINJ due to avoidance than in the prior analysis, leading to higher AINJ estimates. Additional details on the avoidance process are discussed further in 2.2.2 Quantifying Impacts on Hearing.

2.2.2 Quantifying Impacts on Hearing

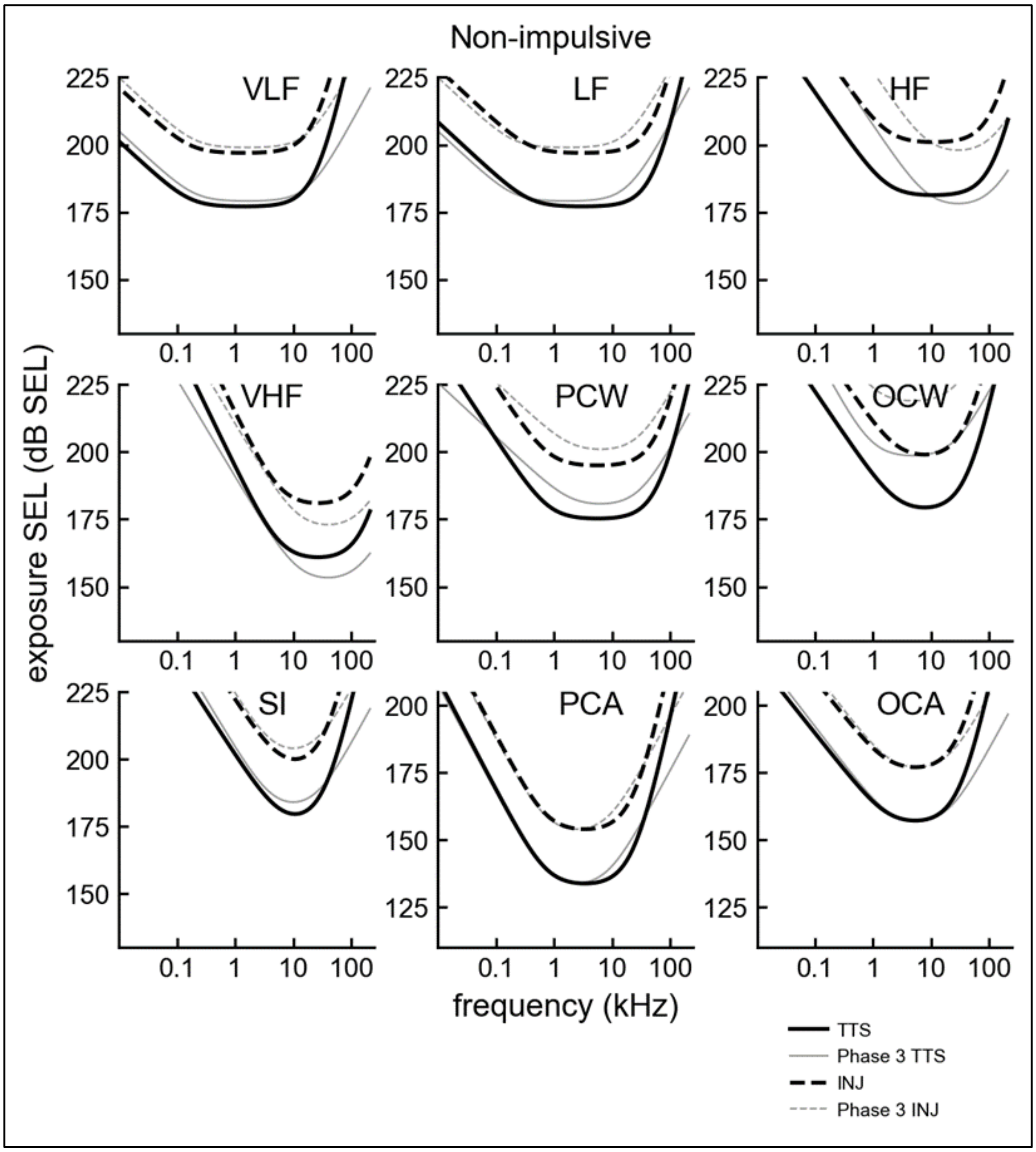
The auditory criteria and thresholds used in this analysis have been updated since the prior assessment of impacts due to military readiness activities in the Study Area. They incorporate new best available science since the release of NMFS guidance for assessing the effects of sound on marine mammal hearing (National Marine Fisheries Service, 2018) and since the publication of recommendations by the expert panel on marine mammal auditory criteria (Southall et al., 2019).

The best way to illustrate frequency-dependent susceptibility to auditory effects is an exposure function. For each marine mammal auditory group, exposure functions for TTS and AINJ (previously called PTS) incorporate both the shape of the group's auditory weighting function and its weighted threshold value for either TTS or AINJ. The updated exposure functions and the exposure functions used in the prior analysis of impacts (Phase 3) are shown together in Figure 2.2-1 and Figure 2.2-2. Exposure functions for non-impulsive sounds are in Figure 2.2-1. Impulsive sounds are analyzed using two criteria, sound exposure level (SEL) and peak pressure. Figure 2.2-2 shows the exposure functions for the SEL-based criteria and Table 2.2-1 shows the peak pressure criteria used for impulsive sounds.

The auditory criteria and thresholds (described in the *Criteria and Thresholds TR*) underwent several notable changes from the prior analysis that influence estimates of the number of marine mammals that could be impacted in each training or testing event.

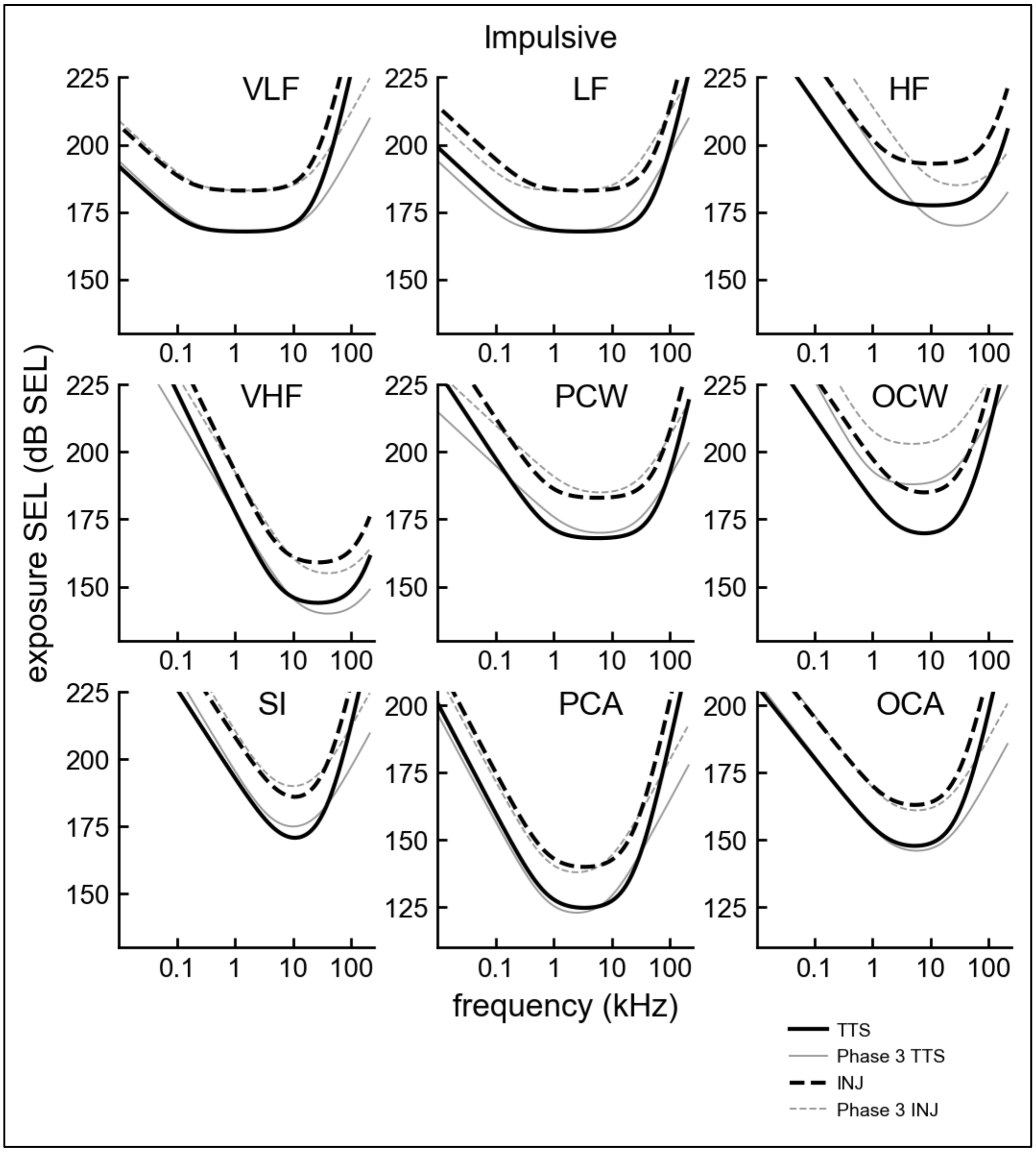
- The mysticetes have been split from one auditory group (the low frequency cetaceans, LF) into two auditory groups: the LF (including minke, humpback, gray, Rice's, Bryde's, and sei whales), and the very low frequency cetaceans, VLF (blue, fin, right, and bowhead whales). While the VLF auditory group retains similar susceptibility to auditory effects as the prior analysis, the new LF auditory group is predicted to be more susceptible to effects at higher frequencies and less susceptible to effects at lower frequencies. Consequently, for LF species, estimated auditory effects due to sources at frequencies above 10 kHz are substantially higher than in prior analysis of the same activities.

- The auditory group previously called the mid-frequency cetaceans (MF) is now called the high frequency cetaceans (HF). All species previously in the MF cetacean auditory group (most odontocetes) are now in the HF cetacean auditory group, and there is no MF cetacean exposure function. In the future, there may be sufficient data to support splitting the current HF cetacean auditory group into MF and HF auditory groups, with certain larger odontocetes (sperm, beaked, and killer whales) in the MF auditory group.
- The HF cetaceans are predicted to be much more susceptible to auditory effects at low and mid-frequencies than previously analyzed. Consequently, the estimated auditory effects due to sources under 10 kHz, including MF1 hull-mounted sonar and other Anti-Submarine Warfare sonars, are substantially higher for this auditory group than in prior analyses of the same activities.
- The auditory group previously called the high frequency cetaceans (HF) is now called the very high frequency cetaceans (VHF). This auditory group, which includes harbor porpoises and *kogia* species, is predicted to be less susceptible to auditory effects at high frequencies (above 10 kHz) than previously analyzed. Consequently, estimated impacts to this group from high frequency sources is slightly lower than prior analyses of the same activities.
- The phocid carnivores (PCW) are predicted to be slightly more susceptible and otariids and other marine carnivores (OCW) are predicted to be substantially more susceptible to auditory effects across their hearing range than previously analyzed. (Note: there are no otariids present in the Study Area, and other marine carnivores are considered extralimital in the Study Area). Consequently, estimated auditory effects for PCW are higher than in prior analyses of the same activities.



Note: Auditory groups are very low frequency cetaceans (VLF), low frequency cetaceans (LF), high frequency cetaceans (HF), very high frequency cetaceans (VHF), phocid carnivores in water and air (PCW and PCA), otariids and other marine carnivores in water and in air (OCW and OCA), and sirenians (SI). Heavy solid lines —Phase 4 TTS exposure functions. Thin solid lines —Phase 3 TTS exposure functions. Heavy dashed lines —Phase 4 AINJ exposure functions. Thin dashed lines —Phase 3 AINJ exposure functions. Figure taken from U.S. Department of the Navy (2024a).

Figure 2.2-1: Marine Mammal TTS and AINJ Exposure Functions for Sonars and Other Non-Impulsive Sources.



Note: Auditory groups are very low frequency cetaceans (VLF), low frequency cetaceans (LF), high frequency cetaceans (HF), very high frequency cetaceans (VHF), phocid carnivores in water and air (PCW and PCA), otariids and other marine carnivores in water and in air (OCW and OCA), and sirenians (SI). Heavy solid lines —Phase 4 TTS exposure functions. Thin solid lines —Phase 3 TTS exposure functions. Heavy dashed lines —Phase 4 AINJ exposure functions. Thin dashed lines — Phase 3 AINJ exposure functions. Figure taken from U.S. Department of the Navy (2024a).

Figure 2.2-2: Marine Mammal TTS and AINJ Exposure Functions for Impulsive Sources.

Table 2.2-1. Peak SPL Thresholds for Auditory Impacts to Marine Mammals from Impulsive Sources.

Hearing Group	*TTS*		*AINJ*		*Change*
	Phase 3	*Phase 4*	*Phase 3*	*Phase 4*	
VLF & LF	213	216	219	222	+3
HF	224	224	230	230	0
VHF	196	196	202	202	0
OCW	226	224	232	230	-2
PCW	212	217	218	223	+5
SI	220	219	226	225	-1

Note: values are unweighted peak pressures in dB re 1 µPa underwater. Auditory group OCW is not present in the Study Area. 3) VLF = very low frequency cetacean, LF = low frequency cetacean, HF = high frequency cetacean, VHF = very high frequency cetacean, OCW = otariid in water, PCW = phocid in water, SI = sirenian.

The instances of AINJ and TTS predicted by the Navy Acoustic Effects Model are not reduced to account for visual observation mitigation in this analysis, unlike prior analyses. Still, it is likely that some model-predicted instances of AINJ and TTS would not occur during actual events using platforms and acoustic sources with applicable mitigation. If Lookouts sight a marine mammal within or entering a mitigation zone, the use of sonars, air guns, pile drivers, and explosives would be delayed, relocated, powered down, or ceased, as appropriate for the source as described in the *Mitigation* section. This would reduce an animal's sound exposure level or prevent an exposure that could cause hearing loss altogether.

Auditory impacts can be reduced when an animal avoids sonar. The Navy Acoustic Effects Model estimates the reduction in cumulative sound exposure level due to marine mammal avoidance of high-level sonar exposures. The estimated cumulative exposure level, including any reductions due to avoidance (if initiated), is compared to the thresholds for AINJ and TTS to assess auditory impacts. If the thresholds for AINJ or TTS are not exceeded, the potential for behavioral response is assessed based on the highest exposure in the simulation. Initiation of aversive behavior is based on the applicable behavioral response function for a species. Avoidance speeds and durations are estimated from baseline species data and actual sonar exposure data, when available. This analysis assumes that a small portion (5 percent) of delphinids in the odontocete behavioral group would not avoid most events but would stay in the vicinity to engage in bow-riding or other behaviors near platforms (i.e., the cumulative sound exposure level is not reduced through avoidance). A detailed explanation of the new avoidance model and the species avoidance factors are in the *Quantitative Analysis TR (U.S. Department of the Navy, 2024b)*.

The ability to reduce cumulative sound exposure level depends on susceptibility to auditory effects, sensitivity to behavioral disturbance, and characteristics of the sonar source, including duty cycle, source level, and frequency. Table 2.2-2 shows the percentage reduction of AINJ across all the modeled activities in this analysis due to avoidance. The reduction in AINJ due to avoidance differs across activities and between auditory and behavioral groups as shown. Groups that are relatively less sensitive to behavioral disturbance compared to susceptibility to auditory effects are less likely to avoid AINJ; these include the Mysticete and Odontocete behavioral groups. Groups that are relatively more sensitive to behavioral disturbance compared to susceptibility to auditory effects are more likely to avoid AINJ; these include the Sensitive Species and Pinniped behavioral groups. The reduction in AINJ for most groups is less than assumed in prior analyses[3] for most species except for beaked whales (High-Frequency cetacean auditory group and Sensitive Species behavioral group).

Table 2.2-2: Reduction in AINJ due to Avoiding Sonars in the Navy Acoustic Effects Model Across Activities

	Behavioral Group			
Hearing Group	**ODONT**	**SENS**	**MYST**	**PINN**
HF	59 - 91 %	98 - 99 %	-	-
VHF	27 - 27 %	82 - 82 %	-	-
LF	-	-	0 - 8 %	-
VLF	-	-	5 - 58 %	-
PW	-	-	-	85 - 94 %

Table Created: 16 April 2024

Notes: HF = High Frequency Cetaceans, VHF = Very High Frequency Cetaceans, LF = Low Frequency Cetaceans, VLF = Very Low Frequency Cetaceans, PCW = Phocids in water, ODONT = Odontocetes, SENS = Sensitive Species, MYST = Mysticetes, PINN = Pinnipeds

Recovery from TTS after a sound exposure is not quantified in this analysis (see the *Marine Mammal Acoustic Background* section). Small amounts of TTS (a few dB) typically begin to recover immediately after the sound exposure and may fully recover in minutes, while larger amounts of TTS require longer to recover. Most TTS fully recovers within 24 hours, but larger shifts could take days to fully recover. In general, TTS quantified based on SEL for intermittent sound exposures is likely over-estimated because some recovery from TTS may occur in the quiet periods between sounds, especially when the duty cycle is low. Lower duty cycles allow for more time between sounds and therefore more of an opportunity for hearing to recover. Modeled effects using the SEL-based criteria are therefore likely to accurately predict impacts from higher duty cycle sources and certainly overestimate impacts from lower duty cycle sources.

See Section 2.5 (Ranges to Effects) for information on the ranges to TTS and AINJ with distance based on the type of sound sources and hearing group, as well as several other factors.

2.2.3 Quantifying Behavioral Responses to Sonars

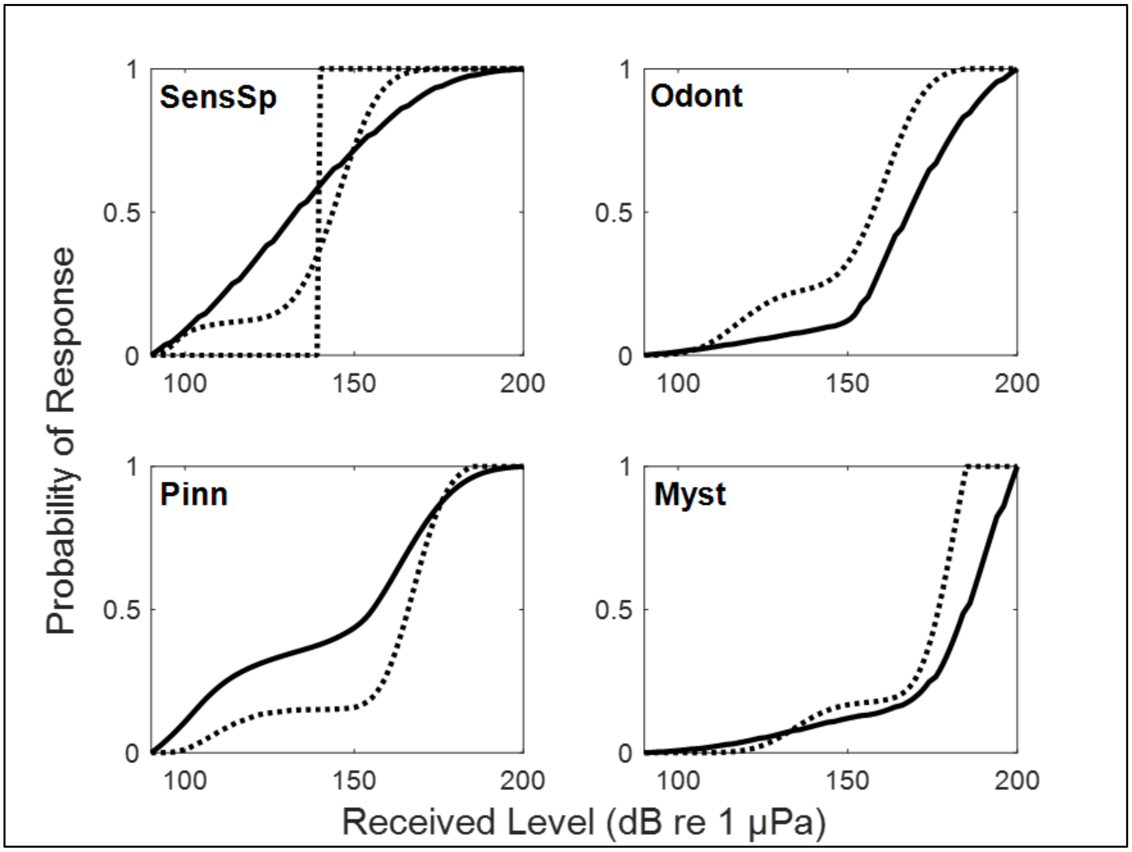
Criteria and thresholds for behavioral responses have been updated since the prior analysis (see *Criteria and Thresholds TR*). Notable differences between the prior and updated criteria and thresholds for behavioral responses to sonars are as follows:

- Beaked whales and harbor porpoise are in a combined Sensitive Species behavioral group (previously, these groups had unique response functions). Other behavioral groupings remain the same: Mysticetes (all baleen whales), Odontocetes (most toothed whales, dolphins, and porpoises), and Pinnipeds (true seals, sea lions, walruses, sea otters, polar bears).

[3] In prior analyses, the reduction in AINJ due to avoidance was calculated outside of the Navy Acoustic Effects Model by applying a common reduction factor based on spreading loss from a hull-mounted sonar and assuming that all nearby animals would avoid the sound source. This resulted in reducing most NAEMO-predicted AINJ to TTS.

- Behavioral cut-off conditions have been revised. The prior analysis only applied distance cut-offs. This analysis applies a dual cut-off condition based on both distance and received level. The cut-off distances have also been revised. These updates are described at the end of this section.

For each group, a biphasic behavioral response function was developed using best available data and Bayesian dose response models. The behavioral response functions are shown in Figure 2.2-3.



Notes: Revised behavioral response functions (solid lines) and prior behavioral response functions (Phase 3, dotted lines). SensSp = Sensitive Species, Odont = Odontocetes, Pinn = Pinnipeds, Myst = Mysticetes. Both the Phase 3 beaked whale behavioral response function and the Phase 3 harbor porpoise step function are plotted against the new Sensitive Species curve. Figure taken from U.S. Department of the Navy (2024a)

Figure 2.2-3: Behavioral Response Functions

Due to the addition of new data and the separation of some species groups, the most significant differences from prior analyses include the following:

- The Sensitive Species behavioral response function is more sensitive at lower received levels but less sensitive at higher received levels than the prior beaked whale and harbor porpoise functions.
- The Odontocete behavioral response function is less sensitive across all received levels due to including additional behavioral response research. This will result in a lower number of behavioral responses than in the prior analysis for the same event, but also reduces the avoidance of auditory effects.
- The Pinniped in-water behavioral response function is more sensitive due to including additional captive pinniped data. Only three behavioral studies using captive pinnipeds were available for the derivation of the behavioral response function. Behavioral studies of captive animals can be difficult to extrapolate to wild animals due to several factors (e.g., use of trained subjects). This means the pinniped behavioral response function likely overestimates effects compared to observed reactions of wild pinnipeds to sound and anthropogenic activity.
- The Mysticete behavioral response function is less sensitive across most received levels due to including additional behavioral response research. This will result in a lower number of behavioral

responses than in the prior analysis for the same event, but also reduces the avoidance of auditory effects.

The behavioral response functions only relate the highest received level of sound during an event to the probability that an animal will have a behavioral response. Currently, there are insufficient data to develop criteria that include the context of an exposure, characteristics of individual animals, behavioral state, duration of an exposure, sound source duty cycle, the number of individual sources in an activity, or how loud the animal may perceive the sonar signal to be based on the frequency of the sonar versus the animal's hearing range, although these factors certainly influence the severity of a behavioral response.

The behavioral response functions also do not account for distance. At moderate to low received levels the correlation between probability of reaction and received level is very poor and it appears that other variables mediate behavioral reactions (e.g., Ellison et al., 2011) such as the distance between the animal and the sound source. Data suggest that beyond a certain distance, significant behavioral responses are unlikely. At shorter ranges (less than 10 km) some behavioral responses have been observed at received levels below 140 dB re 1 µPa. Thus, proximity may mediate behavioral responses at lower received levels. Since most data used to derive the behavioral response functions is within 10 km of the source, probability of reaction at farther ranges is not well-represented. Therefore, the source-receiver range must be considered separately to estimate likely significant behavioral reactions.

This analysis applies behavioral cut-off conditions to responses predicted using the behavioral response functions. Animals within a specified distance and above a minimum probability of response are assumed to have a significant behavioral response. The cut-off distance is based on the farthest source-animal distance across all known studies where animals exhibited a significant behavioral response. Animals beyond the cut-off distance but with received levels above the sound pressure level associated with a probability of response of 0.50 on the behavioral response function are also assumed to have a significant behavioral response. The actual likelihood of significant behavioral reactions occurring beyond the distance cut-off is unknown. Significant behavioral responses beyond 100 km are unlikely based on source-animal distance and attenuated received levels. The behavioral cut-off conditions are shown in Table 2.2-3. Additional information on the derivation of the cut-off conditions is in the *Criteria and Thresholds TR*.

Table 2.2-3: Phase IV Behavioral Cut-off Conditions for each Species Group

Behavioral Group	Received level associated with p(0.50) on the behavioral response function	Cut-off Range
Sensitive Species	133 dB	40 km
Odontocetes	168 dB	15 km
Mysticetes	185 dB	10 km
Pinnipeds	156 dB	5 km

[1] Includes beaked whales and harbor porpoises. [2] A minimum p(response) condition was not applied in the prior Phase 3 analysis. [3] Distance cutoffs for moderate source level/single platform and high source level/multi-platform conditions in Phase 3: beaked whales (25/50 km), harbor porpoises (20/40 km), odontocetes (10/20 km), mysticetes (10/20 km), and pinnipeds 5/10 km).

See Section 2.5 (Ranges to Effects) for information on the probability of behavioral response with distance based on the type of sonar and behavioral group, as well as several other factors.

2.2.4 Quantifying Behavioral Responses to Air Guns, Pile Driving, and Explosives

Behavioral responses are quantified for air guns, pile driving (impact and vibratory), and explosions. These stressors are all impulsive sounds except for vibratory pile driving, which is a continuous, broadband non-impulsive sound. The thresholds used to quantify behavioral responses to air guns, pile driving, and explosions are described in the *Criteria and Thresholds TR* and are listed in Table 2.2-4. These thresholds are the same as those applied in the prior analysis of these stressors in the Study Area, although the explosive behavioral threshold has shifted, corresponding to changes in the TTS thresholds as explained below.

Table 2.2-4: Behavioral Response Thresholds for Air Gun, Pile Driving, and Explosive Sounds

Sound Source	Behavioral Threshold
air gun	160 dB rms re 1 µPa SPL
impact pile driving	160 dB rms re 1 µPa SPL
vibratory pile driving	120 dB rms re 1 µPa SPL
multiple explosions	5 dB less than the TTS onset threshold (weighted SEL)
Single explosions or one cluster	TTS onset threshold (weighted SEL)

While seismic and pile driving 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 compared to responses to explosives used in military readiness activities, which would typically consist of single impulses or a cluster of impulses (i.e., acute sounds), rather than long-duration, repeated impulses (i.e., potentially chronic sounds).

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. If a significant response were to occur, this analysis assumes it would be within the range of auditory impacts (AINJ and TTS). This reasoning was applied to analysis of previous shock trials and is extended to the criteria used in this analysis. Because of this approach, the number of auditory impacts is higher than the number of behavioral impacts in the quantified results for some stocks.

If more than one explosive event occurs within any given 24-hour period within a military readiness activity, criteria are applied to predict the number of animals that may have a behavioral reaction. For events with multiple explosions, the behavioral threshold used in this analysis is 5 dB less than the TTS onset threshold. This value is derived from observed onsets of behavioral response by test subjects (bottlenose dolphins) during non-impulse TTS testing (Schlundt et al., 2000).

See Section 2.5 (Ranges to Effects) for information on the behavioral response distances from these stressors.

2.2.5 Quantifying Non-Auditory Injury due to Explosives

The criterion for mortality is based on severe lung injury observed in terrestrial mammals exposed to underwater explosions as recorded in Goertner (1982). The criteria for non-auditory injury are based on slight lung injury or gastrointestinal (GI) tract injury observed in the same data set. Mortality and slight lung injury impacts to marine mammals are estimated using impulse thresholds based on both calf/pup/juvenile and adult masses (see *Criteria and Thresholds TR*). The peak pressure threshold applies to all species and age classes. Unlike the prior analysis, this analysis relies on the onset rather than the mean estimated threshold for these effects. This revision results in a small increase in the predicted non-auditory injuries and mortalities for the same event versus prior analyses. Thresholds are provided in Table 2.2-5 for use in non-auditory injury assessment for marine mammals exposed to underwater explosives.

Table 2.2-5: Thresholds for Estimating Ranges to Potential Effect for Non-Auditory Injury

Effect	Threshold
Onset Mortality - Impulse	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury - Impulse (Non-auditory)	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury - Peak Pressure (Non-auditory)	237 dB re 1 µPa peak

Where M is animal mass (kg) and D is animal depth (m).

See Section 2.5 (Ranges to Effects) for information on the distance to which non-auditory injury and mortality would extend from a detonation based on the size of the explosion, the marine mammal species, as well as several other factors.

2.3 Assessing Impacts on Individuals and Populations

2.3.1 Severity of Behavioral Responses to Military Readiness Activities

The statutory definition of Level B harassment of marine mammals for military readiness activities is the “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 3(18)(B) of the MMPA). The terms “significant response” or “significant behavioral response” are used to describe behavioral reactions that may lead to an abandonment or significant alteration of a natural behavior pattern. Defining when a behavioral response becomes significant, as well as setting corresponding predictive exposure threshold values, is challenging. Whether an animal discernably responds, and the severity of that response are likely influenced by the animal's life experience, motivation, and conditioning; the physical condition of the animal; and the context of the exposure (Ellison et al. 2015, Southall et al. 2007, Southall et al. 2019).

Behavioral responses can be generally categorized as low, moderate, or high severity. Low severity responses are within an animal's range of typical (baseline) behaviors and would not be considered significant. High severity responses are those with a higher likelihood of consequences to growth, survival, or reproduction, such as behaviors that increase the risk of injury, prolonged separation of a female and dependent offspring, prolonged displacement from foraging areas, or prolonged disruption of breeding behavior. High severity reactions would always be considered significant, even if no direct negative outcome is observed. For example, separation of a killer whale mother-calf pair was observed when they were approached by a vessel with an active sonar source during a behavioral response study (Miller et al., 2014), but the animals rejoined once the ship passed.

Stranding is a very high severity response. Use of mid-frequency sonar has been associated with atypical mass strandings of beaked whales (Bernaldo de Quirós et al., 2019; D'Amico et al., 2009). Five stranding events, mostly involving beaked whales, have been attributed to U.S. Navy active sonar use. The confluence of factors that contributed to those strandings is now better understood (see the *Background* section), and U.S. Navy sonar has not been identified as a casual factor in an atypical mass stranding since 2006. Other high severity responses have not been observed during observations of actual training or testing activities. The Navy does not anticipate that marine mammal strandings or mortality will result from the operation of sonar during military readiness activities in the study area. Through adaptive management under the Marine Mammal Protection Act (MMPA), NMFS and the Navy will determine the appropriate way to proceed if a causal relationship were to be found between Navy activities and a future stranding.

The behavioral responses predicted in this analysis are likely moderate severity within the scale presented in Southall et al. (2021b). Examples of moderate severity responses include avoidance, changes in vocalization, reduced foraging, reduced surfacing, and changes in courtship behavior. If moderate behaviors are sustained long enough to be outside of normal daily variations in feeding, reproduction, resting, migration/movement, or social cohesion, they are considered significant.

Given the available data on marine mammal behavioral responses, this analysis errs toward overestimating the number of significant behavioral responses. It is not possible to ascertain the true significance of most observed reactions that underlie the behavioral response functions used in this analysis. The behavioral criteria assume that most reactions that lasted for the duration of a sound exposure or longer were significant, regardless of exposure duration. It is possible that some short duration responses would not rise to the level of harassment as defined above. In addition, the experimental designs used during some behavioral response studies with non-captive animals were unlike military readiness activities in important ways. These differences include closely approaching and tagging subject animals; following subjects before the exposure; vectoring towards avoiding animals; or multiple close passes by focal animal groups. In contrast, military platforms would not purposely undertake such close approaches nor make directed movements toward animals. As researchers have improved experimental designs in subsequent behavioral response studies, more recent data better reflects responses in contexts more closely matching exposures during military readiness activities. Interpreting studies with captive animals presents other challenges, as captive animals may have different behavioral motivations than non-captive animals, and the context of exposure (confined environment, distance from source) differs from non-captive exposures. Thus, some behavioral reactions associated with acoustic received levels then used to develop behavioral risk functions may have been influenced by other aspects of the experimental exposures.

2.3.2 Potential Opportunities to Mitigate Auditory and Non-Auditory Injury

Visual observation of mitigation zones and nearby sea space is prescribed in the section *Mitigation*. In summary, trained Lookouts would be positioned on surface vessels, aircraft, piers, or the shore to observe designated mitigation zones around stressors prior to and during the use of certain sound sources and explosives. The specified mitigation zones are the largest areas Lookouts can reasonably be expected to observe during typical activity conditions, while being practical to implement from an operational standpoint. When a marine mammal (and in some instances, indicators of marine mammal presence like floating concentrations of vegetation) is sighted within or entering a mitigation zone, sound-producing activities are delayed, relocated, powered down, or ceased. These actions either reduce an acoustic dose (in the case of an ongoing acoustic stressor) or prevent an injurious exposure altogether (in the case of a single exposure like an explosion).

Ranges to auditory effects (AINJ and TTS) for marine mammals exposed to sonars are in Section 2.5.1 (Range to Effects for Sonar and Other Transducers) for the following sonars: hull-mounted surface ship sonar (bins MF1, MF1C, and MF1K), helicopter dipping sonar, sonobuoy sonar, and towed mine-hunting sonar. The median ranges to AINJ for all hearing groups due to hull-mounted sonars are encompassed by the applicable mitigation zones (200 yd. shut down/ 500 yd. power down/ 1,000 yd. power down). The median ranges to AINJ for all hearing groups for the remaining sonar are encompassed by the applicable mitigation zone (200 yd. shut down). Ranges to mortality for marine mammal exposed to in-water explosions are in Section 2.5.4 (Ranges to Effects for Explosives) for all bins. Mitigation ranges for explosives differ depending on the type of activity. In all cases, the mitigation zones encompass the ranges to mortality for the bin sizes that may be used.

Although the mitigation zones cover the range to AINJ for most sonar sources in most conditions, this analysis does not reduce model-predicted impacts to account for visual observations. Instead, the Navy Acoustic Effects Model identified the number of instances that animats with doses exceeding thresholds for AINJ (sonar) also had their closest points of approach within applicable mitigation zones. These instances are considered potential mitigation opportunities, which would be further influenced by other factors such as the sightability of the species and viewing conditions, as discussed in the *Mitigation* section. These instances were only assessed using the applicable mitigation zone size for platforms and sources with visual observation requirements. The closest point of approach considers any predicted animal avoidance of a sound source in the activity.

The results for activities that use sonar and have at least one model-predicted AINJ in any of the marine mammal auditory groups are shown in Table 2.3-1. Activities that have no predicted auditory injuries (following the rounding rules presented below, under Section 2.4 [Species Impact Assessments]) are not shown in Table 2.3-1. The mixed results across activities are due to a variety of factors. Some scenarios under each activity may include platforms or sources that do not have applicable visual observation requirements. Other activities may occur in locations where there are low numbers of animals in an auditory group; thus, the ratio is sensitive to the limited number of instances modeled. Most auditory injuries to the HF cetacean auditory group have an associated closest point of approach in a mitigation zone. Some of these will be observed and the exposure minimized or avoided as a result of mitigation. A portion (5 percent) of the auditory group was assumed to not avoid in the model to account for close approach behaviors like bow-riding. In an actual event, if delphinids were observed bow-riding, the activity could continue without powering down or ceasing the sonar, as described in the *Mitigation* section.

Table 2.3-1: Potential Mitigation Opportunities during Activities with Sonar

Activity Name	HF	LF	PCW	VHF	VLF
Acoustic and Oceanographic Research (ONR)	32%	31%	13%	12%	23%
Amphibious Ready Group Marine Expeditionary Unit Composite Training Unit Exercise	100%	-	-	-	-
Anti-Submarine Warfare Mission Package Testing	100%	100%	-	-	-
Anti-Submarine Warfare Torpedo Exercise - Ship	100%	100%	-	100%	-
Anti-Submarine Warfare Tracking Exercise - Ship	100%	100%	90%	95%	89%
At-Sea Sonar Testing	99%	84%	50%	69%	93%
Composite Training Unit Exercise	100%	100%	-	94%	-
Countermeasure Testing	-	-	-	52%	-
In-Port Maintenance Testing	31%	-	-	-	-
Medium Coordinated ASW	99%	96%	60%	86%	96%
Pierside Sonar Testing	0%	100%	92%	-	-
Semi-Stationary Equipment Testing	100%	-	0%	0%	-
Sinking Exercise	-	-	-	31%	-
Small Coordinated ASW	100%	84%	51%	85%	84%
Small Integrated ASW	100%	81%	48%	81%	80%
Submarine Navigation	100%	-	100%	-	-
Submarine Sea Trials - Weapons System Testing	-	-	-	35%	-
Submarine Sonar Maintenance and Systems Checks	100%	-	100%	-	0%
Surface Ship Sonar Maintenance and Systems Checks	100%	100%	-	100%	-
Surface Ship Sonar Testing/Maintenance (NAVSEA)	100%	-	-	100%	-
Sustainment Exercise	98%	80%	46%	82%	82%
Torpedo (Explosive) Testing	-	-	-	43%	-
Torpedo (Non-Explosive) Testing	97%	100%	-	26%	-
Undersea Warfare Testing	100%	100%	-	99%	-
Unmanned Underwater Vehicle Testing	-	-	-	100%	-
Unmanned Underwater Vehicle Training - Certification and Development	100%	-	-	7%	-

Table Created: 16 May 2024 10:59:10 AM

Notes: 1) Auditory group SI is not included because no AINJ are predicted for this group. 2) If modeling found no risk of AINJ (i.e., model-predicted results for an auditory group were true zeroes), then opportunities to mitigate AINJ are not assessed in this table. This is represented with a dash (-). 3) Data are only shown for AINJ associated with sources/platforms within an activity that have applicable mitigation zones per the *Mitigation* section. 4) Potential mitigation opportunities would be further influenced by other factors such as the sightability of the species and viewing conditions, as discussed in the *Mitigation* section. 5) HF = high frequency cetacean, LF = low frequency cetacean, PCW = phocid in water, VHF = very high frequency cetacean, VLF = very low frequency cetacean.

Similarly for explosives, this analysis does not reduce model-predicted impacts to account for visual observations, even though the mitigation zones cover the range to mortality. For this Proposed Action, all predicted instances of mortality and non-auditory injury occurred within the associated mitigation zones for each type of explosive. Therefore, the predicted instances of mortality are over-estimated, as it is likely that some animals in the mitigation zone will be observed, especially for species that are highly visible such as delphinids in pods and for activities with nearby lookouts, and the exposure avoided, as described in *Mitigation.* If mortalities are predicted for any stock, the likely causal activity is identified in this analysis and associated mitigation identified.

Although air guns have an applicable mitigation zone (200 yd. shutdown), no instances of AINJ are predicted. Therefore, mitigation opportunities are not assessed for air guns.

2.3.3 Behavioral Responses by Distance and Sound Pressure Level

Figure 2.3-1 and Figure 2.3-2 provide the total number of predicted behavioral responses under a maximum year of activities for each behavioral response group (i.e., Odontocetes, Mysticetes, Pinnipeds, and Sensitive Species) across all activities and all sonar sources without applying TTS or AINJ thresholds. In other words, in these plots, behavioral response functions were applied to all animats in the Navy's acoustic effects model, assuming animals that did receive TTS or AINJ would also be likely to exhibit a behavioral response. For these two figures, the total bar height represents the total number of behavioral responses as indicated on the vertical axis, whereas the dark gray bars indicate the number of significant behavioral responses as defined for military readiness activities using the distance and probability of response cut-off conditions described at the end of Section 2.2.3 (Quantifying Behavioral Responses to Sonars) and presented in Table 2.2-3 for each behavioral response group.

Figure 2.3-1 shows the total number of behavioral responses in 6-dB SPL bins representing the highest received SPL. All exposures equal to or above the received level associated with p(0.50) on the applicable behavioral response function are assumed to be significant in this analysis. A portion of behavioral responses predicted at lower received levels (as low as 100 dB SPL) are also assumed to be significant. These are due exposures to sources with lower source levels while within the cutoff ranges in Table 2.2-3. Overall, there are few exposures to sonar above 200 dB SPL.

Figure 2.3-2 shows the total number of behavioral responses in 5 km bins. For odontocetes and mysticetes, few significant behavioral responses are estimated beyond the cutoff ranges in Table 2.2-3, which are 15 km and 10 km, respectively. For pinnipeds, all behavioral responses within 5 km are assumed to be significant. Some significant behavioral responses for higher source level sonars are predicted out to and beyond 50 km. All behavioral responses within 40 km are assumed to be significant for sensitive species, with some significant responses predicted as far as 100 km for the highest-level sonar sources.

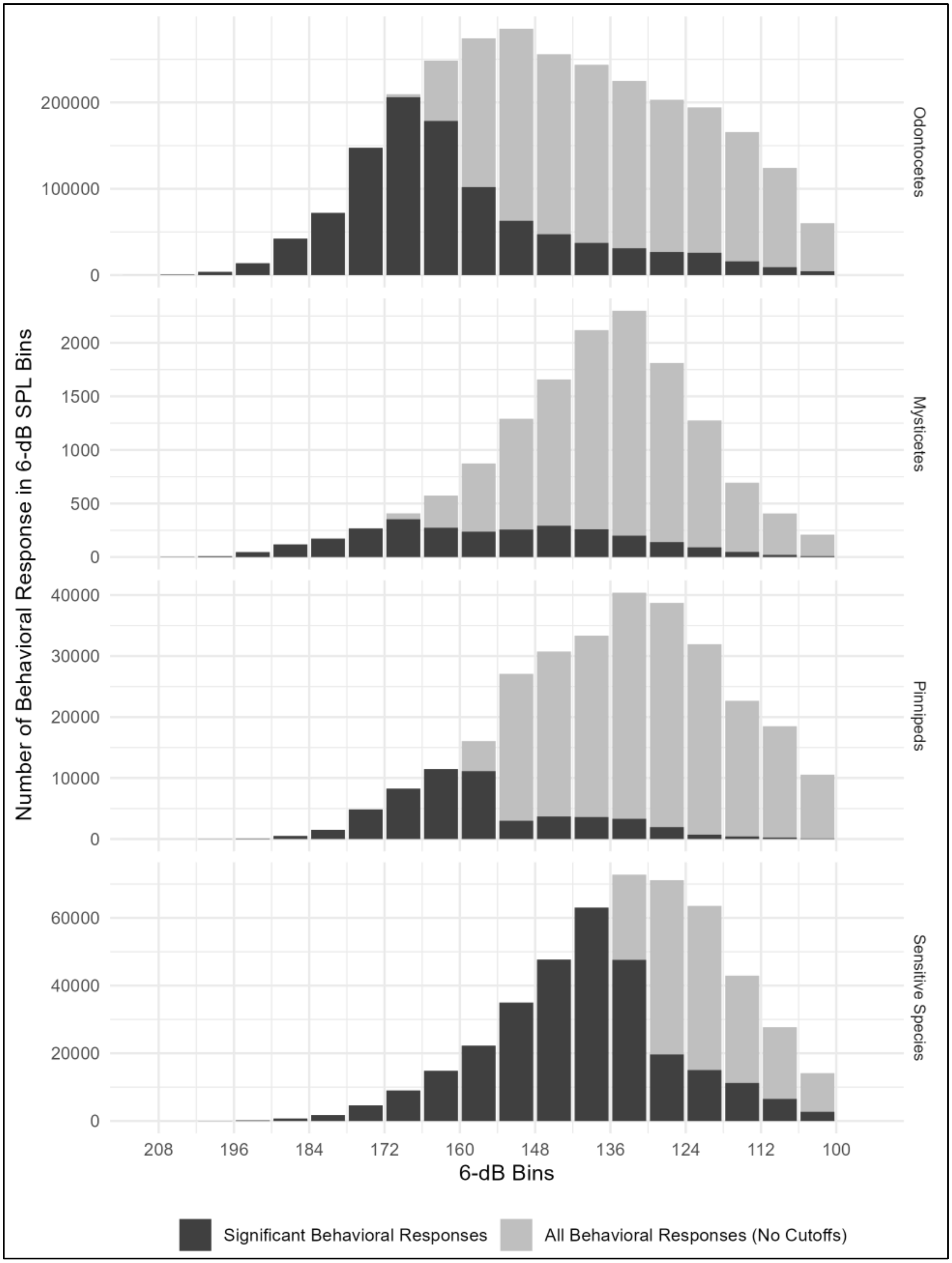


Figure 2.3-1: Total predicted Instances of Marine Mammal Behavioral Responses in the Study Area by Received Level

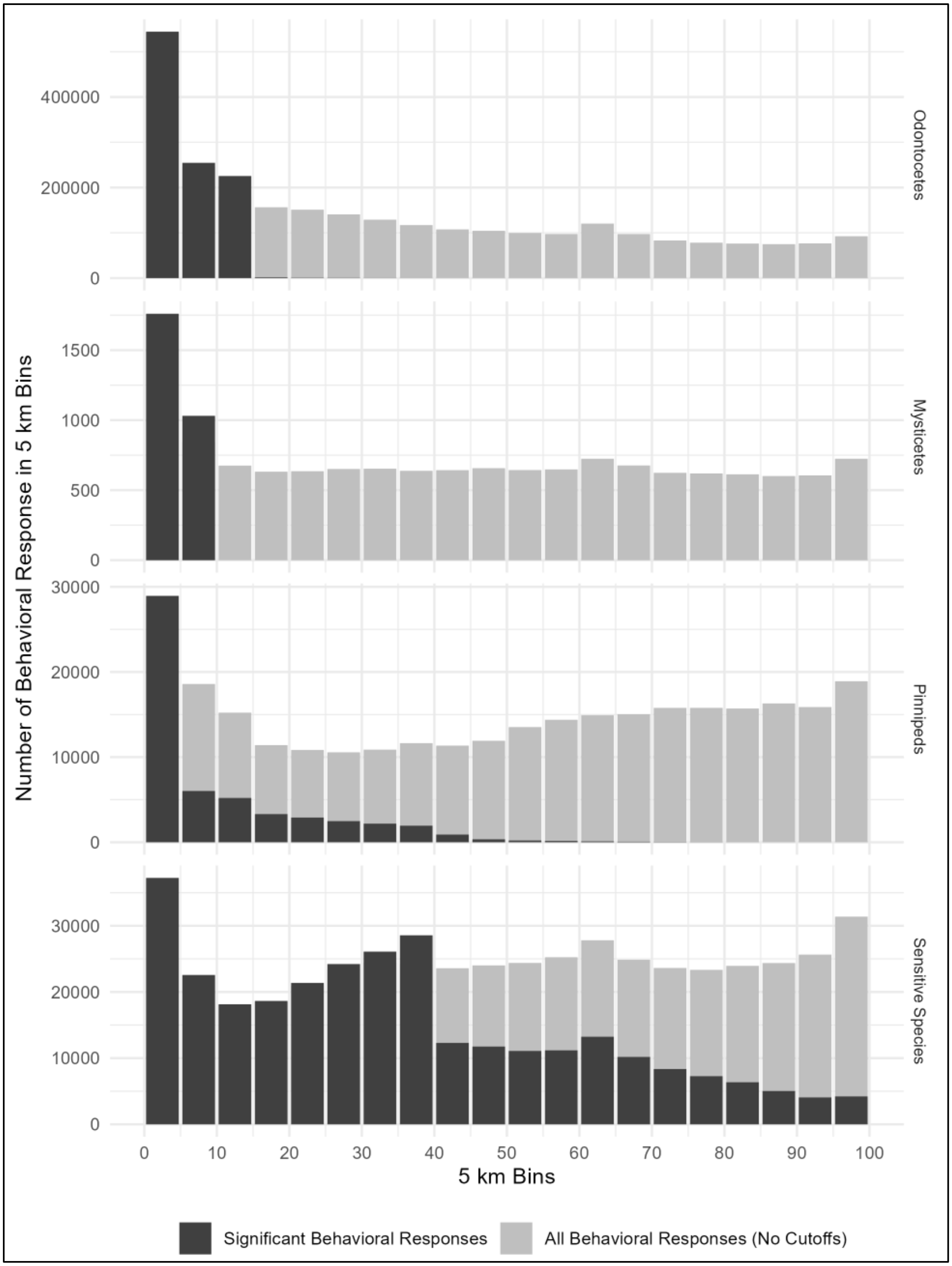


Figure 2.3-2: Total Predicted Instances of Marine Mammal Behavioral Responses in the Study Area by Distance

2.3.4 Risks to Marine Mammal Populations

To issue a Letter of Authorization under the Marine Mammal Protection Act, NMFS must determine that an impact "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." Assessing the consequences to a marine mammal population due to individual, short-term responses can be difficult and has been the subject of many studies.

Given the scope of the Proposed Action and the current state of best available 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 impacted as a result of the proposed training and testing.

This analysis adapts the assessment of species vulnerability described in Southall et al. (2023). The relativistic risk assessment approach in Southall et al. (2023) was designed to compare risk to populations from specific industry impact scenarios at different locations or times of year. This approach may not be suitable for many military readiness activities, for which alternate spatial or seasonal scenarios are not usually feasible. However, the concepts considered in that framework's population vulnerability assessment are useful in this analysis, including population status (endangered or threatened), population trend (decreasing, stable, or increasing), population size, and chronic exposure to other anthropogenic or environmental stressors. These stock vulnerability factors are provided for every stock in the Study Area in Table 2.3-4 for ESA-listed species and in Table 2.3-5 for species that are not ESA-listed.

This analysis also relies on the population consequences of disturbance themes identified in Keen et al. (2021). These themes fall into three categories: *life history traits, environmental conditions, and disturbance source characteristics*.

Life history trait definitions used in this analysis are shown in Table 2.3-2. Life history traits include:

- Movement ecology (resident/nomadic/migratory): Resident animals that have small home ranges relative to the size and duration of an impact zone would have a higher risk of repeated exposures to an ongoing activity. Animals that are nomadic over a larger range may have less predictable risk of repeated exposure. For resident and nomadic populations, overlap of a stressor with feeding or reproduction depend more on time of year rather than location in their habitat range. In contrast, migratory animals may have higher or reduced potential for exposure during feeding and reproduction based on both location, time of the year, and duration of an activity. The risk of repeated exposure during individual events may be lower during migration as animals maintain directed transit through an area.
- Reproductive strategy (capital/income/mixed): Reproduction is energetically expensive for female marine mammals. Mysticetes and phocids are capital breeders. Capital breeders rely on their capital, or energy stores, to migrate, maintain pregnancy, and nurse a calf. Capital breeders would be more resilient to short-term foraging disruption due to their reliance on built-up energy reserves. Otariids and most odontocetes are income breeders, which rely on some level of income, or regular foraging, to give birth and nurse a calf. Income breeders would be more sensitive to the consequences of disturbances that impact foraging during lactation. Some species exhibit traits of both, such as beaked whales.

- Body size (small/medium/large): Smaller animals require more food intake per unit body mass than large animals. They must consume food on a regular basis and are likely to be non-migratory and income breeders. The smallest odontocetes, the porpoises, must maintain high metabolisms to maintain thermoregulation and cannot rely on blubber stores for long periods of time, whereas larger odontocetes can more easily thermoregulate. The larger size of other odontocetes is an adaptation for deep diving that allows them to access high quality mesopelagic and bathypelagic prey. Both small and large odontocetes have lower foraging efficiency than the large whales. The filter-feeding large whales (mysticetes) consume most of their food within several months of the year and rely on extensive lipid reserves for the remainder of the year. The metabolism of mysticetes allows for fasting while seeking prey patches during foraging season and prolonged periods of fasting outside of foraging season (Goldbogen et al., 2023). Their energy stores support capital breeding and long migrations. The effect of a temporary feeding disturbance is likely to have inconsequential impacts to a mysticete but may be consequential for small cetaceans. Despite their relatively smaller size, amphibious pinnipeds have lower thermoregulatory requirements because they spend a portion of time on land. For purposes of this assessment, marine mammals were generally categorized as small (less than 10 ft.), medium (10-30 ft.), or large (more than 30 ft.) based on length.
- Pace of life (slow/medium/fast): Populations with a fast pace of life are characterized by early age of maturity, high birth rates, and short life spans, whereas populations with a slow pace of life are characterized by later age of maturity, low birth rates, and long life spans. The consequences of disturbance in these populations differ. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations are quick to recover. Reproduction in populations with a slow pace of life is resilient to foraging disruption, but late maturity and low birth rates mean that long-term impacts to breeding adults have a longer-term effect on population growth rates. Pace of life was categorized for each species in this analysis by comparing age at sexual maturity, birth rate interval, life span, body size, and feeding and reproductive strategy. Pace of life attribute definitions are shown in Table 2.3-3.

The above life history traits are identified for each stock in the Study Area in Table 2.3-4 for ESA-listed species and in Table 2.3-5 for all other stocks in the Study Area. If a species or stock has life history trait characteristics that span two classifications, both are shown (e.g., if a species exhibits both resident and nomadic behavior, it is described as resident-nomadic in the table).

Table 2.3-2: Life History Characteristic Definitions

Life History Characteristic	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Chronic Anthropogenic Risk Factors*	*Chronic Biological Risk Factors (Non-Noise)*
Categories/ Definitions	[Small, Medium, Large]	[Capitol, Income, Intermediate/ Mixed]	[Fast, Medium, Slow]	Risk from anthropogenic stressors (e.g., acoustic, fisheries interactions, vessel strike)	Presence of disease, parasites, prey limitations, or high predation
Source of Information	Keen et al. (2021)	Keen et al. (2021)	Keen et al. (2021)	SAR, Best Available Science, NMFS Species Profiles	SAR, Best Available Science, NMFS Species Profiles
Definitions	Small: <3 m Medium: 3 - 9 m Large: > 9 m	Capitol breeder- stores energy prior to parturition for lactation Income Breeder- feeds during lactation	See Table 2.3-3	Environmental factors outside of Action Proponent's noise-generating activities. Increased prevalence of third-party stressors may increase species-specific vulnerability to the potential disturbance (Southall et al., 2021a).	

Notes: < = less than; > = more than; NMFS = National Marine Fisheries Service; SAR= stock assessment report

Table 2.3-3: Pace of Life Attribute Definitions

Attribute[1]	*Definitions*		
	Fast	*Medium*	*Slow*
Body Size	Small	Medium	Large
Birth Rate Interval	1 to 2 years	2 to 3 years	3+ years
Sexual Maturity[2]	Up to 3.75 years on average	3.75 to 7 years on average	7+ years on average
Lifespan	Up to 29 years	29 to 50 years	50+ years
Pace of Life Overall	Majority (3+) fast attributes	Majority medium[3]	Majority (3+) slow attributes

[1] Attribute citations NMFS 2023, Keen et al. 2021

[2] If sexual maturity was reported as a range for a particular species, an average value was used.

[3] If there was not an equal number of attributes, justification based on body size and birth rate interval was used to make final category decision. For example, most pinniped species were an even mix of small, medium, and fast attributes. However, with their overall small body size and birth rate interval of one year, it was determined that they fall in the "fast" Pace of Life category overall.

Note: + = or more

Environmental conditions include external anthropogenic and biological risk factors (not associated with the proposed activities) that can stress individuals and populations, making them more susceptible to long-term consequences. These factors include fisheries interactions, pollution, climate change, vessel strike, and other anthropogenic noise sources. These additional stressors are also considered when assessing the overall vulnerability of a stock to repeated effects from acoustic and explosive stressors.

Disturbance source characteristics include overlap with biologically important habitats, the duration and frequency (how often it occurs) of disturbance, and the nature and context of the exposure. In this analysis, disturbance source characteristics are considered as follows:

- The numbers and types of effects are estimated in areas that are identified as biologically important for certain species and in designated critical habitats for ESA-listed species.
- Information about the context of exposures can be obtained through the current exposure modeling process, including season, location of the activity, the distance from an acoustic source where an exposure threshold is exceeded, and the type of activity that resulted in modeled impacts.
- To obtain an estimate of the average number of times individual marine mammals within each stock may be affected annually, the total number of non-injurious (i.e., behavioral response, TTS) and injurious effects (i.e., AINJ, INJ, Mortality) are considered versus the population abundance.
- Activities that occur on instrumented ranges and within homeports, and long duration activities, such as major training exercises, require special consideration due to the potential for more frequent repeated impacts to individuals as compared to individuals living outside areas where military readiness activities may be concentrated.

Table 2.3-4: Stock Vulnerability Factors and Life History Traits for ESA-listed Marine Mammal Stocks within the Study Area

Species	*Stock*[1]	*Movement Ecology*	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Population Trend*	*Chronic Anthropogenic Risk Factors*	*Other Chronic Risk Factors (Non-Noise)*
Blue whale	Western North Atlantic (Gulf of St. Lawrence)	Migratory	Large	Capital	Slow	Unk, but possibly increasing	Vessel strikes, entanglement, habitat degradation, pollution, vessel disturbance, ocean noise	Climate change
Fin whale	Western North Atlantic	Migratory	Large	Capital	Slow	Unk	Vessel strikes, entanglement, habitat degradation, pollution, vessel disturbance, ocean noise	Climate change
North Atlantic right whale	Western	Migratory	Large	Capital	Slow	Decreasing	Vessel strikes, entanglement, habitat degradation, pollution, vessel disturbance, ocean noise	Climate change
Rice's whale	Northern Gulf of Mexico	Nomadic	Large	Capital	Slow	Decreasing[2]	Vessel strike, ocean noise, energy exploration and development, oil spills, fisheries and aquaculture interaction, ocean debris	Small population size, limited distribution, climate change
Sei whale	Nova Scotia	Migratory	Large	Capital	Slow	Unk	Vessel strike, entanglement, ocean noise	Climate change
Sperm whale	North Atlantic	Nomadic	Large	Income	Slow	Unk	Vessel strike, entanglement, ocean noise, marine debris, oil spills and contaminants	Climate change
Sperm whale	Northern Gulf of Mexico	Resident-migratory	Large	Income	Slow	Unk, but possibly stable	Vessel strike, entanglement, ocean noise, marine debris, oil spills and contaminants, energy exploration and development	Climate change
West Indian manatee	Florida	Nomadic	Small-Med	Income	Med	Increasing	Vessel strike, habitat loss, entanglement, harassment	Harmful algal blooms, climate change

[1] Stock designations for the U.S. Exclusive Economic Zone and abundance estimates are from Atlantic and Gulf of Mexico Stock Assessment Reports prepared by NMFS (Hayes et al., 2023a). [2] (National Marine Fisheries Service, 2023).
Notes: Unk = unknown, Med = medium

Table 2.3-5: Stock Vulnerability Factors and Life History Traits for non-ESA-listed Marine Mammal Stocks within the Study Area

Species	*Stock*[1]	*Movement Ecology*	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Population Trend*	*Chronic Anthropogenic Risk Factors*	*Other Chronic Risk Factors (Non-Noise)*
Atlantic spotted dolphin	Western North Atlantic	Unk, likely nomadic	Small	Income	Med	Decreasing	Entanglement, ocean noise, illegal feeding/ harassment	Climate change
Atlantic spotted dolphin	Gulf of Mexico	Migratory	Small	Income	Med	Unk	Entanglement, fishery interaction, ocean noise, illegal feeding/ harassment, energy exploration and development, oil spills	Climate change
Atlantic white-sided dolphin	Western North Atlantic	Nomadic	Small	Income	Fast	Unk	Entanglement, ocean noise, fishery interaction, hunting (Newfoundland, Canada, Greenland)	Climate change
Blainville's beaked whale	Western North Atlantic	Nomadic-resident	Med	Mixed	Med	Unk	Entanglement, marine debris, ocean noise	Climate Change
Blainville's beaked whale	Northern Gulf of Mexico	Nomadic-resident	Med	Mixed	Med	Unk	Entanglement, marine debris, ocean noise, energy exploration and development, oil spills	Climate Change
Bryde's whale	Atlantic (no SAR; only expected outside of U.S. EEZ)	Unk, likely migratory	Large	Capital	Slow	Unk	Vessel strikes, entanglement, habitat degradation, pollution, vessel disturbance, ocean noise	Climate change
Clymene dolphin	Western North Atlantic	Nomadic	Small	Income	Fast	Unk	Entanglement, fishery interaction, ocean noise, PCBs, hunting (Caribbean)	Climate change
Clymene dolphin	Gulf of Mexico	Nomadic	Small	Income	Fast	Likely increasing	Fishery interaction, Deepwater horizon, energy exploration and development, oil spills	Climate change
Common bottlenose dolphin	Western North Atlantic, Offshore	Migratory	Small-Med	Income	Med	Stable, potentially decreasing	Biotoxins, chemical contaminants, fishery interaction, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Western North Atlantic Northern Migratory Coastal	Migratory	Small-Med	Income	Med	Decreasing	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change

Species	*Stock*[1]	*Movement Ecology*	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Population Trend*	*Chronic Anthropogenic Risk Factors*	*Other Chronic Risk Factors (Non-Noise)*
Common bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	Migratory	Small-Med	Income	Med	Decreasing	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Western North Atlantic South Carolina/ Georgia Coastal	Migratory	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Northern North Carolina Estuarine System	Resident	Small-Med	Income	Med	Unk (potentially stable)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Southern North Carolina Estuarine System	Resident	Small-Med	Income	Med	Unk	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Northern South Carolina Estuarine System	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding and harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Charleston Estuarine System	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Northern Georgia/ Southern South Carolina Estuarine System	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Central Georgia Estuarine System	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding and harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change

Species	*Stock*[1]	*Movement Ecology*	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Population Trend*	*Chronic Anthropogenic Risk Factors*	*Other Chronic Risk Factors (Non-Noise)*
Common bottlenose dolphin	Southern Georgia Estuarine System	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Western North Atlantic, Northern Florida Coastal	Nomadic	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Jacksonville Estuarine System	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Western North Atlantic, Central Florida Coastal	Nomadic	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Indian River Lagoon Estuarine System	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Northern Gulf of Mexico Continental Shelf	Nomadic-resident	Small-Med	Income	Med	Unk, potentially increasing	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Gulf of Mexico Eastern Coastal	Nomadic-resident	Small-Med	Income	Med	Unk, potentially increasing	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Gulf of Mexico Northern Coastal	Nomadic-resident	Small-Med	Income	Med	Unk, potentially increasing	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change

Species	*Stock[1]*	*Movement Ecology*	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Population Trend*	*Chronic Anthropogenic Risk Factors*	*Other Chronic Risk Factors (Non-Noise)*
Common bottlenose dolphin	Gulf of Mexico Western Coastal	Nomadic-resident	Small-Med	Income	Med	Unk, potentially stable	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Northern Gulf of Mexico Oceanic	Nomadic-resident	Small-Med	Income	Med	Stable	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Neuces Bay/ Corpus Christi Bay	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Sabine Lake	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	St. Andrew Bay	Resident	Small-Med	Income	Med	Unk (insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Mississippi Sound, Lake Borgne, Bay Boudreau	Resident	Small-Med	Income	Med	Unk, potentially stable	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	St. Joseph Bay	Resident	Small-Med	Income	Med	Stable	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Common bottlenose dolphin	Tampa Bay	Nomadic-resident	Small-Med	Income	Med	Unk (Insufficient data)	Biotoxins, chemical contaminants, fishery interaction, habitat alteration, illegal feeding/ harassment, ocean noise, oil spills and energy exploration, vessel strikes	Disease, climate change
Cuvier's beaked whale	Western North Atlantic	Nomadic-resident	Med	Mixed	Med	Unk, possibly increasing	Ocean noise	Climate Change

Species	*Stock*[1]	*Movement Ecology*	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Population Trend*	*Chronic Anthropogenic Risk Factors*	*Other Chronic Risk Factors (Non-Noise)*
Cuvier's beaked whale	Northern Gulf of Mexico	Nomadic-resident	Med	Mixed	Med	Unk	Ocean noise, energy exploration and development, oil spills	Climate change
False killer whale	Western North Atlantic	Nomadic	Med	Income	Med	Unk (Insufficient data)	Fishery interaction, contaminants, hunting	Disease, climate change
False killer whale	Northern Gulf of Mexico	Resident-nomadic	Med	Income	Med	Decreasing	Fishery interaction, contaminants, hunting, Deepwater Horizon and other oil spills	Disease, climate change
Fraser's dolphin	Western North Atlantic	Nomadic	Small	Income	Fast	Unk	Fishery interaction	Climate change
Fraser's dolphin	Northern Gulf of Mexico	Resident-nomadic	Small	Income	Fast	Unk	Fishery interaction, energy exploration and development, oil spills	Climate change
Gervais' beaked whale	Western North Atlantic	Nomadic-resident	Med	Mixed	Med	Unk	Entanglement, hunting, ocean noise	Climate change
Gervais' beaked whale	Northern Gulf of Mexico	Nomadic-resident	Med	Mixed	Med	Unk	Entanglement, ocean noise, energy exploration and development, oil spills	Climate change
Gray seal	Western North Atlantic	Nomadic-migratory	Small	Capital	Fast	Increasing	Entanglement, illegal take/ killing, chemical contaminants, oil spills and energy exploration, vessel strike/interaction	Climate change, disease
Harbor porpoise	Gulf of Maine/ Bay of Fundy	Resident-nomadic	Small	Income	Fast	Unk	Fishery interaction, ocean noise	Climate change
Harbor seal	Western North Atlantic	Nomadic-migratory	Small	Capital	Fast	Stable/ decline	Entanglement, illegal feeding/ harassment, habitat degradation, vessel strike, chemical contaminants	Climate change, disease
Harp seal	Western North Atlantic	Migratory	Small	Capital	Fast	Increasing	Hunting, vessel strike, entanglement, pollution, oil spills/ energy exploration	Climate change, prey limitations
Hooded seal	Western North Atlantic	Migratory	Small	Capital	Fast	Increasing	Vessel strike, habitat loss, entanglement, harassment	Harmful algal blooms, climate change
Humpback whale	Gulf of Maine	Migratory	Large	Capital	Slow	Increasing	Vessel strikes, entanglement, habitat degradation, pollution, vessel disturbance, ocean noise	Climate change

Species	*Stock*[1]	*Movement Ecology*	*Body Size*	*Feeding/ Breeding Strategy*	*Pace of Life*	*Population Trend*	*Chronic Anthropogenic Risk Factors*	*Other Chronic Risk Factors (Non-Noise)*
Killer whale	Western North Atlantic	Nomadic	Large	Income	Slow	Unk	Chemical contaminants, vessel traffic and noise, entanglement, oil spills	Climate change
Killer whale	Gulf of Mexico	Resident	Large	Income	Slow	Unk	Chemical contaminants, vessel traffic and noise, entanglement, oil spills, energy exploration and development	Climate change
Long-finned pilot whale	Western North Atlantic	Nomadic	Med	Income	Slow	Unk	Entanglements, contaminants, ocean noise	Climate change, disease
Melon-headed whale	Western North Atlantic	Nomadic	Small	Income	Med	Unk (Insufficient data)	Fishery interaction, ocean noise, pollution	Climate change
Melon-headed whale	Northern Gulf of Mexico	Resident-nomadic	Small	Income	Med	Unk	Fishery interaction, ocean noise, pollution, energy exploration and development, oil spills	Climate change
Minke whale	Canadian East Coast	Migratory	Med/ Large	Capital	Slow	Unk	Vessel strikes, entanglement, habitat degradation, pollution, vessel disturbance	Climate change, disease
Northern bottlenose whale	Western North Atlantic	Nomadic-resident	Large	Mixed	Med	Unk	Ocean noise, hunting	Climate change
Pantropical spotted dolphin	Western North Atlantic	Nomadic	Small	Income	Med	Stable, potentially increasing	Entanglement, Illegal feeding/ harassment	Climate change
Pantropical spotted dolphin	Northern Gulf of Mexico	Resident-nomadic	Small	Income	Med	Potentially increasing	Entanglement, Illegal feeding/ harassment, energy exploration and development, oil spills	Climate change
Pygmy and dwarf sperm whales	Western North Atlantic	Unk	Small-Med	Income	Fast	Increasing	Entanglement, vessel strike, marine debris, ocean noise, hunting (Lesser Antilles)	Disease, climate change
Pygmy and dwarf sperm whales	Gulf of Mexico	Unk	Small-Med	Income	Fast	Unk	Entanglement, vessel strike, marine debris, ocean noise, energy exploration and development, oil spills	Disease, climate change
Pygmy killer whale	Western North Atlantic	Nomadic	Small	Income	Med	Unk (Insufficient data)	Entanglement, ocean noise	Climate change

Species	***Stock[1]***	***Movement Ecology***	***Body Size***	***Feeding/ Breeding Strategy***	***Pace of Life***	***Population Trend***	***Chronic Anthropogenic Risk Factors***	***Other Chronic Risk Factors (Non-Noise)***
Pygmy killer whale	Northern Gulf of Mexico	Resident-nomadic	Small	Income	Med	Unk	Entanglement, ocean noise, oil spill, oil and gas exploration	Climate change
Risso's dolphin	Western North Atlantic	Nomadic	Small-Med	Income	Med	Unk (Insufficient data)	Entanglement, environmental contamination, hunting, ocean noise	Climate change
Risso's dolphin	Northern Gulf of Mexico	Resident-nomadic	Small-Med	Income	Med	Unk (Insufficient data)	Entanglement, environmental contamination, hunting, ocean noise, energy exploration and development, oil spills	Climate change
Rough-toothed dolphin	Western North Atlantic	Nomadic	Small	Income	Med	Unk (Insufficient data)	Entanglement, ocean noise	Climate change
Rough-toothed dolphin	Northern Gulf of Mexico	Resident-nomadic	Small	Income	Med	Unk	Entanglement, ocean noise, energy exploration and development, oil spills	Climate change
Short-beaked common dolphin	Western North Atlantic	Nomadic	Small	Income	Med	Unk	Entanglement	Climate change
Short-finned pilot whale	Western North Atlantic	Resident-nomadic	Med	Income	Slow	Stable	Entanglement, fishery interaction, vessel strikes	Climate change
Short-finned pilot whale	Northern Gulf of Mexico	Resident	Med	Income	Slow	Unk	Entanglement, fishery interaction, vessel strikes, energy exploration and development, oil spills	Climate change
Sowerby's beaked whale	Western North Atlantic	Nomadic-resident	Med	Mixed	Med	Unk	Ocean noise, PCBs, entanglement	Climate change
Spinner dolphin	Western North Atlantic	Nomadic	Small	Income	Fast	Unk	Marine debris, ocean noise	Disease
Spinner dolphin	Northern Gulf of Mexico	Nomadic	Small	Income	Fast	Unk	Marine debris, ocean noise, energy exploration and development, oil spills	Disease
Striped dolphin	Western North Atlantic	Nomadic	Small	Income	Med	Unk	Entanglement	Climate change, disease
Striped dolphin	Northern Gulf of Mexico	Nomadic	Small	Income	Med	Unk	Entanglement, energy exploration and development, oil spills	Climate change, disease

Species	Stock[1]	Movement Ecology	Body Size	Feeding/ Breeding Strategy	Pace of Life	Population Trend	Chronic Anthropogenic Risk Factors	Other Chronic Risk Factors (Non-Noise)
True's beaked whale	Western North Atlantic	Nomadic-resident	Med	Mixed	Med	Unk, possibly increasing	Ocean noise	Climate change
White-beaked dolphin	Western North Atlantic	Nomadic-migratory	Small	Income	Fast	Unk	Entanglement	Climate change

[1] Stock designations for the U.S. Exclusive Economic Zone and abundance estimates are from Atlantic and Gulf of Mexico Stock Assessment Reports prepared by NMFS (Hayes et al., 2023).
Note: Unk = unknown, Med = medium, PCBs = Polychlorinated biphenyls

The costs to marine mammals affected by acoustic and explosive stressors vary based on the type and magnitude of the effect.

- Marine mammals that experience masking may have their ability to communicate with conspecifics reduced, especially at farther 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. Other marine mammals that communicate at higher frequencies (e.g., minke whale, dolphins) may be affected by some short-term and intermittent masking. 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 lower frequency broadband sound sources such as explosives. Sounds from mid-frequency sonar could mask killer whale vocalizations, making them more difficult to detect, especially at farther ranges. A single or even a few short periods of masking, if it were to occur, to an individual marine mammal per year are unlikely to have any long-term consequences for that individual.
- Threshold shifts do not necessarily affect all hearing frequencies equally, and typically occur at the exposure frequency or within an octave above the exposure frequency. Recovery from threshold shift 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 recover. Most TTS, if it does occur, would likely 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. During the period that a marine mammal had hearing loss, social calls from conspecifics could be more difficult to detect or interpret. Killer whales are a primary predator of most other marine mammals. Some hearing loss could make killer whale calls more difficult to detect at farther ranges until hearing recovers. Odontocete 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 porpoises and Kogia whales. Echolocation associated with feeding and navigation in odontocetes could be affected by higher-frequency hearing loss but is unlikely to be affected by threshold shift at lower frequencies. 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 TTS in an individual marine mammal per year are unlikely to have any long-term consequences for that individual.
- Auditory injury (AINJ) includes but is not limited to permanent hearing loss. AINJ that did occur would likely be of a small amount (single digit permanent threshold shift) or could cause other physiological changes without any permanent hearing loss (see the *Criteria and Thresholds TR*). In cases where AINJ results in permanent hearing loss, this could reduce an animal's ability to detect biologically relevant sounds, which could have minor long-term consequences for individuals. However, permanent loss of some degree of hearing is a normal occurrence as mammals age (see the *Marine Mammal Background Section*). While a small loss of hearing sensitivity may include some degree of energetic costs, it would be unlikely to impact behaviors, opportunities, or detection capabilities to a degree that would interfere with reproductive success or survival. However, individuals that are already in a compromised state at the time of exposure may be more likely to be impacted as compared to relatively healthy individuals.
- Exposures that result in non-auditory injuries 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. The death of an animal would eliminate future reproductive potential, which is considered in the analysis of potential long-term consequences to the population.

Assessments of likely long-term consequences to populations of marine mammals are provided by empirical data gathered from areas where military readiness activities routinely occur. Substantial Navy-funded marine mammal survey data, monitoring data, and scientific research have been collected since 2006. These empirical data are beginning to provide insight on the qualitative analysis of the actual (as opposed to model-predicted numerical) impact on marine mammals resulting from training and testing activities based on observations of marine mammals generally in and around range complexes (see the *Background* section).

2.4 Species Impact Assessments

The following sections analyze impacts to each marine mammal stock under the Proposed Action and show model-predicted estimates of take under a maximum year for the preferred alternative (Alternative 1 in the AFTT Draft SEIS/OEIS). The methods used to quantify impacts for each substressor are described above in Section 2.2 (Quantifying Impacts on Marine Mammals from Acoustic and Explosive Stressors). The methods used to assess significance of individual impacts and risks to marine mammal populations are described above in Section 2.3 (Assessing Impacts on Individuals and Populations).

For each stock, a multi-sectioned table (Table 2.4-2 through Table 2.4-82) quantifies impacts as follows:

Section 1

The first section shows the number of instances of each effect type that could occur due to each substressor (sonar, air gun, pile driving, or explosives) over a maximum year of activity. Impacts are shown by type of activities (U.S. Navy training activities, U.S. Coast Guard training activities, or Navy testing activities). While impacts to each stock are assessed holistically, this breakout by types of activities corresponds to the incidental take authorizations requested under the Marine Mammal Protection Act for this Proposed Action.

The number of instances of effect is not the same as the number of individuals that could be affected, as some individuals in a stock could be affected multiple times, whereas others may not be affected at all. The instances of effect are those predicted by the Navy's Acoustic Effects Model and are not further reduced to account for visual observation mitigation that may reduce effects near some sound sources and explosives as described in the *Mitigation* section.

In the modeling, instances of effect are calculated within 24-hour periods of each individually modeled event. Impacts are assigned to the highest order threshold exceeded at the animat, which is a dosimeter in the model that represents an animal of a particular species or stock. Non-auditory injuries are assumed to outrank auditory effects, and auditory effects are assumed to outrank significant behavioral responses. In all instances any auditory impact or injury are assumed to represent a concurrent significant behavioral response. For example, if a significant behavioral response and TTS are predicted for the same animat in a modeled event, the effect is counted as a TTS in the table.

For most activities, total impacts are based on multiplying the average expected impacts at a location by the number of times that activity is expected to occur. This is a reasonable method to estimate impacts for activities that occur every year and multiple times per year. There are two exceptions to that approach in this analysis: Civilian Port Defense (a training activity using sonar) and Small Ship Shock Trial (a testing activity using explosives). These two activities do not occur every year, have a very small number of total events over seven years, and could occur at one of many locations. Notably, Civilian

Port Defense is the only proposed activity at certain port locations. Instead of using averaged impacts across locations for these two activities, the maximum impacts to any stock at any of the possible locations is used. While this approach results in unrealistically high estimates of impacts for some stocks for these two activities, it ensures that this analysis appropriately assesses potential impacts to regional stocks where these infrequent events may occur.

The summation of instances of effect includes all fractional values caused by averaging multiple modeled iterations of individual events. Impacts are only rounded to whole numbers at the level of substressor and type of activities. Rounding follows standard rounding rules, in which values less than 0.5 round down to the lower whole number, and values equal to or greater than 0.5 round up to the higher whole number. A zero value (0) indicates that the sum of impacts is greater than true zero but less than 0.5. A dash (-) indicates that no impacts are predicted (i.e., a "true" zero). This would occur when there is no overlap of an animat in the modeling with a level of acoustic exposure that would result in any possibility of impacts during any activity. Non-auditory injury and mortality are only associated with use of explosives; thus, these types of effects are also true zeroes for any other acoustic substressor. The summation of impacts across seven years is shown in Section 2.4.5 (Impact Summary Tables). The seven-year sum accounts for any variation in the annual levels of activities. The seven-year sum includes any fractional impact values predicted in any year, which is then rounded following standard rounding rules. That is, the seven-year impacts are not the result of summing the rounded annual impacts. If a seven-year sum was larger than the annual impacts multiplied by seven, the annual maximum impacts were increased by dividing the seven-year sum of impacts by seven then rounding up to the nearest integer. For example, this could happen if maximum annual impacts are 1.34 (rounds to 1 annually) and seven-year impacts are 8.60 (rounds to 9), where 9 divided by 7 years (9 ÷ 7 = 1.29) is greater than the estimated annual maximum of 1. In this instance, the maximum annual impacts would be adjusted from one to two based on rounding up 1.29 to 2. In multiple instances, this approach resulted in increasing the maximum annual impacts predicted by the Navy's Acoustic Effects Model.

Section Two

The second section estimates the average number of times an individual in the stock would be affected. The annual impacts per individual is the sum of all instances of effect divided by the population abundance estimate. The annual injurious impacts per individual is only the sum of injuries (auditory, non-auditory, and mortality) divided by the population abundance estimate. [Note: The term "injury" in the following species assessments is an inclusive category and may include auditory or non-auditory injuries. When a statement is specific to a type of injury, the injury type will be stated.]

To estimate repeated impacts across large areas relative to species geographic distributions, comparing the impacts predicted in the Navy's Acoustic Effects Model to abundances predicted using the Navy Marine Species Density Database (NMSDD) models is usually preferable. Per that approach, impacts and abundances are based on the same underlying assumptions about a species presence. NOAA's stock abundance report estimates, however, may better account for stocks that extend outside of the U.S. Exclusive Economic Zone or beyond the Study Area, such as migratory whales or oceanic species. They may also provide a better estimate for stocks that are closely monitored, such as certain ESA-listed species. For each stock, therefore, the population abundance estimate is the greater of (1) the best population estimate from the stock abundance report prepared by NOAA or (2) the average abundance predicted by the NMSDD within the U.S. Exclusive Economic Zone (see the *Density TR*). These values are shown in Table 2.4-1 for stocks with modeled impacts in the Study Area. NOAA's stock abundance report population estimates and NMSDD abundance estimates can differ substantially because these estimates may be based on different methods and data sources. NOAA's stock abundance reports only consider data from within the prior eight years, whereas the NMSDD considers a longer data history. NOAA's stock abundance reports estimate the number of animals in a population but not spatial densities. NMSDD uses predictive density models to estimate species presence, even where sighting data is limited or lacking altogether. Thus, NMSDD density models beyond the U.S. Exclusive Economic Zone have greater uncertainty than those within the U.S. Exclusive Economic Zone, where most proposed activities would occur. Each density model is limited to the variables and assumptions considered by the original data source provider. These factors and others described in the *Density TR* should be considered when examining the estimated impact numbers in comparison to current population abundance information for any given species or stock.

This analysis does not estimate the distribution of instances of effect across a population (i.e., whether some animals in a population would be affected more times than others). The Navy's Acoustic Effects Model does not currently model animat movements within, into, and out of the Study Area over a year. Additionally, while knowledge of stock movements and residencies is improving, significant data gaps remain.

Section Three

The third section shows the percent of total impacts that would occur within seasons and general geographic areas. The general geographic areas are Northeast (Atlantic waters north of New Jersey), Mid-Atlantic (Atlantic waters from New Jersey to North Carolina), Southeast (Atlantic waters from South Carolina to Florida), Key West (areas around the southernmost portion of Florida), Gulf of Mexico, and High Seas (areas of the Atlantic east of the range complexes, generally outside of the US Exclusive Economic Zone).

Section Four

The fourth section shows which activities are most impactful to a stock. Activities that cause five percent or more of total impacts to a stock are shown.

Section Five (when applicable)

The fifth section shows impacts in critical habitats where they are designated for ESA-listed species. Separately, impacts within the draft Biologically Important Areas ("BIAs II") for that stock are shown. Impacts may be due to activities within or outside of those areas.

Biologically Important Areas have no legal, statutory, or regulatory power. Rather, Biologically Important Areas represent areas and times where marine mammal species are known to concentrate for activities related to reproduction, feeding, and migration, as well as the known ranges of small and resident populations.

At the time of this analysis, "BIAs I" had been published and "BIAs II" were in development for the East Coast and the Gulf of Mexico. Maps of "BIAs I" and the times of year that they are active are in the *Marine Mammal Background* section. This analysis shows impacts predicted to occur within the draft "BIAs II" boundaries based on draft shapefiles provided by NMFS to the Navy in 2023. The Navy did not have access to the draft scores for these areas that were being developed using the methodology described in Harrison et al. (2023). Impacts in the "BIAs II" are shown only for the timeframes that they would be active. If a stock does not have ESA critical habitat or a "BIA II," then Section 5 of the tables is not shown.

Table 2.4-1: Estimated Abundances of Stocks Present in the AFTT Study Area[1]

Species	*Stock*	*SAR*[2]	*NMSDD in EEZ*[3]
Atlantic spotted dolphin	Northern Gulf of Mexico	21,506	11,476
Atlantic spotted dolphin	Western North Atlantic	39,921	28,226[a]
Atlantic white-sided dolphin	Western North Atlantic	93,223	14,869[a]
Blainville's beaked whale	Northern Gulf of Mexico	98	99[f]
Blainville's beaked whale	Western North Atlantic	10,107[g]	1,279[f]
Blue whale	Western North Atlantic	402[c]	19[a]
Bottlenose dolphin	Central Georgia Estuarine System	UNK	415[b]
Bottlenose dolphin	Charleston Estuarine System	UNK	16[b]
Bottlenose dolphin	Gulf of Mexico Eastern Coastal	16,407	13,382
Bottlenose dolphin	Gulf of Mexico Northern Coastal	11,543	7,031
Bottlenose dolphin	Northern Gulf of Mexico Oceanic	7,462	21,997
Bottlenose dolphin	Gulf of Mexico Western Coastal	20,759	26,100
Bottlenose dolphin	Indian River Lagoon Estuarine System	1,032	484
Bottlenose dolphin	Jacksonville Estuarine System	UNK	19[b]
Bottlenose dolphin	Mississippi Sound Lake Borgne Bay Boudreau	1,265	1,057
Bottlenose dolphin	Northern Georgia and Southern South Carolina Estuarine System	UNK	19[b]
Bottlenose dolphin	Northern Gulf of Mexico Continental Shelf	63,289	109,059
Bottlenose dolphin	Northern North Carolina Estuarine System	823	1,227
Bottlenose dolphin	Northern South Carolina Estuarine System	453	15
Bottlenose dolphin	Nueces Bay Corpus Christi Bay	58	41
Bottlenose dolphin	Sabine Lake	122	148
Bottlenose dolphin	Southern Georgia Estuarine System	UNK	619[b]
Bottlenose dolphin	Southern North Carolina Estuarine System	UNK	486[b]
Bottlenose dolphin	St. Andrew Bay	199	114
Bottlenose dolphin	St. Joseph Bay	142	34
Bottlenose dolphin	Tampa Bay	UNK	599[b]
Bottlenose dolphin	Western North Atlantic Central Florida Coastal	1,218	7,063
Bottlenose dolphin	Western North Atlantic Northern Florida Coastal	877	2,598
Bottlenose dolphin	Western North Atlantic Northern Migratory Coastal	6,639	10,325
Bottlenose dolphin	Western North Atlantic Offshore	62,851	150,704
Bottlenose dolphin	Western North Atlantic South Carolina Georgia Coastal	6,027	4,105
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	3,751	7,911
Bryde's whale	Primary	-[d]	-[e]
Clymene dolphin	Northern Gulf of Mexico	513	3,126
Clymene dolphin	Western North Atlantic	4,237	8,573
Cuvier's beaked whale	Northern Gulf of Mexico	18	368[f]
Cuvier's beaked whale	Western North Atlantic	5,744	4,901
Dwarf sperm whale	Northern Gulf of Mexico	168	510
Dwarf sperm whale	Western North Atlantic	3,875	2,426[a]
False killer whale	Northern Gulf of Mexico	494	1,023[f]
False killer whale	Western North Atlantic	1,791	97

Species	*Stock*	*SAR[2]*	*NMSDD in EEZ[3]*
Fin whale	Western North Atlantic	6,802	1,075[a]
Fraser's dolphin	Northern Gulf of Mexico	213	1,081
Fraser's dolphin	Western North Atlantic	UNK	518[a]
Gervais beaked whale	Northern Gulf of Mexico	20	386[f]
Gervais beaked whale	Western North Atlantic	10,107[g]	991[f]
Gray seal	Western North Atlantic	27,300	24,717
Harbor porpoise	Gulf of Maine Bay of Fundy	95,542	10,270[a]
Harbor seal	Western North Atlantic	61,336	10,184[a]
Harp seal	Western North Atlantic	7,600,000	10,007[a]
Hooded seal	Western North Atlantic	593,300	1,097[a]
Humpback whale	Gulf of Maine	1,396	690[a]
Killer whale	Northern Gulf of Mexico	267	511[f]
Killer whale	Western North Atlantic	UNK	51[a]
Long-finned pilot whale	Western North Atlantic	39,215	5,392[a]
Melon-headed whale	Northern Gulf of Mexico	1,749	3,579[f]
Melon-headed whale	Western North Atlantic	UNK	495[a]
Minke whale	Canadian Eastern Coastal	21,968	1,339[a]
North Atlantic right whale	Western	338	216[a]
Northern bottlenose whale	Western North Atlantic	UNK	82[a]
Pantropical spotted dolphin	Northern Gulf of Mexico	37,194	35,057
Pantropical spotted dolphin	Western North Atlantic	6,593	1,147[a]
Pygmy killer whale	Northern Gulf of Mexico	613	1,278[f]
Pygmy killer whale	Western North Atlantic	UNK	54[a]
Pygmy sperm whale	Northern Gulf of Mexico	168	510
Pygmy sperm whale	Western North Atlantic	3,875	2,426[a]
Rice's whale	Northern Gulf of Mexico	51	118
Risso's dolphin	Northern Gulf of Mexico	1,974	813
Risso's dolphin	Western North Atlantic	35,215	12,845[a]
Rough toothed dolphin	Northern Gulf of Mexico	UNK	3,452[a]
Rough toothed dolphin	Western North Atlantic	136	824
Sei whale	Nova Scotia	6,282	316[a]
Short-finned pilot whale	Northern Gulf of Mexico	1,321	1,835
Short-finned pilot whale	Western North Atlantic	28,924	6,235[a]
Short-beaked common dolphin	Western North Atlantic	172,974	73,015[a]
Sowerby's beaked whale	Western North Atlantic	10,107[g]	1,279[f]
Sperm whale	North Atlantic	4,349	4,242
Sperm whale	Northern Gulf of Mexico	1,180	1,614
Spinner dolphin	Northern Gulf of Mexico	2,991	1,422
Spinner dolphin	Western North Atlantic	4,102	646[a]
Striped dolphin	Northern Gulf of Mexico	1,817	7,782

Species	*Stock*	*SAR*[2]	*NMSDD in EEZ*[3]
Striped dolphin	Western North Atlantic	67,036	43,044[a]
True's beaked whale	Western North Atlantic	10,107[g]	1,279[f]
White-beaked dolphin	Western North Atlantic	536,016	44[a]

SAR: Stock Assessment Report, UNK: Unknown, EEZ: Exclusive Economic Zone

[1] Values are only shown for stocks (or species) with modeled impacts in the Study Area. If a stock is not shown in this table, that stock had no modeled impacts or was not included in the impact modeling because there was no overlap with areas where sonar, air gun, pile driving, or explosive use is anticipated.

[2] Best abundance estimate from the stock assessment report (Hayes et al., 2023b) is used unless otherwise noted.

[3] See the *Density TR* for additional information.

[a] This abundance estimate from the NMSDD within the EEZ is lower than the overall population abundance because the range of the stock far exceeds the EEZ boundary. See the *Density TR* for additional information.

[b] This abundance estimate from the NMSDD within the EEZ is likely to be lower than the overall population abundance because the NMSDD does not include all inshore and estuarine areas inhabited by the stock. See the *Density TR* for additional information.

[c] The abundance shown is the minimum abundance value from the stock assessment report because no 'Best' estimate is provided.

[d] No stock is designated.

[e] Assumed absent.

[f] Based on splitting abundance for the combined Mesoplodont species density on the East Coast, the combined beaked whale density in the Gulf of Mexico, or the combined Blackfish density in the Gulf of Mexico.

[g] Abundance value is the total estimate for undifferentiated Mesoplodon beaked whales.

2.4.1 Impacts on Mysticetes

The mysticetes have been split from the previous inclusive LF cetacean auditory group in to two auditory groups: the VLF and LF cetaceans. The predicted hearing range of the VLF cetaceans resembles the previous combined auditory group for all mysticetes, whereas the predicted hearing range for the revised LF cetacean group is shifted to slightly higher frequencies. For VLF cetaceans, the range of best hearing is estimated between 0.1 and 10 kHz, which overlaps with low- and mid-frequency sonar sources; however, VLF cetacean vocalizations are below 1 kHz, which overlaps with low-frequency sources. Some activities in the Proposed Action use hull-mounted high duty cycle sonars that increase the potential for masking and auditory effects. Any auditory impacts (TTS and INJ) or masking from MF sonars would be less likely to affect communication than impacts due to low-frequency sonars (see the *Marine Mammal Background Section* and the *Criteria and Thresholds TR).* For LF cetaceans, the range of best hearing and vocalizations is between 1 and 30 kHz, which overlaps with mid- and high-frequency sonar sources. Any auditory effects or masking of LF cetaceans from high-frequency sonar sources would be less likely to affect communication than impacts due to mid-frequency sonars.

For sonar exposures, the behavioral response function indicates less sensitivity to behavioral disturbance than predicted in the prior analysis. As described in 2.2.2 (Quantifying Impacts on Hearing), the methods to model avoidance of sonars have been revised to base a species' probability of an avoidance responses on the behavioral response function. Because the probability of behavioral response has decreased for the Mysticete behavioral group while the estimated susceptibility to auditory effects has increased (primarily for the LF hearing group), this analysis predicts more auditory impacts than the prior analysis. In addition, the cut-off conditions for predicting significant behavioral responses have been revised as shown in Section 2.2.3 (Quantifying Behavioral Responses to Sonars). These factors interact in complex ways that the results of this analysis challenging to compare to prior analyses.

Mysticetes would not be exposed to nearshore pile driving in the Gulf of Mexico, thus impacts for this stressor are not analyzed for any mysticete. Impacts due to non-modeled acoustic stressors are discussed above in Section 2.1.4 (Impacts from Vessel Noise), Section 2.1.5 (Impacts from Aircraft Noise), and Section 2.1.6 (Impacts from Weapons Noise).

2.4.1.1 North Atlantic Right Whale (*Eubalaena glacialis*) - Endangered

North Atlantic right whales are in the VLF cetacean auditory group and the Mysticete behavioral group. The Western stock is the only stock in the Study Area. Model-predicted impacts are presented in Table 2.4-2.

The Western stock of North Atlantic right whales range from winter calving grounds in coastal waters of the southeastern United States to feeding grounds off the coast of Maine, Massachusetts, or Gulf of St. Lawrence. Although it is a migratory population, North Atlantic right whales have been detected across their range year-round. Most impacts would occur in the Northeast in the spring and winter, when North Atlantic right whales have a higher density at feeding grounds located near and south of Cape Cod, including areas overlapped by the Narragansett Bay OPAREA in the Northeast Range Complexes, and in the migratory corridor through the northeast region. Some impacts on North Atlantic right whales would occur in critical habitat and identified biologically important areas for feeding in the northeast. North Atlantic right whales would also be present in the mid-Atlantic and the southeast, where their proximity to the coast means that impacts from offshore activities are limited. In comparison to impacts in other parts of their range, there would be fewer impacts on North Atlantic right whales in identified calving habitat, including critical habitat in the southeast. In the summer and fall, there would be few impacts in the east coast range complexes when North Atlantic right whales are more likely to be on feeding grounds north of the Northeast Range Complexes. Most auditory impacts are attributable to low and mid-frequency sonars used in testing activities in the northeast. Most impacts are auditory effects because mysticetes are relatively less sensitive to disturbance. The increase in the estimated auditory injury due to sonar since the prior analysis is primarily due to changes in the method to assess avoidance of injurious exposures as described above, although increases in estimated North Atlantic right whale density in some areas of the northeast have also likely contributed to an increase in the estimated impacts since the prior analysis. Impacts from explosives would be limited and impacts from air guns would be negligible.

The Action Proponents will implement geographic mitigation to avoid impacts on marine mammals. The maps, mitigation requirements, and mitigation benefits of these areas are fully presented in *Mitigation*. The purpose of the following mitigation areas is to specifically minimize impacts on North Atlantic right whales:

- The existing Northeast North Atlantic Right Whale Mitigation Area minimizes use of low, mid-, and high frequency sonars and prohibits use of explosives in and, in the case of explosive sonobuoys, within 3 NM of an area that matches the extent of Northeast foraging critical habitat. In addition, the existing Gulf of Maine Marine Mammal Mitigation Area would limit use of hull-mounted mid-frequency sonar in an area that encompasses the Northeast foraging critical habitat.
- The existing Jacksonville North Atlantic Right Whale Mitigation Area and the existing Southeast North Atlantic Right Whale Mitigation Area would minimize exposures to sonar and explosives during calving season through use of the Early Warning System. The existing Southeast North Atlantic Right Whale Mitigation Area also prohibits use of explosives and low, mid-, and high frequency sonars except for helicopter dipping sonar (a mid-frequency active sonar) and low-frequency or surface ship hull-mounted mid-frequency active sonar during navigation training or object detection. Use of sonar during these excepted activities would be minimized to the maximum extent practical.

- The existing Dynamic North Atlantic Right Whale Mitigation Area would minimize exposure to sonar and explosives across their range in the U.S. Exclusive Economic Zone.

The instances of impacts on North Atlantic right whales may be over-estimated in both foraging and calving areas because the requirements related to sonar use in the Northeast North Atlantic Right Whale Mitigation Area and Southeast North Atlantic Right Whale Mitigation Area were not accounted for when modeling impacts.

On average, individuals would be impacted several times per year. These impacts are most likely to occur in the Northeast in the winter and spring when North Atlantic right whales would be engaged in feeding behavior or migration. The average risk of injury is low, although it is likely that a small number of auditory injuries could occur. The risk of auditory injury from testing explosives and training sonar is low (less than one) in any year, but an auditory injury is shown for each in the maximum year of impacts due to summing risk across seven years and following the rounding approach discussed in Section 2.4 (Species Impact Assessments). The risk of injury may be reduced through visual observation mitigation for sources with applicable mitigation zones.

The risk of repeated impacts on individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. North Atlantic right whales are large capital breeders with a slow pace of life. They are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves, with the possible exception of individuals who are already in a compromised state due to other stressors such as gear entanglement, auditory injury, or sublethal vessel strike. Any impacts predicted in the east coast migratory corridor are less likely to impact individuals during feeding or breeding behaviors. North Atlantic right whales have a decreasing population trend primarily due to vessel strike and entanglement. Their slow pace of life means that long-term impacts to breeding adults could have a longer-term effect on population growth rates.

Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals, although individuals who suffer an auditory injury would experience minor energetic costs. Since most auditory effects are due to activities that use mid-frequency sources, and the North Atlantic right whale primarily vocalizes below 1 kHz, these impacts would be unlikely to inhibit to inter-specific communication. Long-term consequences to the stock are unlikely.

Two critical habitats were designated by NMFS for North Atlantic right whales to encompass physical and biological features essential to conservation of the species (81 *Federal Register* 4838). The northern unit (Unit 1) includes the Gulf of Maine and Georges Bank region, which are key areas essential for right whale foraging. Physical and biological features of the northern unit are the presence of copepods at certain life stages and the oceanographic conditions, structures, and flow velocities that affect their distribution and aggregation. The southern unit includes the coast of North Carolina, South Carolina, Georgia, and Florida, which are key areas essential for calving. Physical features of the southern unit are defined sea surface temperatures and conditions in November through April for water depths of 6 to 28 m. Maps of these critical habitats are in the *Marine Mammal Background*.

While use of sonar and noise produced by vessels, aircraft, and weapons firing would overlap critical habitat, they would not affect the biological and physical oceanographic features of feeding or calving critical habitat that are essential for the reproduction, rest and refuge, health, continued survival, conservation, and recovery of this species. Explosives would not be used in North Atlantic right whale feeding critical habitat at any time nor in North Atlantic right whale calving critical habitat during calving season. Pile driving would only occur in the Gulf of Mexico, thus would not overlap critical habitat for North Atlantic right whales. Limited use of air guns could occur in critical habitat. Air guns may affect zooplankton very close to the source, although the single air guns used during testing are less powerful than those used in seismic surveys. Any impacts would be minimal, localized, and would not overall reduce copepod aggregations.

Based on the analysis presented above, the use of sonars, air guns, explosives, and activities that produce vessel, aircraft, and weapons noise during military readiness activities may affect North Atlantic right whales. Activities that involve the use of pile driving are not applicable to North Atlantic right whales because there is no geographic overlap of this stressor with species occurrence.

Sonars, explosives, and vessel, aircraft, and weapons noise during military readiness activities would have no effect on designated foraging critical habitat in the Northeast and calving critical habitat in the Southeast for North Atlantic right whales. The use of air guns during military readiness activities may affect designated foraging critical habitat in the Northeast and would have no effect on calving critical habitat in the Southeast for North Atlantic right whales. Activities that involve the use of pile driving are not applicable to North Atlantic right whale critical habitats because there is no geographic overlap of this stressor with those critical habitats.

Table 2.4-2: Estimated Effects to the Western Stock of North Atlantic Right Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	14	10	0	-	-
Explosive	Navy Testing	6	4	1	-	-
Explosive	USCG Training	0	0	-	-	-
Sonar	Navy Training	17	56	1	-	-
Sonar	Navy Testing	71	236	1	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**109**	**306**	**3**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
338	1.24	0.01

Season	Percent of Total Impacts		
	Northeast	Mid-Atlantic	Southeast
Winter	21%	13%	6%
Spring	37%	7%	1%
Summer	3%	0%	0%
Fall	9%	2%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)[1]	Navy Testing	25%
At-Sea Sonar Testing	Navy Testing	18%
Mine Countermeasure Technology Research	Navy Testing	13%
Unmanned Underwater Vehicle Testing	Navy Testing	8%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Critical Habitat	Northeast US (Foraging) (All)	14	57	0	-	-
Critical Habitat	Southeast US (Calving) (All)	7	19	0	-	-
Draft BIA II	Great South Channel/Georges Bank Shelf Break (4,5,6)	4	19	0	-	-
Draft BIA II	Gulf of ME Mating (11,12,1)	0	2	-	-	-
Draft BIA II	Migratory Corridor (3,4,11,12)	45	128	1	-	-
Draft BIA II	Scotian Shelf (6,7,8)	2	3	-	-	-
Draft BIA II	Southeast Atlantic Calving (1,2,3,11,12)	7	25	0	-	-
Draft BIA II	Southern New England (All)	9	42	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
[1] Modeled sources with specific narrow frequency ranges and high source level that produced AINJ in the preliminary modeling for the Acoustic and Oceanographic Research activity will not be employed during fall and winter seasons in Narragansett OPAREA. This seasonal difference in the proposed activity is included in these final modeled impacts.
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2.4.1.2 Rice's Whale (*Balaenoptera ricei*) - Endangered

Rice's whales are in the LF cetacean auditory group and the Mysticete behavioral group. The Northern Gulf of Mexico stock is the only stock in the Study Area. Rice's whale was formerly known as the Northern Gulf of Mexico stock of Bryde's whale. Model-predicted impacts are presented in Table 2.4-3.

The Northern Gulf of Mexico stock of Rice's whales is a nomadic-resident population, moving within their range along the shelf break of the Gulf of Mexico year-round. Their highest density is in the northeastern portion of the Gulf of Mexico, where their presence would overlap activities conducted in the offshore portions of the Naval Surface Warfare Center, Panama City Division Testing Area. Most impacts are due to Unmanned Underwater Vehicle Testing, which may use sonars at a variety of frequencies for multiple hours most days of the year on the testing range. Impacts due to other activities are possible at other locations in the Gulf of Mexico Range Complex. Impacts from explosives would be limited, and there would be no impacts due to air guns. Pile driving activities would occur in a nearshore port area and would not impact Rice's whales.

Most impacts are auditory effects because mysticetes are relatively less sensitive to disturbance compared to received levels that may affect hearing. The increase in the estimated auditory injury since the prior analysis is primarily due to changes in the method to assess avoidance of injurious sonar exposures. The predicted hearing range of LF cetaceans in this analysis is also higher than the predicted hearing range of LF cetaceans in the prior analysis (which previously was a single auditory group containing all mysticetes, including the now separate VLF cetacean auditory group). This has increased the potential for auditory impacts from mid- and high-frequency sources. Increases in estimated Rice's whale density in the Gulf of Mexico (formerly the Bryde's whale density in the Gulf of Mexico) have also likely contributed to an increase in the estimated impacts to this stock since the prior analysis.

The Action Proponents will implement geographic mitigation to avoid impacts on marine mammals. The maps, mitigation requirements, and mitigation benefits of these areas are fully presented in *Mitigation*. The purpose of the following mitigation area is to specifically minimize impacts on Rice's whales:

- The existing Gulf of Mexico Rice's Whale Mitigation Area limits use of surface ship hull-mounted mid-frequency active sonar annually and prohibits use of explosives except during Mine Warfare activities. This area encompasses the area where Rice's whales are most likely to be present as well as most of the eastern portion of proposed critical habitat.

On average, individuals would be impacted several times per year. While it is estimated that this population has less than 100 individuals (National Marine Fisheries Service, 2023), the higher NMSDD abundance value used in the impact modeling is considered when assessing the average annual impacts per individual. Use of the NMSDD abundance value is appropriate for assessing repeated impacts to normalize the model results for over-seeding of animats representing Rice's whales in the Gulf of Mexico (see the full explanation of values in this ratio in Section 2.4 [Species Impact Assessments]).

Impacts are most likely to occur in the winter when Rice's whale densities are predicted to be highest in the northeastern Gulf of Mexico. Unlike most large whales, they are not migratory but nomadic, so the risk of repeated impacts on individuals is likely similar within the population as animals move throughout their range. The average risk of injurious impacts is low, although it is likely that a small number of auditory injuries could occur. The risk of a single auditory injury from training sonar or testing explosives is low (less than one) in any year, but a single auditory injury is predicted for both in the maximum year of impacts due to summing risk across seven years and following the rounding approach discussed in Section 2.4 (Species Impact Assessments). The risk of injury may be reduced through visual observations, although most auditory injuries are attributable to activities with sources and platforms that may not have applicable visual observation mitigation.

The risk of repeated impacts on individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Rice's whales are large capital breeders with a slow pace of life. They are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves to maintain pregnancy and nurse a calf. The population is small, in decline, has a limited distribution, and faces multiple chronic anthropogenic risk factors in the Gulf of Mexico unrelated to this action. Their slow pace of life means that long-term impacts to breeding adults could have a longer-term effect on population growth rates.

The limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals. Long-term consequences to the stock are unlikely.

NMFS has proposed designation of critical habitat for Rice's whales between the 100 and 400 m isobaths on the Gulf of Mexico continental shelf and slope (88 FR 47453). Attributes of this feature include availability and quality of prey (specified fishes and squid); biological (productivity), physical (bottom temperature), and chemical (pollutants) aspects of the marine waters; and sufficiently quiet conditions for normal use and occupancy, with a focus on chronic, low-frequency noise.

Although use of explosives would be limited in a large portion of proposed critical habitat, some individuals of identified prey species could be killed by explosives. These impacts would be localized and infrequent. Noise due to other acoustic stressors would not affect availability and quality of prey, nor would they affect productivity, bottom temperature, or pollutant levels. Use of sonars in military readiness activities is typically intermittent and generally at mid- to high frequencies in the Gulf of Mexico, whereas Rice's whales vocalize at very low frequencies. While this action would not introduce chronic or long-lasting low-frequency noise in proposed critical habitat for Rice's whales, sonars and noise due to air guns, explosives and vessels, aircraft, and weapons firing would overlap proposed critical habitat. Geographic mitigation would minimize impacts due to mid-frequency sonar and explosives, as well as noise due to associated platforms. Pile driving would occur at the port area of Gulfport, Mississippi. Due to distance and propagation pathways, noise from pile driving would not elevate noise in proposed critical habitat.

Based on the analysis presented above, the use of sonars, air guns, explosives, and activities that produce vessel, aircraft, and weapons noise during military readiness activities <u>may affect</u> Rice's whales. Activities that involve the use of pile driving are <u>not applicable</u> to Rice's whales because there is no geographic overlap of this stressor with species occurrence.

Sonars, air guns, explosives, and vessel, aircraft, and weapons noise <u>may affect</u> proposed critical habitat for Rice's whales. Activities that involve the use of pile driving are <u>not applicable</u> to proposed critical habitat for Rice's whales because there is no geographic overlap of this stressor with proposed critical habitat.

Table 2.4-3: Estimated Effects to the Northern Gulf of Mexico Stock of Rice's Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	1	-	-	-
Explosive	Navy Testing	7	4	1	-	-
Sonar	Navy Training	1	6	1	-	-
Sonar	Navy Testing	79	204	1	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**88**	**215**	**3**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
118	2.59	0.03

Season	Percent of Total Impacts Gulf of Mexico
Winter	44%
Spring	19%
Summer	11%
Fall	25%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	68%
Acoustic and Oceanographic Research (ONR)	Navy Testing	12%
Mine Countermeasure Mission Package Testing	Navy Testing	10%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Expanded Range (All)	83	194	1	-	-
Draft BIA II	Northeastern Gulf of Mexico (All)	79	181	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.1.3 Blue Whale (*Balaenoptera musculus*) - Endangered

Blue whales are in the VLF cetacean auditory group and the Mysticete behavioral group. The Western North Atlantic stock is the only stock in the Study Area. Model-predicted impacts are presented in Table 2.4-4.

The Western North Atlantic stock of blue whales is a migratory population, although their migration pattern the North Atlantic Ocean is not well understood. Their primary range is outside of the Study Area. They are frequently located in continental shelf waters near eastern Canada but have also been sighted off the coast of Florida and along the mid-Atlantic ridge (likely the southern portion of their feeding range). Impacts would occur in all regions of the Atlantic, with impacts somewhat higher in the cool season when blue whales are more likely to be present in the southern extent of their range. Most impacts are due to Anti-Submarine Warfare activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Acoustic and Oceanographic Research using low and mid-frequency sonars also contribute to predicted impacts. Impacts from explosives would be limited and there would be no impacts due to air guns. Most impacts are auditory effects because mysticetes are relatively less sensitive to disturbance. The increase in the estimated auditory injury due to sonar since the prior analysis is primarily due to changes in the method to assess avoidance of injurious exposures, although some increases in estimated blue whale density in the northeast have also likely contributed to an increase in the estimated impacts since the prior analysis.

On average, individuals would be impacted less than once per year. The average risk of injury is negligible, although a single auditory injury is predicted for testing sonar. The risk of auditory injury from testing sonar is low (less than one) in any year, but an auditory injury is shown in the maximum year of impacts due to summing risk across seven years and following the rounding approach discussed in Section 2.4 (Species Impact Assessments). The risk of injury may be reduced through visual observation mitigation because blue whales are moderately sightable.

The risk of repeated impacts on individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Blue whales are large capital breeders with a slow pace of life. They are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves. Population trends for blue whales are unknown, but possibly increasing. Their slow pace of life means that long-term impacts to breeding adults could have a longer-term effect on population growth rates.

The limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals. Long-term consequences to the stock are unlikely.

Based on the analysis presented above, the use of sonars, air guns, explosives, and activities that produce vessel, aircraft, and weapons noise during military readiness activities may affect blue whales. Activities that involve the use of pile driving are not applicable to blue whales because there is no geographic overlap of this stressor with species occurrence.

Table 2.4-4: Estimated Effects to the North Atlantic Stock of Blue Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	1	-	-	-
Explosive	Navy Testing	1	2	-	-	-
Sonar	Navy Training	6	32	0	-	-
Sonar	Navy Testing	4	25	1	-	-
Sonar	USCG Training	0	-	-	-	-
Maximum Annual Total		**12**	**60**	**1**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
402	0.18	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	6%	18%	10%	1%
Spring	4%	13%	6%	1%
Summer	3%	6%	6%	1%
Fall	2%	11%	11%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	20%
At-Sea Sonar Testing	Navy Testing	19%
Acoustic and Oceanographic Research (ONR)	Navy Testing	12%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	8%
Small Coordinated ASW	Navy Training	8%
Composite Training Unit Exercise	Navy Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.1.4 Fin Whale (*Balaenoptera physalus*) - Endangered

Fin whales are in the VLF cetacean auditory group and the Mysticete behavioral group. The Western North Atlantic stock is the only stock in the Study Area. Model-predicted impacts are presented in Table 2.4-5.

The Western North Atlantic stock of fin whales is a migratory population, although their migration patterns are not as distinct as other large whales. They may be present year-round in the Atlantic with higher densities near the shelf break in the Northeast and mid-Atlantic. Densities near feeding areas on the shelf in the Northeast are higher in the summer. Impacts would be attributable to various activities in these regions, with most impacts occurring in spring and winter. Most auditory impacts are attributable to low and mid- frequency sonars used in testing activities and Anti-Submarine Warfare sonars in the Northeast and Virginia Capes Range Complexes. Most impacts are auditory effects because mysticetes are relatively less sensitive to disturbance compared to received levels that may affect hearing. The increase in the estimated auditory injury since the prior analysis is primarily due to changes in the method to assess avoidance of injurious sonar exposures. Some decreases in estimated fin whale density in the northeast and mid-Atlantic have likely contributed to an overall decrease in the estimated impacts since the prior analysis. Impacts due to air guns would be negligible.

Most model-predicted auditory impacts for explosives used in testing are due to Small Ship Shock Trials. Some auditory injuries could be mitigated. The Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone.

On average, individuals would be impacted less than once per year. The average risk of injury is very low, although auditory injuries are predicted. The risk of injury may be reduced through visual observation mitigation.

The risk of repeated impacts on individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Fin whales are large capital breeders with a slow pace of life. They are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves. Population trends for fin whales are unknown. Their slow pace of life means that long-term impacts to breeding adults could have a longer-term effect on population growth rates.

The limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals. Long-term consequences to the stock are unlikely.

Based on the analysis presented above, the use of sonars, air guns, explosives, and activities that produce vessel, aircraft, and weapons noise during military readiness activities <u>may affect</u> fin whales. Activities that involve the use of pile driving are <u>not applicable</u> to fin whales because there is no geographic overlap of this stressor with species occurrence.

Table 2.4-5: Estimated Effects to the Western North Atlantic Stock of Fin Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	-	-	-	-
Explosive	Navy Training	30	8	0	-	-
Explosive	Navy Testing	110	159	12	-	-
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	218	833	6	-	-
Sonar	Navy Testing	328	1,010	12	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**689**	**2,011**	**30**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
6,802	0.40	0.00

Season	Percent of Total Impacts		
	Northeast	Mid-Atlantic	Southeast
Winter	9%	22%	1%
Spring	13%	24%	1%
Summer	8%	8%	0%
Fall	6%	8%	0%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	18%
At-Sea Sonar Testing	Navy Testing	15%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	11%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	7%
Small Coordinated ASW	Navy Training	7%
Mine Countermeasure and Neutralization Testing (NAVSEA)	Navy Testing	6%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	East of Montauk Point (3,4,5,6,7,8,9,10)	5	0	-	-	-
Draft BIA II	Southern Gulf of ME (All)	16	36	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.1.5 Bryde's Whale (*Balaenoptera brydei/edeni*)

Bryde's whales are in the LF cetacean auditory group and the Mysticete behavioral group. There is no defined stock of Bryde's whales in U.S. waters. The Northern Gulf of Mexico stock of Bryde's whale is now designated as a separate species, the Rice's whale. Bryde's whales may be present in far southern portions of the Study Area. Model-predicted impacts are presented in Table 2.4-6.

Bryde's whales are among the least known of the baleen whales. The Atlantic population of Bryde's whales is likely a migratory population that travels within its tropical and subtropical range year-round. Most Bryde's whales congregate in tropical waters south of the Study Area, and only occasionally travel as far north as Virginia. Thus, Bryde's whales inhabit areas where overlap with military readiness activities is limited. Only a small number of non-injurious impacts due to sonar are predicted. Impacts from explosives are negligible and no impacts are predicted due to air guns.

It is not possible to accurately predict the potential for repeated impacts to individuals in this population. The NMSDD only covers a small portion of the area expected to be inhabited by this population in the Atlantic Ocean in the southeastern portion of the Study Area outside of the U.S. Exclusive Economic Zone. Still, the number of predicted impacts is low, thus the risk of repeated exposures is likely negligible.

Consequences to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Being large capital breeders, Bryde's whales have a slow pace of life and may be less susceptible to impacts from foraging disruption. Migratory movement ecology combined with the overall low number of predicted impacts for this stock means the risk of consequences to any individual is low. Long-term consequences to this population are unlikely.

Table 2.4-6: Estimated Effects to Bryde's Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	0	-	-	-
Sonar	Navy Training	1	9	-	-	-
Sonar	Navy Testing	1	-	-	-	-
Maximum Annual Total		**2**	**9**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts
	High Seas
Winter	48%
Spring	23%
Summer	9%
Fall	20%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	84%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	7%
Anti-Submarine Warfare Tracking Exercise - Submarine	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.1.6 Humpback Whale (*Megaptera novaeangliae*)

Humpback whales are in the LF cetacean auditory group and the Mysticete behavioral group. The Gulf of Maine stock is the only stock in the Study Area. Model-predicted impacts are presented in Table 2.4-7.

The Gulf of Maine stock of humpback whales have particularly strong site fidelity in the Gulf of Maine feeding grounds March to December and in the Caribbean calving grounds from December to May. Humpback whales, however, may be present in the Study Area, particularly in the mid-Atlantic and Northeast, year-round. They are present near the Chesapeake Bay mouth except in the summer. Most impacts would occur during the cool season in the Northeast and the mid-Atlantic. Fewer impacts would occur when humpback whales are farther north in feeding areas in the warm season. Most auditory impacts are attributable to low and mid-frequency sonars during testing activities in the northeast, including those using sonars with higher duty cycles and Anti-Submarine Warfare activities in the mid-Atlantic and northeast, which may use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Most impacts are auditory effects because mysticetes are relatively less sensitive to disturbance. The increase in the estimated auditory injury since the prior analysis is primarily due to changes in the method to assess avoidance of injurious sonar exposures. The predicted hearing range of LF cetaceans in this analysis is also higher than the predicted hearing range of LF cetaceans in the prior analysis (which previously was a single auditory group containing all mysticetes, including the now separate VLF cetacean auditory group). This has increased the potential for auditory impacts from mid- and high-frequency sources. Impacts from explosives would be limited and no impacts are predicted due to air guns.

On average, individuals would be impacted once per year. These impacts are most likely to occur in the cool season when humpbacks would be engaged in feeding behavior or migration. The average risk of injury is low, although it is likely that some auditory injuries could occur. The risk of a single auditory injury from training explosives is low (less than one) in any year, but auditory injury is shown in the maximum year of impacts due to summing risk across seven years and following the rounding approach discussed in Section 2.4 (Species Impact Assessments).This auditory injury is shown in the maximum year of impacts per the summation and rounding approach discussed above. The risk of injury may be reduced through visual observation mitigation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Humpback whales are large capital breeders with a slow pace of life. Although some impacts are likely to occur when humpbacks are engaged in feeding behavior, they are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves. Population trends for humpback whales are unknown but may be increasing. Although the Gulf of Maine stock of humpback whales has an increasing population trend and are not endangered, there has been an increase in the number of humpback whale mortalities from Maine to North Carolina, likely in large part due to entanglement and vessel strike. Their slow pace of life means that long-term impacts to breeding adults could have a longer-term effect on population growth rates.

The limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals. Long-term consequences to the stock are unlikely.

Table 2.4-7: Estimated Effects to the Gulf of Maine Stock of Humpback Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	14	7	1	-	-
Explosive	Navy Testing	13	15	0	-	-
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	56	264	6	-	-
Sonar	Navy Testing	127	353	5	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**212**	**640**	**12**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,396	0.62	0.01

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	7%	12%	4%	1%
Spring	21%	27%	2%	0%
Summer	8%	2%	0%	0%
Fall	7%	7%	0%	0%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	16%
At-Sea Sonar Testing	Navy Testing	14%
Mine Countermeasure Technology Research	Navy Testing	8%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	7%
Small Coordinated ASW	Navy Training	7%
Unmanned Underwater Vehicle Testing	Navy Testing	7%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	6%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Gulf of ME Child (3,4,5,6,7,8,9,10,11,12)	16	33	0	-	-
Draft BIA II	Gulf of ME Parent (3,4,5,6,7,8,9,10,11,12)	31	63	1	-	-
Draft BIA II	Mid-Atlantic Shelf (1,2,3,11,12)	28	134	2	-	-
Draft BIA II	NY Bight Parent (5,6,7,8,9)	29	22	0	-	-
Draft BIA II	South New England (4,5,6,7,8,9)	6	2	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.1.7 Minke Whale (*Balaenoptera acutorostrata*)

Minke whales are in the LF cetacean auditory group and the Mysticete behavioral group. Two stocks are in the Study Area – the Canadian East Coast stock and the West Greenland stock. Model-predicted impacts to the Canadian East Coast stock are presented in Table 2.4-8. There are no predicted impacts to the West Greenland stock (not managed by NMFS).

The Canadian East Coast stock generally congregates in the lower Bay of Fundy or New England feeding grounds in warmer months (spring to fall) and migrates to the Southeast in winter. Their seasonally high densities in the Northeast and Southeast, in spring and winter respectively, overlap areas where Anti-Submarine Warfare activities would occur. Most impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Auditory impacts are also attributable to low and mid-frequency sonars during other testing activities, including those with higher duty cycles. Most impacts are auditory effects because mysticetes are relatively less sensitive to disturbance. The increase in the estimated auditory injury since the prior analysis is primarily due to changes in the method to assess avoidance of injurious sonar exposures. The predicted hearing range of LF cetaceans in this analysis is also higher than the predicted hearing range of LF cetaceans in the prior analysis (which previously was a single auditory group containing all mysticetes, including the now separate VLF cetacean auditory group). This has increased the potential for auditory impacts from mid- and high-frequency sources. Increases in estimated minke whale density in the northeast have likely contributed to an increase in the estimated impacts since the prior analysis. The number of impacts due to explosives are limited and impacts due to air guns are negligible.

On average, individuals would be impacted less than once per year. The average risk of injury is negligible, although auditory injuries are predicted. The risk of injury may be reduced through visual observation mitigation, although minke whales have a relatively low sightability.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Although they are the smallest mysticete, minke whales are large capital breeders with a slow pace of life. A portion of impacts would occur in feeding areas in the northeast in the spring, whereas impacts in the mid-Atlantic and southeast would likely occur during migration or potentially breeding in the winter in the southeast. Although some impacts are likely to occur when minke whales are engaged in feeding behavior, they are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves. Population trends for minke whales are unknown. Although the Canadian East Coast stock of minke whales is not endangered, there was an unusual mortality event for minke whales within their range from 2017 to 2022, decreasing the population by at least 140 whales. Their slow pace of life means that long-term impacts to breeding adults could have a longer-term effect on population growth rates.

The limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals. Long-term consequences to the stock are unlikely.

Table 2.4-8: Estimated Effects to the Canadian Eastern Coastal Stock of Minke Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	-	0	-	-	-
Explosive	Navy Training	24	11	1	-	-
Explosive	Navy Testing	26	37	1	0	-
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	239	2,332	17	-	-
Sonar	Navy Testing	401	1,575	37	-	-
Sonar	USCG Training	2	1	-	-	-
Maximum Annual Total		**693**	**3,957**	**56**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
21,968	0.21	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	1%	16%	33%	1%
Spring	9%	13%	7%	1%
Summer	4%	1%	0%	0%
Fall	2%	4%	7%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	23%
At-Sea Sonar Testing	Navy Testing	18%
Composite Training Unit Exercise	Navy Training	9%
Acoustic and Oceanographic Research (ONR)	Navy Testing	8%
Small Coordinated ASW	Navy Training	6%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Central Gulf of ME/Parker Ridge/Cashes Ledge (3,4,5,6,7,8,9,10,11)	4	10	0	-	-
Draft BIA II	Southwestern Gulf of ME/Georges Bank (3,4,5,6,7,8,9,10,11)	7	14	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.1.8 Sei Whale (*Balaenoptera borealis*) - Endangered

Sei whales are in the LF cetacean auditory group and the Mysticete behavioral group. Two stocks are in the Study Area – the Nova Scotia stock and the Labrador Sea stock. Model-predicted impacts to the Nova Scotia stock are presented in Table 2.4-9. There are no predicted impacts to the Labrador Sea stock.

The Nova Scotia stock of sei whales is migratory, traveling east to west within their North Atlantic range year-round. While they do not have any known breeding grounds within U.S. Atlantic waters, they have feeding grounds in deeper waters off coastal Maine and Massachusetts in the warmer months with highest densities in the spring, plus feeding grounds farther northward out of the U.S. Exclusive Economic Zone. Impacts would be more likely in the spring while on feeding grounds in the northeast or in the winter when the stock migrates through the mid-Atlantic and southeast. Impacts are attributable to a variety of activities, with auditory injury attributable to Anti-Submarine Warfare activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Auditory impacts are also attributable to low and mid-frequency sonars during other testing activities, including those with higher duty cycles. Most impacts are auditory effects because mysticetes are relatively less sensitive to disturbance. The increase in the estimated auditory injury since the prior analysis is primarily due to changes in the method to assess avoidance of injurious sonar exposures. The predicted hearing range of LF cetaceans in this analysis is also higher than the predicted hearing range of LF cetaceans in the prior analysis (which previously was a single auditory group containing all mysticetes, including the now separate VLF cetacean auditory group). This has increased the potential for auditory impacts from mid- and high-frequency sources. Increases in estimated sei whale density in the northeast have likely contributed to an increase in the estimated impacts since the prior analysis. The number of impacts due to explosives would be limited, and no impacts are predicted due to air guns.

On average, individuals would be impacted less than once per year. The average risk of injury is negligible, although auditory injuries are predicted. The risk of injury may be reduced through visual observation mitigation because sei whales are moderately sightable.

The risk of repeated impacts on individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Sei whales are large capital breeders with a slow pace of life. A portion of impacts would occur while sei whales are in feeding areas in the Northeast. Sei whales are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves. Population trends for sei whales are unknown. Their slow pace of life means that long-term impacts to breeding adults could have a longer-term effect on population growth rates.

Limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals. Long-term consequences to the stock are unlikely.

Based on the analysis presented above, the use of sonars, air guns, explosives, and activities that produce vessel, aircraft, and weapons noise during military readiness activities may affect sei whales. Activities that involve the use of pile driving are not applicable to sei whales because there is no geographic overlap of this stressor with species occurrence.

Table 2.4-9: Estimated Effects to the Nova Scotia Stock of Sei Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	4	1	0	-	-
Explosive	Navy Testing	6	5	0	-	-
Explosive	USCG Training	1	0	-	-	-
Sonar	Navy Training	38	313	3	-	-
Sonar	Navy Testing	75	305	4	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**125**	**624**	**7**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
6,282	0.12	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	4%	13%	18%	4%
Spring	27%	13%	0%	1%
Summer	4%	0%	0%	0%
Fall	3%	5%	7%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	23%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	19%
Acoustic and Oceanographic Research (ONR)	Navy Testing	9%
Composite Training Unit Exercise	Navy Training	5%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Gulf of ME (5,6,7,8,9,10,11)	18	57	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2 Impacts on Odontocetes

The odontocetes are divided into the HF and VHF cetacean hearing groups. Although the Navy proposes to use substantially fewer hours of hull-mounted sonars in this Proposed Action, the updated HF cetacean criteria reflect greater susceptibility to auditory effects at low and mid-frequencies than previously analyzed. Consequently, the predicted auditory effects due to sources under 10 kHz, including but not limited to MF1 hull-mounted sonar and other Anti-Submarine Warfare sonars, are substantially higher for this auditory group than in prior analyses of the same activities. Thus, for activities with sonars, some modeled exposures that would previously have been categorized as significant behavioral responses may now instead be counted as auditory effects (TTS and AINJ). Similarly, the updated HF cetacean criteria reflect greater susceptibility to auditory effects at low and mid-frequencies in impulsive sounds. For VHF cetaceans, susceptibility to auditory effects has not changed substantially since the prior analysis.

The methods to model sonar avoidance have also been revised to base a species' probability of an avoidance responses on the behavioral response functions as described in 2.2.2 (Quantifying Impacts on Hearing). The combined behavioral response function for Sensitive Species replaces the two prior distinct behavioral response functions for beaked whales and harbor porpoises. Due to their greater susceptibility to disturbance, HF and VHF cetaceans in the Sensitive behavioral group are predicted to avoid many auditory injuries. All other odontocetes remain in the Odontocete behavioral group. Because the probability of behavioral response has decreased for the Odontocete behavioral group while the estimated susceptibility to auditory effects has increased for the HF hearing group (susceptibility to auditory effects has not notably changed for the VHF cetaceans), this analysis predicts more auditory impacts than the prior analysis for these species even though the Navy proposes to use substantially fewer hours of hull-mounted sonars in this Proposed Action. The cut-off conditions for predicting significant behavioral responses have also been revised for both the Sensitive Species and Odontocete behavioral groups as shown in Section 2.2.3 (Quantifying Behavioral Responses to Sonars). These factors interact in complex ways that make comparing the results of this analysis to prior analyses challenging.

Impacts due to non-modeled acoustic stressors are discussed above in Section 2.1.4 (Impacts from Vessel Noise), Section 2.1.5 (Impacts from Aircraft Noise), and Section 2.1.6 (Impacts from Weapons Noise).

2.4.2.1 Sperm Whale (*Physeter macrocephalus*) - Endangered

Sperm whales are in the HF cetacean auditory group and the Odontocete behavioral group. Three stocks are in the Study Area – the North Atlantic stock, the Northern Gulf of Mexico stock, and the Puerto Rico and U.S. Virgin Islands stock. Model-predicted impacts to the North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-10 and

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	4	6	1	1	-
Explosive	Navy Testing	2	5	2	0	0
Explosive	USCG Training	1	0	-	-	-
Sonar	Navy Training	5,692	1,487	1	-	-
Sonar	Navy Testing	3,174	2,218	3	-	-
Sonar	USCG Training	5	-	-	-	-
Maximum Annual Total		**8,878**	**3,716**	**7**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
4,349	2.90	0.00

	Percent of Total Impacts			
Season	**Northeast**	**Mid-Atlantic**	**Southeast**	**High Seas**
Winter	3%	24%	1%	2%
Spring	2%	21%	1%	2%
Summer	3%	16%	1%	1%
Fall	2%	19%	1%	2%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	23%
At-Sea Sonar Testing	Navy Testing	21%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	11%
Small Coordinated ASW	Navy Training	6%
Acoustic and Oceanographic Research (ONR)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-11. There are no predicted impacts to the Puerto Rico and U.S. Virgin Islands stock.

Sperm whales generally have higher abundances in deep water and areas of high productivity. The North Atlantic stock of sperm whales generally congregate around the shelf break off North Carolina in colder months (winter), and as the weather warms, a proportion of sperm whales move progressively northward from Virginia to the north of Georges Bank. However, some of the North Atlantic stock of sperm whales remain in the waters around North Carolina. Their year-round higher densities in deep waters near and beyond the Atlantic continental shelf break, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Although the Navy proposes to use substantially fewer hours of hull-mounted sonar in this Proposed Action, predicted auditory injuries are higher due to the updated HF cetacean criteria reflecting greater susceptibility to auditory effects from mid-frequency sonars than previously analyzed and changes in the method used to assess avoidance of injurious sonar exposures. The risk of impacts due to air guns is negligible.

For the North Atlantic stock, the model-predicted auditory injuries and the negligible risk of non-auditory injury for testing explosives are due to Small Ship Shock Trials. The Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone. The risk of a auditory or non-auditory injury from training explosives and the risk of auditory injury from training sonar are low (less than one) in any year for this stock, but single instances of each are shown in the maximum year of impacts due to summing risk across seven years and following the rounding approach discussed in Section 2.4 (Species Impact Assessments). The risk of injury may be reduced through visual observation mitigation.

While sperm whales in the Northern Gulf of Mexico stock are distributed in deep-water habitats throughout the Northern Gulf of Mexico, they also tend to aggregate at the mouth of the Mississippi River and along the continental slope. Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico to Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. There are no auditory or non-auditory injuries predicted for this stock. Impacts due to explosives are limited, and there would be no impacts due to air guns or pile driving.

On average, individuals in the North Atlantic stock could be impacted several times per year and individuals in the Gulf of Mexico stock could be impacted less than once per year. The average risk of injurious impacts in both populations is negligible, although it is likely that a small number of injuries could occur to individuals in the North Atlantic stock. The risk of injury may be reduced through visual observation mitigation.

The risk of repeated impacts on individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As large odontocetes with a slow pace of life, sperm whales are likely more resilient to missed foraging opportunities due to acoustic disturbance than smaller odontocetes. Still, sperm whales are income breeders and may be more susceptible to impacts due to lost foraging opportunities during reproduction, especially if they occur during lactation (Farmer et al., 2018). Sperm whales are nomadic-migratory and move within their range year-round with some seasonal shifts. Because they are nomadic, the risk of repeated impacts on individuals is likely similar within the population as animals move throughout their range. Risk of impacts would also be similar across seasons and critical life functions. However, because of their longer generation times, this population would require more time to recover if significantly impacted. In addition, both stocks of sperm whales are endangered and depleted. Both stocks also have unknown population trends, but it is possible sperm whales in the Gulf of Mexico have a stable population.

On average, the limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an injury may experience minor energetic costs. Long-term consequences to the stock are unlikely.

Based on the analysis presented above, the use of sonars, air guns, explosives, and activities that produce vessel, aircraft, and weapons noise during military readiness activities may affect sperm whales.

Activities that involve the use of pile driving are not applicable to sperm whales because there is no geographic overlap of this stressor with species occurrence.

Table 2.4-10: Estimated Effects to the North Atlantic Stock of Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	4	6	1	1	-
Explosive	Navy Testing	2	5	2	0	0
Explosive	USCG Training	1	0	-	-	-
Sonar	Navy Training	5,692	1,487	1	-	-
Sonar	Navy Testing	3,174	2,218	3	-	-
Sonar	USCG Training	5	-	-	-	-
Maximum Annual Total		**8,878**	**3,716**	**7**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
4,349	2.90	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	3%	24%	1%	2%
Spring	2%	21%	1%	2%
Summer	3%	16%	1%	1%
Fall	2%	19%	1%	2%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	23%
At-Sea Sonar Testing	Navy Testing	21%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	11%
Small Coordinated ASW	Navy Training	6%
Acoustic and Oceanographic Research (ONR)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-11: Estimated Effects to the Northern Gulf of Mexico Stock of Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	1	0	-	-
Explosive	Navy Testing	1	1	0	0	0
Explosive	USCG Training	0	-	-	-	-
Sonar	Navy Training	32	4	-	-	-
Sonar	Navy Testing	214	21	-	-	-
Maximum Annual Total		**248**	**27**	**0**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,614	0.17	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	10%	11%
Spring	8%	11%
Summer	10%	20%
Fall	11%	18%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Sonobuoy Lot Acceptance Test	Navy Testing	19%
Unmanned Underwater Vehicle Testing	Navy Testing	16%
Acoustic and Oceanographic Research (ONR)	Navy Testing	12%
Torpedo (Non-Explosive) Testing	Navy Testing	10%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	10%
Submarine Sea Trials - Weapons System Testing	Navy Testing	7%
Airborne Mine Countermeasures - Mine Detection	Navy Training	7%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.2 Dwarf and Pygmy Sperm Whale (*Kogia sima* and *Kogia breviceps*)

Dwarf and pygmy sperm whales are analyzed together, as these species are difficult to distinguish during wildlife surveys and as a result are frequently classified together as Kogia species. Kogia species are in the VHF cetacean auditory group and the Odontocete behavioral group. Two stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-12 and Table 2.4-13 for dwarf sperm whales and Table 2.4-14 and Table 2.4-15 for pygmy sperm whales.

The Western North Atlantic stock of dwarf and pygmy sperm whales inhabit the outer continental shelf and beyond from the Gulf of St. Lawrence to the Bahamas. Their year-round higher densities in deep waters along the Atlantic continental shelf break, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to the Western North Atlantic stocks are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Unlike the HF cetaceans, the estimated susceptibility to auditory effects has not significantly changed for VHF cetaceans. Although the Navy proposes to use substantially fewer hours of hull-mounted sonars in this Proposed Action, the increase in the estimated auditory injuries since the prior analysis is primarily due to changes in method to assess avoidance of injurious sonar exposures.

The Northern Gulf of Mexico stocks of dwarf and pygmy sperm whales are present year-round in the Gulf of Mexico, with higher densities in continental slope waters near the Mississippi River Delta, as well as the continental shelf break and upper continental slope waters where squid densities are higher.

Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico to Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to these stocks. A large portion of impacts would be due to Unmanned Underwater Vehicle Testing, which may employ lower source levels but for long durations at higher frequencies where VHF cetaceans are more susceptible to auditory impacts. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence.

For both stocks of dwarf and pygmy sperm whales, the negligible risk of mortality and non-auditory injury, and nearly all auditory injuries for testing explosives predicted by modeling are due to Small Ship Shock Trials. The mortality and non-auditory injury are unlikely to occur, as the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly those that occur in pods, such as *Kogia* species. No marine mammal mortalities have been identified during multi-day post-event observations following previous ship shock trials.

On average, individuals in the Western North Atlantic stocks could be impacted about twice per year, and individuals in the Northern Gulf of Mexico stocks would be impacted less than once per year. The individual risk of injurious impacts in both populations is low. The risk of injury may be reduced through visual observation mitigation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As small-medium odontocetes that are income breeders with a fast pace of life, dwarf and pygmy sperm whales are likely less resilient to missed foraging opportunities, especially during lactation. Little is known about the movement ecology of these stocks. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations would be quick to recover. While the Northern Gulf of Mexico stocks of these species were impacted by the *Deepwater Horizon* oil spill in 2010, the populations of both the Western North Atlantic and the Northern Gulf of Mexico stocks are estimated to be increasing.

The limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an injury may experience minor energetic costs. Most predicted impacts are temporary auditory effects that are unlikely to contribute to any long-term impacts to individuals. Long-term consequences to these stocks are unlikely.

Table 2.4-12: Estimated Effects to the Western North Atlantic Stock of Dwarf Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	1	0	-	-
Explosive	Navy Training	27	33	7	-	-
Explosive	Navy Testing	13	31	20	0	0
Explosive	USCG Training	1	1	1	-	-
Sonar	Navy Training	743	2,875	25	-	-
Sonar	Navy Testing	521	2,076	139	-	-
Sonar	USCG Training	2	4	-	-	-
Maximum Annual Total		**1,308**	**5,021**	**192**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
3,875	1.68	0.05

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	4%	29%	4%	2%
Spring	3%	16%	3%	1%
Summer	2%	11%	2%	1%
Fall	2%	17%	3%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	26%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	25%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	9%
Small Coordinated ASW	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-13: Estimated Effects to the Northern Gulf of Mexico Stock of Dwarf Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	-	-	-	-
Explosive	Navy Training	2	2	1	0	-
Explosive	Navy Testing	2	27	16	-	-
Explosive	USCG Training	1	1	-	-	-
Sonar	Navy Training	2	8	0	-	-
Sonar	Navy Testing	19	124	5	-	-
Sonar	USCG Training	0	-	-	-	-
Maximum Annual Total		**27**	**162**	**22**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
510	0.41	0.04

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	2%	35%
Spring	1%	15%
Summer	1%	10%
Fall	1%	36%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	56%
Acoustic and Oceanographic Research (ONR)	Navy Testing	12%
Small Ship Shock Trial	Navy Testing	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-14: Estimated Effects to the Western North Atlantic Stock of Pygmy Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	1	-	-	-
Explosive	Navy Training	26	33	9	-	-
Explosive	Navy Testing	12	30	18	0	-
Explosive	USCG Training	1	1	1	-	-
Sonar	Navy Training	774	2,792	25	-	-
Sonar	Navy Testing	525	2,095	132	-	-
Sonar	USCG Training	2	2	-	-	-
Maximum Annual Total		**1,341**	**4,954**	**185**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
3,875	1.67	0.05

	Percent of Total Impacts			
Season	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	4%	28%	4%	2%
Spring	3%	17%	3%	1%
Summer	2%	10%	2%	1%
Fall	2%	17%	3%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	25%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	25%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	9%
Small Coordinated ASW	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-15: Estimated Effects to the Northern Gulf of Mexico Stock of Pygmy Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	2	2	1	-	-
Explosive	Navy Testing	3	29	16	-	-
Explosive	USCG Training	1	1	-	-	-
Sonar	Navy Training	2	9	1	-	-
Sonar	Navy Testing	20	106	4	-	-
Sonar	USCG Training	0	-	-	-	-
Maximum Annual Total		**28**	**147**	**22**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
510	0.39	0.04

	Percent of Total Impacts	
Season	Key West	Gulf of Mexico
Winter	2%	33%
Spring	1%	15%
Summer	1%	13%
Fall	2%	34%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	49%
Acoustic and Oceanographic Research (ONR)	Navy Testing	14%
Small Ship Shock Trial	Navy Testing	8%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.3 Blainville's Beaked Whale (*Mesoplodon densirostris*)

Blainville's beaked whales are in the HF cetacean auditory group and the Sensitive behavioral group. Two Blainville's beaked whale stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-16 and Table 2.4-17.

This species is one of the most widely distributed deep-diving beaked whales. The Western North Atlantic stock of Blainville's beaked whales generally congregate over continental shelf margins from Canada to North Carolina, but this stock has been reported as far south as the Bahamas. Their year-round higher densities in deep waters over the Atlantic continental shelf margins, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The model-predicted auditory and non-auditory impacts, and the negligible risk of mortality, for explosives used in testing are due to Small Ship Shock Trials. Some injuries could be mitigated. The Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone.

The Northern Gulf of Mexico stock of Blainville's beaked whales is present year-round in deep water areas in the Gulf of Mexico and Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars occur in these regions, there are relatively fewer impacts to this stock. This stock could be impacted by a variety of activities.

There would be no impacts due to air guns for either stock, and there would be no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

On average, individuals in the Western North Atlantic stock could be impacted several times per year, primarily due to behavioral responses. On average, individuals in the Gulf of Mexico stock could experience behavioral responses less than twice per year. A small number of auditory injuries could occur to individuals in the western North Atlantic stock. The risk of injury may be reduced through visual observation mitigation, although beaked whales have low sightability.

The risk of repeated impacts to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As medium-sized odontocetes with a medium pace of life, Blainville's beaked whales are likely moderately resilient to missed foraging opportunities due to acoustic disturbance. While beaked whales are mixed breeders (i.e., behaviorally income breeders), they demonstrate capital breeding strategies during gestation and lactation (Keen et al., 2021), so they may be more vulnerable to prolonged loss of foraging opportunities during gestation. Because Blainville's beaked whales have a nomadic-resident movement ecology, the risk of repeated impacts to individuals is likely similar within the population as animals move throughout their range. However, since this species has longer generation times, this population would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of Blainville's beaked whales are unlikely.

Table 2.4-16: Estimated Effects to the Western North Atlantic Stock of Blainville's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	2	1	-	-
Explosive	Navy Testing	1	1	1	1	0
Explosive	USCG Training	0	-	-	-	-
Sonar	Navy Training	15,211	53	-	-	-
Sonar	Navy Testing	10,331	98	0	-	-
Sonar	USCG Training	7	-	-	-	-
Maximum Annual Total		**25,551**	**154**	**2**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
10,107	2.54	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	6%	25%	1%	4%
Spring	5%	15%	0%	3%
Summer	5%	12%	0%	3%
Fall	4%	14%	0%	3%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	20%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	15%
At-Sea Sonar Testing	Navy Testing	9%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	6%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	6%
Anti-Submarine Warfare Tracking Exercise - Maritime Patrol Aircraft	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-17: Estimated Effects to the Northern Gulf of Mexico Stock of Blainville's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Testing	0	0	-	-	-
Sonar	Navy Training	12	0	-	-	-
Sonar	Navy Testing	114	0	-	-	-
Maximum Annual Total		**126**	**0**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
99	1.27	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	16%	9%
Spring	14%	6%
Summer	18%	10%
Fall	16%	12%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Sonobuoy Lot Acceptance Test	Navy Testing	41%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	21%
Acoustic and Oceanographic Research (ONR)	Navy Testing	7%
Torpedo (Non-Explosive) Testing	Navy Testing	6%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.4 Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whales are in the HF cetacean auditory group and the Sensitive behavioral group. Three Cuvier's beaked whale stocks are in the Study Area – the Western North Atlantic stock, the Northern Gulf of Mexico stock, and the Puerto Rico and U.S. Virgin Islands stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-18 and Table 2.4-19. There are no predicted impacts to the Puerto Rico and U.S. Virgin Islands stock.

This species is one of the more commonly seen deep-diving beaked whales. The Western North Atlantic stock of Cuvier's beaked whales generally congregate over continental shelf margins from Canada to North Carolina, but this stock has been reported as far south as the Caribbean. Their year-round higher densities in deep waters over the Atlantic continental shelf margins, especially in the mid-Atlantic near Cape Hatteras, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The model-predicted auditory impacts and the negligible risk of non-auditory injury for explosives used in testing are mostly due to Small Ship Shock Trials. Some injuries could be mitigated. The Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone.

The Northern Gulf of Mexico stock of Cuvier's beaked whales is present year-round in deep water areas in the Gulf of Mexico and Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock.

There would be no impacts on either stock due to air guns, and there would be no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

On average, individuals in the Western North Atlantic stock could be impacted approximately twenty times per year, primarily due to behavioral responses. Beaked whales are a behaviorally sensitive species, and their high density along the mid-Atlantic shelf break overlaps areas where Anti-Submarine Warfare activities typically occur. The revised cut-off conditions for significant behavioral responses result in predicting significant responses farther than observed in studies of beaked whale responses to sonar (see Section 2.3.3 [Behavioral Responses by Distance and Sound Pressure Level]). A small number of auditory injuries could occur to individuals in the western North Atlantic stock. The risk of injury may be reduced through visual observation mitigation, although beaked whales have low sightability. The potential for repeated impacts to individuals in the Gulf of Mexico is low. On average, individuals in the Gulf of Mexico stock would be impacted less than twice per year, primarily due to behavioral responses, with no predicted injuries.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As medium-sized odontocetes with a medium pace of life, Cuvier's beaked whales are likely more resilient to missed foraging opportunities due to acoustic disturbance than smaller odontocetes. While beaked whales are mixed breeders (i.e., behaviorally income breeders), they demonstrate capital breeding strategies during gestation and lactation (Keen et al., 2021), so they may be more vulnerable to prolonged loss of foraging opportunities during gestation. Because Cuvier's beaked whales have a nomadic-resident movement ecology, the risk of repeated impacts to individuals is likely similar within the population as animals move throughout their range. However, since this species has longer generation times, this population would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an injury may experience minor energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of Cuvier's beaked whales are unlikely.

Table 2.4-18: Estimated Effects to the Western North Atlantic Stock of Cuvier's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	6	4	1	-	-
Explosive	Navy Testing	1	8	2	0	0
Explosive	USCG Training	1	1	-	-	-
Sonar	Navy Training	65,767	234	-	-	-
Sonar	Navy Testing	45,642	373	0	-	-
Sonar	USCG Training	40	-	-	-	-
Maximum Annual Total		**111,457**	**620**	**3**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
5,744	19.51	0.00

	Percent of Total Impacts			
Season	**Northeast**	**Mid-Atlantic**	**Southeast**	**High Seas**
Winter	4%	29%	1%	2%
Spring	3%	18%	0%	2%
Summer	3%	15%	0%	1%
Fall	2%	18%	0%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	19%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	16%
At-Sea Sonar Testing	Navy Testing	10%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	7%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%
Anti-Submarine Warfare Tracking Exercise - Maritime Patrol Aircraft	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-19: Estimated Effects to the Northern Gulf of Mexico Stock of Cuvier's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	-	-	-	-
Explosive	Navy Testing	0	1	0	-	-
Sonar	Navy Training	40	1	-	-	-
Sonar	Navy Testing	417	1	-	-	-
Maximum Annual Total		**457**	**3**	**0**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
368	1.25	0.00

Season	Percent of Total Impacts: Key West	Percent of Total Impacts: Gulf of Mexico
Winter	14%	8%
Spring	15%	6%
Summer	17%	11%
Fall	16%	13%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Sonobuoy Lot Acceptance Test	Navy Testing	40%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	22%
Acoustic and Oceanographic Research (ONR)	Navy Testing	8%
Torpedo (Non-Explosive) Testing	Navy Testing	6%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.5 Gervais' Beaked Whale (*Mesoplodon europaeus*)

Gervais' beaked whales are in the HF cetacean auditory group and the Sensitive behavioral group. Two Gervais' beaked whale stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-20 and Table 2.4-21.

The Western North Atlantic stock of Gervais' beaked whales generally congregate over continental shelf margins from New York to North Carolina. Their year-round higher densities in deep waters over the Atlantic continental shelf margins, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The Northern Gulf of Mexico stock of Gervais' beaked whales is present year-round in deep water areas in the Gulf of Mexico and Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. There are no auditory impacts predicted for this stock.

There would be no impacts due to air guns for either stock and no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

Most estimated impacts in both stocks are due to behavioral responses and the potential for repeated impacts within in a year to individuals in either stock is low. On average, individuals in the Western North Atlantic stock could be impacted several times per year, primarily due to behavioral responses. On average, individuals in the Gulf of Mexico stock would experience non-injurious impacts less than once per year. A single auditory injury could occur in the western North Atlantic stock. The risk of injury may be reduced through visual observation mitigation, although beaked whales have low sightability.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As medium-sized odontocetes with a medium pace of life, Gervais' beaked whales are likely moderately resilient to missed foraging opportunities due to acoustic disturbance. While beaked whales are mixed breeders (i.e., behaviorally income breeders), they demonstrate capital breeding strategies during gestation and lactation (Keen et al., 2021), so they may be more vulnerable to prolonged loss of foraging opportunities during gestation. Because Gervais' beaked whales have a nomadic-resident movement ecology, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an injury may experience minor energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of Gervais' beaked whales are unlikely.

Table 2.4-20: Estimated Effects to the Western North Atlantic Stock of Gervais' Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	1	1	-	-	-
Explosive	Navy Testing	1	1	1	0	-
Sonar	Navy Training	15,616	143	-	-	-
Sonar	Navy Testing	9,485	191	-	-	-
Sonar	USCG Training	7	-	-	-	-
Maximum Annual Total		**25,110**	**336**	**1**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
10,107	2.52	0.00

Season	Percent of Total Impacts: Northeast	Mid-Atlantic	Southeast	High Seas
Winter	7%	26%	1%	4%
Spring	5%	15%	0%	3%
Summer	4%	10%	0%	3%
Fall	3%	15%	0%	3%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	21%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	17%
At-Sea Sonar Testing	Navy Testing	9%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	6%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-21: Estimated Effects to the Northern Gulf of Mexico Stock of Gervais' Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Testing	0	1	-	-	-
Sonar	Navy Training	13	1	-	-	-
Sonar	Navy Testing	110	0	-	-	-
Maximum Annual Total		**123**	**2**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
386	0.32	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	16%	10%
Spring	14%	4%
Summer	16%	8%
Fall	19%	13%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Sonobuoy Lot Acceptance Test	Navy Testing	42%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	18%
Torpedo (Non-Explosive) Testing	Navy Testing	7%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	6%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.6 Sowerby's Beaked Whale (*Mesoplodon bidens*)

Sowerby's beaked whales are in the HF cetacean auditory group and the Sensitive behavioral group. One Sowerby's beaked whales' stock is in the Study Area – the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock is presented in Table 2.4-22.

The Western North Atlantic stock of Sowerby's beaked whales is the most northerly distributed stock of deep-diving mesoplodonts. They generally congregate over continental shelf margins from Labrador to Massachusetts. Their year-round higher densities in deep waters over the Atlantic continental shelf margins, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

Most estimated impacts are due to behavioral responses and the potential for more than a few repeated impacts within a year to individuals in either stock is low. On average, individuals in the Western North Atlantic stock would be impacted several times per year. The risk of injury may be reduced through visual observation mitigation, although beaked whales have low sightability.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As medium-sized odontocetes with a medium pace of life, Sowerby's beaked whales are likely moderately resilient to missed foraging opportunities due to acoustic disturbance. While beaked whales are mixed breeders (i.e., behaviorally income breeders), they demonstrate capital breeding strategies during gestation and lactation (Keen et al., 2021), so they may be more vulnerable to prolonged loss of foraging opportunities during gestation. Because Sowerby's beaked whales have a nomadic-resident movement ecology, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. However, since this species has longer generation times, this population would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an injury may experience minor energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic stock of Sowerby's beaked whales is unlikely.

Table 2.4-22: Estimated Effects to the Western North Atlantic Stock of Sowerby's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	1	0	-	-
Explosive	Navy Testing	1	1	1	0	0
Explosive	USCG Training	-	0	-	-	-
Sonar	Navy Training	15,679	165	-	-	-
Sonar	Navy Testing	9,570	198	-	-	-
Sonar	USCG Training	6	-	-	-	-
Maximum Annual Total		**25,257**	**365**	**1**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
10,107	2.54	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	7%	27%	1%	4%
Spring	5%	15%	0%	3%
Summer	4%	10%	0%	3%
Fall	3%	15%	0%	3%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	21%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	17%
At-Sea Sonar Testing	Navy Testing	9%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	6%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.7 True's Beaked Whale (*Mesoplodon mirus*)

True's beaked whales are in the HF cetacean auditory group and the Sensitive behavioral group. One True's beaked whale stock is in the Study Area – the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock is presented in Table 2.4-23.

True's beaked whales generally have higher abundances in warm temperate water. The Western North Atlantic stock of True's beaked whales generally congregate over continental shelf margins from Nova Scotia to Cape Hatteras, with northern occurrence likely relating to the Gulf Stream. Their year-round higher densities in warmer deep waters over the Atlantic continental shelf margins, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

Most estimated impacts are due to behavioral responses and the potential for more than a few repeated impacts within a year to individuals in either stock is low. On average, individuals in the Western North Atlantic stock would be impacted several times per year. A single auditory injury could occur. The risk of injury may be reduced through visual observation mitigation, although beaked whales have low sightability.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As medium-sized odontocetes with a medium pace of life, True's beaked whales are likely moderately resilient to missed foraging opportunities due to acoustic disturbance. While beaked whales are mixed breeders (i.e., behaviorally income breeders), they demonstrate capital breeding strategies during gestation and lactation (Keen et al., 2021), so they may be more vulnerable to prolonged loss of foraging opportunities during gestation. Because True's beaked whales have a nomadic-resident movement ecology, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of impacts would also be similar across seasons and critical life functions.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an injury may experience energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic stock of True's beaked whales are unlikely.

Table 2.4-23: Estimated Effects to the Western North Atlantic Stock of True's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	1	0	-	-
Explosive	Navy Testing	1	1	1	-	0
Explosive	USCG Training	0	-	-	-	-
Sonar	Navy Training	15,721	169	-	-	-
Sonar	Navy Testing	9,488	194	-	-	-
Sonar	USCG Training	6	-	-	-	-
Maximum Annual Total		**25,217**	**365**	**1**	**-**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
10,107	2.53	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	7%	27%	1%	4%
Spring	5%	15%	0%	3%
Summer	4%	11%	0%	3%
Fall	3%	15%	0%	3%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	21%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	17%
At-Sea Sonar Testing	Navy Testing	9%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	6%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.8 Northern Bottlenose Whale (*Hyperoodon ampullatus*)

Northern bottlenose whales are in the HF cetacean auditory group and the Sensitive behavioral group. One Northern bottlenose whale stock is in the Study Area – the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock is presented in Table 2.4-24.

Northern bottlenose whales generally have higher abundances in deep subarctic waters. The Western North Atlantic stock of Northern bottlenose whales is uncommon in U.S. waters and generally congregates in areas of high relief, including shelf breaks and submarine canyons from the Davis Strait to

New England, although strandings have occurred as far south as North Carolina. Their year-round higher densities in deep waters over the Atlantic continental shelf breaks, especially in the Northeast, overlap areas where various sonar testing and training activities would occur.

It is not possible to accurately predict the potential for repeated impacts to individuals in the Western North Atlantic stock. The abundance in the area predicted by using the NMSDD in the U.S. Exclusive Economic Zone is an under-estimate because it does not include most areas inhabited by this stock. There is no stock assessment report estimate of population size due to the lack of recent data. Given that Northern bottlenose whales are more commonly seen in parts of their range that extend north past Canada and are seldom found in waters less than 2,000 m deep, their abundance is much higher outside the U.S. Exclusive Economic Zone and are less likely to be found in or exhibit any residential movement ecology within the Study Area. While the actual risk of repeated impacts is not quantifiable, it is likely to be low. It is possible that a single AINJ could occur although the risk of injury may be reduced through visual observation mitigation.

The risk of repeated impacts to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As medium-sized odontocetes with a medium pace of life, Northern bottlenose whales are moderately resilient to missed foraging opportunities due to acoustic disturbance. While beaked whales are mixed breeders (i.e., behaviorally income breeders), they demonstrate capital breeding strategies during gestation and lactation (Keen et al., 2021), so they may be more vulnerable to prolonged loss of foraging opportunities during gestation. Because Northern bottlenose whales have a nomadic-resident movement ecology, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of impacts would also be similar across seasons and critical life functions. Because of their longer generation times, this population would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an auditory injury may experience energetic costs. Based on the above analysis and given that the AFTT Study Area is not the primary habitat for Northern bottlenose whales, long-term consequences for the Western North Atlantic stock of Northern bottlenose whales are unlikely.

Table 2.4-24: Estimated Effects to the Western North Atlantic Stock of Northern Bottlenose Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Testing	1	0	1	-	-
Sonar	Navy Training	824	4	-	-	-
Sonar	Navy Testing	817	5	-	-	-
Maximum Annual Total		**1,642**	**9**	**1**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts	
	Northeast	Mid-Atlantic
Winter	14%	20%
Spring	15%	11%
Summer	10%	12%
Fall	8%	9%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	13%
Acoustic and Oceanographic Research (ONR)	Navy Testing	11%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	8%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	8%
Anti-Submarine Warfare Tracking Exercise - Maritime Patrol Aircraft	Navy Training	8%
At-Sea Sonar Testing	Navy Testing	8%
Submarine Sonar Maintenance and Systems Checks	Navy Training	7%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	6%
Acoustic and Oceanographic Research (NAVSEA)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.9 Fraser's Dolphin (*Lagenodelphis hosei*)

Fraser's dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Two Fraser's dolphin stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-25 and Table 2.4-26.

The Western North Atlantic stock of Fraser's dolphins generally congregate in deep tropical waters with occurrence likely related to the Gulf Stream. Their estimated year-round density in deep tropical waters, especially in the Southeast, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The Northern Gulf of Mexico stock of Fraser's dolphins is present year-round in deep waters of the Gulf of Mexico. Impacts to this stock are attributable to a variety of activities that occur across the Gulf of Mexico to Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. Some impacts would be due to Unmanned Underwater Vehicle Testing which may employ lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts. There are no auditory or non-auditory injuries predicted for this stock.

There would be no impacts due to air guns for either stock, and there would be no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

It is not possible to accurately predict the potential for repeated impacts to individuals in the Western North Atlantic stock. The abundance in the area predicted by using the NMSDD in the U.S. Exclusive Economic Zone is an under-estimate because it does not include most areas inhabited by this stock. There is no stock assessment report estimate of population size due to the lack of recent data. Little is known about the population of Fraser's dolphins in the Atlantic, but density models suggest that most of this population is offshore. While Fraser's dolphins are assumed to be present in deep oceanic waters, there was only one sighting of Fraser's dolphins offshore of the 1,500-m isobath in a six-year survey. Although the actual risk of repeated impacts is not quantifiable, their atypical occurrence in the Study Area, coupled with that fact that they are a nomadic species with a likely larger population outside the U.S. Exclusive Economic Zone, decreases the likelihood of repeated impacts. A small number of injuries could occur to individuals in the Western North Atlantic stock, although the risk of injury may be reduced through visual observation mitigation. On average, individuals in the Gulf of Mexico stock would experience non-injurious impacts less than once per year.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Fraser's dolphins are income breeders with a small body and fast pace of life, suggesting they are less resilient to missed foraging opportunities due to acoustic disturbance, especially during lactation (Farmer et al., 2018). Both populations move within their range year-round. The nomadic stock's risk of repeated exposures to individuals is likely similar within the population as animals move throughout their Western North Atlantic range. Although the Northern Gulf of Mexico stock has a nomadic-resident movement ecology, this stock has a low risk of repeated exposure due to the limited number of activities in the area. Risk of impacts are somewhat similar across seasons and critical life functions, with slightly more impacts expected for both stocks in the colder months. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations would be quick to recover.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an injury may experience minor energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of Fraser's dolphins are unlikely.

Table 2.4-25: Estimated Effects to the Western North Atlantic Stock of Fraser's Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	1	1	0	-
Explosive	Navy Testing	1	2	0	0	-
Sonar	Navy Training	1,000	902	1	-	-
Sonar	Navy Testing	359	638	1	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**1,362**	**1,543**	**3**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts		
	Mid-Atlantic	Southeast	High Seas
Winter	14%	15%	4%
Spring	8%	10%	2%
Summer	4%	12%	2%
Fall	12%	15%	2%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	24%
At-Sea Sonar Testing	Navy Testing	20%
Composite Training Unit Exercise	Navy Training	13%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	8%
Small Coordinated ASW	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-26: Estimated Effects to the Northern Gulf of Mexico Stock of Fraser's Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	1	0	-	-
Explosive	Navy Testing	0	0	0	0	-
Sonar	Navy Training	17	6	-	-	-
Sonar	Navy Testing	150	66	0	-	-
Maximum Annual Total		**168**	**73**	**0**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,081	0.22	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	8%	27%
Spring	5%	24%
Summer	5%	11%
Fall	7%	14%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	30%
Acoustic and Oceanographic Research (ONR)	Navy Testing	15%
Sonobuoy Lot Acceptance Test	Navy Testing	14%
Torpedo (Non-Explosive) Testing	Navy Testing	7%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	6%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	6%
Submarine Sea Trials - Weapons System Testing	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.10 Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*)

Atlantic white-sided dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. One stock of Atlantic white-sided dolphin is in the Study Area – the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock is presented in Table 2.4-27.

The Western North Atlantic stock of Atlantic white-sided dolphins generally congregate in cold temperate to subpolar waters over the continental shelf from Greenland to North Carolina, with higher abundances around the Gulf of Maine in colder months. Their year-round higher densities in deep waters over the Atlantic continental shelf, especially in the Northeast, overlap areas where Anti-Submarine Warfare and various testing activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The potential for repeated impacts to individuals is low. On average, Individuals in the Western North Atlantic stock would be impacted less than once per year. The average individual risk of injurious impacts is negligible and may be reduced through visual observation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Atlantic white-sided dolphins are income breeders with a small body and fast pace of life, suggesting they are less resilient to missed foraging opportunities due to acoustic disturbance, especially during lactation. This nomadic population moves within their range year-round, including northern habitats outside the Study Area, so the risk of repeated exposures to individuals within the population is likely similar year-round. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations would be quick to recover.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an injury may experience energetic costs. Based on the above analysis, long-term consequences for the Western North stock of Atlantic white-sided dolphins are unlikely.

Table 2.4-27: Estimated Effects to the Western North Atlantic Stock of Atlantic White-Sided Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	4	6	1	1	-
Explosive	Navy Testing	6	3	1	0	0
Explosive	USCG Training	2	1	0	-	-
Sonar	Navy Training	2,051	1,172	2	-	-
Sonar	Navy Testing	5,106	2,547	4	-	-
Sonar	USCG Training	3	-	-	-	-
Maximum Annual Total		**7,172**	**3,729**	**8**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
93,223	0.12	0.00

Season	Percent of Total Impacts		
	Northeast	Mid-Atlantic	High Seas
Winter	25%	2%	2%
Spring	26%	8%	2%
Summer	16%	2%	0%
Fall	17%	2%	0%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	25%
Unmanned Underwater Vehicle Testing	Navy Testing	12%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	8%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	8%
Acoustic and Oceanographic Research (ONR)	Navy Testing	7%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.11 White-Beaked Dolphin (*Lagenorhynchus albirostris*)

White-beaked dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. One stock is in the Study Area – the Western North Atlantic stock. Model-predicted impacts are presented in Table 2.4-28.

The Western North Atlantic stock of white-beaked dolphins is a nomadic/migratory population that travels within their temperate and subarctic range year-round. Within the Study Area, white-beaked dolphins are concentrated in the western Gulf of Maine and around Cape Cod. Most white-beaked dolphins move south (towards Massachusetts) and farther offshore during the colder months and return north (towards Greenland) and closer to shore when the ice recedes during the warmer months. Thus, white-beaked dolphins inhabit areas where overlap with military readiness activities is limited, particularly in warmer seasons when this stock migrates north. Only a small number of non-injurious impacts due to sonar are predicted.

There is no risk of repeated exposures to this stock. Consequences to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Being small income breeders with a fast pace of life, white-beaked dolphins may be susceptible to energetic costs from foraging disruption, especially during lactation. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations are quick to recover. Nomadic movement ecology combined with the overall low number of predicted impacts for this stock means the risk of consequences to any individual is low. Long-term consequences to the stock are unlikely.

Table 2.4-28: Estimated Effects to the Western North Atlantic Stock of White-Beaked Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	USCG Training	0	-	-	-	-
Sonar	Navy Training	3	1	-	-	-
Sonar	Navy Testing	7	5	-	-	-
Maximum Annual Total		**10**	**6**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
536,016	0.00	0.00

Season	Percent of Total Impacts	
	Northeast	High Seas
Winter	34%	5%
Spring	27%	0%
Summer	18%	1%
Fall	13%	2%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	40%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	12%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	11%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	10%
Anti-Submarine Warfare Tracking Exercise - Maritime Patrol Aircraft	Navy Training	7%
Submarine Sea Trials - Weapons System Testing	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.12 Killer Whale (*Orcinus orca*)

Killer whales are in the HF cetacean auditory group and the Odontocete behavioral group. Two killer whale stocks are in the Study Area – the Western North Atlantic stock and the Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Gulf of Mexico stocks are presented in Table 2.4-29 and Table 2.4-30.

The Western North Atlantic stock of killer whales is rare and uncommon in the Study Area, particularly nearshore. They generally congregate in offshore and Arctic waters such as the Labrador Current, Gulf Stream, and North Atlantic Gyre open-ocean areas. Little is known about the presence of this stock in the Study Area, and density estimates are uncertain. Most sonar impacts to this stock are due to Anti-Submarine Warfare activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Impacts from air guns would be unlikely.

The Gulf of Mexico stock of killer whales is present year-round in deep, offshore waters of the Gulf of Mexico. Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico. Fewer impacts are predicted for this stock in Key West because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions. Some impacts would be due to Unmanned Underwater Vehicle Testing which may employ lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts. There are no injuries predicted for this stock. There would be no impacts due to air guns. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence.

It is not possible to accurately predict the potential for repeated impacts to individuals in the Western North Atlantic stock. The population abundance predicted by using NMSDD in the U.S. Exclusive Economic Zone is an under-estimate because that excludes most areas inhabited by this stock. There is no stock assessment report estimate due to the lack of recent data. Little is known about the population of killer whales in the North Atlantic, but their distribution extends outside the U.S. Exclusive Economic Zone. While the actual risk of repeated impacts is not quantifiable, it is likely to be low. A single auditory injury could occur in the Western North Atlantic stock, but the risk of injurious impacts may be reduced through visual observation. On average, individuals in the Gulf of Mexico stock would experience non-injurious impacts less than once per year.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Killer whales are large, income-breeding odontocetes with a slow pace of life, suggesting they are more resilient to missed foraging opportunities due to acoustic disturbance, except during lactation. Both populations move within their range year-round. Because the Western North Atlantic are nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range, with slightly more impact to this stock during colder months in the mid-Atlantic. Although the Gulf of Mexico stock has a resident movement ecology, they have a low risk of repeated exposure due to the limited number of activities in the area. Overall, killer whales would be resilient to missed foraging opportunities but would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer an auditory injury would experience energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Gulf of Mexico stocks of killer whales are unlikely.

Table 2.4-29: Estimated Effects to the Western North Atlantic Stock of Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	0	0	-	-	-
Explosive	Navy Testing	1	1	0	-	0
Sonar	Navy Training	68	42	0	-	-
Sonar	Navy Testing	30	37	1	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**100**	**80**	**1**	**-**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	5%	26%	7%	1%
Spring	3%	11%	5%	1%
Summer	2%	8%	4%	1%
Fall	2%	16%	7%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	19%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	18%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	9%
Small Coordinated ASW	Navy Training	8%
Airborne Mine Countermeasures - Mine Detection	Navy Training	8%
Composite Training Unit Exercise	Navy Training	7%
Acoustic and Oceanographic Research (ONR)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-30: Estimated Effects to the Northern Gulf of Mexico Stock of Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	-	0	-	-
Explosive	Navy Testing	-	0	0	-	-
Sonar	Navy Training	8	5	-	-	-
Sonar	Navy Testing	76	21	0	-	-
Maximum Annual Total		**84**	**26**	**0**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
511	0.22	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	8%	22%
Spring	2%	15%
Summer	3%	15%
Fall	3%	33%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	32%
Acoustic and Oceanographic Research (ONR)	Navy Testing	20%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	8%
Sonobuoy Lot Acceptance Test	Navy Testing	7%
Torpedo (Non-Explosive) Testing	Navy Testing	7%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	6%
Submarine Sea Trials - Weapons System Testing	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.13 Long-Finned Pilot Whale (*Globicephala melas*)

Long-finned pilot whales are in the HF cetacean auditory group and the Odontocete behavioral group. One stock is in the Study Area – the Western North Atlantic stock. Model-predicted impacts are presented in Table 2.4-31.

Long-finned pilot whales generally have higher abundances along the continental shelf break, in continental slope waters, and in areas of high topographic relief. The Western North Atlantic stock of long-finned pilot whales travels within their temperate and subpolar range year-round. Long-finned pilot whales are typically distributed on the Northeastern continental shelf edge during colder months and move north towards the Gulf of Maine and beyond the Study Area in warmer months. However, they are also associated with the Gulf stream and overlap spatially with the mid-Atlantic shelf break between North Carolina and New Jersey. This overlaps areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

For long-finned pilot whales, the model-predicted mortalities, non-auditory injuries, and many auditory injuries for testing explosives are due to Small Ship Shock Trials. These mortalities and injuries are unlikely to occur, as the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly those that occur in pods, such as pilot whales. No marine mammal mortalities have been identified during multi-day post-event observations following previous ship shock trials.

On average, individuals in the Western North Atlantic stock could be impacted less than once per year. The average individual risk of injurious take is negligible, although a small number of injuries could occur to individuals. The risk of injury may be reduced through visual observation mitigation.

Consequences to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Long-finned pilot whales are large income breeders with a slow pace of life, suggesting they are less susceptible to impacts from foraging disruption due to acoustic disturbance. This, combined with a nomadic movement ecology, and the overall low number of predicted impacts for this stock, means the risk of consequences to any individual is low.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences to the Western North Atlantic stock of long-finned pilot whales are unlikely.

Table 2.4-31: Estimated Effects to the Western North Atlantic Stock of Long-Finned Pilot Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	4	3	2	1	-
Explosive	Navy Testing	18	25	7	2	1
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	8,540	4,954	2	-	-
Sonar	Navy Testing	4,220	3,929	6	-	-
Maximum Annual Total		**12,783**	**8,912**	**17**	**3**	**1**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
39,215	0.55	0.00

Season	Percent of Total Impacts		
	Northeast	Mid-Atlantic	High Seas
Winter	5%	30%	1%
Spring	5%	23%	1%
Summer	2%	12%	0%
Fall	3%	19%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	21%
At-Sea Sonar Testing	Navy Testing	15%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	12%
Small Coordinated ASW	Navy Training	9%
Acoustic and Oceanographic Research (ONR)	Navy Testing	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.14 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

Short-finned pilot whales are in the HF cetacean auditory group and the Odontocete behavioral group. Three short-finned pilot whale stocks are in the Study Area – the Western North Atlantic stock, the Northern Gulf of Mexico stock, and the Puerto Rico and U.S. Virgin Islands stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-32 and Table 2.4-33. There are no predicted impacts to the Puerto Rico and U.S. Virgin Islands stock.

Short-finned pilot whales can be found in warm temperate and tropical waters deep offshore. The Western North Atlantic stock generally congregates in warm offshore waters such as the continental shelf break, in slope waters, and in areas of high topographic relief. Their year-round higher densities in warm deep waters, especially in the mid-Atlantic (Cape Hatteras), overlaps areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The Gulf of Mexico stock of short-finned pilot whales is present year-round in deep, offshore waters on the continental shelf and continental slope in the Gulf of Mexico. Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico with fewer impacts in Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. Most impacts, including auditory impacts, would be due to Acoustic and Oceanographic Research activities. The number of impacts due to other acoustic stressors (i.e., explosives, air guns) would be limited, and there would be no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

For the Western North Atlantic stock of short-finned pilot whales, the model-predicted mortality, non-auditory injury, and most auditory injuries for testing explosives are due to Small Ship Shock Trials. These mortalities and injuries are unlikely to occur, as the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see *Mitigation*). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly those that occur in pods, such as pilot whales. No marine mammal mortalities have been identified during multi-day post-event observations following previous ship shock trials.

On average, individuals in the Western North Atlantic stock could be impacted about once per year. On average, individuals in the Gulf of Mexico stock could be impacted less than once per year. The average individual risk of injurious impacts in both populations is negligible, although a small number of injuries could occur to individuals in either stock. The risk of injury may be reduced through visual observation mitigation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Short-finned pilot whales are medium-sized, income breeding odontocetes with a slow pace of life, making them somewhat resilient to missed foraging opportunities due to acoustic disturbance, except for during lactation. Both populations move within their range year-round. Because the Western North Atlantic stock is resident-nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range, with slightly more impact to this stock during colder months in the mid-Atlantic. Although the Gulf of Mexico stock has a resident movement ecology, they have a low risk of repeated exposure due to the limited number of activities in the area. While the Northern Gulf of Mexico stock of short-finned pilot whales was greatly impacted by the *Deepwater Horizon* oil spill in 2010, it has a potentially stable population. However, because of their longer generation times, this population would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury would incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of short-finned pilot whales are unlikely.

Table 2.4-32: Estimated Effects to the Western North Atlantic Stock of Short-Finned Pilot Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	7	5	1	0	0
Explosive	Navy Testing	13	21	6	1	1
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	12,319	9,414	2	-	-
Sonar	Navy Testing	4,625	6,626	10	-	-
Sonar	USCG Training	13	0	-	-	-
Maximum Annual Total		**16,978**	**16,067**	**19**	**1**	**1**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
28,924	1.14	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	2%	19%	11%	1%
Spring	2%	14%	9%	1%
Summer	1%	8%	8%	0%
Fall	1%	13%	8%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	24%
At-Sea Sonar Testing	Navy Testing	17%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	9%
Small Coordinated ASW	Navy Training	7%
Composite Training Unit Exercise	Navy Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-33: Estimated Effects to the Northern Gulf of Mexico Stock of Short-Finned Pilot Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	0	1	-	-	-
Explosive	Navy Testing	1	1	1	0	0
Sonar	Navy Training	54	33	0	-	-
Sonar	Navy Testing	574	357	2	-	-
Maximum Annual Total		**629**	**392**	**3**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,835	0.56	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	2%	17%
Spring	2%	16%
Summer	4%	28%
Fall	4%	29%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	58%
Unmanned Underwater Vehicle Testing	Navy Testing	9%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	7%
Torpedo (Non-Explosive) Testing	Navy Testing	5%
Sonobuoy Lot Acceptance Test	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.15 False Killer Whale (*Pseudorca crassidens*)

False killer whales are in the HF cetacean auditory group and the Odontocete behavioral group. Two false killer whale stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-34 and Table 2.4-35.

The Western North Atlantic stock generally congregates in warm temperate and tropical waters deep offshore from Maine to Florida, and only rarely come into shallow coastal waters. Their year-round higher densities in warm deep waters, especially in the mid-Atlantic, overlaps areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Impacts from explosives would be limited, and no impacts are predicted due to air guns.

The Gulf of Mexico stock of false killer whales is present year-round in deep offshore waters, primarily in the eastern Gulf of Mexico. Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico with fewer impacts in Key West. Most impacts would be due to Unmanned Underwater Vehicle Testing which may employ lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts. There are no auditory or non-auditory injuries predicted for this stock. There would be no impacts due to air guns, and there would be no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

On average, individuals in either stock would be impacted less than once per year. A single AINJ could occur to an individual in the Western North Atlantic stock, although the risk of injury may be reduced through visual observation mitigation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As medium-sized odontocetes that are income breeders, false killer whales are likely somewhat resilient to missed foraging opportunities due to acoustic disturbance but may be vulnerable to impacts during lactation. In addition, because of their longer generation times, false killer whales would require more time to recover if significantly impacted. Both populations move within their range year-round. Because the Western North Atlantic stock is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Although the Gulf of Mexico stock is in decline and has a resident-nomadic movement ecology, they have a low risk of repeated exposure due to the limited number of activities in the area.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals that experience auditory injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of false killer whales are unlikely.

Table 2.4-34: Estimated Effects to the Western North Atlantic Stock of False Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	0	-	-	-
Explosive	Navy Testing	-	1	-	-	-
Sonar	Navy Training	236	170	-	-	-
Sonar	Navy Testing	80	84	1	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**317**	**255**	**1**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,791	0.32	0.00

Season	Percent of Total Impacts: Northeast	Mid-Atlantic	Southeast	High Seas
Winter	6%	16%	4%	14%
Spring	2%	18%	5%	8%
Summer	2%	5%	0%	4%
Fall	1%	9%	1%	7%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	40%
At-Sea Sonar Testing	Navy Testing	12%
Airborne Mine Countermeasures - Mine Detection	Navy Training	8%
Acoustic and Oceanographic Research (ONR)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-35: Estimated Effects to the Northern Gulf of Mexico Stock of False Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	-	0	0	-	-
Explosive	Navy Testing	1	1	0	-	-
Sonar	Navy Training	15	9	-	-	-
Sonar	Navy Testing	152	52	0	-	-
Maximum Annual Total		**168**	**62**	**0**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,023	0.22	0.00

Season	Percent of Total Impacts: Key West	Percent of Total Impacts: Gulf of Mexico
Winter	8%	28%
Spring	2%	16%
Summer	3%	11%
Fall	2%	29%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	36%
Acoustic and Oceanographic Research (ONR)	Navy Testing	18%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	8%
Sonobuoy Lot Acceptance Test	Navy Testing	7%
Torpedo (Non-Explosive) Testing	Navy Testing	7%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.16 Melon-Headed Whale (*Peponocephala electra*)

Melon-headed whales are in the HF cetacean auditory group and the Odontocete behavioral group. Two melon-headed whale stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-36 and Table 2.4-37.

The Western North Atlantic stock of melon-headed whales generally congregate in deep tropical and subtropical waters offshore such as the southern parts of the Gulf Stream and North Atlantic Gyre open-ocean areas. Their higher densities in deep offshore waters, especially in the Southeast and mid-Atlantic during colder months, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Impacts from explosives would be limited, and no impacts are predicted due to air guns.

The Northern Gulf of Mexico stock of melon-headed whales is present year-round in deep, offshore waters, primarily beyond the edge of the continental shelf and over the abyssal plain near Alabama. Impacts to this stock are attributable to a variety of activities that occur across the Gulf of Mexico with fewer impacts in Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. Most impacts would be due to Unmanned Underwater Vehicle Testing which may employ lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts. There would be no impacts due to air guns, and there would be no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

It is not possible to accurately predict the potential for repeated impacts to individuals in the Western North Atlantic stock. The population abundance predicted by using NMSDD in the U.S. Exclusive Economic Zone is likely an under-estimate because that excludes most areas that density models suggest are inhabited by this stock. There is no stock assessment report estimate of population size due to the lack of recent data. Given that melon-headed whales are a nomadic and oceanic species found in waters greater than 2,500 m deep, they are rarely sighted in the U.S. Exclusive Economic Zone. Their abundance is likely higher outside the U.S. Exclusive Economic Zone. While the actual risk of repeated impacts is not quantifiable, it is likely to be low. On average, individuals in the Gulf of Mexico stock could be impacted less than once per year. A small number of auditory injuries could occur to individuals in either stock, although the risk of injury may be reduced through visual observation mitigation especially since melon-headed whales tend to travel in large groups.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As small odontocetes that are income breeders with a medium pace of life, melon-headed whales are likely somewhat resilient to missed foraging opportunities due to acoustic disturbance, but could be vulnerable during lactation(Farmer et al., 2018). Both stocks of melon-headed whales move within their range year-round. Because the Western North Atlantic stock is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Although the Northern Gulf of Mexico stock has a nomadic-resident movement ecology, this stock has a low risk of repeated exposure due to the limited number of activities in the area. However, because of their longer generation times, this population would require more time to recover if significantly impacted. The Northern Gulf of Mexico stock was greatly impacted by the *Deepwater Horizon* oil spill in 2010.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of melon-headed whales are unlikely.

Table 2.4-36: Estimated Effects to the Western North Atlantic Stock of Melon-Headed Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	0	0	0	-
Explosive	Navy Testing	1	0	0	0	0
Sonar	Navy Training	1,684	1,833	1	-	-
Sonar	Navy Testing	305	772	2	-	-
Sonar	USCG Training	3	-	-	-	-
Maximum Annual Total		**1,993**	**2,605**	**3**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts		
	Mid-Atlantic	Southeast	High Seas
Winter	9%	14%	8%
Spring	6%	9%	6%
Summer	3%	6%	3%
Fall	16%	14%	7%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	42%
At-Sea Sonar Testing	Navy Testing	15%
Composite Training Unit Exercise	Navy Training	11%
Small Coordinated ASW	Navy Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-37: Estimated Effects to the Northern Gulf of Mexico Stock of Melon-Headed Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	0	0	-	-
Explosive	Navy Testing	1	1	0	0	0
Sonar	Navy Training	53	28	-	-	-
Sonar	Navy Testing	525	163	1	-	-
Maximum Annual Total		**579**	**192**	**1**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
3,579	0.22	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	9%	27%
Spring	2%	15%
Summer	3%	13%
Fall	3%	29%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	34%
Acoustic and Oceanographic Research (ONR)	Navy Testing	18%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	8%
Sonobuoy Lot Acceptance Test	Navy Testing	7%
Torpedo (Non-Explosive) Testing	Navy Testing	7%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.17 Pygmy Killer Whale (*Feresa attenuata*)

Pygmy killer whales are in the HF cetacean auditory group and the Odontocete behavioral group. Two pygmy killer whale stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-38 and Table 2.4-39.

Pygmy killer whales are considered rare throughout their range. The Western North Atlantic stock of pygmy killer whales generally congregate in deep tropical and subtropical waters offshore such as the Gulf Stream and North Atlantic Gyre open-ocean areas. Their year-round higher densities in deep offshore waters, especially in the Southeast, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Impacts from explosives would be limited, and no impacts are predicted due to air guns.

The Northern Gulf of Mexico stock of pygmy killer whales is present year-round in deep waters off the continental shelf and over the abyssal plain more often on the eastern oceanic Gulf of Mexico. Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico with fewer impacts in Key West. Most impacts would be due to Unmanned Underwater Vehicle Testing which may employ lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts. There are no auditory or non-auditory injuries predicted for this stock. There would be no impacts due to air guns, and there would be no impacts due to pile driving because there is no geographic overlap of pile driving with species occurrence.

It is not possible to accurately predict the potential for repeated impacts to individuals in the Western North Atlantic stock. The population size predicted by using the NMSDD in the U.S. Exclusive Economic Zone is an under-estimate because it does not include most areas inhabited by this stock. There is no stock assessment report estimate of population size due to the lack of recent data. While the actual risk of repeated impacts is not quantifiable, it is likely to be low. On average, individuals in the Gulf of Mexico stock could be impacted less than once per year. A single AINJ could occur to individuals in the Western North Atlantic stock, although the risk of injury may be reduced through visual observation mitigation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Little is known about pygmy killer whale demographics, but they are income breeders with a small body and medium pace of life, suggesting they are less resilient to missed foraging opportunities due to acoustic disturbance, especially during lactation(Farmer et al., 2018). Both stocks of pygmy killer whales move within their range year-round. Because the Western North Atlantic stock is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Although the Northern Gulf of Mexico stock has a nomadic-resident movement ecology, this stock has a low risk of repeated exposure due to the limited number of activities in the area. However, because of their longer generation times, this population would require more time to recover if significantly impacted. The Northern Gulf of Mexico stock was greatly impacted by the *Deepwater Horizon* oil spill in 2010.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals that experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of pygmy killer whales are unlikely.

Table 2.4-38: Estimated Effects to the Western North Atlantic Stock of Pygmy Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	-	1	0	-
Explosive	Navy Testing	0	1	0	-	-
Sonar	Navy Training	185	183	0	-	-
Sonar	Navy Testing	30	77	0	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**216**	**261**	**1**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts		
	Mid-Atlantic	Southeast	High Seas
Winter	7%	14%	11%
Spring	4%	9%	8%
Summer	4%	4%	4%
Fall	8%	18%	9%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	39%
At-Sea Sonar Testing	Navy Testing	13%
Composite Training Unit Exercise	Navy Training	11%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	10%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-39: Estimated Effects to the Northern Gulf of Mexico Stock of Pygmy Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	0	-	-	-
Explosive	Navy Testing	1	1	0	0	0
Sonar	Navy Training	18	11	-	-	-
Sonar	Navy Testing	185	69	0	-	-
Maximum Annual Total		**204**	**81**	**0**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,278	0.22	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	8%	24%
Spring	2%	18%
Summer	3%	13%
Fall	3%	30%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	36%
Acoustic and Oceanographic Research (ONR)	Navy Testing	18%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	8%
Sonobuoy Lot Acceptance Test	Navy Testing	7%
Torpedo (Non-Explosive) Testing	Navy Testing	6%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.18 Atlantic Spotted Dolphin (*Stenella frontalis*)

Atlantic spotted dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Three Atlantic spotted dolphin stocks are in the Study Area – the Western North Atlantic stock, the Northern Gulf of Mexico stock, and the Puerto Rico and U.S. Virgin Island stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-40 and Table 2.4-41. There are no predicted impacts to the Puerto Rico and U.S. Virgin Islands stock.

The Western North Atlantic stock can be found in warm-temperate and tropical waters deep offshore from New England to the Caribbean and tends to congregate in continental slope waters north of Cape Hatteras and in the deeper slope and offshore waters of the mid-Atlantic south of Cape Hatteras. Their higher densities in warm deep waters over the continental shelf and upper slope, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. In addition, densities of Atlantic spotted dolphins have increased along the mid-Atlantic shelf, potentially increasing the estimated impacts in the area from the prior analysis.

The Northern Gulf of Mexico stock of Atlantic spotted dolphins is present year-round in offshore waters, primarily in deep continental shelf to slope waters with seasonal migration to west Florida's continental shelf in the colder months (fall to spring). Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico, with fewer impacts in Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. Most impacts, including auditory impacts, would be due to Acoustic and Oceanographic Research activities. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence.

For both stocks of Atlantic spotted dolphins, the model-predicted mortalities, non-auditory injuries, and auditory injuries for testing explosives are due to Small Ship Shock Trials. These mortalities, non-auditory injuries, and some auditory injuries could be mitigated. The visual observation mitigation zone is intensely monitored before, during, and following a ship shock trial detonation (see the *Mitigation* section). A pod of Atlantic spotted dolphins within the range to injury would likely be sighted during extensive pre-event visual observations. No marine mammal mortalities have been identified during multi-day post-event observations following previous ship shock trials.

On average, individuals in the Western North Atlantic stock could be impacted several times per year. On average, individuals in the Gulf of Mexico stock would be impacted less than once per year. A small number of injuries could occur to individuals in either stock, however the risk of injury may be reduced through visual observation mitigation. The average individual risk of injury is negligible.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As small odontocetes that are income breeders with a medium pace of life, Atlantic spotted dolphins are likely moderately resilient to missed foraging opportunities due to acoustic disturbance but could be vulnerable during lactation. Both stocks of Atlantic spotted dolphins move within their range year-round. Because the Western North Atlantic stock is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. The Northern Gulf of Mexico stock has a migratory movement ecology. This makes them less susceptible to repeated impacts since Atlantic spotted dolphins move seasonally between habitats, reducing the likelihood for prolonged year-round exposure.

The Northern Gulf of Mexico stock was greatly impacted by the *Deepwater Horizon* oil spill in 2010. The Western North Atlantic stock's population is in decline.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals that experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of Atlantic spotted dolphins are unlikely.

Table 2.4-40: Estimated Effects to the Western North Atlantic Stock of Atlantic Spotted Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	35	37	4	1	0
Explosive	Navy Testing	39	27	4	3	1
Explosive	USCG Training	1	1	-	-	-
Sonar	Navy Training	34,866	39,711	22	-	-
Sonar	Navy Testing	16,870	29,186	56	-	-
Sonar	USCG Training	29	1	-	-	-
Maximum Annual Total		**51,840**	**68,963**	**86**	**4**	**1**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
39,921	3.03	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	1%	18%	10%	1%
Spring	1%	16%	9%	1%
Summer	0%	10%	6%	1%
Fall	1%	15%	9%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	16%
At-Sea Sonar Testing	Navy Testing	14%
Small Coordinated ASW	Navy Training	10%
Composite Training Unit Exercise	Navy Training	9%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	9%
Acoustic and Oceanographic Research (ONR)	Navy Testing	7%
Undersea Warfare Testing	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-41: Estimated Effects to the Northern Gulf of Mexico Stock of Atlantic Spotted Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	1	3	1	0	-
Explosive	Navy Testing	17	11	1	0	0
Explosive	USCG Training	1	0	-	-	-
Sonar	Navy Training	508	280	0	-	-
Sonar	Navy Testing	6,523	5,425	18	-	-
Sonar	USCG Training	35	-	-	-	-
Maximum Annual Total		**7,085**	**5,719**	**20**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
21,506	0.60	0.00

Season	Percent of Total Impacts: Gulf of Mexico
Winter	23%
Spring	23%
Summer	27%
Fall	26%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	41%
Unmanned Underwater Vehicle Testing	Navy Testing	34%
Mine Countermeasure Mission Package Testing	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.19 Pantropical Spotted Dolphin (*Stenella attenuata*)

Pantropical spotted dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Two Pantropical spotted dolphin stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-42 and Table 2.4-43.

The Western North Atlantic stock of Pantropical spotted dolphins can be found in tropical and subtropical waters deep offshore from New England to the Caribbean. They tend to congregate along the continental slope in the Atlantic, north of Cape Hatteras, and over the Blake Plateau and in deeper waters of the mid-Atlantic, south of Cape Hatteras. Their higher densities in deep waters over the continental slope and beyond, especially in the High Seas, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The pantropical spotted dolphin is the most sighted species of cetacean in the oceanic waters of the Northern Gulf of Mexico. The Northern Gulf of Mexico stock of Pantropical spotted dolphins is present year-round in offshore waters, primarily over the lower continental slope. Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico, with fewer impacts in Key West. Most impacts would be due to Unmanned Underwater Vehicle Testing which may employ lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts.

For the Northern Gulf of Mexico stock, the model-predicted mortalities, non-auditory injuries, and auditory injuries for testing explosives are due to Small Ship Shock Trials. These mortalities, non-auditory injuries, and some auditory injuries could be mitigated, as the visual observation mitigation zone is intensely monitored before, during, and following a ship shock trial detonation (see the *Mitigation* section). A typical pod of hundreds to thousands of Pantropical spotted dolphins within the range to injury would likely be sighted during extensive pre-event visual observations. No marine mammal mortalities have been identified during multi-day post-event observations following previous ship shock trials.

On average, individuals in the Western North Atlantic stock could be impacted about twice per year. On average, individuals in the Gulf of Mexico stock would be impacted less than once per year. A small number of injuries could occur to individuals in either stock, although the risk of injury may be reduced through visual observation mitigation, especially since Pantropical spotted dolphins tend to travel in large groups. The average individual risk of injury is negligible.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As small odontocete income breeders with a medium pace of life, Pantropical spotted dolphins are likely somewhat resilient to missed foraging opportunities due to acoustic disturbance, except for during lactation(Farmer et al., 2018). Both stocks of Pantropical spotted dolphins move within their range year-round. Because the Western North Atlantic stock is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. However, risk of impacts appears to increase as this population travels through the High Sea portion of the Study Area in colder months. Although the Northern Gulf of Mexico stock has a nomadic-resident movement ecology, this stock has a low risk of repeated exposure due to the limited number of activities in the area. The Northern Gulf of Mexico stock was greatly impacted by the *Deepwater Horizon* oil spill in 2010.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of Pantropical spotted dolphins are unlikely.

Table 2.4-42: Estimated Effects to the Western North Atlantic Stock of Pantropical Spotted Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	2	1	1	0	0
Explosive	Navy Testing	0	0	0	0	0
Sonar	Navy Training	5,641	5,332	2	-	-
Sonar	Navy Testing	788	1,299	2	-	-
Sonar	USCG Training	5	-	-	-	-
Maximum Annual Total		**6,436**	**6,632**	**5**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
6,593	1.98	0.00

	Percent of Total Impacts		
Season	Mid-Atlantic	Southeast	High Seas
Winter	5%	7%	20%
Spring	4%	8%	13%
Summer	4%	5%	7%
Fall	4%	9%	14%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	49%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	8%
Composite Training Unit Exercise	Navy Training	7%
At-Sea Sonar Testing	Navy Testing	7%
Anti-Submarine Warfare Tracking Exercise - Submarine	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-43: Estimated Effects to the Northern Gulf of Mexico Stock of Pantropical Spotted Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	1	1	1	1	0
Explosive	Navy Testing	2	11	2	2	2
Explosive	USCG Training	0	0	0	-	-
Sonar	Navy Training	498	220	1	-	-
Sonar	Navy Testing	4,088	1,495	2	-	-
Sonar	USCG Training	0	-	-	-	-
Maximum Annual Total		**4,589**	**1,727**	**6**	**3**	**2**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
37,194	0.17	0.00

Season	Percent of Total Impacts: Key West	Percent of Total Impacts: Gulf of Mexico
Winter	10%	15%
Spring	5%	7%
Summer	5%	25%
Fall	8%	24%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	36%
Sonobuoy Lot Acceptance Test	Navy Testing	12%
Acoustic and Oceanographic Research (ONR)	Navy Testing	11%
Torpedo (Non-Explosive) Testing	Navy Testing	9%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	6%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.20 Striped Dolphin (*Stenella coeruleoalba*)

Striped dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Two striped dolphin stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-44 and Table 2.4-45.

The Western North Atlantic stock of striped dolphins generally congregate over deeper waters of the continental slope from Nova Scotia to Cape Hatteras. Their year-round higher densities in deep waters over the Atlantic continental shelf break, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most sonar impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. The number of impacts due to air guns would be limited.

The Northern Gulf of Mexico stock of striped dolphins is present year-round in deep, offshore waters of the Gulf of Mexico. Impacts to this stock are attributable to a variety of activities that occur in military readiness areas across the Gulf of Mexico, with fewer impacts in Key West. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. Most auditory impacts would be due to Unmanned Underwater Vehicle Testing which may employ sonars with lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence.

For both stocks, the model-predicted mortalities, non-auditory injuries, and nearly all auditory injuries for testing explosives are due to Small Ship Shock Trials. These mortalities, non-auditory injuries, and some auditory injuries could be mitigated, as the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly species that occur in groups. Striped dolphins tend to travel in large groups up to one hundred individuals. No marine mammal mortalities have been identified during multi-day post-event observations following previous ship shock trials.

On average, individuals in the Western North Atlantic stock could be impacted several times per year. On average, individuals in the Gulf of Mexico stock would be impacted less than once per year. A small number of injuries could occur to individuals in either stock, although the risk of injury may be reduced through mitigation, especially since striped dolphins tend to travel in large groups.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As income breeders with a small body and medium pace of life, striped dolphins are somewhat resilient to missed foraging opportunities due to acoustic disturbance, except for during lactation (Farmer et al., 2018). Striped dolphins are nomadic, so the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range year-round. The Northern Gulf of Mexico stock of striped dolphins has a potentially stable population, although they are listed as strategic. This species was greatly impacted by the *Deepwater Horizon* oil spill in 2010. Because of their longer generation times, this population would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience an injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of striped dolphins are unlikely.

Table 2.4-44: Estimated Effects to the Western North Atlantic Stock of Striped Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	-	-	-	-
Explosive	Navy Training	11	13	3	1	0
Explosive	Navy Testing	17	78	16	15	6
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	69,973	51,282	22	-	-
Sonar	Navy Testing	37,593	49,900	134	-	-
Sonar	USCG Training	0	-	-	-	-
Maximum Annual Total		**107,596**	**101,274**	**175**	**16**	**6**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
67,036	3.12	0.00

	Percent of Total Impacts		
Season	Northeast	Mid-Atlantic	High Seas
Winter	2%	32%	2%
Spring	2%	25%	1%
Summer	1%	13%	1%
Fall	1%	19%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	26%
At-Sea Sonar Testing	Navy Testing	22%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	9%
Small Coordinated ASW	Navy Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-45: Estimated Effects to the Northern Gulf of Mexico Stock of Striped Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	1	1	0	-
Explosive	Navy Testing	1	10	4	2	1
Explosive	USCG Training	0	-	-	-	-
Sonar	Navy Training	186	57	0	-	-
Sonar	Navy Testing	1,541	580	0	-	-
Maximum Annual Total		**1,728**	**648**	**5**	**2**	**1**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
7,782	0.31	0.00

	Percent of Total Impacts	
Season	Key West	Gulf of Mexico
Winter	17%	23%
Spring	3%	14%
Summer	3%	5%
Fall	7%	28%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	49%
Sonobuoy Lot Acceptance Test	Navy Testing	12%
Torpedo (Non-Explosive) Testing	Navy Testing	8%
Airborne Mine Countermeasures - Mine Detection	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.21 Clymene Dolphin (*Stenella clymene*)

Clymene dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Two Clymene dolphin stocks are in the Study Area – the Western North Atlantic stock and the Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Gulf of Mexico stocks are presented in Table 2.4-46 and Table 2.4-47.

While the Western North Atlantic stock of Clymene dolphins has been sighted as far north as New Jersey, they are a primarily tropical and subtropical species and prefer the deep water over the continental shelf of Cape Hatteras. Their year-round higher densities in deep waters over the Atlantic continental shelf, especially in the mid-Atlantic to the east of the Chesapeake Bay mouth, overlap areas where Anti-Submarine Warfare activities are concentrated. Most impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Auditory injuries could occur for this stock due to At-Sea Sonar Testing activities concentrated in the Virginia Capes Range Complex. Explosive impacts would be limited, and no impacts are predicted for air guns.

For the Western North Atlantic stock, the model-predicted mortality, non-auditory injury, and auditory injury for explosive testing activities are due to Small Ship Shock Trials. These mortalities, non-auditory injuries, and some auditory injuries could be mitigated, as the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly species that occur in groups. The number of other impacts due to explosives would be limited. For training activities, the annual model-predicted mortality and non-auditory injury are the combined impacts for activities per the summation and rounding approach discussed above.

The Gulf of Mexico stock of Clymene dolphins is most frequently sighted on the lower slope and deep-water areas west of the Mississippi River. Although the predicted densities of this stock have decreased, there is year-round higher abundances in deep waters of the Gulf of Mexico. Most auditory impacts would be due to Acoustic and Oceanographic Research activities. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock and the number of impacts due to other acoustic and explosive stressors would be limited. No impacts are predicted for air guns. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence.

On average, individuals in the Western North Atlantic stock could be affected multiple times over a year, although most estimated impacts are non-injurious. There is a large discontinuity between the density model within the U.S. Exclusive Economic Zone, which was used to assess annual impacts to individuals, and the density model in farther oceanic areas where impacts from some activities were modeled. Thus, the estimate of repeated takes to individuals is likely over-estimated. On average, individuals in the Gulf of Mexico stock would be impacted less than once per year. A small number of injuries could occur to individuals in either stock, although the risk of injury may be reduced through visual observation mitigation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As small odontocete income breeders with a fast pace of life, Clymene dolphins are likely less resilient to missed foraging opportunities due to acoustic disturbance, especially during lactation. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations are quick to recover. Clymene dolphins are nomadic, so the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range year-round. Risk of impacts would also be similar across seasons and critical life functions. The Gulf of Mexico stock of Clymene dolphins is possibly increasing, although they are still listed as strategic. The Gulf of Mexico stock was impacted by the *Deepwater Horizon* oil spill in 2010. A very large number of impacts in the Gulf of Mexico Range Complex could have a significant effect on the Gulf of Mexico stock of Clymene dolphins.

As discussed above, the estimates of repeated disturbance are likely over-estimated for the North Atlantic stock. A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience an injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Gulf of Mexico stocks of Clymene dolphins are unlikely.

Table 2.4-46: Estimated Effects to the Western North Atlantic Stock of Clymene Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	16	21	6	1	1
Explosive	Navy Testing	5	6	1	1	1
Explosive	USCG Training	-	0	0	-	-
Sonar	Navy Training	39,694	29,729	8	-	-
Sonar	Navy Testing	20,507	42,746	87	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**60,223**	**72,502**	**102**	**2**	**2**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
8,573	15.49	0.01

Season	Percent of Total Impacts: Mid-Atlantic	Percent of Total Impacts: High Seas
Winter	33%	1%
Spring	26%	0%
Summer	15%	0%
Fall	24%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	30%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	27%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	9%
Small Coordinated ASW	Navy Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-47: Estimated Effects to the Northern Gulf of Mexico Stock of Clymene Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	0	0	-	-
Explosive	Navy Testing	1	1	1	1	0
Explosive	USCG Training	-	0	-	-	-
Sonar	Navy Training	35	31	0	-	-
Sonar	Navy Testing	354	177	1	-	-
Maximum Annual Total		**390**	**209**	**2**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
3,126	0.19	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	12%	25%
Spring	0%	16%
Summer	1%	13%
Fall	1%	31%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	49%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	9%
Sonobuoy Lot Acceptance Test	Navy Testing	7%
Torpedo (Non-Explosive) Testing	Navy Testing	7%
Unmanned Underwater Vehicle Testing	Navy Testing	6%
Submarine Sea Trials - Weapons System Testing	Navy Testing	5%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.22 Spinner Dolphin (*Stenella longirostris*)

Spinner dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Three Spinner dolphin stocks are in the Study Area – the Western North Atlantic stock, the Northern Gulf of Mexico stock, and the Puerto Rico and U.S. Virgin Islands stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-48 and Table 2.4-49. There are no predicted impacts to the Puerto Rico and U.S. Virgin Islands stock.

The distribution of the Western North Atlantic stock of spinner dolphins in the Atlantic is poorly known, but spinner dolphins have higher abundances in deep water along most of the United States coast. Their year-round higher densities in deep waters of the Western North Atlantic, especially in the mid-Atlantic and high seas, overlap areas where Anti-Submarine Warfare activities would occur. Most impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Decreases in estimated spinner dolphin density have likely contributed to the decrease in the estimated impacts since the prior analysis. Impacts due to explosives are limited. No impacts are predicted due to air guns.

While spinner dolphins in the Gulf of Mexico can be found as far west as Texas, they are primarily located in offshore waters beyond the edge of the continental shelf east of the Mississippi River. Nearly all impacts would be due to Unmanned Underwater Vehicle Testing at the Naval Surface Warfare Center Panama City Division Testing Range. This activity may employ sonars with lower source levels, but for longer periods and at frequencies where HF cetaceans are susceptible to auditory impacts. Because fewer Anti-Submarine Warfare activities with hull-mounted sonars are used in these regions, there are relatively fewer impacts to this stock. There are no auditory or non-auditory injuries predicted for this stock. Decreases in estimated spinner dolphin density have likely contributed to the decrease in the estimated impacts since the prior analysis. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence. No impacts are predicted due to air guns.

On average, individuals in the Western North Atlantic stock could be impacted less than twice per year. On average, individuals in the Northern Gulf of Mexico could be impacted less than a once per year. The average risk of injury to both stocks is negligible, although a small number of auditory injuries are predicted for the Western North Atlantic stock. The risk of injury may be reduced through visual observation mitigation, as spinner dolphins have relatively higher sightability.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As income breeders with a small body and a fast pace of life, spinner dolphins are less resilient to missed foraging opportunities due to acoustic disturbance, especially during lactation. Because this stock is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of impacts would also be similar across seasons and critical life functions. The population trend for the Western North Atlantic stock is unknown. The Northern Gulf of Mexico stock of spinner dolphins has a potentially stable population, but this stock was impacted the most of any cetacean stock exposed to the *Deepwater Horizon* oil spill in 2010. Recovery of this stock was estimated to take the longest (105 years) without active restoration efforts. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations are quick to recover.

Limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Long-term consequences to these stocks are unlikely.

Table 2.4-48: Estimated Effects to the Western North Atlantic Stock of Spinner Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	1	0	-	-
Explosive	Navy Testing	1	1	0	0	-
Sonar	Navy Training	2,193	1,991	1	-	-
Sonar	Navy Testing	410	757	1	-	-
Sonar	USCG Training	3	-	-	-	-
Maximum Annual Total		**2,607**	**2,750**	**2**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
4,102	1.31	0.00

Season	Percent of Total Impacts: Northeast	Mid-Atlantic	Southeast	High Seas
Winter	3%	15%	9%	13%
Spring	1%	5%	9%	11%
Summer	1%	2%	1%	5%
Fall	1%	13%	2%	10%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	44%
At-Sea Sonar Testing	Navy Testing	11%
Airborne Mine Countermeasures - Mine Detection	Navy Training	6%
Small Coordinated ASW	Navy Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-49: Estimated Effects to the Northern Gulf of Mexico Stock of Spinner Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	-	0	-	-	-
Explosive	Navy Testing	0	1	0	0	-
Sonar	Navy Training	12	8	0	-	-
Sonar	Navy Testing	466	169	-	-	-
Maximum Annual Total		**478**	**178**	**0**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
2,991	0.22	0.00

Season	Percent of Total Impacts: Key West	Percent of Total Impacts: Gulf of Mexico
Winter	0%	19%
Spring	0%	34%
Summer	0%	18%
Fall	1%	28%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	86%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.23 Rough-Toothed Dolphin (*Steno bredanensis*)

Rough-toothed dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Two rough-toothed dolphin stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-50 and Table 2.4-51.

Rough-toothed dolphins are the most widely distributed tropical dolphin in the Study Area. The Western North Atlantic stock can be found from New England to Florida, particularly in deep oceanic and continental shelf waters. Their year-round higher densities in deep waters over the Atlantic continental shelf, especially in the Southeast, overlap areas where Anti-Submarine Warfare activities would occur. Most impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Decreases in estimated rough-toothed dolphin density have likely contributed to the decrease in the estimated impacts since the prior analysis. Impacts due to explosives would be limited. No impacts are predicted due to air guns.

The Northern Gulf of Mexico stock of rough-toothed dolphins has year-round higher densities in both continental shelf and oceanic waters of the Gulf of Mexico. Most auditory and behavioral impacts would be due to unmanned underwater vehicle and Acoustic and Oceanographic Research activities. The number of impacts due to explosives would be limited and impacts due to air guns would be unlikely. The risk of a single non-auditory injury from explosives is low in any year, but a non-auditory injury is predicted when summing across seven years. This non-auditory injury is shown in the maximum year of impacts per the summation and rounding approach discussed above. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence.

On average, individuals in the Western North Atlantic stock would be impacted several times per year. Both the stock assessment report abundance estimate and the estimate of abundance within the NMSDD likely does not cover the full oceanic range of this stock. Thus, the estimate of annual takes per individual is likely an over-estimate. On average, individuals in the Northern Gulf of Mexico stock would be impacted less than once per year. The average risk of injury is low for the Western North Atlantic stock and negligible for the Gulf of Mexico stock, although auditory injuries are predicted for both. A small number of injuries could occur to individuals in either stock. The risk of injury may be reduced through visual observation mitigation, as rough-toothed dolphins are moderately sightable.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As income breeders with a small body and a medium pace of life, rough-toothed dolphins have some resilience to missed foraging opportunities due to acoustic disturbance, except for during lactation. Because the Western North Atlantic stock is nomadic and the Gulf of Mexico Stock is nomadic-resident, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of impacts would also be similar across seasons and critical life functions. The population trend for the Western North Atlantic stock is unknown. While the Northern Gulf of Mexico stock of rough-toothed dolphins has a potentially stable population, this species was impacted by the *Deepwater Horizon* oil spill in 2010 and was estimated to take decades to recover. In addition, because of their longer generation times, this population would require more time to recover if it was further significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic and Northern Gulf of Mexico stocks of rough-toothed dolphins are unlikely.

Table 2.4-50: Estimated Effects to the Western North Atlantic Stock of Rough-Toothed Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	2	2	1	0	-
Explosive	Navy Testing	1	1	0	0	-
Sonar	Navy Training	1,444	1,917	2	-	-
Sonar	Navy Testing	425	959	3	-	-
Sonar	USCG Training	2	-	-	-	-
Maximum Annual Total		**1,874**	**2,879**	**6**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
824	5.78	0.01

	Percent of Total Impacts		
Season	**Mid-Atlantic**	**Southeast**	**High Seas**
Winter	11%	18%	3%
Spring	9%	13%	2%
Summer	6%	11%	1%
Fall	11%	13%	2%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	25%
At-Sea Sonar Testing	Navy Testing	15%
Composite Training Unit Exercise	Navy Training	14%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	8%
Small Coordinated ASW	Navy Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-51: Estimated Effects to the Northern Gulf of Mexico Stock of Rough-Toothed Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	1	1	0	-	-
Explosive	Navy Testing	6	4	1	1	0
Explosive	USCG Training	0	0	-	-	-
Sonar	Navy Training	89	37	-	-	-
Sonar	Navy Testing	888	612	1	-	-
Sonar	USCG Training	4	-	-	-	-
Maximum Annual Total		**988**	**654**	**2**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
3,452	0.48	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	2%	29%
Spring	2%	16%
Summer	2%	19%
Fall	2%	28%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	37%
Acoustic and Oceanographic Research (ONR)	Navy Testing	18%
Insertion/Extraction (NAVSEA)	Navy Testing	9%
Mine Countermeasure Mission Package Testing	Navy Testing	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.24 Common Bottlenose Dolphin (*Tursiops truncatus*)

Bottlenose dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. There are multiple oceanic, coastal, and estuarine stocks in the Study Area. Model-predicted impacts to each stock are presented in Table 2.4-52 through Table 2.4-74. After the Atlantic offshore table, tables are ordered from north to south in the Atlantic and from east to west in the Gulf of Mexico. There are no predicted impacts to many of the bottlenose dolphin stocks in the Study Area.[4] In prior analyses, impacts to stocks were apportioned after modeling of impacts on a combined common bottlenose dolphin density. In this analysis, offshore and coastal bottlenose dolphin stocks were apportioned directly in the model, and densities were developed for all inland stocks (i.e., bays and estuaries) that may overlap military readiness activities.

[4] There are no model-predicted impacts to the following Atlantic common bottlenose dolphin stocks: Northern South Carolina Estuarine System; Charleston Estuarine System; Central Georgia Estuarine System; Biscayne Bay; Florida Keys (Bahia Honda to Key West), and Puerto Rico and U.S. Virgin Islands. There are no model-predicted impacts to the following Gulf of Mexico common bottlenose dolphin stocks: Laguna Madre; Copano Bay/Aransas Bay/San Antonio Bay/Redfish Bay/Espiritu Santo Bay; Matagorda Bay/Tres Palacios Bay/Lavaca Bay; West Bay; Galveston Bay/East Bay/Trinity Bay; Calcasieu Lake; Vermillion Bay/West Cote Blanche Bay/Atchafalaya Bay; Terrebonne-Timbalier Bay Estuarine System; Barataria Bay Estuarine System; Mississippi River Delta; Mobile Bay/Bon Secour Bay; Perdido Bay; Pensacola Bay/East Bay; Choctawhatchee Bay; St. Vincent Sound/Apalachicola Bay/St. George Sound; Apalachee Bay; Waccasassa Bay/Withlacoochee Bay/Crystal Bay; St. Joseph Sound/Clearwater Harbor; Sarasota Bay/Little Sarasota Bay; Pine Island Sound/Charlotte Harbor/Gasparilla Sound/Lemon Bay; Caloosahatchee River; Estero Bay; Chokoloskee Bay/Ten Thousand Islands/Gullivan Bay; Whitewater Bay; Florida Bay; and Florida Keys.

Bottlenose dolphins occur in tropical to temperate waters of the Atlantic Ocean and in the Gulf of Mexico, including migratory and nomadic oceanic stocks; regional migratory and nomadic coastal stocks; and generally resident stocks in bays, sounds, and estuaries.

Most impacts to the Western North Atlantic Offshore Stock are due to Anti-Submarine Warfare activities in the mid-Atlantic and the southeast regions (see Table 2.4-52). Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. The model-predicted mortality, non-auditory injuries, and nearly all auditory injuries for testing explosives are due to small shipshock trials. These mortalities, non-auditory injuries, and some auditory injuries could be mitigated, as the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly species that occur in groups. Bottlenose dolphins tend to travel in groups of several animals to over a hundred. No marine mammal mortalities have been identified during multi-day post-event observations following previous ship shock trials. The risk of mortality from training explosives is low (less than one) in any year and is mostly attributable to mine neutralization explosive ordnance disposal. A single mortality is shown in the maximum year of impacts when summing risk across seven years and following the rounding approach discussed in Section 2.4 (Species Impact Assessments). This mortality may be mitigated through visual observation mitigation because lookouts are close to the detonation location. The potential for an individual to be repeatedly impacted is low for this large nomadic-migratory stock, with risk potentially higher in the cool season in the mid-Atlantic and Southeast. Although auditory and non-auditory injuries are predicted, the average risk of injurious impacts to individuals is negligible.

Nearly all auditory impacts and most behavioral impacts on the Western North Atlantic Northern Migratory Coastal stock and the Northern North Carolina Estuarine System stock are due to hull-mounted or submarine sonars while pierside at or navigating out of Norfolk, VA (see Table 2.4-53 and Table 2.4-54). Because the Western North Atlantic Coastal Migratory stock migrates farther up the mid-Atlantic coast in summer, the potential for impacts is greater in the other seasons when this stock is more likely to be present in waters around Virginia. Nearly all impacts on the Northern North Carolina Estuarine System stock would occur in the summer when animals are more likely to occupy inshore locations. On average, individuals in both stocks are likely to be impacted multiple times within a year, with animals close to activities in Norfolk at higher risk and animals in other parts of their range at lower risk. The average risk of injurious impacts to individuals is very low for both stocks.

Impacts to the Southern North Carolina Estuarine System stock (see Table 2.4-55) would be limited. No injuries are predicted. On average, individuals would be impacted less than once per year.

Most impacts to the Western North Atlantic Southern Migratory Stock and Western North Atlantic South Carolina/Georgia Coastal stock are due to Anti-Submarine Warfare activities in the mid-Atlantic and the southeast regions (Table 2.4-56 and Table 2.4-57). The potential for an individual to be repeatedly impacted is low for these migratory stocks. These stocks would overlap in coastal southeast waters in the cool season, when impacts on the Western North Atlantic Southern Migratory Coastal stock would potentially be higher while this stock is present in deeper waters. The average risk of injurious impacts is negligible, although it is likely that a small number of injuries could occur to individuals in both stocks. The risk of mortality from training explosives is low (less than one) in any year for the Western North Atlantic South Carolina/Georgia Coastal stock and is mostly attributable to mine neutralization explosive ordnance disposal. A single mortality is shown in the maximum year of impacts when summing risk across seven years and following the rounding approach discussed in Section 2.4

(Species Impact Assessments.) This mortality may be mitigated through visual observation mitigation because lookouts are close to the detonation location.

Most impacts to the Southern Georgia Estuarine System stock (see Table 2.4-59) are due to submarine navigation. On average, individuals would be impacts less than once per year, and the average risk of injurious impacts is negligible.

Most impacts on the Western North Atlantic Northern Florida Coastal stock would be due to sonar use in the Jacksonville Range Complex (see Table 2.4-60). Most behavioral impacts would occur due to surface ship object detection near Mayport, FL, whereas auditory impacts would be due to various activities using sonars. Because they are nomadic, the risk of repeated impacts on individuals is likely similar within the population as animals move throughout their range. It is likely that individuals in this stock would be impacted multiple times per year. The average risk of injurious impacts is negligible, although it is likely that a small number of injuries could occur.

All impacts to the Jacksonville Estuarine System stock would occur due to sonar use at or near Mayport, FL (see Table 2.4-61). Average annual impact per individual are not shown for this stock. There is no stock assessment report estimate of population size due to the lack of recent data. The population size predicted using the NMSDD is an under-estimate because it does not include all estuarine areas inhabited by this resident stock. It is reasonable to estimate that individuals in this stock may be impacted several times per year. No injuries are predicted for this stock.

The Western North Atlantic Central Florida Coastal stock would be affected by various activities (see Table 2.4-62). While auditory impacts are attributable to a variety of activities, behavioral impacts are mostly attributable to submarine navigation. Similarly, most behavioral impacts on the Indian River Lagoon Estuarine System stock are attributable to submarine navigation (Table 2.4-63). On average, individuals in both stocks would be impacted a couple of times per year. The average risk of injurious impacts is negligible for both stocks, although it is likely that a small number of injuries could occur to individuals in the Western North Atlantic Central Florida Coastal stock.

In the Gulf of Mexico, activities are less likely to involve use of Anti-Submarine Warfare sonars, and impacts are more likely to be attributable to activities using lower source level sonars or impulsive sources related to Mine Warfare, Unmanned Systems, or Other Systems Testing. In the eastern portion of the Gulf of Mexico, this would result in limited impacts with no injuries to the resident-nomadic Gulf of Mexico Eastern Coastal stock, the St. Joseph Bay stock, and the St. Andrew Bay stock (see Table 2.4-65, Table 2.4-66, and Table 2.4-67). To the west, this would result in a limited number of impacts to the resident-nomadic Gulf of Mexico Western Coastal stock (see Table 2.4-72). Farther offshore, most impacts to individuals in the resident- nomadic Northern Gulf of Mexico Continental Shelf stock and nomadic Gulf of Mexico Oceanic stock would similarly be attributable to those activities (see Table 2.4-68 and Table 2.4-69). On average, individuals in all these stocks would be impacted less than once per year. The average risk of injurious impacts to individuals in the Northen Gulf of Mexico Continental Shelf stock, Gulf of Mexico Oceanic stock, and Gulf of Mexico Western Coastal stock is negligible, although it is likely that a small number of injuries could occur.

The resident-nomadic Gulf of Mexico Northern Coastal stock and the resident Mississippi Sound/Lake Borgne/Bay Boudreau stock are the only two bottlenose dolphin stocks that may be exposed to pile driving noise during the Port Damage Repair activity at Gulfport, Mississippi (see Table 2.4-70 and Table 2.4-71). This activity may cause behavioral impacts, but no auditory impacts are predicted. In addition, the Gulf of Mexico Northern Coastal stock may be exposed to near-shore line charge testing that could cause most of this stock's predicted explosive auditory impacts. The cease-fire mitigation zone for this activity would likely prevent some of these model-predicted impacts. On average, individuals in the Gulf of Mexico Northern Coastal stock would be impacted less than once per year, and individuals in the Mississippi Sound/Lake Borgne/Bay Boudreau stock about once a year. The average risk of injurious impacts to individuals in both stocks is negligible.

Civilian Port Defense is an activity that would occur once per year at only one of nine locations. If it were to overlap certain resident bay and estuary stocks, it would be the only activity impacting those stocks (Northern Georgia/ Southern South Carolina Estuarine System, Table 2.4-58; Tampa Bay, Table 2.4-64; Sabine Lake, Table 2.4-73; and Nueces Bay/Corpus Christi Bay, Table 2.4-74). The number of impacts due to this activity is small. At each of these locations, only a portion of animals in the population would be impacted during each event. On average, individuals in these stocks would be impacted less than once per year.

The risk of repeated impacts to individuals of most stocks is very low. On average, individuals in most stocks would be impacted less than once per year. Individuals in the estuarine stocks at homeports at Norfolk, VA and Mayport, FL or in offshore coastal areas near these homeports may be impacted several times per year.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Bottlenose dolphins are income breeders with a small-medium body size and a medium pace of life, suggesting they are moderately resilient to foraging disruption due to acoustic disturbance, except for during lactation. Many stocks have unknown population trends. The two stocks with trend analyses (Western North Atlantic Northern and Southern Migratory Coastal stocks) indicate a potential population decline. Gulf of Mexico stocks that suffered significant population declines due to the *Deepwater Horizon* oil spill in 2010 are estimated to have a multi-decade recovery to baseline population levels, including the Gulf of Mexico Northern Coastal stock; the Mississippi Sound/Lake Borgne/Bay Boudreau stock; the Northern Gulf of Mexico Continental Shelf stock; the Northern Gulf of Mexico Oceanic stock; and Gulf of Mexico Western Coastal stock. Because of their longer generation times, this population would require more time to recover if significantly impacted.

A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who suffer a slight recoverable injury or an auditory injury may experience minor energetic costs. Because bottlenose dolphins are resilient to limited instances of disturbance, long-term consequences are unlikely for any stock in the Study Area.

Table 2.4-52: Estimated Effects to the Western North Atlantic Offshore Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	-	-	-	-
Explosive	Navy Training	50	53	6	1	1
Explosive	Navy Testing	67	76	14	2	1
Explosive	USCG Training	1	1	-	0	-
Sonar	Navy Training	62,316	57,732	20	-	-
Sonar	Navy Testing	28,717	37,950	69	-	-
Sonar	USCG Training	103	1	-	-	-
Maximum Annual Total		**91,255**	**95,813**	**109**	**3**	**2**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
150,704	1.24	0.00

Season	Percent of Total Impacts		
	Northeast	Mid-Atlantic	Southeast
Winter	2%	20%	10%
Spring	2%	16%	8%
Summer	1%	9%	7%
Fall	2%	15%	7%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	18%
At-Sea Sonar Testing	Navy Testing	15%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	10%
Composite Training Unit Exercise	Navy Training	9%
Small Coordinated ASW	Navy Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-53: Estimated Effects to the Western North Atlantic Northern Migratory Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	0	-	-	-
Explosive	Navy Training	21	41	5	1	0
Explosive	Navy Testing	2	2	1	-	-
Sonar	Navy Training	52,040	12,610	28	-	-
Sonar	Navy Testing	2,442	3,790	25	-	-
Sonar	USCG Training	2,712	60	-	-	-
Maximum Annual Total		**57,217**	**16,503**	**59**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
10,325	7.15	0.01

Season	Percent of Total Impacts
	Mid-Atlantic
Winter	30%
Spring	32%
Summer	8%
Fall	30%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Surface Ship Object Detection	Navy Training	40%
Submarine Navigation	Navy Training	21%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	14%
Unmanned Underwater Vehicle Training - Certification and Development	Navy Training	7%
Pierside Sonar Testing	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-54: Estimated Effects to the Northern North Carolina Estuarine System Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	-	-	-	-
Explosive	Navy Testing	-	0	0	-	-
Sonar	Navy Training	7,653	1,527	3	-	-
Sonar	Navy Testing	436	415	3	-	-
Sonar	USCG Training	489	11	-	-	-
Maximum Annual Total		**8,579**	**1,953**	**6**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,227	8.59	0.00

Season	Percent of Total Impacts
	Mid-Atlantic
Winter	0%
Spring	1%
Summer	98%
Fall	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Surface Ship Object Detection	Navy Training	44%
Submarine Navigation	Navy Training	16%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	14%
Unmanned Underwater Vehicle Training - Certification and Development	Navy Training	9%
Pierside Sonar Testing	Navy Testing	6%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Northern NC Estuarine System Coastal (1,2,3,7,8,9,10,11,12)	20	13	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:08 AM

Table 2.4-55: Estimated Effects to the Southern North Carolina Estuarine System Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	-	-	-	-
Explosive	Navy Testing	0	-	-	-	-
Sonar	Navy Training	81	80	-	-	-
Maximum Annual Total		**82**	**80**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
486	0.33	0.00

Season	Percent of Total Impacts	
	Mid-Atlantic	Southeast
Winter	10%	0%
Spring	13%	0%
Summer	17%	0%
Fall	59%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Small Coordinated ASW	Navy Training	61%
Civilian Port Defense	Navy Training	37%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Southern NC Estuarine System (7,8,9,10)	1	0	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:51 AM

Table 2.4-56: Estimated Effects to the Western North Atlantic Southern Migratory Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	19	29	4	1	0
Explosive	Navy Testing	9	3	1	0	-
Sonar	Navy Training	2,345	6,475	2	-	-
Sonar	Navy Testing	269	734	1	-	-
Sonar	USCG Training	294	3	-	-	-
Maximum Annual Total		**2,936**	**7,244**	**8**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
7,911	1.29	0.00

Season	Percent of Total Impacts	
	Mid-Atlantic	Southeast
Winter	15%	15%
Spring	25%	13%
Summer	10%	2%
Fall	10%	10%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Small Coordinated ASW	Navy Training	25%
Composite Training Unit Exercise	Navy Training	22%
Sustainment Exercise	Navy Training	10%
Small Integrated ASW	Navy Training	9%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:16 AM

Table 2.4-57: Estimated Effects to the Western North Atlantic South Carolina / Georgia Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	5	5	1	0	1
Explosive	Navy Testing	9	3	1	0	0
Sonar	Navy Training	1,172	2,685	2	-	-
Sonar	Navy Testing	239	841	2	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**1,426**	**3,534**	**6**	**0**	**1**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
6,027	0.82	0.00

Season	Percent of Total Impacts	
	Mid-Atlantic	Southeast
Winter	2%	30%
Spring	1%	26%
Summer	1%	16%
Fall	1%	23%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Composite Training Unit Exercise	Navy Training	28%
Small Coordinated ASW	Navy Training	15%
Acoustic and Oceanographic Research (ONR)	Navy Testing	13%
Undersea Warfare Testing	Navy Testing	8%
Medium Coordinated ASW	Navy Training	7%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	6%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:20 AM

Table 2.4-58: Estimated Effects to the Northern Georgia / Southern South Carolina Estuarine System Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	2	-	-	-	-
Maximum Annual Total		**2**	**-**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts
	Southeast
Winter	20%
Spring	5%
Summer	39%
Fall	36%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Civilian Port Defense	Navy Training	100%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:17 AM

Table 2.4-59: Estimated Effects to the Southern Georgia Estuarine System Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	84	38	1	-	-
Sonar	Navy Testing	1	-	-	-	-
Maximum Annual Total		**85**	**38**	**1**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
619	0.20	0.00

Season	Percent of Total Impacts Southeast
Winter	30%
Spring	21%
Summer	36%
Fall	13%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Submarine Navigation	Navy Training	95%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Southern GA (All)	26	23	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:55 AM

Table 2.4-60: Estimated Effects to the Western North Atlantic Northern Florida Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	2	3	1	0	-
Explosive	Navy Testing	4	1	1	-	-
Sonar	Navy Training	15,287	1,711	1	-	-
Sonar	Navy Testing	1,761	2,616	2	-	-
Sonar	USCG Training	0	-	-	-	-
Maximum Annual Total		**17,054**	**4,331**	**5**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
2,598	8.23	0.00

Season	Percent of Total Impacts Southeast
Winter	35%
Spring	24%
Summer	15%
Fall	25%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Surface Ship Object Detection	Navy Training	71%
Mine Countermeasure Technology Research	Navy Testing	11%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:31 AM

Table 2.4-61: Estimated Effects to the Jacksonville Estuarine System Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	264	84	-	-	-
Sonar	Navy Testing	5	7	0	-	-
Maximum Annual Total		**269**	**91**	**0**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
*	*	*

Season	Percent of Total Impacts
	Southeast
Winter	23%
Spring	17%
Summer	15%
Fall	45%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Surface Ship Object Detection	Navy Training	88%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	7%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Jacksonville (All)	77	1	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:25 AM

Table 2.4-62: Estimated Effects to the Western North Atlantic Central Florida Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	10	8	1	1	-
Explosive	Navy Testing	12	5	1	0	0
Sonar	Navy Training	6,517	1,157	1	-	-
Sonar	Navy Testing	1,377	1,403	0	-	-
Sonar	USCG Training	5	-	-	-	-
Maximum Annual Total		**7,921**	**2,573**	**3**	**1**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
7,063	1.49	0.00

Season	Percent of Total Impacts
	Southeast
Winter	38%
Spring	28%
Summer	11%
Fall	24%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Submarine Navigation	Navy Training	69%
Undersea Warfare Testing	Navy Testing	10%
Acoustic and Oceanographic Research (ONR)	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:35 AM

Table 2.4-63: Estimated Effects to the Indian River Lagoon Estuarine System Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	1,421	1	0	-	-
Sonar	Navy Testing	17	137	0	-	-
Maximum Annual Total		**1,438**	**138**	**0**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,032	1.53	0.00

Season	Percent of Total Impacts Southeast
Winter	34%
Spring	15%
Summer	8%
Fall	43%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Submarine Navigation	Navy Training	89%
Pierside Sonar Testing	Navy Testing	10%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Indian River Lagoon Estuarine System (All)	1,070	110	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:30 AM

Table 2.4-64: Estimated Effects to the Tampa Bay Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	163	187	-	-	-
Maximum Annual Total		**163**	**187**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
599	0.58	0.00

Season	Percent of Total Impacts Gulf of Mexico
Winter	27%
Spring	21%
Summer	26%
Fall	26%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Civilian Port Defense	Navy Training	100%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Tampa Bay (All)	10	12	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:39 AM

Table 2.4-65: Estimated Effects to the Gulf of Mexico Eastern Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	1	-	-	-
Explosive	Navy Testing	-	1	0	-	-
Sonar	Navy Training	27	-	-	-	-
Sonar	Navy Testing	47	3	-	-	-
Maximum Annual Total		**75**	**5**	**0**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
16,407	0.00	0.00

Season	Percent of Total Impacts: Key West	Percent of Total Impacts: Gulf of Mexico
Winter	7%	7%
Spring	6%	32%
Summer	11%	21%
Fall	13%	3%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Mine Detection and Classification Testing (NAVSEA)	Navy Testing	32%
Insertion/Extraction (NAVSEA)	Navy Testing	30%
Mine Countermeasures - Mine Neutralization - Remotely Operated Vehicles	Navy Training	14%
Semi-Stationary Equipment Testing	Navy Testing	11%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:48 AM

Table 2.4-66: Estimated Effects to the St. Joseph Bay Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	7	-	-	-	-
Sonar	Navy Testing	35	-	-	-	-
Maximum Annual Total		**42**	**-**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
142	0.30	0.00

Season	Percent of Total Impacts: Gulf of Mexico
Winter	29%
Spring	24%
Summer	19%
Fall	28%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Insertion/Extraction (NAVSEA)	Navy Testing	77%
Mine Countermeasures - Mine Neutralization - Remotely Operated Vehicles	Navy Training	16%
Unmanned Underwater Vehicle Testing	Navy Testing	6%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	St Joseph Bay (All)	38	-	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:43 AM

Table 2.4-67: Estimated Effects to the St. Andrew Bay Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Testing	1	1	-	-	-
Sonar	Navy Training	14	-	-	-	-
Sonar	Navy Testing	30	0	0	-	-
Maximum Annual Total		**45**	**1**	**0**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
199	0.23	0.00

Season	Percent of Total Impacts
	Gulf of Mexico
Winter	18%
Spring	27%
Summer	35%
Fall	20%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Insertion/Extraction (NAVSEA)	Navy Testing	68%
Mine Countermeasures - Mine Neutralization - Remotely Operated Vehicles	Navy Training	30%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	St. Andrew Bay (All)	42	0	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:56:47 AM

Table 2.4-68: Estimated Effects to the Gulf of Mexico Oceanic Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	1	1	0	-	-
Explosive	Navy Testing	3	1	1	0	0
Explosive	USCG Training	1	0	-	-	-
Sonar	Navy Training	432	83	1	-	-
Sonar	Navy Testing	4,326	1,425	2	-	-
Sonar	USCG Training	1	-	-	-	-
Maximum Annual Total		**4,764**	**1,510**	**4**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
21,997	0.29	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	8%	18%
Spring	8%	16%
Summer	10%	18%
Fall	5%	18%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	40%
Acoustic and Oceanographic Research (ONR)	Navy Testing	17%
Sonobuoy Lot Acceptance Test	Navy Testing	9%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	8%
Torpedo (Non-Explosive) Testing	Navy Testing	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:39 AM

Table 2.4-69: Estimated Effects to the Northern Gulf of Mexico Continental Shelf Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	0	-	-	-
Explosive	Navy Training	14	19	2	1	0
Explosive	Navy Testing	369	177	3	1	0
Explosive	USCG Training	4	3	1	-	-
Sonar	Navy Training	4,268	364	0	-	-
Sonar	Navy Testing	42,067	23,967	21	-	-
Sonar	USCG Training	78	-	-	-	-
Maximum Annual Total		**46,801**	**24,530**	**27**	**2**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
109,059	0.65	0.00

Season	Percent of Total Impacts Gulf of Mexico
Winter	31%
Spring	19%
Summer	26%
Fall	24%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	30%
Insertion/Extraction (NAVSEA)	Navy Testing	25%
Mine Countermeasure Technology Research	Navy Testing	13%
Acoustic and Oceanographic Research (ONR)	Navy Testing	13%
Mine Countermeasure Mission Package Testing	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:12 AM

Table 2.4-70: Estimated Effects to the Gulf of Mexico Northern Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	1	2	1	-	-
Explosive	Navy Testing	86	117	16	-	-
Pile Driving	Navy Training	1,894	0	-	-	-
Sonar	Navy Training	197	-	-	-	-
Sonar	Navy Testing	4,346	503	-	-	-
Maximum Annual Total		**6,524**	**622**	**17**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
11,543	0.62	0.00

Season	Percent of Total Impacts Gulf of Mexico
Winter	32%
Spring	23%
Summer	26%
Fall	19%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Insertion/Extraction (NAVSEA)	Navy Testing	51%
Port Damage Repair	Navy Training	26%
Unmanned Underwater Vehicle Testing	Navy Testing	14%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 16 May 2024 10:57:44 AM

Table 2.4-71: Estimated Effects to the Mississippi Sound Lake Borgne Bay Boudreau Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Pile Driving	Navy Training	1,564	0	-	-	-
Sonar	Navy Testing	151	43	1	-	-
Maximum Annual Total		**1,715**	**43**	**1**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,265	1.39	0.00

Season	Percent of Total Impacts: Gulf of Mexico
Winter	23%
Spring	27%
Summer	25%
Fall	24%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Port Damage Repair	Navy Training	89%
At-Sea Sonar Testing	Navy Testing	6%
Pierside Sonar Testing	Navy Testing	6%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	MS Sound (All)	151	43	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-72: Estimated Effects to the Gulf of Mexico Western Coastal Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	0	0	-	-	-
Explosive	Navy Testing	2	1	1	0	-
Sonar	Navy Training	359	432	-	-	-
Sonar	Navy Testing	1,412	1,125	-	-	-
Maximum Annual Total		**1,773**	**1,558**	**1**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
26,100	0.13	0.00

Season	Percent of Total Impacts: Gulf of Mexico
Winter	38%
Spring	23%
Summer	13%
Fall	26%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Mine Countermeasure Technology Research	Navy Testing	77%
Acoustic and Oceanographic Research (ONR)	Navy Testing	20%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Aransas Pass (All)	0	1	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-73: Estimated Effects to the Sabine Lake Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	1	-	-	-	-
	Maximum Annual Total	**1**	**-**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
148	0.01	0.00

Season	Percent of Total Impacts Gulf of Mexico
Winter	9%
Spring	24%
Summer	33%
Fall	35%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Civilian Port Defense	Navy Training	100%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-74: Estimated Effects to the Nueces Bay / Corpus Christi Bay Stock of Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Navy Training	4	-	-	-	-
Sonar	Navy Testing	0	-	-	-	-
	Maximum Annual Total	**4**	**-**	**-**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
58	0.07	0.00

Season	Percent of Total Impacts Gulf of Mexico
Winter	21%
Spring	27%
Summer	23%
Fall	29%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Civilian Port Defense	Navy Training	100%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.25 Short-Beaked Common Dolphin (*Delphinus delphis*)

Short-beaked common dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. One short-beaked common dolphin stock is in the Study Area – the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock is presented in Table 2.4-75.

Short-beaked common dolphins generally have higher abundances over the continental shelf year-round. While the North Atlantic stock of short-beaked common dolphins can be found from Canada to Florida, they are frequently located off Cape Hatteras to Georges Bank during colder months (mid-January to May) and in Georges Bank during warmer months (mid-summer to autumn). Impacts would be higher in the cool season when they have higher densities in the mid-Atlantic and the northeast. Their higher densities in waters over the continental shelf in the mid-Atlantic, particularly in the winter and spring, overlap areas where Anti-Submarine Warfare activities would occur. While most auditory injuries would be due to Acoustic and Oceanographic Research activities, most impacts overall to this stock are due to Anti-Submarine Warfare activities. Some of Anti-Submarine Warfare activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking.

The model-predicted mortalities, most non-auditory injuries, and a large portion of auditory injuries for testing explosives are due to Small Ship Shock Trials. These mortalities, non-auditory injuries, and some auditory injuries could be mitigated, as the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly species that occur in groups. Short-beaked common dolphins tend to travel in large groups averaging hundreds, and occasionally thousands, of individuals. No marine mammal mortalities have been identified during multi-day post-event observations following previous **ship shock trials**. A large portion of auditory injuries due to testing with explosives is also due to Countermeasure and Neutralization Testing (NAVSEA) conducted in the Virginia Capes Range Complex. This activity has specific visual observation mitigation requirements that may reduce the potential for injurious impacts.

On average, individuals in this stock would be impacted twice per year. A small number of injuries could occur to individuals in the Western North Atlantic stock, although the risk of injury may be reduced through visual observation mitigation.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As income breeders with a small body and a medium pace of life, short-beaked dolphins have some resilience to missed foraging opportunities due to acoustic disturbance, except for during lactation. Because this stock is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of impacts would also be similar across seasons and critical life functions. The population trend for the Western North Atlantic stock of short-beaked common dolphins is unknown. Due to this species' longer generation times, this population would require more time to recover if significantly impacted.

Limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an injury may experience minor energetic costs. Long-term consequences to the stock are unlikely.

Table 2.4-75: Estimated Effects to the Western North Atlantic Stock of Short-Beaked Common Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	-	-	-	-
Explosive	Navy Training	50	42	5	1	-
Explosive	Navy Testing	384	325	32	18	5
Explosive	USCG Training	3	3	1	-	-
Sonar	Navy Training	83,926	81,845	33	-	-
Sonar	Navy Testing	52,543	50,344	100	-	-
Sonar	USCG Training	13	-	-	-	-
Maximum Annual Total		**136,920**	**132,559**	**171**	**19**	**5**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
172,974	1.56	0.00

Season	Percent of Total Impacts: Northeast	Percent of Total Impacts: Mid-Atlantic
Winter	7%	38%
Spring	9%	30%
Summer	4%	2%
Fall	5%	5%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	18%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	16%
At-Sea Sonar Testing	Navy Testing	11%
Small Coordinated ASW	Navy Training	9%
Acoustic and Oceanographic Research (ONR)	Navy Testing	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.26 Risso's Dolphin (*Grampus griseus*)

Risso's dolphins are in the HF cetacean auditory group and the Odontocete behavioral group. Two Risso's dolphin stocks are in the Study Area – the Western North Atlantic stock and the Northern Gulf of Mexico stock. Model-predicted impacts to the Western North Atlantic and Northern Gulf of Mexico stocks are presented in Table 2.4-76 and Table 2.4-77.

While the North Atlantic stock of Risso's dolphins can be found from Newfoundland to Florida, they are frequently located on the continental shelf edge from Cape Hatteras to Georges Bank during warmer months (spring to autumn) and in the mid-Atlantic Bight or further offshore in colder months (winter). Their year-round higher densities in deep waters near and beyond the Atlantic continental shelf break, especially in the mid-Atlantic, overlap areas where Anti-Submarine Warfare activities would occur. Most impacts to this stock are due to these activities. Some of these activities use hull-mounted high duty cycle sonars that increase the potential for auditory effects and masking. Auditory injuries are also attributable to other activities, notably Acoustic and Oceanographic Research.

For the Western North Atlantic stock, the model-predicted mortality, non-auditory injury, and most auditory injuries for testing explosives are due to Small Ship Shock Trials. The mortality, non-auditory injury, and some auditory injuries could be mitigated. The Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly species that occur in groups.

The Northern Gulf of Mexico stock of Risso's dolphins has year-round higher densities in the continental slope waters of the Gulf of Mexico. This stock would be relatively less impacted, with no predicted auditory injuries. Impacts would be most likely due to Anti-Submarine Warfare, Unmanned Systems, and Acoustic and Oceanographic Science and Technology activities. The number of impacts due to explosives would be limited. There would be no impacts due to pile driving because there is no geographic overlap of this stressor with species occurrence.

On average, individuals in the Western North Atlantic stock would be impacted less than twice per year. On average, individuals in the Gulf of Mexico stock would be impacted less than once per year. The average risk of injury is negligible, although a small number of injuries could occur to individuals in the Western North Atlantic stock. The risk of injury may be reduced through visual observation mitigation, as Risso's dolphins are relatively sightable.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As income breeders with a small-medium body and a medium pace of life, Risso's dolphins are moderately resilient to foraging disruption due to acoustic disturbance, except for during lactation. The Western North Atlantic stock is nomadic and the Northern Gulf of Mexico stock is resident-nomadic. The risk of repeated exposures to individuals is likely similar within the populations as animals move throughout their range. Both stocks have unknown population trends. Due to this species' longer generation times, this population would require more time to recover if significantly impacted.

Limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals in the Western North Atlantic stock who suffer an injury may experience minor energetic costs. Long-term consequences to both stocks are unlikely.

Table 2.4-76: Estimated Effects to the Western North Atlantic Stock of Risso's Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Training	4	5	1	1	0
Explosive	Navy Testing	18	31	3	1	1
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	12,425	9,694	3	-	-
Sonar	Navy Testing	7,772	7,293	16	-	-
Sonar	USCG Training	6	-	-	-	-
Maximum Annual Total		**20,226**	**17,024**	**23**	**2**	**1**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
35,215	1.06	0.00

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	High Seas
Winter	6%	11%	6%	1%
Spring	6%	10%	4%	0%
Summer	7%	13%	10%	0%
Fall	5%	12%	8%	0%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	20%
At-Sea Sonar Testing	Navy Testing	17%
Acoustic and Oceanographic Research (ONR)	Navy Testing	8%
Composite Training Unit Exercise	Navy Training	8%
Small Coordinated ASW	Navy Training	6%
Surface Ship Sonar Maintenance and Systems Checks	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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Table 2.4-77: Estimated Effects to the Northern Gulf of Mexico Stock of Risso's Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Training	0	0	0	-	-
Explosive	Navy Testing	1	1	0	0	0
Sonar	Navy Training	16	7	0	-	-
Sonar	Navy Testing	138	40	0	-	-
Sonar	USCG Training	0	-	-	-	-
Maximum Annual Total		**155**	**48**	**0**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
1,974	0.10	0.00

Season	Percent of Total Impacts	
	Key West	Gulf of Mexico
Winter	4%	22%
Spring	7%	9%
Summer	9%	18%
Fall	7%	23%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Unmanned Underwater Vehicle Testing	Navy Testing	30%
Acoustic and Oceanographic Research (ONR)	Navy Testing	17%
Sonobuoy Lot Acceptance Test	Navy Testing	11%
Torpedo (Non-Explosive) Testing	Navy Testing	9%
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	8%
Anti-Submarine Warfare Tracking Exercise - Ship	Navy Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.27 Harbor Porpoise (*Phocoena phocoena*)

Harbor porpoises are in the VHF cetacean auditory group and the Sensitive behavioral group. Model-predicted impacts to the Gulf of Maine/Bay of Fundy stock are presented in Table 2.4-78. There are no predicted impacts to the Gulf of St. Lawrence stock, the Newfoundland stock, and the Greenland stock, which are present in the Study Area but not managed by NMFS.

Harbor porpoises generally have higher abundances in shallow waters (less than 150 m) and near shore, but they sometimes move into deeper offshore waters. While the Gulf of Maine/Bay of Fundy stock of harbor porpoises can be found from Greenland to North Carolina, they are primarily concentrated in the southern Bay of Fundy and northern Gulf of Maine during warmer months (summer), and from Maine to New Jersey during colder months (fall and spring). Most impacts would occur in the Northeast during the cool season when harbor porpoises are present in high densities.

As VHF cetaceans, harbor porpoises are more susceptible to auditory impacts in mid- to high frequencies than other species. Auditory impacts from sonars are attributable to a variety of activities, with most auditory injuries attributable to Acoustic and Oceanographic Research and Anti-Submarine Warfare activities. Harbor porpoises are also more susceptible to behavioral disturbance than other species. Harbor porpoises are highly sensitive to many sound sources and generally demonstrate strong avoidance of most types of acoustic stressors. Overall auditory impacts are lower than in the prior analysis, due to changes in the action and a reduction in predicted sensitivity to auditory impacts in the mid- to high-frequency range.

As VHF cetaceans, harbor porpoises are also more susceptible than other species to auditory impacts from explosives. Auditory injuries are attributable to a variety of activities. Most training auditory injuries are attributable to bombing exercise air-to-surface and Mine Warfare activities in the Virginia Capes Range Complex. Most testing auditory injuries area associated with Acoustic and Oceanographic Research and torpedo (explosive) testing in the Northeast Range Complexes, as well Small Ship Shock Trials.

On average, individuals in this stock would be impacted about once per year. The average risk of injury is negligible, although auditory injuries are predicted. The risk of injury may be reduced through visual observation mitigation. Notably, the Navy conducts extensive visual observations for ship shock trials in accordance with NMFS-reviewed event-specific mitigation and monitoring plans (see the *Mitigation* section). Adherence to these plans increases the likelihood that Lookouts would sight surface active marine mammals within the ship shock trial mitigation zone, particularly species that occur in groups.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. As small odontocetes and income breeders with a fast pace of life, harbor porpoises are less resilient to missed foraging opportunities than larger odontocetes. Because this stock is nomadic-resident, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of impacts would also be similar across seasons and critical life functions. The population trend for the Gulf of Maine/Bay of Fundy stock of harbor porpoises is unknown. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations are quick to recover.

The limited instances of predicted behavioral and non-injurious auditory impacts are unlikely to result in any long-term impacts to individuals, although individuals who suffer an injury may experience minor energetic costs. Long-term consequences to the stock are unlikely.

Table 2.4-78: Estimated Effects to the Gulf of Maine/ Bay of Fundy Stock of Harbor Porpoises over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	2	3	1	-	-
Explosive	Navy Training	74	235	67	0	-
Explosive	Navy Testing	75	120	29	0	0
Explosive	USCG Training	22	24	4	-	-
Sonar	Navy Training	34,065	2,022	6	-	-
Sonar	Navy Testing	46,821	3,627	48	-	-
Sonar	USCG Training	46	6	-	-	-
Maximum Annual Total		**81,105**	**6,037**	**155**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
95,542	0.91	0.00

Season	Percent of Total Impacts: Northeast	Percent of Total Impacts: Mid-Atlantic
Winter	38%	10%
Spring	40%	5%
Summer	3%	0%
Fall	4%	0%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Anti-Submarine Warfare Tracking Test (Fixed-Wing)	Navy Testing	13%
Submarine Navigation	Navy Training	10%
Unmanned Underwater Vehicle Testing	Navy Testing	10%
At-Sea Sonar Testing	Navy Testing	8%
Submarine Sonar Maintenance and Systems Checks	Navy Training	8%
Anti-Submarine Warfare Tracking Test (Rotary Wing)	Navy Testing	7%
Anti-Submarine Warfare Tracking Exercise - Maritime Patrol Aircraft	Navy Training	5%
Acoustic and Oceanographic Research (ONR)	Navy Testing	5%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Draft BIA II	Gulf of ME (7,8,9)	211	4	1	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.3 Impacts on Pinnipeds

All pinnipeds analyzed below are seals in the Phocid Carnivores in Water (PCW) auditory group. The updated PCW criteria reflect greater susceptibility to auditory effects at low and mid-frequencies than previously analyzed.

For sonar exposures, the updated pinniped behavioral response function indicates greater sensitivity to behavioral disturbance compared to the prior analysis. As described in Section 2.2.2 (Quantifying Impacts on Hearing), the methods to model avoidance of sonars have been revised to base a species' probability of an avoidance responses on the behavioral response function. In addition, the cut-off conditions for predicting significant behavioral responses have been revised as shown in Section 2.2.3 (Quantifying Behavioral Responses to Sonars). These factors interact in complex ways that the results of this analysis challenging to compare to prior analyses.

Pinnipeds would not be exposed to nearshore pile driving in the Gulf of Mexico because there is no geographic overlap of this stressor with species occurrence. Impacts due to non-modeled acoustic stressors are discussed above in Section 2.1.4 (Impacts from Vessel Noise), Section 2.1.5 (Impacts from Aircraft Noise), and Section 2.1.6 (Impacts from Weapons Noise).

2.4.3.1 Gray Seal (*Halichoerus grypus*)

The only stock of gray seals in the Study Area is the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock are presented in Table 2.4-79.

While gray seals have been spotted as far south as North Carolina, they are primarily located from Labrador to New Jersey and are known to pup in at least two locations in Maine (Green Island, Seal Island) and one in Massachusetts (Muskeget Island). Gray seals are a coastal species but may forage far from shore.

Most auditory impacts would be attributable to sonar used in submarine navigation and other activities. The potential for repeated effects to individuals is low – on average, individuals in this stock would be impacted less than once per year. The average risk of injurious impacts to individuals is negligible although a small number of auditory injuries could occur. The risk of AINJ could be further reduced with visual observation mitigation. It is more likely that gray seals would experience short-term behavioral impacts.

The risk of repeated impacts to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Gray seals have a fast pace of life, but pinnipeds have a relatively lower energy requirement for their body size, which may moderate any impact due to foraging disruption. The Western North Atlantic stock of gray seals is nomadic-migratory, traveling within their range year-round; therefore, the risk of repeated impacts on individuals is likely similar within the population. Individuals are likely to be exposed to Navy noise sources when in their more southern habitats in the northeast region, especially in colder months when they breed and give birth. Because of their shorter generation times, this population would require less time to recover if significantly impacted.

The population of Western North Atlantic gray seals is likely increasing, although they have been subject to two unusual mortality events along the Northeast Coast of the United States since 2018 due to infectious disease. A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic stock of gray seals are unlikely.

Table 2.4-79: Estimated Effects to the Western North Atlantic Stock of Gray Seals over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	0	-	-	-
Explosive	Navy Training	46	44	3	0	-
Explosive	Navy Testing	38	19	2	0	-
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	5,241	2,531	11	-	-
Sonar	Navy Testing	4,438	3,318	8	-	-
Sonar	USCG Training	46	1	-	-	-
Maximum Annual Total		**9,811**	**5,914**	**24**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
27,300	0.58	0.00

Season	Percent of Total Impacts	
	Northeast	Mid-Atlantic
Winter	27%	17%
Spring	23%	10%
Summer	6%	1%
Fall	16%	0%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Submarine Navigation	Navy Training	25%
Unmanned Underwater Vehicle Testing	Navy Testing	19%
Mine Countermeasure Technology Research	Navy Testing	10%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%
At-Sea Sonar Testing	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.3.2 Harbor Seal (*Phoca vitulina*)

The only stock of harbor seals in the Study Area is the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock are presented in Table 2.4-80.

The Western North Atlantic stock of harbor seals are a nomadic-migratory population, occurring throughout their typical range from the Gulf of St. Lawrence to North Carolina year-round. They inhabit nearshore waters and rarely travel more than 20 km offshore.

Most auditory impacts would be attributable to sonar used in submarine navigation and other activities. The potential for repeated effects on individuals is low – on average, individuals in this stock would be impacted less than once per year. The average risk of injurious impacts to individuals is negligible although a small number of auditory injuries could occur. The risk of AINJ could be further reduced with visual observation mitigation. It is more likely that harbor seals would experience short-term behavioral impacts.

The risk of repeated impacts to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Harbor seals have a fast pace of life, but pinnipeds have a relatively lower energy requirement for their body size, which may moderate any impact due to foraging disruption. Harbor seals travel to exploit seasonally available food and give birth to pups. Specifically, the Western North Atlantic stock of harbor seals frequent southern New England to North Carolina from fall to spring and begin their northward movement to Maine and eastern Canada in spring to summer, although they are also found there year-round. Because they are nomadic/migratory, the risk of repeated impacts on individuals is likely similar within the population.

Individuals are likely to be exposed to Navy noise sources when in their more southern habitats in the northeast region, especially in colder months. Because of their shorter generation times, this population would require less time to recover if significantly impacted.

The population of Western North Atlantic harbor seals may be stable, declining, or shifting its geographic distribution, with increased presence in southern New England and mid-Atlantic regions. In addition to being common bycatch by commercial fisheries, harbor seals have been subject to two unusual mortality events along the Northeast Coast of the United States since 2018 due to infectious disease. A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic stock of harbor seals are unlikely.

Table 2.4-80: Estimated Effects to the Western North Atlantic Stock of Harbor Seals over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	1	0	-	-	-
Explosive	Navy Training	72	67	4	0	-
Explosive	Navy Testing	54	25	2	0	0
Explosive	USCG Training	2	2	1	-	-
Sonar	Navy Training	7,331	3,737	14	-	-
Sonar	Navy Testing	5,878	4,858	11	-	-
Sonar	USCG Training	68	2	-	-	-
Maximum Annual Total		**13,406**	**8,691**	**32**	**0**	**0**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
61,336	0.36	0.00

Season	Percent of Total Impacts	
	Northeast	Mid-Atlantic
Winter	28%	19%
Spring	24%	11%
Summer	0%	0%
Fall	17%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Submarine Navigation	Navy Training	25%
Unmanned Underwater Vehicle Testing	Navy Testing	18%
Mine Countermeasure Technology Research	Navy Testing	9%
At-Sea Sonar Testing	Navy Testing	6%
Acoustic and Oceanographic Research (ONR)	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.3.3 Harp Seal (*Pagophilus groenlandicus*)

The only stock of harp seals in the Study Area is the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock are presented in Table 2.4-81.

The Western North Atlantic stock of harp seals are a migratory population, occurring throughout the Arctic and their cold temperate range year-round but generally following the seasonal movement of pack ice, on which they breed. Their primary range is from Canada to New Jersey, frequenting New England from winter to spring and then migrating north to Canadian waters to pup and breed. Harp seals are closely associated with drifting pack ice – their primary breeding, molting, and foraging habitat, and their range extends beyond the shelf break off Newfoundland.

Most auditory impacts would be attributable to sonar used in submarine navigation and other activities. The potential for repeated effects on individuals is extremely low. On average, individuals in this stock that did experience impacts would most likely do so only once per year. The average risk of injurious impacts to individuals is negligible although a small number of auditory injuries could occur. The risk of AINJ could be further reduced with visual observation mitigation. It is more likely that harp seals would experience short-term behavioral impacts.

The risk of repeated impacts to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Harp seals have a fast pace of life, but pinnipeds have a relatively lower energy requirement for their body size, which may moderate any impact due to foraging disruption. However, compared to other pinnipeds, harp seals may be less resilient to changes in prey availability since they rely primarily on a preferred prey (capelin). The Western North Atlantic stock of harp seals is migratory, traveling within the Study Area primarily from winter to spring. These animals move seasonally to Canadian habitats outside of areas where most activities occur, so the potential for year-round exposure is limited. Individuals are likely to be exposed to Navy noise sources when in their more southern habitats in the northeast region. Harp seals have a large inter-annual variability in reproductive rates due to variations in prey abundance and mid-winter ice coverage and may not reproduce as quickly as other pinnipeds.

While the Western North Atlantic harp seal population is possibly increasing, this stock of harp seals is commercially hunted in Canada and climate change threatens the pack ice that constitutes a key feature of their habitat. A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic stock of harp seals are unlikely.

Table 2.4-81: Estimated Effects to the Western North Atlantic Stock of Harp Seals over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	0	-	-	-	-
Explosive	Navy Testing	13	8	1	0	-
Explosive	USCG Training	2	2	1	-	-
Sonar	Navy Training	7,813	6,819	2	-	-
Sonar	Navy Testing	8,808	2,327	2	-	-
Maximum Annual Total		**16,636**	**9,156**	**6**	**0**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
7,600,000	0.00	0.00

Season	Percent of Total Impacts
	Northeast
Winter	30%
Spring	30%
Summer	11%
Fall	29%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Submarine Navigation	Navy Training	50%
Unmanned Underwater Vehicle Testing	Navy Testing	22%
At-Sea Sonar Testing	Navy Testing	9%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.3.4 Hooded Seal (*Cystophora cristata*)

The only stock of hooded seals in the Study Area is the Western North Atlantic stock. Model-predicted impacts to the Western North Atlantic stock are presented in Table 2.4-82.

The Western North Atlantic stock of hooded seals are a migratory population, occurring throughout the Arctic and their cold temperate range year-round but generally following the seasonal movement of pack ice, on which they breed. Although they have been sighted as far south as Puerto Rico, their typical range is from Canada to Florida, favoring three breeding areas around Canada. When outside of Canada, the Western North Atlantic stock of hooded seals is more likely to occur in Maine from winter to spring and could migrate south to Florida from summer to fall.

Most auditory impacts would be attributable to activities using Anti-Submarine Warfare and other sonars. The potential for repeated effects on individuals is extremely low. On average, individuals in this stock that did experience impacts would most likely do so only once per year. The average risk of injurious impacts to individuals is negligible although a small number of auditory injuries could occur. The risk of AINJ could be further reduced with visual observation mitigation. It is more likely that hooded seals would experience short-term behavioral impacts.

The risk of repeated impacts to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Hooded seals have a fast pace of life, but pinnipeds have a relatively lower energy requirement for their body size, which may moderate any impact due to foraging disruption. Because they are migratory, the risk of repeated impacts on individuals is likely similar within the population. Individuals are likely to be exposed to Navy noise sources in the northeast region. These animals move seasonally within the Study Area and are primarily located in the Northeast (where most activities occur) only in winter to spring, so the potential for year-round exposure is limited. Because of their shorter generation times, this population may require less time to recover if significantly impacted. However, hooded seals may not reproduce as quickly as other pinnipeds when breeding conditions do not provide sufficient ice coverage.

While the Western North Atlantic hooded seal population is likely increasing, this species is commercially hunted in Canada and climate change threatens the pack ice that constitutes a key feature of their habitat. A few instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience injury may incur energetic costs. Based on the above analysis, long-term consequences for the Western North Atlantic stock of hooded seals are unlikely.

Table 2.4-82: Estimated Effects to the Western North Atlantic Stock of Hooded Seals over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Navy Testing	1	1	0	-	-
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Training	343	117	1	-	-
Sonar	Navy Testing	735	527	1	-	-
Maximum Annual Total		**1,080**	**646**	**2**	**-**	**-**

Population Abundance Estimate	Annual Impacts per Individual	Annual Injurious Impacts per Individual
593,300	0.00	0.00

Season	Percent of Total Impacts Northeast
Winter	30%
Spring	37%
Summer	15%
Fall	19%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
At-Sea Sonar Testing	Navy Testing	27%
Unmanned Underwater Vehicle Testing	Navy Testing	17%
Anti-Submarine Warfare Tracking Exercise - Submarine	Navy Training	9%
Submarine Sea Trials - Weapons System Testing	Navy Testing	8%
Submarine Navigation	Navy Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.4 Impacts on Sirenians

The West Indian manatee is the only species of sirenian present in the Study Area. Manatees are assessed using the Mysticete behavioral response function due to the limited data that suggest they are relatively less sensitive to acoustic disturbance. Manatees are in the Sirenian (SI) hearing group. The updated SI criteria reflect slightly greater susceptibility to some mid- to high-frequency auditory impacts compared to the prior analysis (Figure 2.2-1). The model results for sirenians do not incorporate avoidance of sonars.

Impacts due to non-modeled acoustic stressors are discussed above in Section 2.1.4 (Impacts from Vessel Noise), Section 2.1.5 (Impacts from Aircraft Noise), and Section 2.1.6 (Impacts from Weapons Noise).

2.4.4.1 West Indian Manatee (*Trichechus manatus*) - Endangered

Two stocks of West Indian manatees are in the Study Area – the Florida stock and the Puerto Rico stock. There would be no impacts to the Puerto Rico stock. The Florida stock may be incidentally exposed to noise due to military readiness activities.

The Florida stock of West Indian manatees is generally limited to the inland and coastal waters of Florida during the colder months (winter). As the weather warms (spring to fall) they travel as far north as Massachusetts or as far west as coastal Texas in the Gulf of Mexico. The potential for impacts due to exposure to military readiness activities conducted offshore, including use of air guns, would be discountable. Proposed activities with other acoustic and explosive sources were compared to inshore and nearshore manatee densities in Georgia and Florida. The density layer used to assess exposure to military readiness activities likely overestimates manatee density due to limited surveys (see the *Density*

TR). For example, due to lack of winter surveys in Cumberland Sound near King's Bay, GA, fall density estimate was used as a proxy for the winter density estimate.

The potential for sonar exposures due to activities conducted nearshore or at inshore locations on the east coast, including at Kings Bay, GA and Mayport, FL in the Jacksonville Range Complex Inshore, and on the west coast of Florida, including in the Gulf of Mexico Range Complex Inshore, would be low year-round. Any exposure to sonar would be more likely during colder months in shallow water areas along the Florida coast. The greatest potential of overlap with sonar activities would be on the east coast of Florida near Port Canaveral and the South Florida Ocean Measurement Facility. The activities that are most likely to expose manatees to sonar at Port Canaveral are Civilian Port Defense, Pierside Sonar Testing, and Submarine Navigation. Civilian Port Defense is an activity that would occur once every two years at only one of nine possible locations, including Port Canaveral. Thus, it is about as likely as not that the activity will occur at Port Canaveral during the seven-year period analyzed. Submarine Navigation would occur on the Port Canaveral navigation track. For all these activities, Lookouts would conduct visual observation mitigation that would encompass the range to auditory impacts. At South Florida Ocean Measurement Facility, there is only potential for sonar exposures in the winter. There would be limited overlap between activities at South Florida Ocean Measurement Facility and submerged aquatic vegetation, reducing the potential to disturb foraging manatees.

The use of explosives is limited in the shallow water areas where manatees are present. Explosive activities that could overlap nearshore and inshore manatee habitat include Semi-Stationary Equipment Testing at Port Canaveral, FL and Truman Annex Key West; Line Charge Testing at Naval Surface Warfare Center Panama City Division Testing Range; and Mine Neutralization Explosive Ordnance Disposal in the Key West Range Complex Inshore (Demolition Key). These activities have specific visual observation mitigation zones that would reduce the potential for impacts. In addition, use of explosives during Line Charge Testing and Semi-Stationary Equipment Testing would occur only several times per year and less than once per year, respectively, so the potential for overlap with manatee presence in the winter would be limited.

Some individuals may be present in the areas surrounding Gulfport, Mississippi, during Port Damage Repair activities, which include pile driving. Pile driving would occur at an industrial port that does not contain preferred habitat for manatees. Auditory impacts are not anticipated due to the short, predicted ranges to effects (1 m or less for piles driven using impact methods and 12 m or less for piles driven using vibratory methods) and the implementation of 'soft start' procedures that may warn manatees to avoid the area prior to receiving sound levels that could produce these effects. Furthermore, the risk of impacts may be reduced further through visual observation mitigation as the ranges for auditory effects are well within the 100 yd. mitigation zone.

The risk of repeated exposures to individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. Manatees are income breeders with a small-medium body size and a medium pace of life, suggesting they are moderately resilient to foraging disruption due to acoustic disturbance. West Indian manatees are nomadic and move within their range year-round. Even though they are nomadic, the risk of repeated exposures to individuals is likely higher within their habitat in coastal Florida, where most West Indian manatees spend most of their time, especially in winter. Risk of impacts would also be similar across critical life functions. Although they have endured several recent unusual mortality events, the Florida stock of West Indian manatees may have an increasing population. While vessel strike is the largest anthropogenic impact to manatees, entanglement, cold stress, toxic red tide poisoning, and habitat destruction (vegetation loss) are additional risk factors.

Pursuant to the MMPA, the use of acoustic sources or explosives during training or testing activities as described under Alternative 1 or 2 will not result in the unintentional taking of manatees incidental to those activities. Military readiness activities would be dispersed throughout the year, decreasing the likelihood of repeated exposure to the same individual. Pierside and port activities would occur in areas of low-quality habitat, reducing the likelihood of exposure. Mitigations would be in place to halt an activity if a manatee were spotted in the mitigation zone. If a few non-injurious impacts were to occur to an individual over the course of a year, it is unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding or sheltering. These factors would reduce the likelihood that any impacts would be considered take under the military readiness definition.

USFWS designated critical habitat for manatees at multiple inland rivers and coastal waterways throughout Florida. Military readiness activities would not affect access to these inland river and coastal waterways. Critical habitat overlaps the Study Area within the St. Johns River (Mayport), Banana River (Port Canaveral), St. Mary's River entrance channel (near Kings Bay), and a small portion of inland waters encompassed by the South Florida Ocean Measurement Facility Testing Range boundary. Manatees in these portions of the designated West Indian manatee critical habitat areas may be exposed to sonars, vessel noise, and aircraft noise, but are unlikely to be exposed to explosive or weapons noise. These sounds would not affect the biological or physical features that are essential for the reproduction, rest and refuge, health, continued survival, conservation, and recovery of this species. Although the designation did not identify specific physical and biological features essential to the conservation of the manatee, important elements of the habitat required by the West Indian manatee for feeding and breeding have been reported as the presence of seagrasses and warm water refuges, which would not be affected by these proposed activities. Noise from air guns and pile driving would not overlap critical habitat.

Based on the analysis presented above, the use of sonar, pile driving, air guns, and explosives, and activities that produce vessel, aircraft, and weapons noise during military readiness activities <u>may affect</u> West Indian manatees.

Sonars, air guns, explosives, and vessel, aircraft, and weapons noise during military readiness activities would have <u>no effect</u> on designated critical habitat for West Indian manatees. Activities that involve the use of pile driving are <u>not applicable</u> to West Indian manatee critical habitats because there is no geographic overlap of this stressor with those critical habitats.

2.4.5 Impact Summary Tables

The tables in this section show impacts to all stocks under the preferred alternative for the following:

- Maximum annual and seven-year total impacts due to sonar use during Navy training activities, during U.S. Coast Guard training activities only, and during testing activities. The maximum annual impacts per stock are the same values presented in each species impact assessment above. See Table 2.4-83 through Table 2.4-88.
- Maximum annual and seven-year total impacts due to air gun use during testing activities. (Note: No air gun used is proposed during training activities.) See Table 2.4-89 and Table 2.4-90.
- Maximum annual and seven-year total impacts due to pile driving during training activities. (Note: No pile driving is proposed during U.S. Coast Guard training activities nor during testing activities.) See Table 2.4-91 and Table 2.4-92.

- Maximum annual and seven-year total impacts due to explosives during Navy training activities, during U.S. Coast Guard training activities only, and during testing activities (including Small Ship Shock Trials). See Table 2.4-93 through Table 2.4-99.
- Maximum annual impacts due to Small Ship Shock Trials, part of Navy testing. Note that these results were included in the overall explosive results but broken out in these tables for clarity and for consistency with previous analyses. See Table 2.4-97.
- A description of the methods used to calculate the estimated effects to marine mammal stocks from acoustic and explosive stressors over seven years of Navy training and testing is available in Section 2.4 (Species Impact Assessments).

2.4.5.1 Sonar Impact Summary Tables

2.4.5.1.1 Navy Training

Table 2.4-83: Estimated Effects to Marine Mammal Stocks from Sonar and Other Active Transducers over One Year of Maximum Navy Training

Species	Stock	BEH	TTS	AINJ
Blue whale	North Atlantic	6	32	0
Fin whale	Western North Atlantic	218	833	6
North Atlantic right whale	Western	17	56	1
Rice's whale	Northern Gulf of Mexico	1	6	1
Sei whale	Western North Atlantic	38	313	3
Bryde's whale	Primary	1	9	-
Humpback whale	Gulf of ME	56	264	6
Minke whale	Canadian Eastern Coastal	239	2,332	17
Sperm whale	Northern Gulf of Mexico	32	4	-
	North Atlantic	5,692	1,487	1
Atlantic spotted dolphin	Western North Atlantic	34,866	39,711	22
	Northern Gulf of Mexico	508	280	0
Atlantic white-sided dolphin	Western North Atlantic	2,051	1,172	2
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	2,345	6,475	2
	Western North Atlantic SC GA Coastal	1,172	2,685	2
	Western North Atlantic Offshore	62,316	57,732	20
	Western North Atlantic Northern Migratory Coastal	52,040	12,610	28
	Western North Atlantic Northern FL Coastal	15,287	1,711	1
	Western North Atlantic Central FL Coastal	6,517	1,157	0
	Tampa Bay	163	187	-
	St. Joseph Bay	7	-	-
	St. Andrew Bay	14	-	-
	Southern NC Estuarine System	81	80	-
	Southern GA Estuarine System	84	38	1
	Sabine Lake	1	-	-
	Nueces and Corpus Christi Bays	4	-	-
	Northern SC Estuarine System	-	-	-
	Northern NC Estuarine System	7,653	1,527	3
	Northern Gulf of Mexico Continental Shelf	4,268	364	0
	Northern GA/Southern SC Estuarine System	2	-	-
	MS Sound, Lake Borgne, and Bay Boudreau	-	-	-
	Jacksonville Estuarine System	264	84	-
	Indian River Lagoon Estuarine System	1,421	1	0
	Gulf of Mexico Western Coastal	359	432	-
	Gulf of Mexico Oceanic	432	83	1
	Gulf of Mexico Northern Coastal	197	-	-
	Gulf of Mexico Eastern Coastal	27	-	-
	Central GA Estuarine System	0	-	-
Clymene dolphin	Western North Atlantic	39,694	29,729	8
	Northern Gulf of Mexico	35	31	0
False killer whale	Western North Atlantic	236	170	-
	Northern Gulf of Mexico	15	9	-
Fraser's dolphin	Western North Atlantic	1,000	902	1
	Northern Gulf of Mexico	17	6	-
Killer whale	Western North Atlantic	68	42	0

Species	Stock	BEH	TTS	AINJ
	Northern Gulf of Mexico	8	5	-
Long-finned pilot whale	Western North Atlantic	8,540	4,954	2
Melon-headed whale	Western North Atlantic	1,684	1,833	1
	Northern Gulf of Mexico	53	28	-
Pantropical spotted dolphin	Western North Atlantic	5,641	5,332	2
	Northern Gulf of Mexico	498	220	1
Pygmy killer whale	Western North Atlantic	185	183	0
	Northern Gulf of Mexico	18	11	-
Risso's dolphin	Western North Atlantic	12,425	9,694	3
	Northern Gulf of Mexico	16	7	0
Rough-toothed dolphin	Western North Atlantic	1,444	1,917	2
	Northern Gulf of Mexico	89	37	-
Short-beaked common dolphin	Western North Atlantic	83,926	81,845	33
Short-finned pilot whale	Western North Atlantic	12,319	9,414	2
	Northern Gulf of Mexico	54	33	0
Spinner dolphin	Western North Atlantic	2,193	1,991	1
	Northern Gulf of Mexico	12	8	0
Striped dolphin	Western North Atlantic	69,973	51,282	22
	Northern Gulf of Mexico	186	57	0
White-beaked dolphin	Western North Atlantic	3	1	-
Blainville's beaked whale	Western North Atlantic	15,211	53	-
	Northern Gulf of Mexico	12	0	-
Gervais' beaked whale	Western North Atlantic	15,616	143	-
	Northern Gulf of Mexico	13	1	-
Goose-beaked whale	Western North Atlantic	65,767	234	-
	Northern Gulf of Mexico	40	1	-
Northern bottlenose whale	Western North Atlantic	824	4	-
Sowerby's beaked whale	Western North Atlantic	15,679	165	-
True's beaked whale	Western North Atlantic	15,721	169	-
Dwarf sperm whale	Western North Atlantic	743	2,875	25
	Northern Gulf of Mexico	2	8	0
Pygmy sperm whale	Western North Atlantic	774	2,792	25
	Northern Gulf of Mexico	2	9	1
Harbor porpoise	Gulf of ME/Bay of Fundy	34,065	2,022	6
Gray seal	Western North Atlantic	5,241	2,531	11
Harbor seal	Western North Atlantic	7,331	3,737	14
Harp seal	Western North Atlantic	7,813	6,819	2
Hooded seal	Western North Atlantic	343	117	1

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

Table 2.4-84: Estimated Effects to Marine Mammal Stocks from Sonar and Other Active Transducers Over Seven Years of Navy Training

Species	Stock	BEH	TTS	AINJ
Blue whale	North Atlantic	42	220	0
Fin whale	Western North Atlantic	1,520	5,810	38
North Atlantic right whale	Western	113	370	2
Rice's whale	Northern Gulf of Mexico	7	41	1
Sei whale	Western North Atlantic	264	2,136	17
Bryde's whale	Primary	6	63	-
Humpback whale	Gulf of ME	387	1,827	40
Minke whale	Canadian Eastern Coastal	1,665	15,771	113
Sperm whale	Northern Gulf of Mexico	224	28	-
	North Atlantic	39,824	10,380	1
Atlantic spotted dolphin	Western North Atlantic	241,359	266,255	151
	Northern Gulf of Mexico	3,544	1,948	0
Atlantic white-sided dolphin	Western North Atlantic	14,333	8,190	8
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	15,085	41,513	14
	Western North Atlantic SC GA Coastal	7,399	16,942	8
	Western North Atlantic Offshore	431,069	386,677	131
	Western North Atlantic Northern Migratory Coastal	363,648	86,215	196
	Western North Atlantic Northern FL Coastal	106,216	10,461	3
	Western North Atlantic Central FL Coastal	44,348	5,270	0
	Tampa Bay	490	560	-
	St. Joseph Bay	47	-	-
	St. Andrew Bay	92	-	-
	Southern NC Estuarine System	255	279	-
	Southern GA Estuarine System	498	212	1
	Sabine Lake	2	-	-
	Nueces and Corpus Christi Bays	11	-	-
	Northern NC Estuarine System	53,027	10,363	20
	Northern Gulf of Mexico Continental Shelf	29,367	2,365	0
	Northern GA/Southern SC Estuarine System	6	-	-
	Jacksonville Estuarine System	1,825	583	-
	Indian River Lagoon Estuarine System	9,598	3	0
	Gulf of Mexico Western Coastal	1,076	1,296	-
	Gulf of Mexico Oceanic	3,024	580	1
	Gulf of Mexico Northern Coastal	1,379	-	-
	Gulf of Mexico Eastern Coastal	115	-	-
	Central GA Estuarine System	0	-	-
Clymene dolphin	Western North Atlantic	277,855	208,097	54
	Northern Gulf of Mexico	242	217	0
False killer whale	Western North Atlantic	1,647	1,174	-
	Northern Gulf of Mexico	99	61	-
Fraser's dolphin	Western North Atlantic	6,872	5,948	6
	Northern Gulf of Mexico	119	38	-
Killer whale	Western North Atlantic	476	283	0
	Northern Gulf of Mexico	51	31	-
Long-finned pilot whale	Western North Atlantic	59,774	34,676	8
Melon-headed whale	Western North Atlantic	11,682	12,286	2
	Northern Gulf of Mexico	366	195	-
Pantropical spotted dolphin	Western North Atlantic	39,262	36,344	11
	Northern Gulf of Mexico	3,486	1,538	1
Pygmy killer whale	Western North Atlantic	1,283	1,229	0

Species	Stock	BEH	TTS	AINJ
	Northern Gulf of Mexico	125	73	-
Risso's dolphin	Western North Atlantic	86,042	64,728	21
	Northern Gulf of Mexico	109	46	0
Rough-toothed dolphin	Western North Atlantic	9,949	12,681	9
	Northern Gulf of Mexico	617	245	-
Short-beaked common dolphin	Western North Atlantic	587,262	572,658	228
Short-finned pilot whale	Western North Atlantic	85,503	63,500	11
	Northern Gulf of Mexico	377	231	0
Spinner dolphin	Western North Atlantic	15,284	13,673	3
	Northern Gulf of Mexico	80	55	0
Striped dolphin	Western North Atlantic	489,808	358,968	153
	Northern Gulf of Mexico	1,300	394	0
White-beaked dolphin	Western North Atlantic	20	7	-
Blainville's beaked whale	Western North Atlantic	106,367	371	-
	Northern Gulf of Mexico	79	0	-
Gervais' beaked whale	Western North Atlantic	109,195	999	-
	Northern Gulf of Mexico	89	1	-
Goose-beaked whale	Western North Atlantic	459,656	1,636	-
	Northern Gulf of Mexico	280	1	-
Northern bottlenose whale	Western North Atlantic	5,765	24	-
Sowerby's beaked whale	Western North Atlantic	109,639	1,153	-
True's beaked whale	Western North Atlantic	109,931	1,178	-
Dwarf sperm whale	Western North Atlantic	5,191	19,945	174
	Northern Gulf of Mexico	14	55	0
Pygmy sperm whale	Western North Atlantic	5,409	19,359	171
	Northern Gulf of Mexico	14	61	1
Harbor porpoise	Gulf of ME/Bay of Fundy	237,737	14,003	41
Gray seal	Western North Atlantic	36,379	17,593	73
Harbor seal	Western North Atlantic	51,139	25,808	97
Harp seal	Western North Atlantic	54,673	47,692	12
Hooded seal	Western North Atlantic	2,397	808	1

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

2.4.5.1.2 Navy Testing

Table 2.4-85: Estimated Effects to Marine Mammal Stocks from Sonar and Other Active Transducers Over a Maximum Year of Navy Testing

Species	Stock	BEH	TTS	AINJ
Blue whale	North Atlantic	4	25	1
Fin whale	Western North Atlantic	328	1,010	12
North Atlantic right whale	Western	71	236	1
Rice's whale	Northern Gulf of Mexico	79	204	1
Sei whale	Western North Atlantic	75	305	4
Bryde's whale	Primary	1	-	-
Humpback whale	Gulf of ME	127	353	5
Minke whale	Canadian Eastern Coastal	401	1,575	37
Sperm whale	Northern Gulf of Mexico	214	21	-
	North Atlantic	3,174	2,218	3
Atlantic spotted dolphin	Western North Atlantic	16,870	29,186	56
	Northern Gulf of Mexico	6,523	5,425	18
Atlantic white-sided dolphin	Western North Atlantic	5,106	2,547	4
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	269	734	1
	Western North Atlantic SC GA Coastal	239	841	2
	Western North Atlantic Offshore	28,717	37,950	69
	Western North Atlantic Northern Migratory Coastal	2,442	3,790	25
	Western North Atlantic Northern FL Coastal	1,761	2,616	2
	Western North Atlantic Central FL Coastal	1,377	1,403	0
	Tampa Bay	-	-	-
	St. Joseph Bay	35	-	-
	St. Andrew Bay	30	0	0
	Southern NC Estuarine System	-	-	-
	Southern GA Estuarine System	1	-	-
	Sabine Lake	-	-	-
	Nueces and Corpus Christi Bays	0	-	-
	Northern SC Estuarine System	-	-	-
	Northern NC Estuarine System	436	415	3
	Northern Gulf of Mexico Continental Shelf	42,067	23,967	21
	Northern GA/Southern SC Estuarine System	-	-	-
	MS Sound, Lake Borgne, and Bay Boudreau	151	43	1
	Jacksonville Estuarine System	5	7	0
	Indian River Lagoon Estuarine System	17	137	0
	Gulf of Mexico Western Coastal	1,412	1,125	-
	Gulf of Mexico Oceanic	4,326	1,425	2
	Gulf of Mexico Northern Coastal	4,346	503	-
	Gulf of Mexico Eastern Coastal	47	3	-
	Central GA Estuarine System	-	-	-
Clymene dolphin	Western North Atlantic	20,507	42,746	87
	Northern Gulf of Mexico	354	177	1
False killer whale	Western North Atlantic	80	84	1
	Northern Gulf of Mexico	152	52	0
Fraser's dolphin	Western North Atlantic	359	638	1
	Northern Gulf of Mexico	150	66	0
Killer whale	Western North Atlantic	30	37	1
	Northern Gulf of Mexico	76	21	0

Species	Stock	BEH	TTS	AINJ
Long-finned pilot whale	Western North Atlantic	4,220	3,929	6
Melon-headed whale	Western North Atlantic	305	772	2
	Northern Gulf of Mexico	525	163	1
Pantropical spotted dolphin	Western North Atlantic	788	1,299	2
	Northern Gulf of Mexico	4,088	1,495	2
Pygmy killer whale	Western North Atlantic	30	77	0
	Northern Gulf of Mexico	185	69	0
Risso's dolphin	Western North Atlantic	7,772	7,293	16
	Northern Gulf of Mexico	138	40	0
Rough-toothed dolphin	Western North Atlantic	425	959	3
	Northern Gulf of Mexico	888	612	1
Short-beaked common dolphin	Western North Atlantic	52,543	50,344	100
Short-finned pilot whale	Western North Atlantic	4,625	6,626	10
	Northern Gulf of Mexico	574	357	2
Spinner dolphin	Western North Atlantic	410	757	1
	Northern Gulf of Mexico	466	169	-
Striped dolphin	Western North Atlantic	37,593	49,900	134
	Northern Gulf of Mexico	1,541	580	0
White-beaked dolphin	Western North Atlantic	7	5	-
Blainville's beaked whale	Western North Atlantic	10,331	98	0
	Northern Gulf of Mexico	114	0	-
Gervais' beaked whale	Western North Atlantic	9,485	191	-
	Northern Gulf of Mexico	110	0	-
Goose-beaked whale	Western North Atlantic	45,642	373	0
	Northern Gulf of Mexico	417	1	-
Northern bottlenose whale	Western North Atlantic	817	5	-
Sowerby's beaked whale	Western North Atlantic	9,570	198	-
True's beaked whale	Western North Atlantic	9,488	194	-
Dwarf sperm whale	Western North Atlantic	521	2,076	139
	Northern Gulf of Mexico	19	124	5
Pygmy sperm whale	Western North Atlantic	525	2,095	132
	Northern Gulf of Mexico	20	106	4
Harbor porpoise	Gulf of ME/Bay of Fundy	46,821	3,627	48
Gray seal	Western North Atlantic	4,438	3,318	8
Harbor seal	Western North Atlantic	5,878	4,858	11
Harp seal	Western North Atlantic	8,808	2,327	2
Hooded seal	Western North Atlantic	735	527	1

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

Table 2.4-86: Estimated Effects to Marine Mammal Stocks from Sonar and Other Active Transducers Over Seven Years of Navy Testing

Species	Stock	BEH	TTS	AINJ
Blue whale	North Atlantic	27	167	2
Fin whale	Western North Atlantic	2,128	6,469	76
North Atlantic right whale	Western	471	1,511	6
Rice's whale	Northern Gulf of Mexico	536	1,387	4
Sei whale	Western North Atlantic	489	2,003	27
Bryde's whale	Primary	1	-	-
Humpback whale	Gulf of ME	836	2,227	33
Minke whale	Canadian Eastern Coastal	2,631	10,399	253
Sperm whale	Northern Gulf of Mexico	1,281	116	-
	North Atlantic	19,302	15,058	15
Atlantic spotted dolphin	Western North Atlantic	101,954	186,189	381
	Northern Gulf of Mexico	42,782	35,096	113
Atlantic white-sided dolphin	Western North Atlantic	32,124	16,876	24
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	1,664	4,137	6
	Western North Atlantic SC GA Coastal	1,483	4,817	8
	Western North Atlantic Offshore	176,788	249,785	470
	Western North Atlantic Northern Migratory Coastal	14,480	23,416	147
	Western North Atlantic Northern FL Coastal	10,598	15,617	8
	Western North Atlantic Central FL Coastal	8,277	8,253	0
	St. Joseph Bay	240	-	-
	St. Andrew Bay	209	0	0
	Southern GA Estuarine System	1	-	-
	Nueces and Corpus Christi Bays	0	-	-
	Northern NC Estuarine System	2,607	2,544	17
	Northern Gulf of Mexico Continental Shelf	288,739	156,296	132
	MS Sound, Lake Borgne, and Bay Boudreau	832	238	1
	Jacksonville Estuarine System	30	39	0
	Indian River Lagoon Estuarine System	119	955	0
	Gulf of Mexico Western Coastal	8,760	6,977	-
	Gulf of Mexico Oceanic	27,878	9,070	8
	Gulf of Mexico Northern Coastal	30,370	3,519	-
	Gulf of Mexico Eastern Coastal	314	14	-
Clymene dolphin	Western North Atlantic	125,318	290,746	599
	Northern Gulf of Mexico	2,062	1,049	2
False killer whale	Western North Atlantic	495	554	1
	Northern Gulf of Mexico	936	325	0
Fraser's dolphin	Western North Atlantic	2,249	4,345	6
	Northern Gulf of Mexico	911	417	0
Killer whale	Western North Atlantic	180	252	1
	Northern Gulf of Mexico	470	128	0
Long-finned pilot whale	Western North Atlantic	25,633	25,706	41
Melon-headed whale	Western North Atlantic	1,841	5,257	10
	Northern Gulf of Mexico	3,233	1,008	1
Pantropical spotted dolphin	Western North Atlantic	4,970	8,555	13
	Northern Gulf of Mexico	25,521	9,358	12
Pygmy killer whale	Western North Atlantic	186	525	0
	Northern Gulf of Mexico	1,137	436	0
Risso's dolphin	Western North Atlantic	46,827	47,956	103
	Northern Gulf of Mexico	857	238	0
Rough-toothed dolphin	Western North Atlantic	2,546	6,351	15

Species	Stock	BEH	TTS	AINJ
	Northern Gulf of Mexico	5,852	4,008	3
Short-beaked common dolphin	Western North Atlantic	334,319	321,736	634
Short-finned pilot whale	Western North Atlantic	28,176	44,522	64
	Northern Gulf of Mexico	3,391	2,176	12
Spinner dolphin	Western North Atlantic	2,487	5,047	7
	Northern Gulf of Mexico	3,161	1,162	-
Striped dolphin	Western North Atlantic	218,185	330,534	918
	Northern Gulf of Mexico	9,961	3,725	0
White-beaked dolphin	Western North Atlantic	44	32	-
Blainville's beaked whale	Western North Atlantic	65,116	672	0
	Northern Gulf of Mexico	733	0	-
Gervais' beaked whale	Western North Atlantic	60,788	1,306	-
	Northern Gulf of Mexico	709	0	-
Goose-beaked whale	Western North Atlantic	288,385	2,556	0
	Northern Gulf of Mexico	2,679	1	-
Northern bottlenose whale	Western North Atlantic	5,056	33	-
Sowerby's beaked whale	Western North Atlantic	61,349	1,351	-
True's beaked whale	Western North Atlantic	60,825	1,324	-
Dwarf sperm whale	Western North Atlantic	3,205	13,540	937
	Northern Gulf of Mexico	112	820	32
Pygmy sperm whale	Western North Atlantic	3,226	13,665	892
	Northern Gulf of Mexico	122	693	23
Harbor porpoise	Gulf of ME/Bay of Fundy	307,933	23,099	297
Gray seal	Western North Atlantic	29,334	20,924	48
Harbor seal	Western North Atlantic	38,909	30,640	67
Harp seal	Western North Atlantic	56,816	15,303	11
Hooded seal	Western North Atlantic	4,337	3,432	4

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

2.4.5.1.3 Coast Guard Training

Table 2.4-87: Estimated Effects to Marine Mammal Stocks from Sonar and Other Active Transducers Over a Maximum Year of Coast Guard Training

Species	Stock	BEH	TTS	AINJ
Blue whale	North Atlantic	0	-	-
Fin whale	Western North Atlantic	1	-	-
North Atlantic right whale	Western	1	-	-
Rice's whale	Northern Gulf of Mexico	1	-	-
Sei whale	Western North Atlantic	1	-	-
Humpback whale	Gulf of ME	1	-	-
Minke whale	Canadian Eastern Coastal	2	1	-
Sperm whale	North Atlantic	5	-	-
Atlantic spotted dolphin	Western North Atlantic	29	1	-
	Northern Gulf of Mexico	35	-	-
Atlantic white-sided dolphin	Western North Atlantic	3	-	-
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	294	3	-
	Western North Atlantic SC GA Coastal	1	-	-
	Western North Atlantic Offshore	103	1	-
	Western North Atlantic Northern Migratory Coastal	2,712	60	-
	Western North Atlantic Northern FL Coastal	0	-	-
	Western North Atlantic Central FL Coastal	5	-	-
	Northern NC Estuarine System	489	11	-
	Northern Gulf of Mexico Continental Shelf	78	-	-
	Gulf of Mexico Oceanic	1	-	-
Clymene dolphin	Western North Atlantic	1	-	-
False killer whale	Western North Atlantic	1	-	-
Fraser's dolphin	Western North Atlantic	1	-	-
Killer whale	Western North Atlantic	1	-	-
Melon-headed whale	Western North Atlantic	3	-	-
Pantropical spotted dolphin	Western North Atlantic	5	-	-
	Northern Gulf of Mexico	0	-	-
Pygmy killer whale	Western North Atlantic	1	-	-
Risso's dolphin	Western North Atlantic	6	-	-
	Northern Gulf of Mexico	0	-	-
Rough-toothed dolphin	Western North Atlantic	2	-	-
	Northern Gulf of Mexico	4	-	-
Short-beaked common dolphin	Western North Atlantic	13	-	-
Short-finned pilot whale	Western North Atlantic	13	0	-
Spinner dolphin	Western North Atlantic	3	-	-
Striped dolphin	Western North Atlantic	0	-	-
Blainville's beaked whale	Western North Atlantic	7	-	-
Gervais' beaked whale	Western North Atlantic	7	-	-
Goose-beaked whale	Western North Atlantic	40	-	-
Sowerby's beaked whale	Western North Atlantic	6	-	-
True's beaked whale	Western North Atlantic	6	-	-
Dwarf sperm whale	Western North Atlantic	2	4	-
	Northern Gulf of Mexico	0	-	-
Pygmy sperm whale	Western North Atlantic	2	2	-
	Northern Gulf of Mexico	0	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	46	6	-
Gray seal	Western North Atlantic	46	1	-
Harbor seal	Western North Atlantic	68	2	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).Table Created: 27 Aug 2024

Table 2.4-88: Estimated Effects to Marine Mammal Stocks from Sonar and Other Active Transducers Over Seven Years of Coast Guard Training

Species	Stock	BEH	TTS	AINJ
Blue whale	North Atlantic	0	-	-
Fin whale	Western North Atlantic	1	-	-
North Atlantic right whale	Western	4	-	-
Rice's whale	Northern Gulf of Mexico	1	-	-
Sei whale	Western North Atlantic	1	-	-
Humpback whale	Gulf of ME	4	-	-
Minke whale	Canadian Eastern Coastal	11	1	-
Sperm whale	North Atlantic	35	-	-
Atlantic spotted dolphin	Western North Atlantic	200	2	-
	Northern Gulf of Mexico	239	-	-
Atlantic white-sided dolphin	Western North Atlantic	16	-	-
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	2,056	20	-
	Western North Atlantic SC GA Coastal	1	-	-
	Western North Atlantic Offshore	716	1	-
	Western North Atlantic Northern Migratory Coastal	18,984	416	-
	Western North Atlantic Northern FL Coastal	0	-	-
	Western North Atlantic Central FL Coastal	30	-	-
	Northern NC Estuarine System	3,423	71	-
	Northern Gulf of Mexico Continental Shelf	542	-	-
	Gulf of Mexico Oceanic	2	-	-
Clymene dolphin	Western North Atlantic	1	-	-
False killer whale	Western North Atlantic	1	-	-
Fraser's dolphin	Western North Atlantic	7	-	-
Killer whale	Western North Atlantic	1	-	-
Melon-headed whale	Western North Atlantic	19	-	-
Pantropical spotted dolphin	Western North Atlantic	29	-	-
	Northern Gulf of Mexico	0	-	-
Pygmy killer whale	Western North Atlantic	2	-	-
Risso's dolphin	Western North Atlantic	41	-	-
	Northern Gulf of Mexico	0	-	-
Rough-toothed dolphin	Western North Atlantic	14	-	-
	Northern Gulf of Mexico	22	-	-
Short-beaked common dolphin	Western North Atlantic	91	-	-
Short-finned pilot whale	Western North Atlantic	91	0	-
Spinner dolphin	Western North Atlantic	15	-	-
Striped dolphin	Western North Atlantic	0	-	-
Blainville's beaked whale	Western North Atlantic	46	-	-
Gervais' beaked whale	Western North Atlantic	45	-	-
Goose-beaked whale	Western North Atlantic	275	-	-
Sowerby's beaked whale	Western North Atlantic	37	-	-
True's beaked whale	Western North Atlantic	39	-	-
Dwarf sperm whale	Western North Atlantic	10	23	-
	Northern Gulf of Mexico	0	-	-
Pygmy sperm whale	Western North Atlantic	10	11	-
	Northern Gulf of Mexico	0	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	321	40	-
Gray seal	Western North Atlantic	322	7	-
Harbor seal	Western North Atlantic	474	8	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

2.4.5.2 Air Gun Impact Summary Tables

Table 2.4-89: Estimated Effects to Marine Mammal Stocks from Air Guns Over a Maximum Year of Navy Testing

Species	Stock	BEH	TTS	AINJ
Fin whale	Western North Atlantic	1	-	-
North Atlantic right whale	Western	0	-	-
Minke whale	Canadian Eastern Coastal	-	0	-
Sperm whale	North Atlantic	0	-	-
Atlantic spotted dolphin	Western North Atlantic	0	-	-
	Northern Gulf of Mexico	0	-	-
Atlantic white-sided dolphin	Western North Atlantic	0	-	-
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	0	-	-
	Western North Atlantic SC GA Coastal	0	-	-
	Western North Atlantic Offshore	1	-	-
	Western North Atlantic Northern Migratory Coastal	0	0	-
	Western North Atlantic Northern FL Coastal	0	-	-
	Western North Atlantic Central FL Coastal	0	-	-
	Northern Gulf of Mexico Continental Shelf	1	0	-
	Gulf of Mexico Western Coastal	0	-	-
	Gulf of Mexico Oceanic	0	-	-
Killer whale	Western North Atlantic	0	-	-
Pantropical spotted dolphin	Western North Atlantic	0	-	-
	Northern Gulf of Mexico	0	-	-
Risso's dolphin	Western North Atlantic	0	-	-
Rough-toothed dolphin	Northern Gulf of Mexico	0	-	-
Short-beaked common dolphin	Western North Atlantic	1	-	-
Short-finned pilot whale	Western North Atlantic	0	-	-
	Northern Gulf of Mexico	0	-	-
Striped dolphin	Western North Atlantic	1	-	-
Gervais' beaked whale	Western North Atlantic	0	-	-
Dwarf sperm whale	Western North Atlantic	1	1	0
	Northern Gulf of Mexico	1	-	-
Pygmy sperm whale	Western North Atlantic	1	1	-
Harbor porpoise	Gulf of ME/Bay of Fundy	2	3	1
Gray seal	Western North Atlantic	1	0	-
Harbor seal	Western North Atlantic	1	0	-
Harp seal	Western North Atlantic	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

Table 2.4-90: Estimated Effects to Marine Mammal Stocks from Air Guns over Seven Years of Navy Testing

Species	Stock	BEH	TTS	AINJ
Fin whale	Western North Atlantic	1	-	-
North Atlantic right whale	Western	0	-	-
Minke whale	Canadian Eastern Coastal	-	0	-
Sperm whale	North Atlantic	0	-	-
Atlantic spotted dolphin	Western North Atlantic	0	-	-
	Northern Gulf of Mexico	0	-	-
Atlantic white-sided dolphin	Western North Atlantic	0	-	-
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	0	-	-
	Western North Atlantic SC GA Coastal	0	-	-
	Western North Atlantic Offshore	1	-	-
	Western North Atlantic Northern Migratory Coastal	0	0	-
	Western North Atlantic Northern FL Coastal	0	-	-
	Western North Atlantic Central FL Coastal	0	-	-
	Northern Gulf of Mexico Continental Shelf	1	0	-
	Gulf of Mexico Western Coastal	0	-	-
	Gulf of Mexico Oceanic	0	-	-
Killer whale	Western North Atlantic	0	-	-
Pantropical spotted dolphin	Western North Atlantic	0	-	-
	Northern Gulf of Mexico	0	-	-
Risso's dolphin	Western North Atlantic	0	-	-
Rough-toothed dolphin	Northern Gulf of Mexico	0	-	-
Short-beaked common dolphin	Western North Atlantic	4	-	-
Short-finned pilot whale	Western North Atlantic	0	-	-
	Northern Gulf of Mexico	0	-	-
Striped dolphin	Western North Atlantic	2	-	-
Gervais' beaked whale	Western North Atlantic	0	-	-
Dwarf sperm whale	Western North Atlantic	3	2	0
	Northern Gulf of Mexico	1	-	-
Pygmy sperm whale	Western North Atlantic	2	4	-
Harbor porpoise	Gulf of ME/Bay of Fundy	12	15	1
Gray seal	Western North Atlantic	7	0	-
Harbor seal	Western North Atlantic	5	0	-
Harp seal	Western North Atlantic	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

2.4.5.3 Pile Driving Impact Summary Tables

Table 2.4-91: Estimated Effects to Marine Mammal Stocks from Pile Driving over a Maximum Year of Navy Training

Species	Stock	BEH	TTS	AINJ
Bottlenose dolphin	MS Sound, Lake Borgne, and Bay Boudreau	1,564	0	-
	Gulf of Mexico Northern Coastal	1,894	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

Table 2.4-92: Estimated Effects to Marine Mammal Stocks from Pile Driving over Seven Years of Navy Training

Species	Stock	BEH	TTS	AINJ
Bottlenose dolphin	MS Sound, Lake Borgne, and Bay Boudreau	10,944	0	-
	Gulf of Mexico Northern Coastal	13,255	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
For BEH, TTS, AINJ annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

2.4.5.4 Explosives Impact Summary Tables

2.4.5.4.1 Navy Training

Table 2.4-93: Estimated Effects to Marine Mammal Stocks from Explosives over a Maximum Year of Navy Training

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Blue whale	North Atlantic	1	1	-	-	-
Fin whale	Western North Atlantic	30	8	0	-	-
North Atlantic right whale	Western	14	10	0	-	-
Rice's whale	Northern Gulf of Mexico	0	1	-	-	-
Sei whale	Western North Atlantic	4	1	0	-	-
Bryde's whale	Primary	0	0	-	-	-
Humpback whale	Gulf of ME	14	7	1	-	-
Minke whale	Canadian Eastern Coastal	24	11	1	-	-
Sperm whale	Northern Gulf of Mexico	1	1	0	-	-
	North Atlantic	4	6	1	1	-
Atlantic spotted dolphin	Western North Atlantic	35	37	4	1	0
	Northern Gulf of Mexico	1	3	1	0	-
Atlantic white-sided dolphin	Western North Atlantic	4	6	1	1	-
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	19	29	4	1	0
	Western North Atlantic SC GA Coastal	5	5	1	0	1
	Western North Atlantic Offshore	50	53	6	1	1
	Western North Atlantic Northern Migratory Coastal	21	41	5	1	0
	Western North Atlantic Northern FL Coastal	2	3	1	0	-
	Western North Atlantic Central FL Coastal	10	8	1	1	-
	Southern NC Estuarine System	1	-	-	-	-
	Northern NC Estuarine System	1	-	-	-	-
	Northern Gulf of Mexico Continental Shelf	14	19	2	1	0
	Gulf of Mexico Western Coastal	0	0	-	-	-
	Gulf of Mexico Oceanic	1	1	0	-	-
	Gulf of Mexico Northern Coastal	1	2	1	-	-
	Gulf of Mexico Eastern Coastal	1	1	-	-	-
Clymene dolphin	Western North Atlantic	16	21	6	1	1
	Northern Gulf of Mexico	0	0	0	-	-
False killer whale	Western North Atlantic	0	0	-	-	-
	Northern Gulf of Mexico	-	0	0	-	-
Fraser's dolphin	Western North Atlantic	1	1	1	0	-
	Northern Gulf of Mexico	1	1	0	-	-
Killer whale	Western North Atlantic	0	0	-	-	-
	Northern Gulf of Mexico	0	-	0	-	-
Long-finned pilot whale	Western North Atlantic	4	3	2	1	-
Melon-headed whale	Western North Atlantic	0	0	0	0	-
	Northern Gulf of Mexico	0	0	0	-	-
Pantropical spotted dolphin	Western North Atlantic	2	1	1	0	0
	Northern Gulf of Mexico	1	1	1	1	0
Pygmy killer whale	Western North Atlantic	0	-	1	0	-
	Northern Gulf of Mexico	0	0	-	-	-
Risso's dolphin	Western North Atlantic	4	5	1	1	0
	Northern Gulf of Mexico	0	0	0	-	-
Rough-toothed dolphin	Western North Atlantic	2	2	1	0	-
	Northern Gulf of Mexico	1	1	0	-	-
Short-beaked common dolphin	Western North Atlantic	50	42	5	1	-

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Short-finned pilot whale	Western North Atlantic	7	5	1	0	0
	Northern Gulf of Mexico	0	1	-	-	-
Spinner dolphin	Western North Atlantic	0	1	0	-	-
	Northern Gulf of Mexico	-	0	-	-	-
Striped dolphin	Western North Atlantic	11	13	3	1	0
	Northern Gulf of Mexico	0	1	1	0	-
Blainville's beaked whale	Western North Atlantic	1	2	1	-	-
Gervais' beaked whale	Western North Atlantic	1	1	-	-	-
Goose-beaked whale	Western North Atlantic	6	4	1	-	-
	Northern Gulf of Mexico	0	-	-	-	-
Sowerby's beaked whale	Western North Atlantic	1	1	0	-	-
True's beaked whale	Western North Atlantic	1	1	0	-	-
Dwarf sperm whale	Western North Atlantic	27	33	7	-	-
	Northern Gulf of Mexico	2	2	1	0	-
Pygmy sperm whale	Western North Atlantic	26	33	9	-	-
	Northern Gulf of Mexico	2	2	1	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	74	235	67	0	-
Gray seal	Western North Atlantic	46	44	3	0	-
Harbor seal	Western North Atlantic	72	67	4	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

Table 2.4-94: Estimated Effects to Marine Mammal Stocks from Explosives over Seven Years of Navy Training

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Blue whale	North Atlantic	2	1	-	-	-
Fin whale	Western North Atlantic	205	50	0	-	-
North Atlantic right whale	Western	93	66	0	-	-
Rice's whale	Northern Gulf of Mexico	0	1	-	-	-
Sei whale	Western North Atlantic	27	3	0	-	-
Bryde's whale	Primary	0	0	-	-	-
Humpback whale	Gulf of ME	94	43	1	-	-
Minke whale	Canadian Eastern Coastal	167	73	7	-	-
Sperm whale	Northern Gulf of Mexico	1	1	0	-	-
	North Atlantic	26	36	3	1	-
Atlantic spotted dolphin	Western North Atlantic	245	257	23	5	0
	Northern Gulf of Mexico	4	19	4	0	-
Atlantic white-sided dolphin	Western North Atlantic	26	41	7	3	-
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	133	202	26	4	0
	Western North Atlantic SC GA Coastal	32	35	3	0	1
	Western North Atlantic Offshore	347	365	39	3	1
	Western North Atlantic Northern Migratory Coastal	147	283	30	1	0
	Western North Atlantic Northern FL Coastal	8	17	1	0	-
	Western North Atlantic Central FL Coastal	65	53	4	2	-
	Southern NC Estuarine System	1	-	-	-	-
	Northern NC Estuarine System	1	-	-	-	-
	Northern Gulf of Mexico Continental Shelf	95	132	12	1	0
	Gulf of Mexico Western Coastal	0	0	-	-	-
	Gulf of Mexico Oceanic	3	4	0	-	-
	Gulf of Mexico Northern Coastal	3	8	2	-	-
	Gulf of Mexico Eastern Coastal	4	7	-	-	-
Clymene dolphin	Western North Atlantic	112	141	37	3	3
	Northern Gulf of Mexico	0	0	0	-	-
False killer whale	Western North Atlantic	0	0	-	-	-
	Northern Gulf of Mexico	-	0	0	-	-
Fraser's dolphin	Western North Atlantic	4	2	2	0	-
	Northern Gulf of Mexico	1	1	0	-	-
Killer whale	Western North Atlantic	0	0	-	-	-
	Northern Gulf of Mexico	0	-	0	-	-
Long-finned pilot whale	Western North Atlantic	28	21	9	1	-
Melon-headed whale	Western North Atlantic	0	0	0	0	-
	Northern Gulf of Mexico	0	0	0	-	-
Pantropical spotted dolphin	Western North Atlantic	8	6	1	0	0
	Northern Gulf of Mexico	5	7	2	2	0
Pygmy killer whale	Western North Atlantic	0	-	1	0	-
	Northern Gulf of Mexico	0	0	-	-	-
Risso's dolphin	Western North Atlantic	28	32	2	1	0
	Northern Gulf of Mexico	0	0	0	-	-
Rough-toothed dolphin	Western North Atlantic	8	9	1	0	-
	Northern Gulf of Mexico	1	3	0	-	-
Short-beaked common dolphin	Western North Atlantic	345	288	29	4	-
Short-finned pilot whale	Western North Atlantic	45	32	7	0	0
	Northern Gulf of Mexico	0	3	-	-	-
Spinner dolphin	Western North Atlantic	0	5	0	-	-
	Northern Gulf of Mexico	-	0	-	-	-

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Striped dolphin	Western North Atlantic	77	87	20	5	0
	Northern Gulf of Mexico	0	2	1	0	-
Blainville's beaked whale	Western North Atlantic	5	8	1	-	-
Gervais' beaked whale	Western North Atlantic	1	3	-	-	-
Goose-beaked whale	Western North Atlantic	36	28	3	-	-
	Northern Gulf of Mexico	0	-	-	-	-
Sowerby's beaked whale	Western North Atlantic	7	5	0	-	-
True's beaked whale	Western North Atlantic	1	1	0	-	-
Dwarf sperm whale	Western North Atlantic	188	227	47	-	-
	Northern Gulf of Mexico	8	10	1	0	-
Pygmy sperm whale	Western North Atlantic	182	225	60	-	-
	Northern Gulf of Mexico	9	12	1	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	515	1,644	464	0	-
Gray seal	Western North Atlantic	322	304	20	0	-
Harbor seal	Western North Atlantic	499	468	28	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

2.4.5.4.2 Navy Testing

Table 2.4-95: Estimated Effects to Marine Mammal Stocks from Explosives over a Maximum Year of Navy Testing (includes Small Ship Shock Trials)

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Blue whale	North Atlantic	1	2	-	-	-
Fin whale	Western North Atlantic	110	159	12	-	-
North Atlantic right whale	Western	6	4	1	-	-
Rice's whale	Northern Gulf of Mexico	7	4	1	-	-
Sei whale	Western North Atlantic	6	5	0	-	-
Humpback whale	Gulf of ME	13	15	0	-	-
Minke whale	Canadian Eastern Coastal	26	37	1	0	-
Sperm whale	Northern Gulf of Mexico	1	1	0	0	0
	North Atlantic	2	5	2	0	0
Atlantic spotted dolphin	Western North Atlantic	39	27	4	3	1
	Northern Gulf of Mexico	17	11	1	0	0
Atlantic white-sided dolphin	Western North Atlantic	6	3	1	0	0
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	9	3	1	0	-
	Western North Atlantic SC GA Coastal	9	3	1	0	0
	Western North Atlantic Offshore	67	76	14	2	1
	Western North Atlantic Northern Migratory Coastal	2	2	1	-	-
	Western North Atlantic Northern FL Coastal	4	1	1	-	-
	Western North Atlantic Central FL Coastal	12	5	1	0	0
	St. Andrew Bay	1	1	-	-	-
	Southern NC Estuarine System	0	-	-	-	-
	Northern SC Estuarine System	0	-	-	-	-
	Northern NC Estuarine System	-	0	0	-	-
	Northern Gulf of Mexico Continental Shelf	369	177	3	1	0
	Gulf of Mexico Western Coastal	2	1	1	0	-
	Gulf of Mexico Oceanic	3	1	1	0	0
	Gulf of Mexico Northern Coastal	86	117	16	-	-
	Gulf of Mexico Eastern Coastal	-	1	0	-	-
	Central GA Estuarine System	0	-	-	-	-
Clymene dolphin	Western North Atlantic	5	6	1	1	1
	Northern Gulf of Mexico	1	1	1	1	0
False killer whale	Western North Atlantic	-	1	-	-	-
	Northern Gulf of Mexico	1	1	0	-	-
Fraser's dolphin	Western North Atlantic	1	2	0	0	-
	Northern Gulf of Mexico	0	0	0	0	-
Killer whale	Western North Atlantic	1	1	0	-	0
	Northern Gulf of Mexico	-	0	0	-	-
Long-finned pilot whale	Western North Atlantic	18	25	7	2	1
Melon-headed whale	Western North Atlantic	1	0	0	0	0
	Northern Gulf of Mexico	1	1	0	0	0
Pantropical spotted dolphin	Western North Atlantic	0	0	0	0	0
	Northern Gulf of Mexico	2	11	2	2	2
Pygmy killer whale	Western North Atlantic	0	1	0	-	-
	Northern Gulf of Mexico	1	1	0	0	0
Risso's dolphin	Western North Atlantic	18	31	3	1	1
	Northern Gulf of Mexico	1	1	0	0	0
Rough-toothed dolphin	Western North Atlantic	1	1	0	0	-
	Northern Gulf of Mexico	6	4	1	1	0
Short-beaked common dolphin	Western North Atlantic	384	325	32	18	5

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Short-finned pilot whale	Western North Atlantic	13	21	6	1	1
	Northern Gulf of Mexico	1	1	1	0	0
Spinner dolphin	Western North Atlantic	1	1	0	0	-
	Northern Gulf of Mexico	0	1	0	0	-
Striped dolphin	Western North Atlantic	17	78	16	15	6
	Northern Gulf of Mexico	1	10	4	2	1
Blainville's beaked whale	Western North Atlantic	1	1	1	1	0
	Northern Gulf of Mexico	0	0	-	-	-
Gervais' beaked whale	Western North Atlantic	1	1	1	0	-
	Northern Gulf of Mexico	0	1	-	-	-
Goose-beaked whale	Western North Atlantic	1	8	2	0	0
	Northern Gulf of Mexico	0	1	0	-	-
Northern bottlenose whale	Western North Atlantic	1	0	1	-	-
Sowerby's beaked whale	Western North Atlantic	1	1	1	0	0
True's beaked whale	Western North Atlantic	1	1	1	-	0
Dwarf sperm whale	Western North Atlantic	13	31	20	0	0
	Northern Gulf of Mexico	2	27	16	-	-
Pygmy sperm whale	Western North Atlantic	12	30	18	0	-
	Northern Gulf of Mexico	3	29	16	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	75	120	29	0	0
Gray seal	Western North Atlantic	38	19	2	0	-
Harbor seal	Western North Atlantic	54	25	2	0	0
Harp seal	Western North Atlantic	13	8	1	0	-
Hooded seal	Western North Atlantic	1	1	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

Table 2.4-96: Estimated Effects to Marine Mammal Stocks from Explosives over Seven Years of Navy Testing (includes Small Ship Shock Trials)

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Blue whale	North Atlantic	2	7	-	-	-
Fin whale	Western North Atlantic	670	653	40	-	-
North Atlantic right whale	Western	34	21	1	-	-
Rice's whale	Northern Gulf of Mexico	49	25	1	-	-
Sei whale	Western North Atlantic	40	22	0	-	-
Humpback whale	Gulf of ME	81	61	0	-	-
Minke whale	Canadian Eastern Coastal	162	140	2	0	-
Sperm whale	Northern Gulf of Mexico	1	1	0	0	0
	North Atlantic	8	15	6	0	0
Atlantic spotted dolphin	Western North Atlantic	221	132	19	6	2
	Northern Gulf of Mexico	119	74	6	0	0
Atlantic white-sided dolphin	Western North Atlantic	37	16	1	0	0
Bottlenose dolphin	Western North Atlantic Southern Migratory Coastal	55	18	2	0	-
	Western North Atlantic SC GA Coastal	55	17	3	0	0
	Western North Atlantic Offshore	396	354	50	6	2
	Western North Atlantic Northern Migratory Coastal	10	11	1	-	-
	Western North Atlantic Northern FL Coastal	21	7	1	-	-
	Western North Atlantic Central FL Coastal	67	29	4	0	0
	St. Andrew Bay	1	1	-	-	-
	Southern NC Estuarine System	0	-	-	-	-
	Northern SC Estuarine System	0	-	-	-	-
	Northern NC Estuarine System	-	0	0	-	-
	Northern Gulf of Mexico Continental Shelf	2,577	1,234	18	1	0
	Gulf of Mexico Western Coastal	10	4	1	0	-
	Gulf of Mexico Oceanic	15	7	2	0	0
	Gulf of Mexico Northern Coastal	601	815	112	-	-
	Gulf of Mexico Eastern Coastal	-	1	0	-	-
	Central GA Estuarine System	0	-	-	-	-
Clymene dolphin	Western North Atlantic	30	29	5	2	2
	Northern Gulf of Mexico	4	3	1	1	0
False killer whale	Western North Atlantic	-	2	-	-	-
	Northern Gulf of Mexico	1	1	0	-	-
Fraser's dolphin	Western North Atlantic	3	5	0	0	-
	Northern Gulf of Mexico	0	0	0	0	-
Killer whale	Western North Atlantic	2	2	0	-	0
	Northern Gulf of Mexico	-	0	0	-	-
Long-finned pilot whale	Western North Atlantic	108	98	19	5	1
Melon-headed whale	Western North Atlantic	1	0	0	0	0
	Northern Gulf of Mexico	1	3	0	0	0
Pantropical spotted dolphin	Western North Atlantic	0	0	0	0	0
	Northern Gulf of Mexico	13	31	5	6	5
Pygmy killer whale	Western North Atlantic	0	1	0	-	-
	Northern Gulf of Mexico	1	1	0	0	0
Risso's dolphin	Western North Atlantic	116	132	16	3	1
	Northern Gulf of Mexico	1	1	0	0	0
Rough-toothed dolphin	Western North Atlantic	2	2	0	0	-
	Northern Gulf of Mexico	39	21	1	1	0
Short-beaked common dolphin	Western North Atlantic	2,320	1,683	147	46	12
Short-finned pilot whale	Western North Atlantic	78	83	19	3	1
	Northern Gulf of Mexico	3	2	1	0	0

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Spinner dolphin	Western North Atlantic	2	1	0	0	-
	Northern Gulf of Mexico	0	1	0	0	-
Striped dolphin	Western North Atlantic	109	232	48	39	16
	Northern Gulf of Mexico	5	27	9	5	2
Blainville's beaked whale	Western North Atlantic	1	2	2	1	0
	Northern Gulf of Mexico	0	0	-	-	-
Gervais' beaked whale	Western North Atlantic	1	2	1	0	-
	Northern Gulf of Mexico	0	1	-	-	-
Goose-beaked whale	Western North Atlantic	7	22	5	0	0
	Northern Gulf of Mexico	0	1	0	-	-
Northern bottlenose whale	Western North Atlantic	1	0	1	-	-
Sowerby's beaked whale	Western North Atlantic	1	5	1	0	0
True's beaked whale	Western North Atlantic	1	2	1	-	0
Dwarf sperm whale	Western North Atlantic	82	128	56	0	0
	Northern Gulf of Mexico	12	78	40	-	-
Pygmy sperm whale	Western North Atlantic	73	129	55	0	-
	Northern Gulf of Mexico	17	87	40	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	493	662	143	0	0
Gray seal	Western North Atlantic	262	122	11	0	-
Harbor seal	Western North Atlantic	370	154	12	0	0
Harp seal	Western North Atlantic	88	50	4	0	-
Hooded seal	Western North Atlantic	4	4	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

At most, Small Ship Shock Trials could occur in two of three possible locations in one year. The below results (Table 2.4-97) show the highest possible impacts to each stock for two events, regardless of location.

Table 2.4-97: Estimated Effects to Marine Mammal Stocks from Small Ship Shock Trials over a Maximum Year of Navy Testing (2 Events)

Species	Stock	TTS	AINJ	INJ	MORT
Blue whale	North Atlantic	2	-	-	-
Fin whale	Western North Atlantic	86	9	-	-
North Atlantic right whale	Western	1	0	-	-
Sei whale	Western North Atlantic	3	-	-	-
Humpback whale	Gulf of ME	9	-	-	-
Minke whale	Canadian Eastern Coastal	24	1	0	-
Sperm whale	Northern Gulf of Mexico	0	0	0	0
	North Atlantic	4	2	0	0
Atlantic spotted dolphin	Western North Atlantic	6	1	2	1
Atlantic white-sided dolphin	Western North Atlantic	1	0	0	0
Bottlenose dolphin	Western North Atlantic SC GA Coastal	0	-	-	-
	Western North Atlantic Offshore	26	9	2	1
Clymene dolphin	Western North Atlantic	2	1	1	1
	Northern Gulf of Mexico	0	-	0	-
False killer whale	Western North Atlantic	1	-	-	-
	Northern Gulf of Mexico	0	0	-	-
Fraser's dolphin	Western North Atlantic	2	0	0	-
Killer whale	Western North Atlantic	0	-	-	0
	Northern Gulf of Mexico	-	0	-	-
Long-finned pilot whale	Western North Atlantic	15	6	2	1
Melon-headed whale	Northern Gulf of Mexico	1	0	0	0
Pantropical spotted dolphin	Northern Gulf of Mexico	9	1	2	2
Pygmy killer whale	Western North Atlantic	1	-	-	-
	Northern Gulf of Mexico	0	0	0	0
Risso's dolphin	Western North Atlantic	15	1	1	1
Rough-toothed dolphin	Western North Atlantic	1	-	0	-
	Northern Gulf of Mexico	1	0	1	0
Short-beaked common dolphin	Western North Atlantic	74	11	18	5
Short-finned pilot whale	Western North Atlantic	11	4	1	1
	Northern Gulf of Mexico	1	1	0	0
Spinner dolphin	Western North Atlantic	1	-	0	-
	Northern Gulf of Mexico	0	-	0	-
Striped dolphin	Western North Atlantic	67	14	15	6
	Northern Gulf of Mexico	10	3	2	1
Blainville's beaked whale	Western North Atlantic	1	1	1	0
Gervais' beaked whale	Western North Atlantic	0	0	0	-
	Northern Gulf of Mexico	1	-	-	-
Goose-beaked whale	Western North Atlantic	6	1	0	-
	Northern Gulf of Mexico	1	0	-	-
Northern bottlenose whale	Western North Atlantic	0	-	-	-
Sowerby's beaked whale	Western North Atlantic	1	0	0	0
True's beaked whale	Western North Atlantic	1	1	-	0
Dwarf sperm whale	Western North Atlantic	17	18	0	0
	Northern Gulf of Mexico	24	15	-	-
Pygmy sperm whale	Western North Atlantic	15	15	-	-
	Northern Gulf of Mexico	26	15	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	23	8	-	-
Gray seal	Western North Atlantic	2	1	-	-
Harbor seal	Western North Atlantic	2	1	-	-

Table Created: 27 Aug 2024

2.4.5.4.3 Coast Guard Training

Table 2.4-98: Estimated Effects to Marine Mammal Stocks from Explosives over a Maximum Year of US Coast Guard Training

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Fin whale	Western North Atlantic	1	1	0	-	-
North Atlantic right whale	Western	0	0	-	-	-
Sei whale	Western North Atlantic	1	0	-	-	-
Humpback whale	Gulf of ME	1	1	0	-	-
Minke whale	Canadian Eastern Coastal	1	1	0	-	-
Sperm whale	Northern Gulf of Mexico	0	-	-	-	-
	North Atlantic	1	0	-	-	-
Atlantic spotted dolphin	Western North Atlantic	1	1	-	-	-
	Northern Gulf of Mexico	1	0	-	-	-
Atlantic white-sided dolphin	Western North Atlantic	2	1	0	-	-
Bottlenose dolphin	Western North Atlantic Offshore	1	1	-	0	-
	Northern Gulf of Mexico Continental Shelf	4	3	1	-	-
	Gulf of Mexico Oceanic	1	0	-	-	-
Clymene dolphin	Western North Atlantic	-	0	0	-	-
	Northern Gulf of Mexico	-	0	-	-	-
Long-finned pilot whale	Western North Atlantic	1	1	0	-	-
Pantropical spotted dolphin	Northern Gulf of Mexico	0	0	0	-	-
Risso's dolphin	Western North Atlantic	1	1	0	-	-
Rough-toothed dolphin	Northern Gulf of Mexico	0	0	-	-	-
Short-beaked common dolphin	Western North Atlantic	3	3	1	-	-
Short-finned pilot whale	Western North Atlantic	1	1	0	-	-
Striped dolphin	Western North Atlantic	1	1	0	-	-
	Northern Gulf of Mexico	0	-	-	-	-
White-beaked dolphin	Western North Atlantic	0	-	-	-	-
Blainville's beaked whale	Western North Atlantic	0	-	-	-	-
Goose-beaked whale	Western North Atlantic	1	1	-	-	-
Sowerby's beaked whale	Western North Atlantic	-	0	-	-	-
True's beaked whale	Western North Atlantic	0	-	-	-	-
Dwarf sperm whale	Western North Atlantic	1	1	1	-	-
	Northern Gulf of Mexico	1	1	-	-	-
Pygmy sperm whale	Western North Atlantic	1	1	1	-	-
	Northern Gulf of Mexico	1	1	-	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	22	24	4	-	-
Gray seal	Western North Atlantic	1	1	0	-	-
Harbor seal	Western North Atlantic	2	2	1	-	-
Harp seal	Western North Atlantic	2	2	1	-	-
Hooded seal	Western North Atlantic	1	1	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

Table 2.4-99: Estimated Effects to Marine Mammal Stocks from Explosives over Seven Years of Coast Guard Training

Species	Stock	BEH	TTS	AINJ	INJ	MORT
Fin whale	Western North Atlantic	1	1	0	-	-
North Atlantic right whale	Western	0	0	-	-	-
Sei whale	Western North Atlantic	1	0	-	-	-
Humpback whale	Gulf of ME	2	1	0	-	-
Minke whale	Canadian Eastern Coastal	1	1	0	-	-
Sperm whale	Northern Gulf of Mexico	0	-	-	-	-
	North Atlantic	1	0	-	-	-
Atlantic spotted dolphin	Western North Atlantic	2	1	-	-	-
	Northern Gulf of Mexico	2	0	-	-	-
Atlantic white-sided dolphin	Western North Atlantic	8	3	0	-	-
Bottlenose dolphin	Western North Atlantic Offshore	4	2	-	0	-
	Northern Gulf of Mexico Continental Shelf	25	18	1	-	-
	Gulf of Mexico Oceanic	1	0	-	-	-
Clymene dolphin	Western North Atlantic	-	0	0	-	-
	Northern Gulf of Mexico	-	0	-	-	-
Long-finned pilot whale	Western North Atlantic	2	1	0	-	-
Pantropical spotted dolphin	Northern Gulf of Mexico	0	0	0	-	-
Risso's dolphin	Western North Atlantic	1	1	0	-	-
Rough-toothed dolphin	Northern Gulf of Mexico	0	0	-	-	-
Short-beaked common dolphin	Western North Atlantic	21	15	1	-	-
Short-finned pilot whale	Western North Atlantic	1	1	0	-	-
Striped dolphin	Western North Atlantic	3	1	0	-	-
	Northern Gulf of Mexico	0	-	-	-	-
White-beaked dolphin	Western North Atlantic	0	-	-	-	-
Blainville's beaked whale	Western North Atlantic	0	-	-	-	-
Goose-beaked whale	Western North Atlantic	1	1	-	-	-
Sowerby's beaked whale	Western North Atlantic	-	0	-	-	-
True's beaked whale	Western North Atlantic	0	-	-	-	-
Dwarf sperm whale	Western North Atlantic	7	5	1	-	-
	Northern Gulf of Mexico	1	1	-	-	-
Pygmy sperm whale	Western North Atlantic	5	5	1	-	-
	Northern Gulf of Mexico	1	1	-	-	-
Harbor porpoise	Gulf of ME/Bay of Fundy	150	166	28	-	-
Gray seal	Western North Atlantic	7	6	0	-	-
Harbor seal	Western North Atlantic	10	8	1	-	-
Harp seal	Western North Atlantic	14	13	1	-	-
Hooded seal	Western North Atlantic	2	1	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual estimated impacts: A dash (-) indicates no estimation of take (true zero).
Table Created: 27 Aug 2024

2.5 Ranges to Effects

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the acoustic and explosive criteria in the *Criteria and Thresholds TR*, and the acoustic and explosive propagation calculations from the Navy Acoustic Effects Model described in the *Quantitative Analysis TR*. The ranges to effects are shown for representative sonar systems, air guns, and explosive bins from E1 (0.1–0.25 lb. NEW) to E16 (>7,500–14,500 lb. NEW). Ranges are determined by modeling the distance that noise from a source will need to propagate to reach exposure level thresholds specific to a hearing group that will cause behavioral response, TTS, AINJ, non-auditory injury, and mortality. Ranges to effects are utilized to help predict impacts from acoustic and explosive sources and assess the benefit of mitigation zones.

Tables present median and standard deviation ranges to effects for each hearing group, source or bin, bathymetric depth intervals of ≤200 m and >200 m to represent areas on an off the continental shelf, exposure duration (sonar), and representative cluster size (air guns and explosives). Ranges to effects consider propagation effects of sources modeled at different locations (i.e., analysis points), seasons, source depths, and radials (i.e., each analysis point considers propagation effects in different x-y directions by modeling 18 radials in azimuthal increments of 20° to obtain 360° coverage around an analysis point). The exception to this is ranges to effects for pile driving, which were calculated outside of the Navy Acoustic Effects Model, do not have variance in ranges, and are not presented as a summary statistic (e.g., median and standard deviation).

Boxplots visually present the distribution, variance, and outlier ranges for a given combination of a source or bin, hearing group, and effect. On the boxplots, outliers are plotted as dots, the lowest and highest non-outlier ranges are the extent of the left and right horizontal lines respectively that extend from the sides of a colored box, and the 25th, 50th (i.e., median), and 75th percentiles are the left edge, center line, and right edge of a colored box respectively.

2.5.1 Range to Effects for Sonar and Other Transducers

Ranges to effects for sonar were determined by modeling the distance that sound would need to propagate to reach exposure level thresholds specific to a hearing group that would cause behavioral response, TTS, and AINJ, as described in the *Criteria and Thresholds TR*. The ranges do not account for an animal avoiding a source nor for the movement of the platform, both of which would influence the actual range to onset of auditory effects during an actual exposure.

The tables below provide the ranges to TTS and AINJ for an exposure duration of 1, 30, 60, and 120 seconds for six representative sonar systems. Due to the lower acoustic thresholds for TTS versus AINJ, ranges to TTS are longer. Successive pings can be expected to add together, further increasing the range to the onset of TTS and AINJ.

The mean, 5th, and 95th percentile behavioral response curves below, provide the probability of behavioral response as a function of range for the sensitive species (beaked whales and harbor porpoises), mysticete (all baleen whales), odontocete (most toothed whales, dolphins, and porpoises), and pinniped (true seals, sea lions, walruses, sea otters, polar bears) behavioral response groups.

2.5.1.1 Hull-mounted Surface Ship Sonar (MF1)

Table 2.5-1: Marine Mammal Ranges to Effects for Hull-Mounted Surface Ship Sonar (MF1)

FHG	Depth	Duration	TTS	AINJ
HF	≤200 m	1 s	851 m (179 m)	44 m (2 m)
		30 s	851 m (179 m)	44 m (2 m)
		60 s	1,236 m (345 m)	65 m (5 m)
		120 s	1,501 m (527 m)	85 m (9 m)
	>200 m	1 s	620 m (90 m)	40 m (1 m)
		30 s	620 m (90 m)	40 m (1 m)
		60 s	896 m (206 m)	63 m (3 m)
		120 s	1,000 m (330 m)	84 m (3 m)
VHF	≤200 m	1 s	2,843 m (1,170 m)	150 m (19 m)
		30 s	2,843 m (1,170 m)	150 m (19 m)
		60 s	4,500 m (1,957 m)	230 m (36 m)
		120 s	5,630 m (2,651 m)	300 m (51 m)
	>200 m	1 s	1,833 m (749 m)	150 m (5 m)
		30 s	1,833 m (749 m)	150 m (5 m)
		60 s	3,639 m (1,285 m)	220 m (9 m)
		120 s	4,556 m (1,595 m)	270 m (13 m)
VLF	≤200 m	1 s	1,551 m (615 m)	90 m (10 m)
		30 s	1,551 m (615 m)	90 m (10 m)
		60 s	2,532 m (1,174 m)	140 m (20 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	3,306 m (1,578 m)	180 m (27 m)
	>200 m	1 s	1,000 m (353 m)	88 m (2 m)
		30 s	1,000 m (353 m)	88 m (2 m)
		60 s	1,741 m (663 m)	137 m (4 m)
		120 s	2,375 m (951 m)	170 m (6 m)
LF	≤200 m	1 s	1,701 m (595 m)	95 m (10 m)
		30 s	1,701 m (595 m)	95 m (10 m)
		60 s	2,809 m (1,153 m)	140 m (19 m)
		120 s	3,736 m (1,521 m)	182 m (26 m)
	>200 m	1 s	1,101 m (399 m)	90 m (3 m)
		30 s	1,101 m (399 m)	90 m (3 m)
		60 s	1,844 m (731 m)	140 m (4 m)
		120 s	2,750 m (1,067 m)	180 m (7 m)
PW	≤200 m	1 s	2,201 m (967 m)	120 m (16 m)
		30 s	2,201 m (967 m)	120 m (16 m)
		60 s	3,477 m (1,651 m)	190 m (29 m)
		120 s	4,486 m (2,238 m)	245 m (42 m)
	>200 m	1 s	1,477 m (587 m)	120 m (4 m)
		30 s	1,477 m (587 m)	120 m (4 m)
		60 s	2,736 m (1,086 m)	180 m (8 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	3,919 m (1,384 m)	230 m (10 m)
SI	≤200 m	1 s	430 m (86 m)	0 m (0 m)
		30 s	430 m (86 m)	0 m (0 m)
		60 s	674 m (142 m)	23 m (7 m)
		120 s	861 m (193 m)	35 m (2 m)
	>200 m	1 s	360 m (32 m)	0 m (0 m)
		30 s	360 m (32 m)	0 m (0 m)
		60 s	525 m (67 m)	23 m (4 m)
		120 s	650 m (104 m)	35 m (1 m)

-Median ranges with standard deviation ranges in parentheses

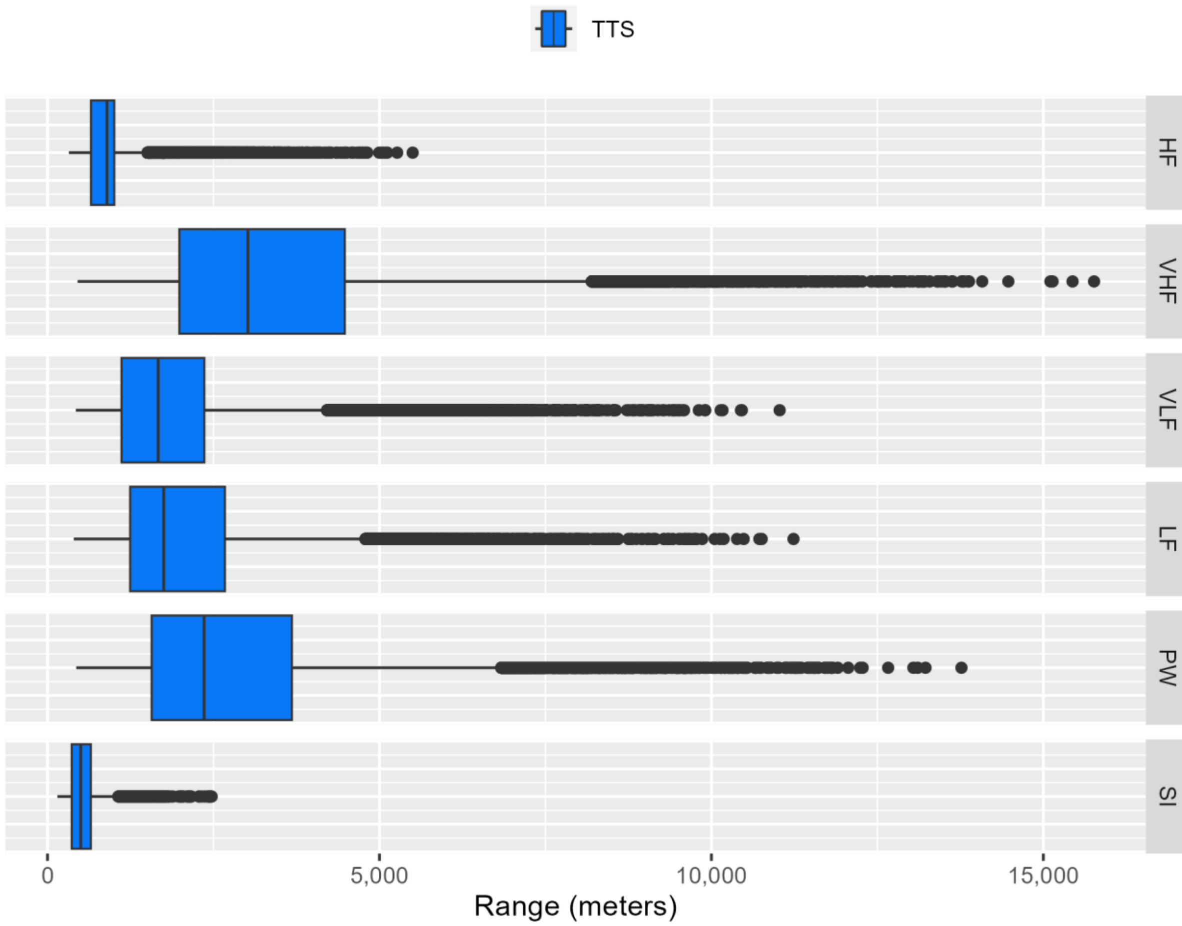


Figure 2.5-1: Marine Mammal Ranges to Temporary Threshold Shift for Hull-Mounted Surface Ship Sonar (MF1)

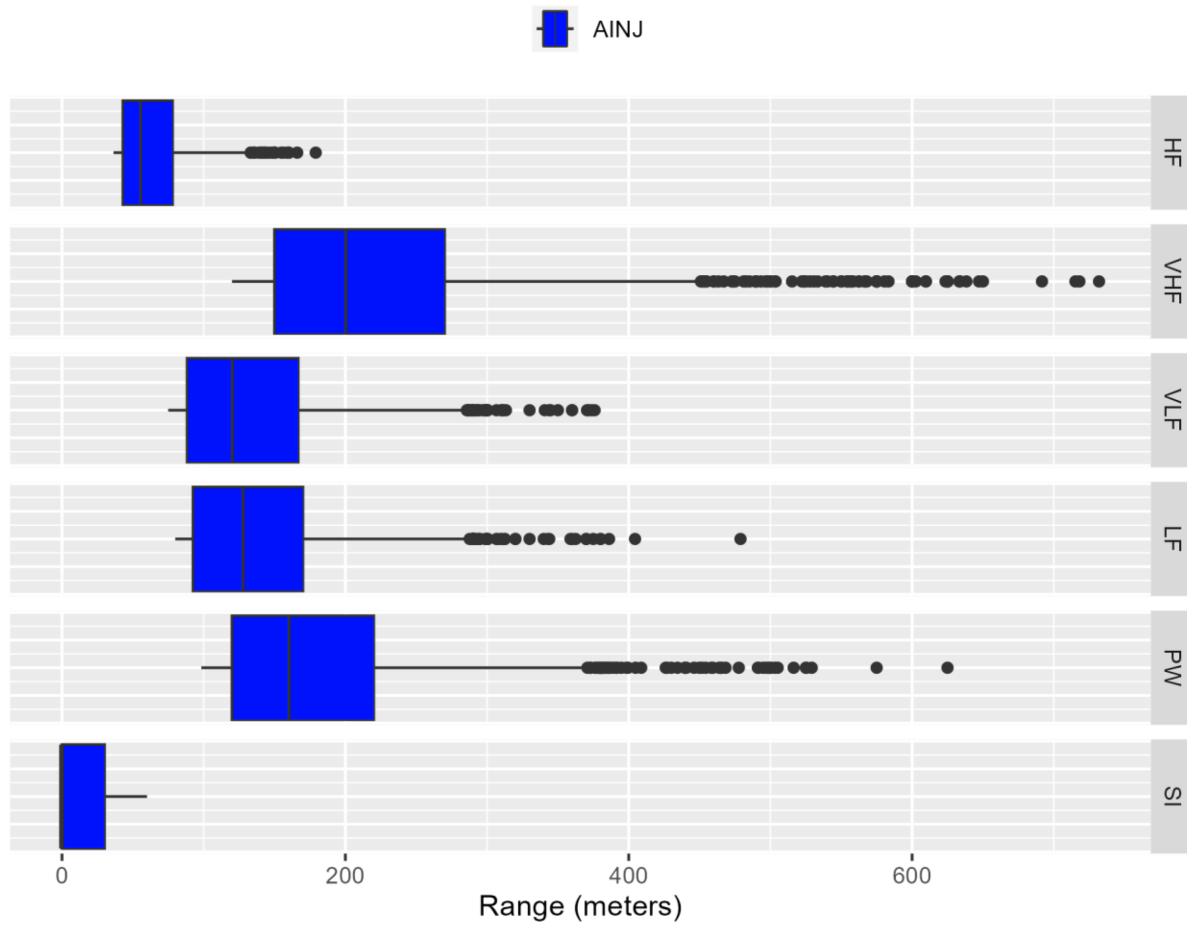


Figure 2.5-2: Marine Mammal Ranges to Auditory Injury for Hull-Mounted Surface Ship Sonar (MF1)

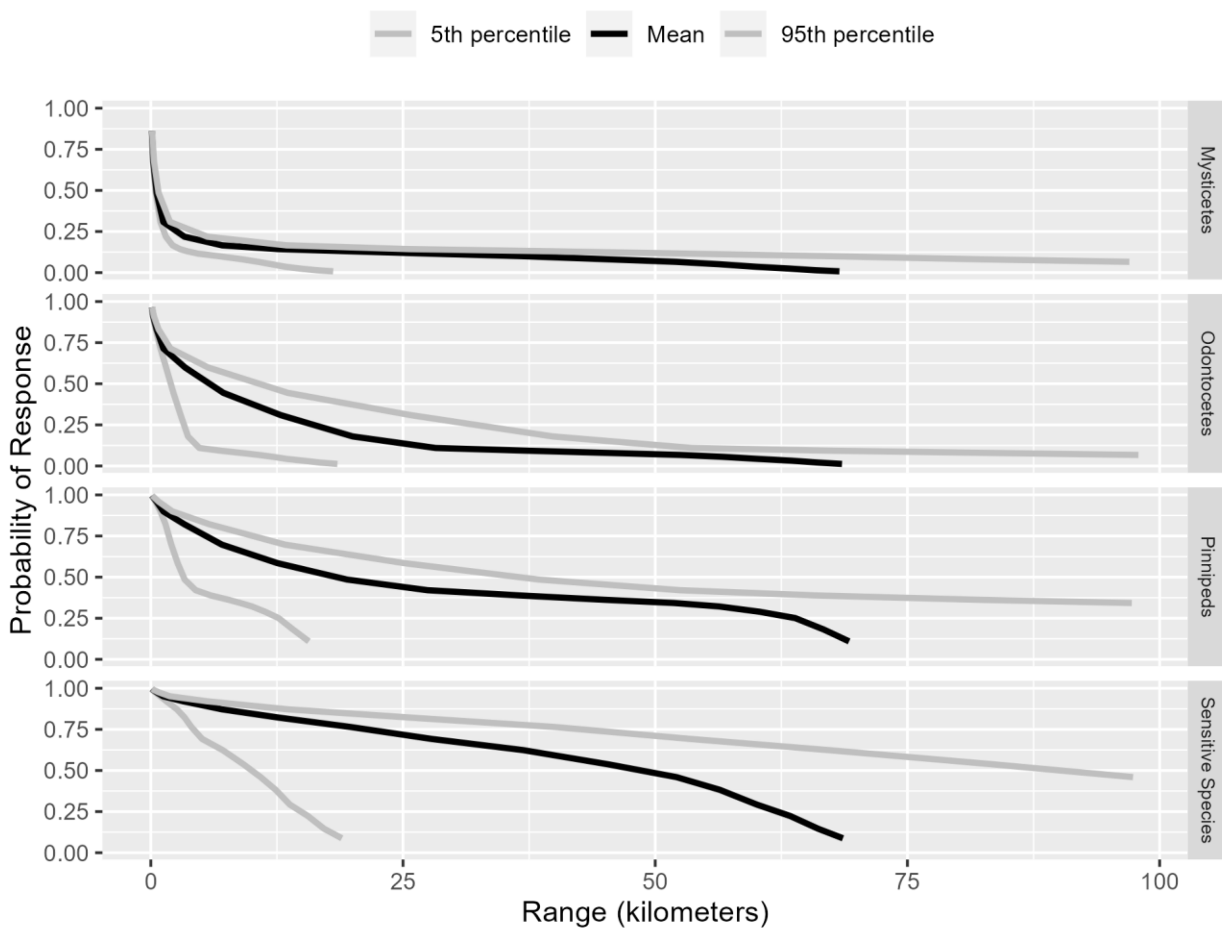


Figure 2.5-3: Marine Mammal Probability of Behavioral Response to Hull-Mounted Surface Ship Sonar (MF1) as a Function of Range

2.5.1.2 Hull-mounted Surface Ship Sonar (MF1K - Kingfisher Mode)

Table 2.5-2: Marine Mammal Ranges to Effects for Hull-Mounted Surface Ship Sonar (MF1K - Kingfisher Mode)

FHG	Depth	Duration	TTS	AINJ
HF	≤200 m	1 s	100 m (9 m)	6 m (1 m)
		30 s	190 m (25 m)	13 m (1 m)
		60 s	269 m (42 m)	17 m (2 m)
		120 s	430 m (80 m)	25 m (1 m)
	>200 m	1 s	97 m (4 m)	4 m (0 m)
		30 s	184 m (6 m)	9 m (0 m)
		60 s	239 m (7 m)	12 m (0 m)
		120 s	348 m (14 m)	20 m (0 m)
VHF	≤200 m	1 s	350 m (61 m)	20 m (1 m)
		30 s	724 m (139 m)	35 m (1 m)
		60 s	976 m (221 m)	50 m (3 m)
		120 s	1,306 m (455 m)	85 m (6 m)
	>200 m	1 s	300 m (8 m)	18 m (1 m)
		30 s	525 m (46 m)	35 m (0 m)
		60 s	700 m (77 m)	47 m (2 m)
		120 s	997 m (141 m)	83 m (3 m)
VLF	≤200 m	1 s	200 m (27 m)	13 m (1 m)
		30 s	413 m (77 m)	24 m (1 m)

FHG	Depth	Duration	TTS	AINJ
		60 s	575 m (106 m)	30 m (1 m)
		120 s	885 m (190 m)	45 m (2 m)
	>200 m	1 s	187 m (5 m)	8 m (0 m)
		30 s	337 m (14 m)	16 m (0 m)
		60 s	440 m (27 m)	28 m (0 m)
		120 s	625 m (48 m)	42 m (1 m)
LF	≤200 m	1 s	200 m (28 m)	14 m (1 m)
		30 s	429 m (80 m)	25 m (0 m)
		60 s	595 m (112 m)	30 m (1 m)
		120 s	915 m (203 m)	45 m (3 m)
	>200 m	1 s	195 m (5 m)	13 m (0 m)
		30 s	350 m (13 m)	24 m (0 m)
		60 s	455 m (32 m)	30 m (0 m)
		120 s	650 m (70 m)	45 m (0 m)
PW	≤200 m	1 s	270 m (43 m)	14 m (0 m)
		30 s	559 m (103 m)	29 m (1 m)
		60 s	776 m (155 m)	39 m (2 m)
		120 s	1,000 m (310 m)	65 m (4 m)
	>200 m	1 s	245 m (6 m)	14 m (0 m)
		30 s	435 m (25 m)	25 m (0 m)

FHG	Depth	Duration	TTS	AINJ
		60 s	562 m (42 m)	30 m (1 m)
		120 s	814 m (93 m)	60 m (2 m)
SI	≤200 m	1 s	50 m (3 m)	0 m (0 m)
		30 s	110 m (10 m)	0 m (0 m)
		60 s	140 m (17 m)	0 m (0 m)
		120 s	220 m (30 m)	0 m (0 m)
	>200 m	1 s	45 m (3 m)	0 m (0 m)
		30 s	110 m (5 m)	0 m (0 m)
		60 s	140 m (4 m)	0 m (0 m)
		120 s	210 m (8 m)	0 m (0 m)

-Median ranges with standard deviation ranges in parentheses

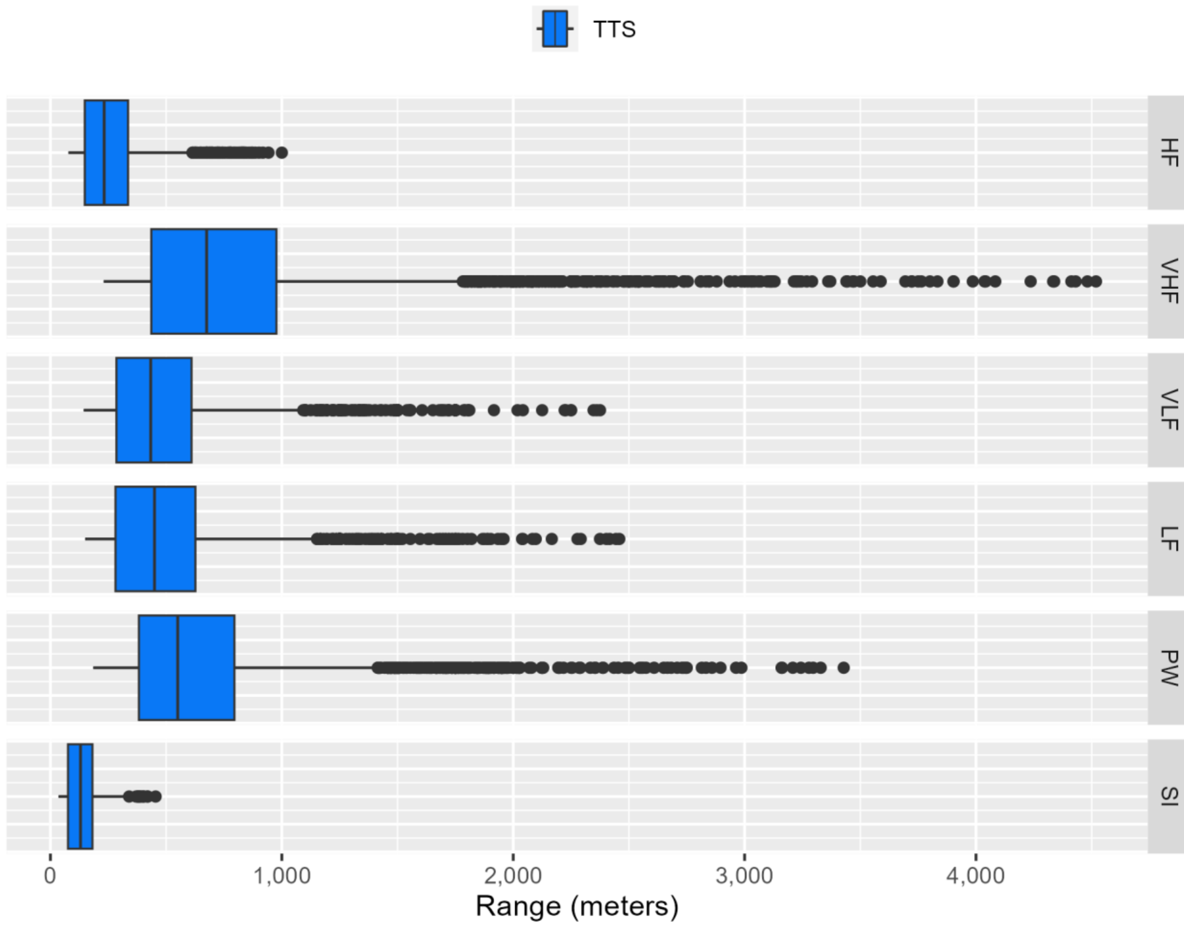


Figure 2.5-4: Marine Mammal Ranges to Temporary Threshold Shift for Hull-Mounted Surface Ship Sonar (MF1K - Kingfisher Mode)

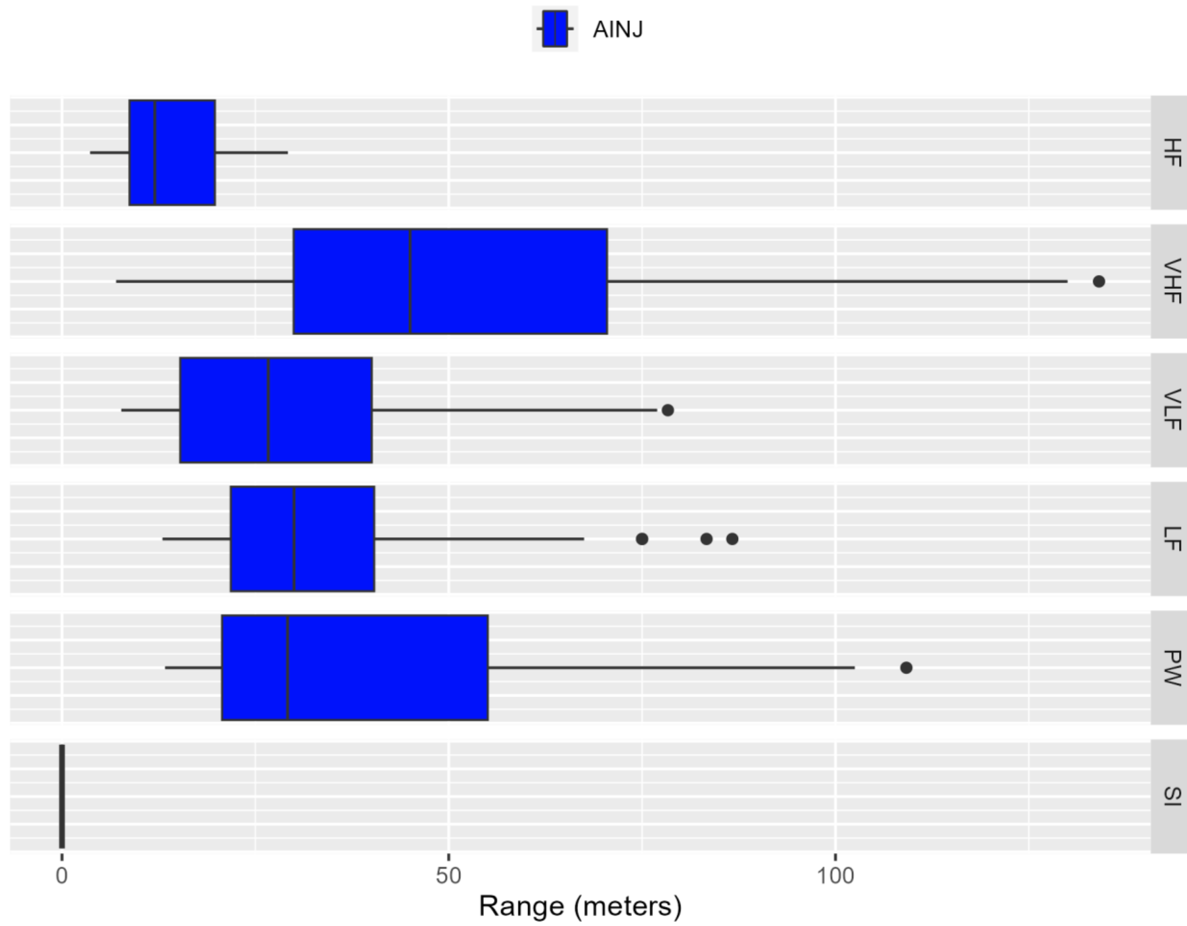


Figure 2.5-5: Marine Mammal Ranges to Auditory Injury for Hull-Mounted Surface Ship Sonar (MF1K - Kingfisher Mode)

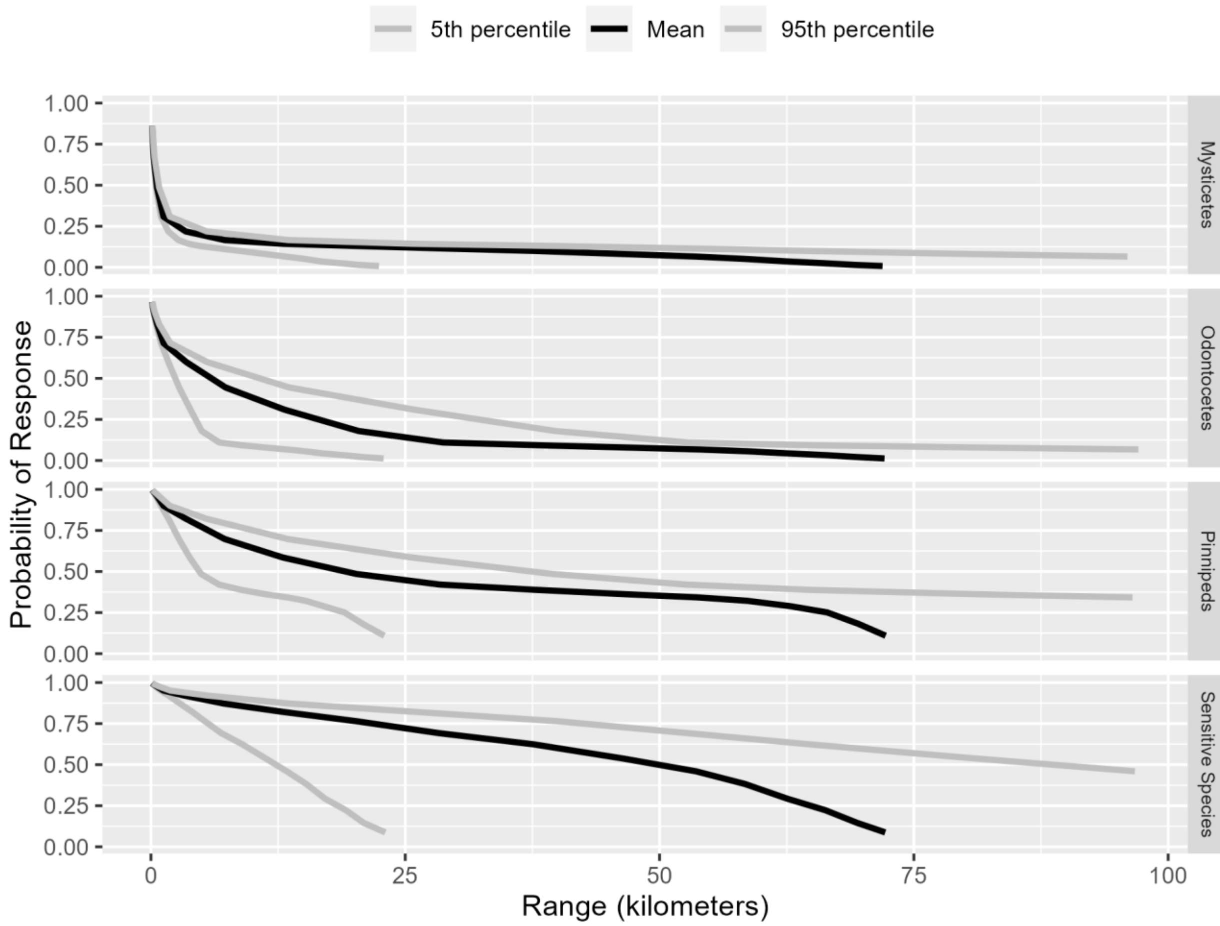


Figure 2.5-6: Marine Mammal Probability of Behavioral Response to Hull-Mounted Surface Ship Sonar (MF1K - Kingfisher Mode) as a Function of Range

2.5.1.3 Hull-mounted Surface Ship Sonar (MF1C - duty cycle >80%)

Table 2.5-3: Marine Mammal Ranges to Effects for Hull-Mounted Surface Ship Sonar (MF1C - Duty Cycle >80%)

FHG	Depth	Duration	TTS	AINJ
HF	≤200 m	1 s	852 m (179 m)	44 m (2 m)
		30 s	1,507 m (528 m)	85 m (9 m)
		60 s	2,577 m (1,049 m)	130 m (17 m)
		120 s	4,197 m (1,737 m)	209 m (30 m)
	>200 m	1 s	619 m (93 m)	40 m (1 m)
		30 s	1,000 m (343 m)	83 m (3 m)
		60 s	1,689 m (646 m)	128 m (4 m)
		120 s	3,190 m (1,154 m)	198 m (8 m)
VHF	≤200 m	1 s	2,880 m (1,174 m)	150 m (19 m)
		30 s	5,750 m (2,659 m)	300 m (51 m)
		60 s	8,333 m (4,266 m)	491 m (91 m)
		120 s	11,653 m (6,326 m)	772 m (155 m)
	>200 m	1 s	1,833 m (774 m)	150 m (6 m)
		30 s	4,576 m (1,635 m)	270 m (13 m)
		60 s	6,264 m (2,360 m)	391 m (33 m)
		120 s	8,602 m (3,423 m)	575 m (79 m)
VLF	≤200 m	1 s	1,556 m (617 m)	90 m (10 m)
		30 s	3,366 m (1,586 m)	180 m (27 m)

FHG	Depth	Duration	TTS	AINJ
		60 s	5,097 m (2,645 m)	283 m (51 m)
		120 s	7,287 m (4,213 m)	463 m (90 m)
	>200 m	1 s	1,000 m (369 m)	87 m (2 m)
		30 s	2,417 m (983 m)	170 m (6 m)
		60 s	4,315 m (1,570 m)	257 m (11 m)
		120 s	5,880 m (2,288 m)	370 m (26 m)
LF	≤200 m	1 s	1,708 m (597 m)	95 m (10 m)
		30 s	3,792 m (1,526 m)	182 m (26 m)
		60 s	5,632 m (2,622 m)	290 m (50 m)
		120 s	8,125 m (4,236 m)	475 m (89 m)
	>200 m	1 s	1,109 m (414 m)	90 m (3 m)
		30 s	2,769 m (1,091 m)	180 m (7 m)
		60 s	4,573 m (1,635 m)	262 m (12 m)
		120 s	6,264 m (2,356 m)	382 m (33 m)
PW	≤200 m	1 s	2,204 m (967 m)	120 m (16 m)
		30 s	4,495 m (2,238 m)	245 m (42 m)
		60 s	6,488 m (3,633 m)	397 m (77 m)
		120 s	9,125 m (5,503 m)	627 m (126 m)
	>200 m	1 s	1,477 m (587 m)	120 m (4 m)
		30 s	3,919 m (1,384 m)	230 m (10 m)

FHG	Depth	Duration	TTS	AINJ
		60 s	5,389 m (2,038 m)	330 m (20 m)
		120 s	7,444 m (2,899 m)	480 m (45 m)
SI	≤200 m	1 s	430 m (86 m)	0 m (0 m)
		30 s	865 m (193 m)	35 m (2 m)
		60 s	1,236 m (368 m)	65 m (6 m)
		120 s	1,764 m (746 m)	110 m (12 m)
	>200 m	1 s	360 m (33 m)	0 m (0 m)
		30 s	650 m (109 m)	35 m (1 m)
		60 s	928 m (238 m)	65 m (3 m)
		120 s	1,250 m (497 m)	110 m (5 m)

-Median ranges with standard deviation ranges in parentheses

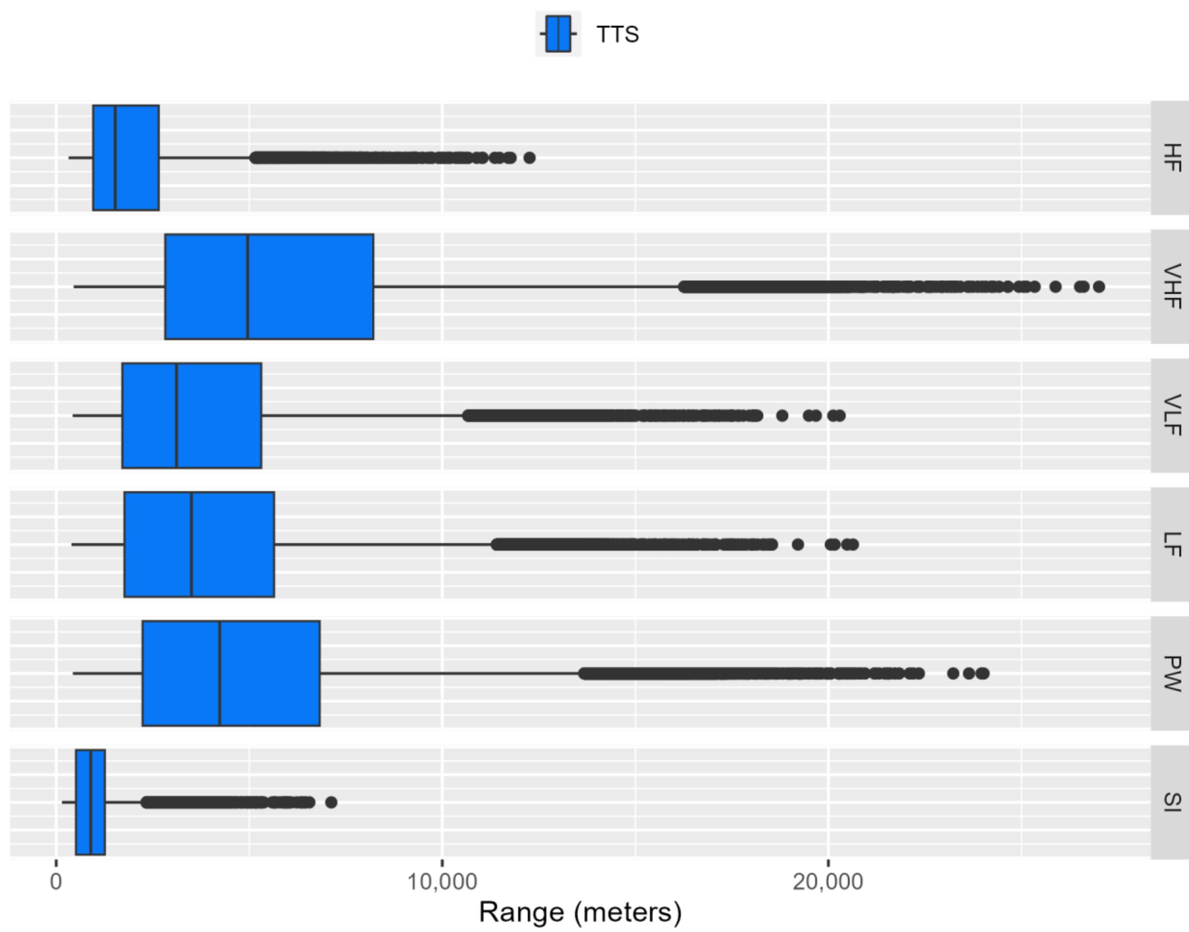


Figure 2.5-7: Marine Mammal Ranges to Temporary Threshold Shift for Hull-Mounted Surface Ship Sonar (MF1C - Duty Cycle >80%)

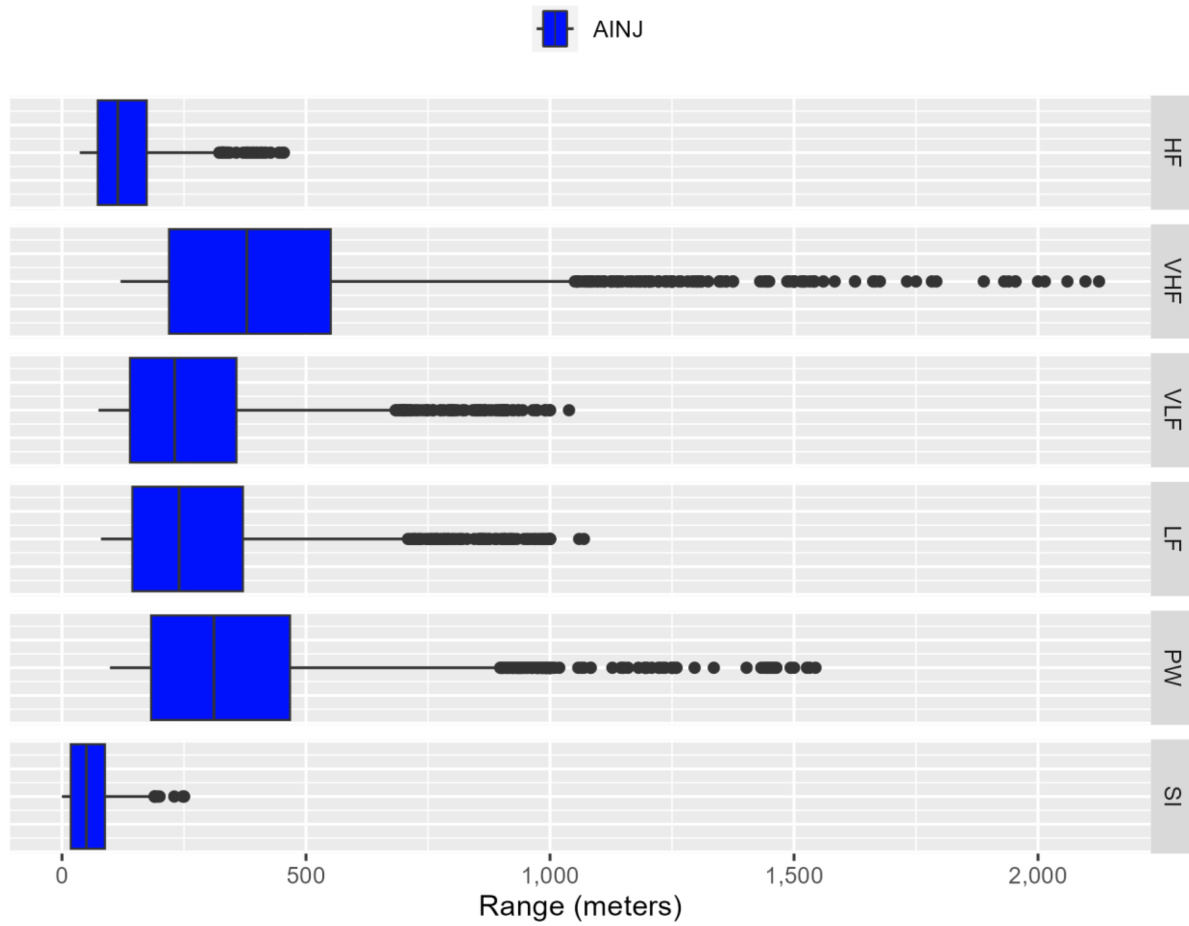


Figure 2.5-8: Marine Mammal Ranges to Auditory Injury for Hull-Mounted Surface Ship Sonar (MF1C - Duty Cycle >80%)

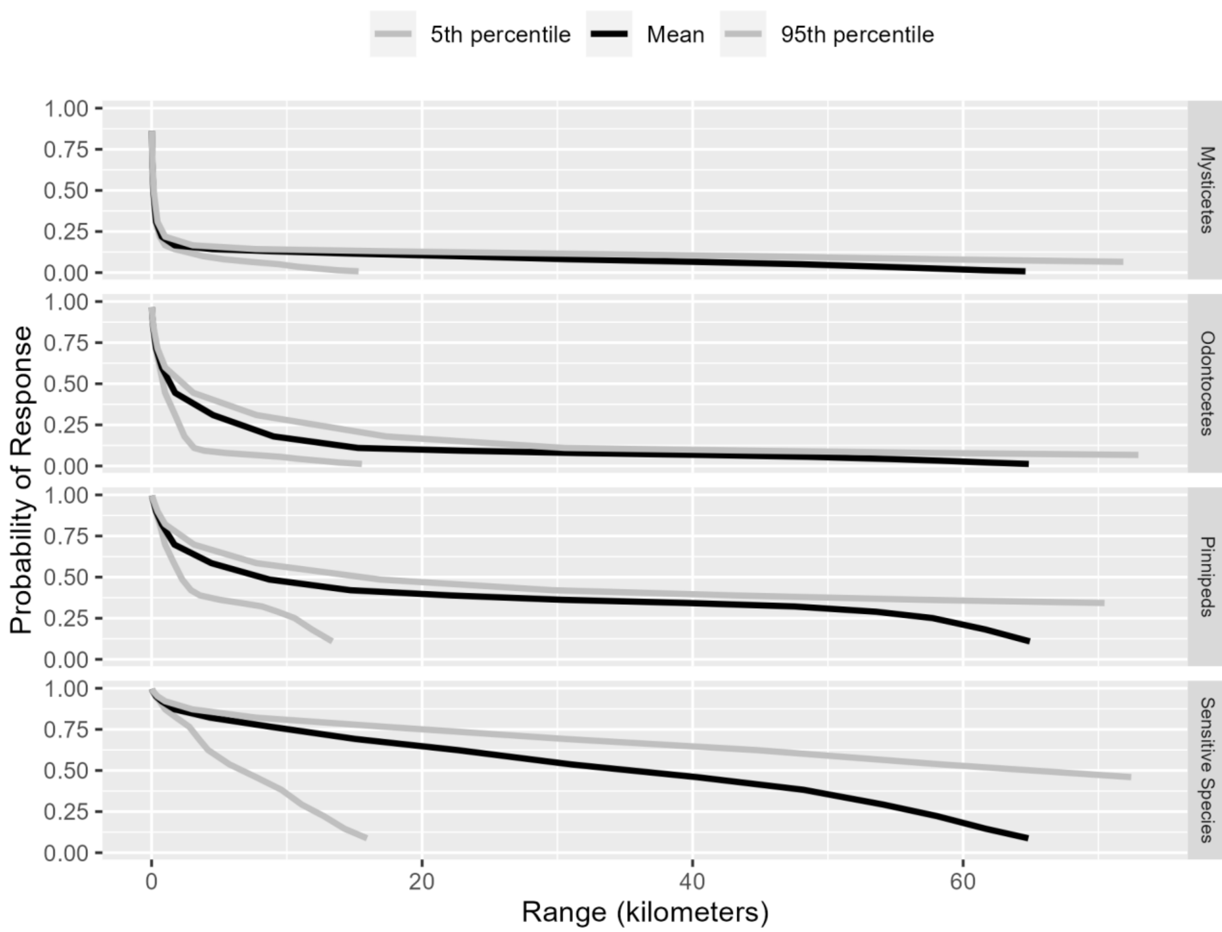


Figure 2.5-9: Marine Mammal Probability of Behavioral Response to Hull-Mounted Surface Ship Sonar (MF1C - Duty Cycle >80%) as a Function of Range

2.5.1.4 Helicopter Dipping Sonar

Table 2.5-4: Marine Mammal Ranges to Effects for Helicopter Dipping Sonar

FHG	Depth	Duration	TTS	AINJ
HF	≤200 m	1 s	55 m (13 m)	5 m (1 m)
		30 s	124 m (33 m)	9 m (2 m)
		60 s	180 m (47 m)	12 m (3 m)
		120 s	280 m (69 m)	17 m (4 m)
	>200 m	1 s	54 m (27 m)	3 m (2 m)
		30 s	109 m (53 m)	6 m (3 m)
		60 s	149 m (73 m)	8 m (4 m)
		120 s	214 m (103 m)	13 m (7 m)
VHF	≤200 m	1 s	100 m (29 m)	8 m (2 m)
		30 s	220 m (63 m)	14 m (3 m)
		60 s	310 m (75 m)	19 m (5 m)
		120 s	478 m (91 m)	25 m (6 m)
	>200 m	1 s	95 m (50 m)	0 m (2 m)
		30 s	180 m (98 m)	0 m (4 m)
		60 s	232 m (123 m)	14 m (8 m)
		120 s	323 m (74 m)	24 m (12 m)
VLF	≤200 m	1 s	170 m (31 m)	8 m (2 m)
		30 s	355 m (58 m)	14 m (5 m)
		60 s	490 m (80 m)	17 m (5 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	725 m (121 m)	35 m (5 m)
	>200 m	1 s	130 m (33 m)	0 m (1 m)
		30 s	233 m (66 m)	3 m (7 m)
		60 s	313 m (97 m)	14 m (7 m)
		120 s	500 m (138 m)	27 m (10 m)
LF	≤200 m	1 s	170 m (46 m)	12 m (4 m)
		30 s	354 m (77 m)	21 m (5 m)
		60 s	490 m (100 m)	25 m (6 m)
		120 s	726 m (130 m)	35 m (9 m)
	>200 m	1 s	145 m (75 m)	0 m (4 m)
		30 s	255 m (99 m)	13 m (10 m)
		60 s	310 m (125 m)	24 m (12 m)
		120 s	438 m (97 m)	35 m (18 m)
PW	≤200 m	1 s	220 m (44 m)	7 m (2 m)
		30 s	440 m (69 m)	22 m (5 m)
		60 s	594 m (95 m)	28 m (6 m)
		120 s	878 m (149 m)	44 m (9 m)
	>200 m	1 s	119 m (66 m)	4 m (4 m)
		30 s	266 m (68 m)	8 m (9 m)
		60 s	409 m (79 m)	12 m (12 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	612 m (107 m)	20 m (21 m)
SI	≤200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	0 m (0 m)	0 m (0 m)
		60 s	0 m (14 m)	0 m (0 m)
		120 s	85 m (21 m)	0 m (0 m)
	>200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	0 m (0 m)	0 m (0 m)
		60 s	0 m (0 m)	0 m (0 m)
		120 s	75 m (42 m)	0 m (0 m)

-Median ranges with standard deviation ranges in parentheses

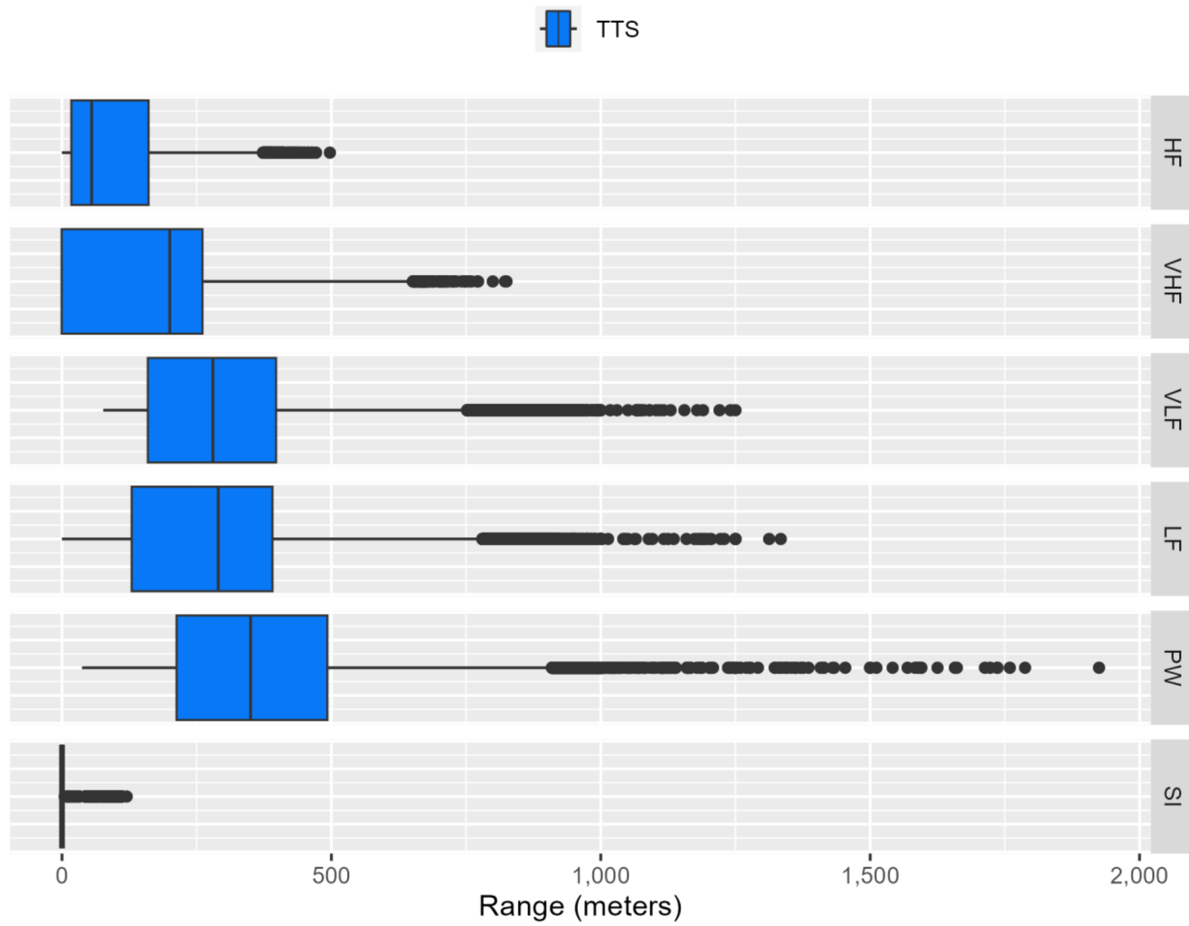


Figure 2.5-10: Marine Mammal Ranges to Temporary Threshold Shift for Helicopter Dipping Sonar

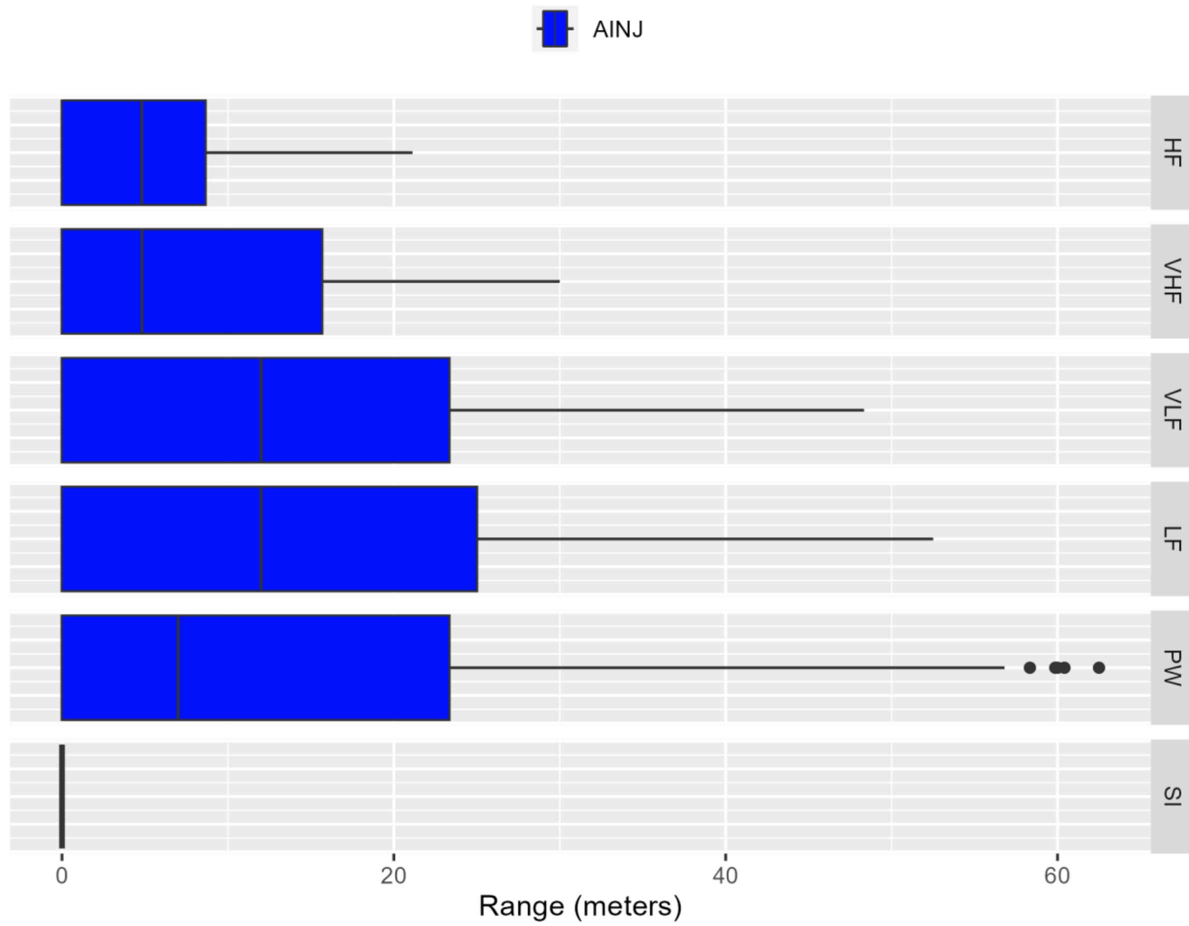


Figure 2.5-11: Marine Mammal Ranges to Auditory Injury for Helicopter Dipping Sonar

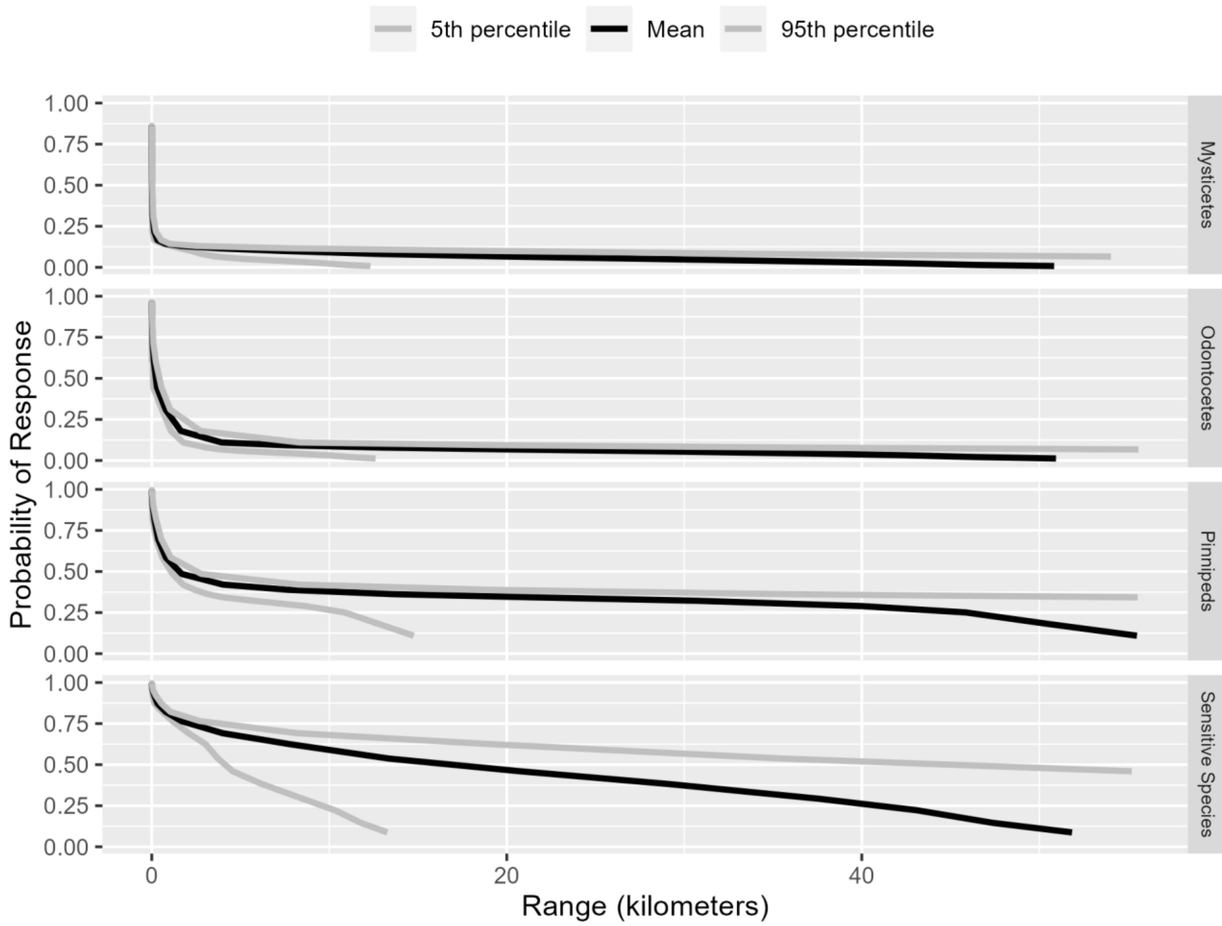


Figure 2.5-12: Marine Mammal Probability of Behavioral Response to Helicopter Dipping Sonar as a Function of Range

2.5.1.5 Sonobuoy Sonar

Table 2.5-5: Marine Mammal Ranges to Effects for Sonobuoy Sonar

FHG	Depth	Duration	TTS	AINJ
HF	≤200 m	1 s	7 m (2 m)	0 m (0 m)
		30 s	16 m (5 m)	0 m (0 m)
		60 s	23 m (7 m)	0 m (0 m)
		120 s	35 m (9 m)	0 m (1 m)
	>200 m	1 s	2 m (3 m)	0 m (0 m)
		30 s	6 m (6 m)	0 m (0 m)
		60 s	11 m (9 m)	0 m (0 m)
		120 s	26 m (14 m)	0 m (0 m)
VHF	≤200 m	1 s	70 m (17 m)	0 m (2 m)
		30 s	140 m (61 m)	9 m (2 m)
		60 s	229 m (89 m)	15 m (3 m)
		120 s	360 m (122 m)	22 m (5 m)
	>200 m	1 s	65 m (31 m)	0 m (1 m)
		30 s	110 m (59 m)	0 m (4 m)
		60 s	180 m (85 m)	10 m (6 m)
		120 s	280 m (64 m)	21 m (10 m)
VLF	≤200 m	1 s	9 m (3 m)	0 m (0 m)
		30 s	17 m (3 m)	0 m (0 m)
		60 s	25 m (6 m)	0 m (0 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	48 m (8 m)	0 m (1 m)
	>200 m	1 s	5 m (4 m)	0 m (0 m)
		30 s	15 m (4 m)	0 m (0 m)
		60 s	22 m (6 m)	0 m (0 m)
		120 s	33 m (7 m)	0 m (0 m)
LF	≤200 m	1 s	12 m (6 m)	0 m (0 m)
		30 s	24 m (9 m)	0 m (0 m)
		60 s	39 m (12 m)	0 m (1 m)
		120 s	55 m (16 m)	0 m (1 m)
	>200 m	1 s	3 m (5 m)	0 m (0 m)
		30 s	19 m (11 m)	0 m (0 m)
		60 s	28 m (17 m)	0 m (0 m)
		120 s	41 m (24 m)	0 m (0 m)
PW	≤200 m	1 s	18 m (4 m)	0 m (0 m)
		30 s	35 m (8 m)	0 m (1 m)
		60 s	52 m (10 m)	0 m (1 m)
		120 s	80 m (17 m)	0 m (2 m)
	>200 m	1 s	14 m (7 m)	0 m (0 m)
		30 s	29 m (15 m)	0 m (0 m)
		60 s	49 m (21 m)	0 m (1 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	74 m (30 m)	0 m (1 m)
SI	≤200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	0 m (0 m)	0 m (0 m)
		60 s	0 m (7 m)	0 m (0 m)
		120 s	0 m (12 m)	0 m (0 m)
	>200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	0 m (0 m)	0 m (0 m)
		60 s	0 m (1 m)	0 m (0 m)
		120 s	0 m (2 m)	0 m (0 m)

-Median ranges with standard deviation ranges in parentheses

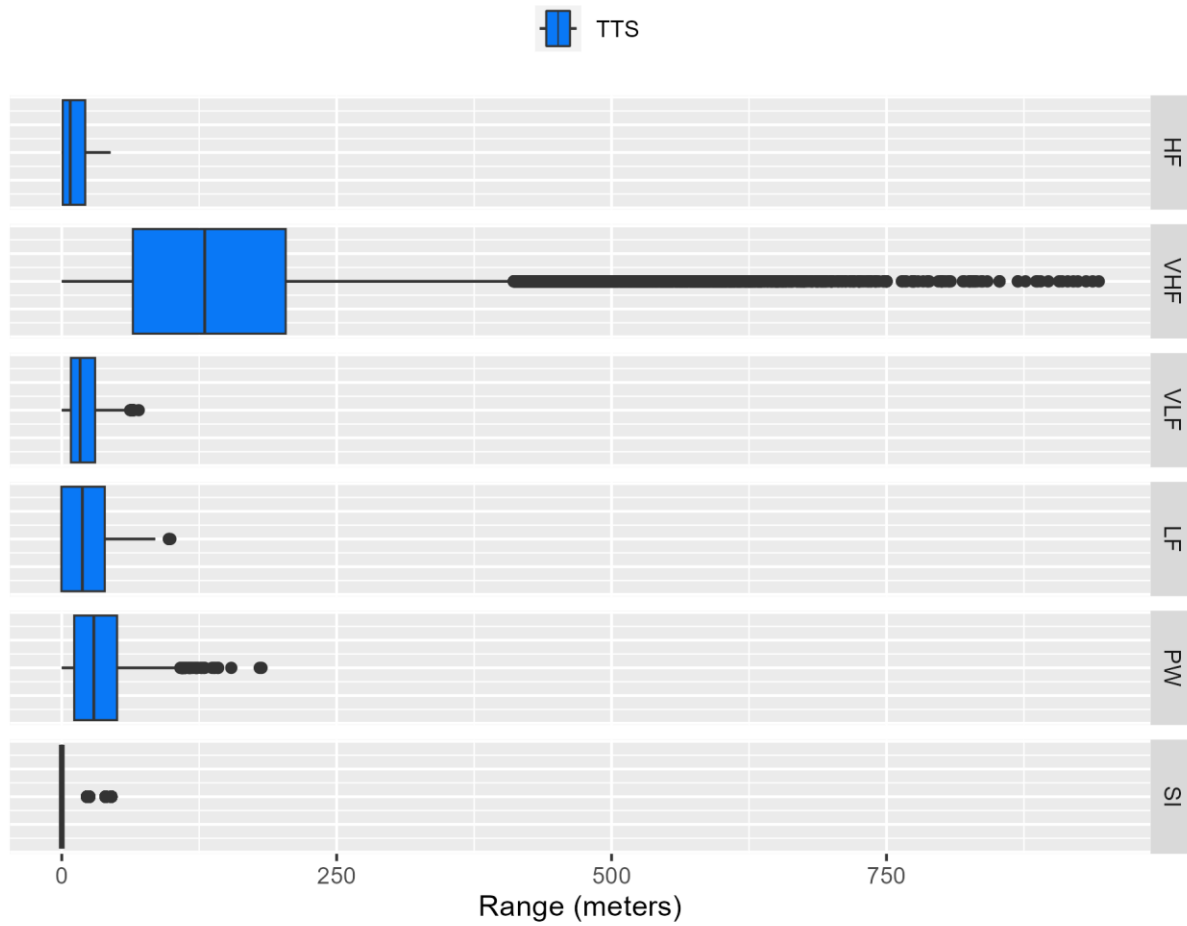


Figure 2.5-13: Marine Mammal Ranges to Temporary Threshold Shift for Sonobuoy Sonar

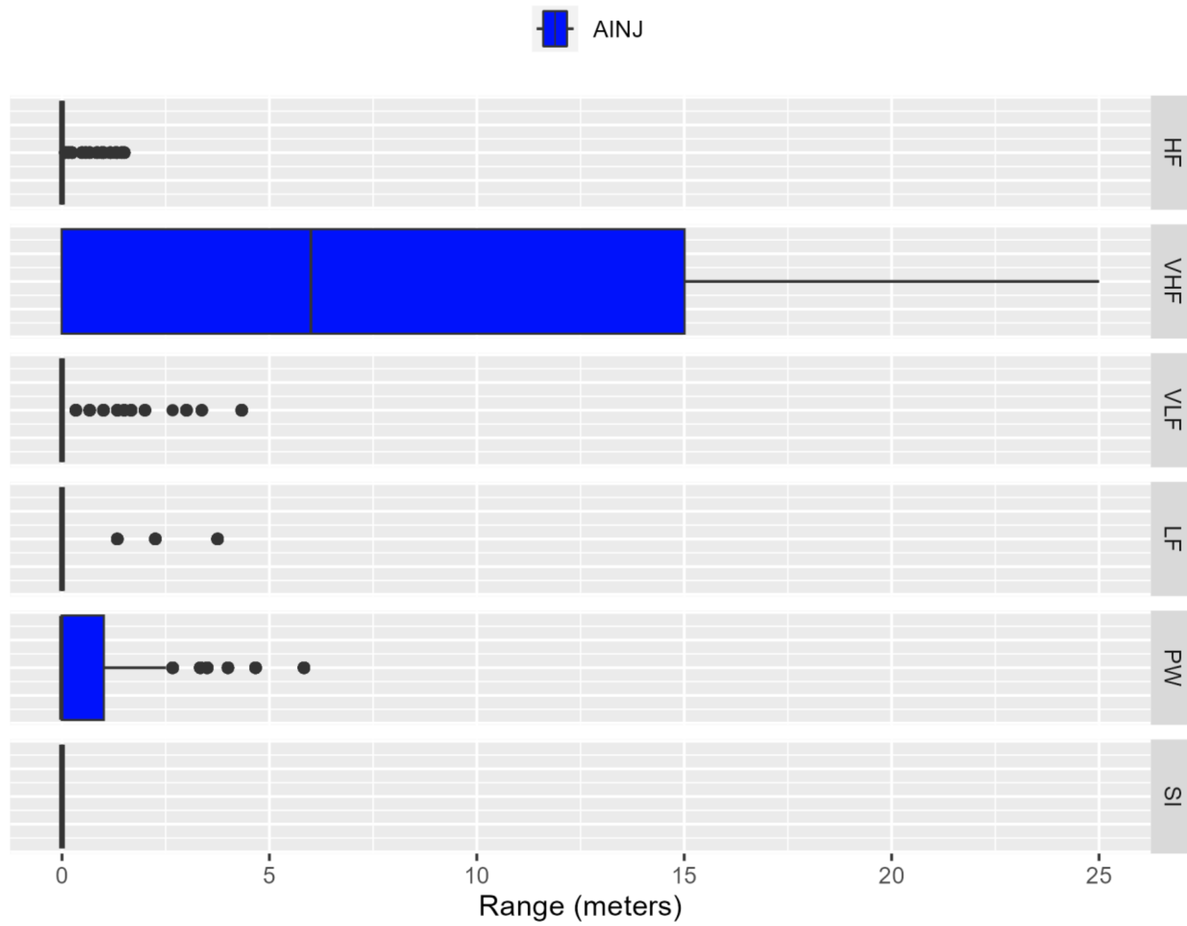


Figure 2.5-14: Marine Mammal Ranges to Auditory Injury for Sonobuoy Sonar

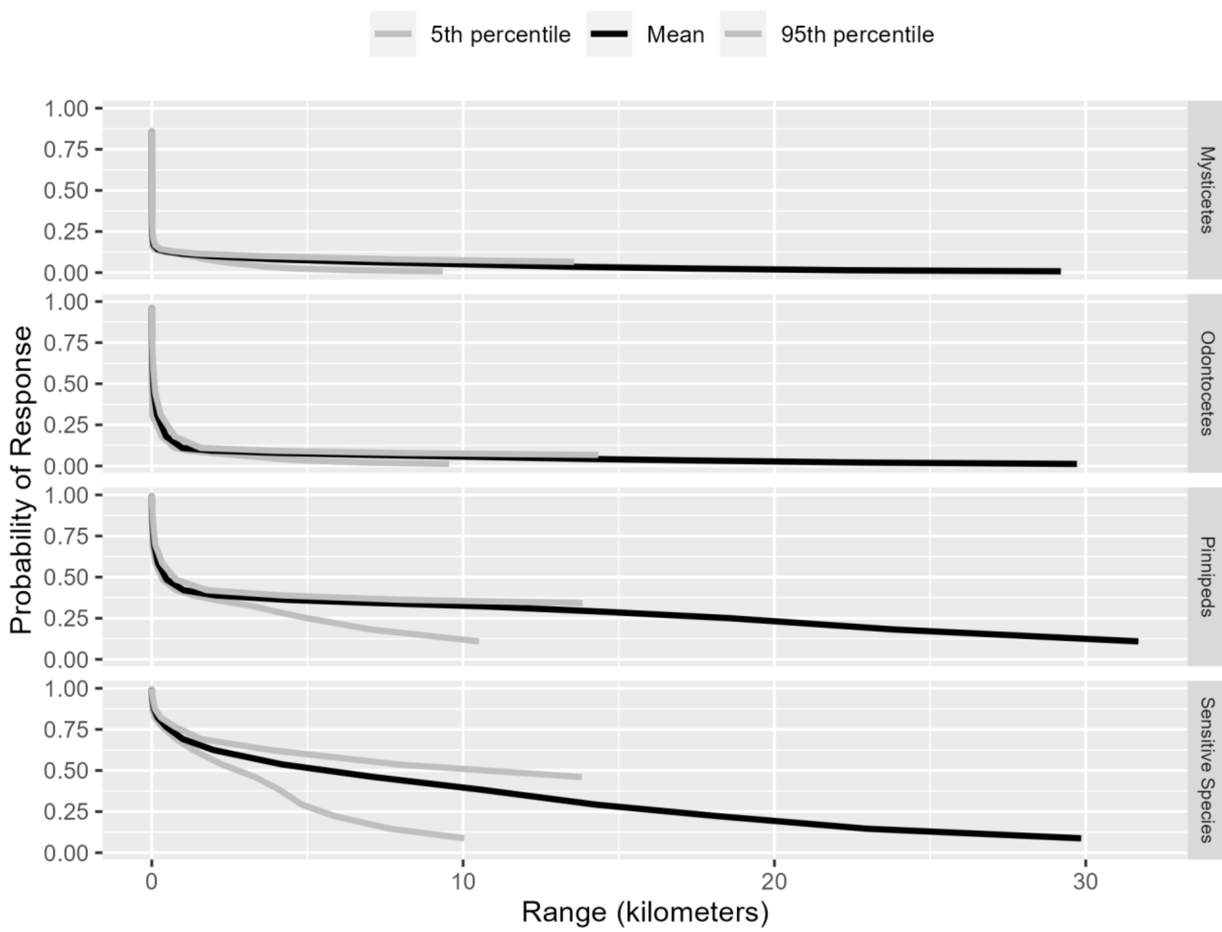


Figure 2.5-15: Marine Mammal Probability of Behavioral Response to Sonobuoy Sonar as a Function of Range

2.5.1.6 Towed Mine-Hunting Sonar

Table 2.5-6: Marine Mammal Ranges to Effects for Towed Mine-Hunting Sonar

FHG	Depth	Duration	TTS	AINJ
HF	≤200 m	1 s	7 m (2 m)	0 m (0 m)
		30 s	14 m (3 m)	0 m (0 m)
		60 s	21 m (4 m)	0 m (1 m)
		120 s	30 m (6 m)	1 m (1 m)
	>200 m	1 s	6 m (2 m)	0 m (0 m)
		30 s	13 m (2 m)	0 m (0 m)
		60 s	20 m (3 m)	0 m (0 m)
		120 s	27 m (2 m)	0 m (0 m)
VHF	≤200 m	1 s	130 m (53 m)	9 m (1 m)
		30 s	290 m (113 m)	16 m (2 m)
		60 s	451 m (161 m)	23 m (3 m)
		120 s	651 m (200 m)	35 m (6 m)
	>200 m	1 s	90 m (4 m)	8 m (1 m)
		30 s	150 m (13 m)	15 m (0 m)
		60 s	213 m (27 m)	22 m (0 m)
		120 s	300 m (38 m)	30 m (0 m)
VLF	≤200 m	1 s	2 m (1 m)	0 m (0 m)
		30 s	4 m (1 m)	0 m (0 m)
		60 s	6 m (2 m)	0 m (0 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	9 m (2 m)	1 m (0 m)
	>200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	3 m (1 m)	0 m (0 m)
		60 s	5 m (1 m)	0 m (0 m)
		120 s	8 m (1 m)	0 m (0 m)
LF	≤200 m	1 s	7 m (3 m)	0 m (0 m)
		30 s	14 m (7 m)	0 m (0 m)
		60 s	22 m (7 m)	1 m (1 m)
		120 s	34 m (9 m)	2 m (1 m)
	>200 m	1 s	7 m (2 m)	0 m (0 m)
		30 s	13 m (4 m)	1 m (0 m)
		60 s	19 m (5 m)	2 m (1 m)
		120 s	32 m (5 m)	2 m (1 m)
PW	≤200 m	1 s	14 m (2 m)	0 m (0 m)
		30 s	25 m (4 m)	1 m (0 m)
		60 s	41 m (7 m)	2 m (0 m)
		120 s	64 m (13 m)	3 m (1 m)
	>200 m	1 s	12 m (1 m)	0 m (0 m)
		30 s	24 m (0 m)	1 m (0 m)
		60 s	34 m (1 m)	1 m (0 m)

FHG	Depth	Duration	TTS	AINJ
		120 s	49 m (1 m)	2 m (0 m)
SI	≤200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	0 m (1 m)	0 m (0 m)
		60 s	0 m (2 m)	0 m (0 m)
		120 s	0 m (6 m)	0 m (0 m)
	>200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	0 m (0 m)	0 m (0 m)
		60 s	0 m (0 m)	0 m (0 m)
		120 s	0 m (0 m)	0 m (0 m)

-Median ranges with standard deviation ranges in parentheses

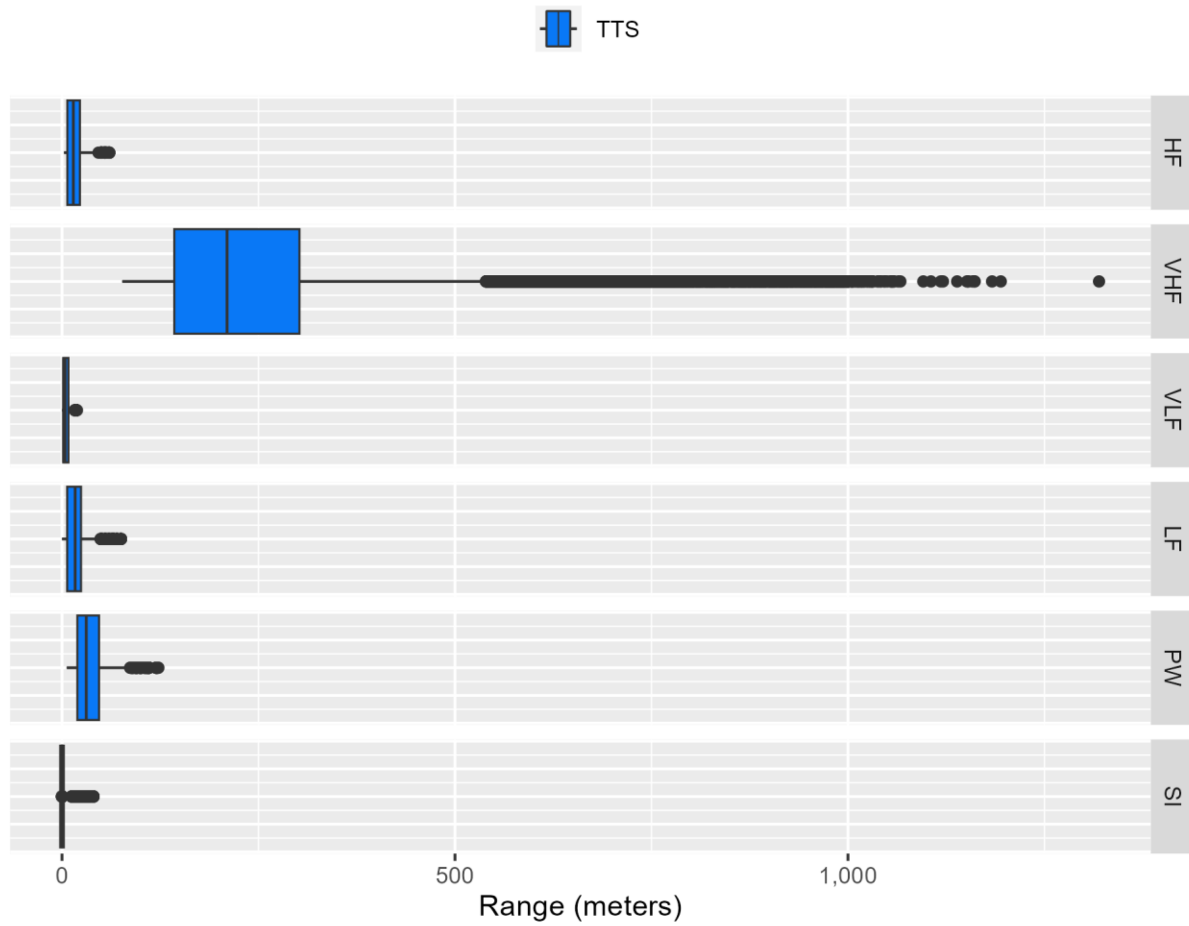


Figure 2.5-16: Marine Mammal Ranges to Temporary Threshold Shift for Towed Mine-Hunting Sonar

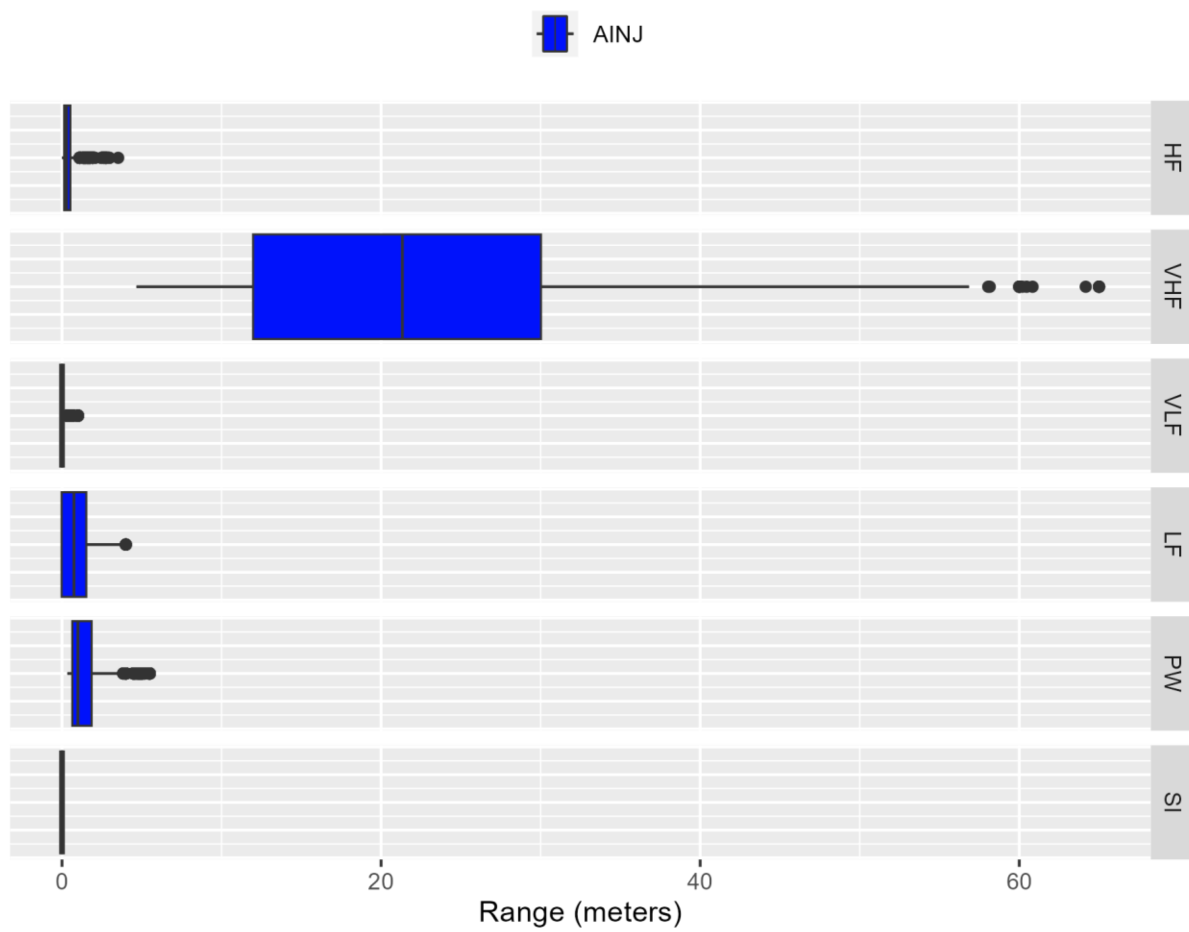


Figure 2.5-17: Marine Mammal Ranges to Auditory Injury for Towed Mine-Hunting Sonar

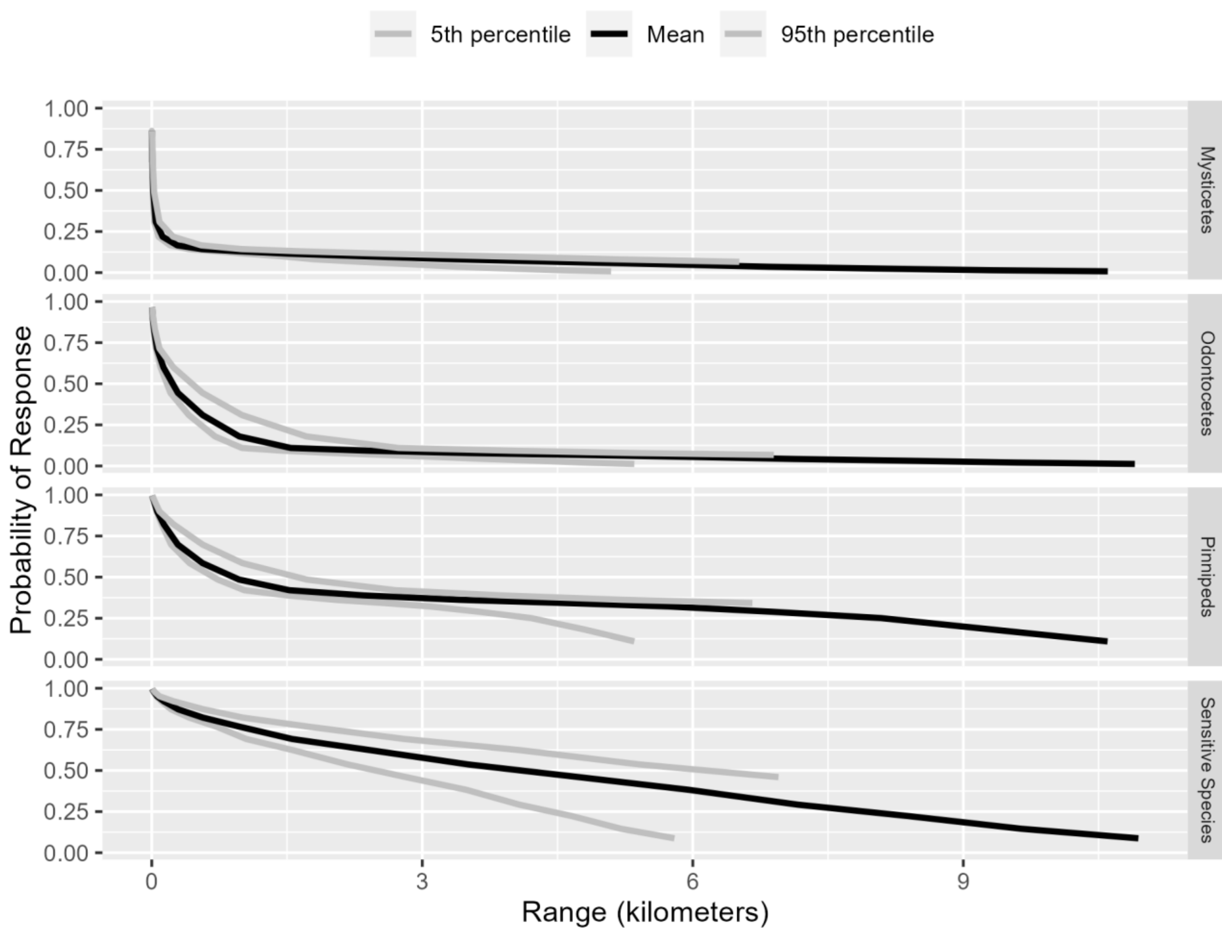


Figure 2.5-18: Marine Mammal Probability of Behavioral Response to Towed Mine-Hunting Sonar as a Function of Range

2.5.2 Ranges to Effects for Air Guns

Ranges to effects for air guns were determined by modeling the distance that sound would need to propagate to reach exposure level thresholds specific to a hearing group that would cause behavioral response, TTS, and AINJ, as described in the *Criteria and Thresholds TR*. The air gun ranges to effects for TTS and AINJ that are in the table are based on the metric (i.e., SEL or SPL) that produced longer ranges.

Table 2.5-7: Marine Mammal Ranges to Effects for Air Guns

FHG	Depth	Cluster Size	BEH	TTS	AINJ
HF	≤200 m	1	151 m (17 m)	2 m (0 m)	1 m (0 m)
	>200 m	1	152 m (20 m)	2 m (0 m)	1 m (0 m)
VHF	≤200 m	1	155 m (18 m)	57 m (3 m)	27 m (2 m)
	>200 m	1	155 m (21 m)	57 m (3 m)	28 m (1 m)
VLF	≤200 m	1	151 m (18 m)	27 m (1 m)	4 m (0 m)
	>200 m	1	153 m (19 m)	27 m (1 m)	4 m (0 m)
LF	≤200 m	1	138 m (14 m)	12 m (0 m)	2 m (0 m)
	>200 m	1	139 m (16 m)	12 m (0 m)	2 m (0 m)
PW	≤200 m	1	146 m (15 m)	5 m (0 m)	2 m (0 m)
	>200 m	1	148 m (17 m)	5 m (0 m)	2 m (0 m)
SI	≤200 m	1	105 m (22 m)	4 m (0 m)	2 m (0 m)
	>200 m	1	108 m (26 m)	4 m (0 m)	2 m (0 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-Median ranges with standard deviation ranges in parentheses
-No ranges for depths ≤200 m or >200 m unless shown

2.5.3 Ranges to Effects for Pile Driving

The predicted ranges to AINJ, TTS, and behavioral response are shown for the only marine mammal hearing group (HF) with predicted impacts due to impact and vibratory pile driving. These ranges were estimated based on activity parameters described in the *Acoustic Stressors* section and using the calculations described in the *Quantitative Analysis TR.*

Table 2.5-8 High Frequency Cetacean Ranges to Effects for Pile Driving

Pile Type	Method	AINJ	TTS	Behavioral Response
16" Timber/Plastic Piles	Impact	2	17	46
16" Timber/Plastic Piles	Vibratory	1	17	6,310
24" Steel Sheet Piles	Vibratory	0	11	3,981

2.5.4 Ranges to Effects for Explosives

Ranges to effects for explosives were determined by modeling the distance that noise from an explosion would need to propagate to reach exposure level thresholds specific to a hearing group that would cause behavioral response, TTS, AINJ, non-auditory injury, and mortality, as described in the *Criteria and Thresholds TR*.

The tables below provide the ranges for a representative cluster size for each bin. Ranges for behavioral response are only provided if more than one explosive cluster occurs. Single explosions at received sound levels below TTS and AINJ thresholds are most likely to result in a brief alerting or orienting response. Due to the lack of subsequent explosions, a significant behavioral response is not expected for a single explosive cluster. 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 AINJ 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. The explosive ranges to effects for TTS and AINJ that are in the tables are based on the metric (i.e., SEL or SPL) that produced longer ranges.

For non-auditory injury in the tables, the larger of the range to slight lung injury or gastrointestinal tract injury was used as a conservative estimate, and the boxplots present ranges for both metrics for comparison. Since the non-auditory metric is SPL-based, ranges are only available for a cluster size of one. Animals within water volumes encompassing the estimated range to non-auditory injury 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.

2.5.4.1 Bin E1 (0.1 - 0.25 lb. NEW)

Table 2.5-9: Marine Mammal Ranges to Effects for E1 (0.1 - 0.25 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	110 m (19 m)	44 m (0 m)	22 m (0 m)	2 m (0 m)
		25	755 m (72 m)	517 m (51 m)	113 m (6 m)	NA	NA
		100	1,013 m (133 m)	755 m (77 m)	238 m (18 m)	NA	NA
	>200 m	1	NA	90 m (2 m)	44 m (0 m)	22 m (0 m)	2 m (0 m)
VHF	≤200 m	1	NA	2,296 m (1,254 m)	740 m (74 m)	22 m (0 m)	3 m (0 m)
		25	8,722 m (2,335 m)	6,141 m (1,475 m)	1,493 m (295 m)	NA	NA
		100	12,539 m (3,621 m)	9,514 m (2,624 m)	3,069 m (995 m)	NA	NA
	>200 m	1	NA	1,706 m (1,298 m)	731 m (74 m)	22 m (0 m)	3 m (0 m)
VLF	≤200 m	1	NA	295 m (144 m)	95 m (5 m)	22 m (0 m)	0 m (0 m)
		25	1,285 m (330 m)	796 m (115 m)	197 m (38 m)	NA	NA
		100	5,072 m (3,029 m)	1,648 m (1,256 m)	354 m (75 m)	NA	NA
	>200 m	1	NA	220 m (89 m)	95 m (3 m)	22 m (0 m)	0 m (0 m)
LF	≤200 m	1	NA	354 m (144 m)	96 m (6 m)	22 m (0 m)	0 m (0 m)
		25	1,609 m (325 m)	974 m (44 m)	288 m (28 m)	NA	NA
		100	4,979 m (2,429 m)	1,988 m (1,304 m)	503 m (54 m)	NA	NA
	>200 m	1	NA	345 m (49 m)	96 m (3 m)	22 m (0 m)	0 m (0 m)
PW	≤200 m	1	NA	342 m (104 m)	89 m (4 m)	22 m (0 m)	2 m (0 m)
		25	1,515 m (249 m)	994 m (36 m)	305 m (25 m)	NA	NA

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
		100	3,802 m (2,023 m)	1,782 m (883 m)	500 m (53 m)	NA	NA
	>200 m	1	NA	307 m (33 m)	88 m (2 m)	22 m (0 m)	2 m (0 m)
SI	≤200 m	1	NA	210 m (61 m)	55 m (5 m)	17 m (0 m)	1 m (0 m)
		25	1,014 m (87 m)	826 m (85 m)	210 m (13 m)	NA	NA
		100	1,604 m (518 m)	1,088 m (150 m)	382 m (36 m)	NA	NA
	>200 m	1	NA	140 m (69 m)	54 m (4 m)	17 m (0 m)	1 m (0 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

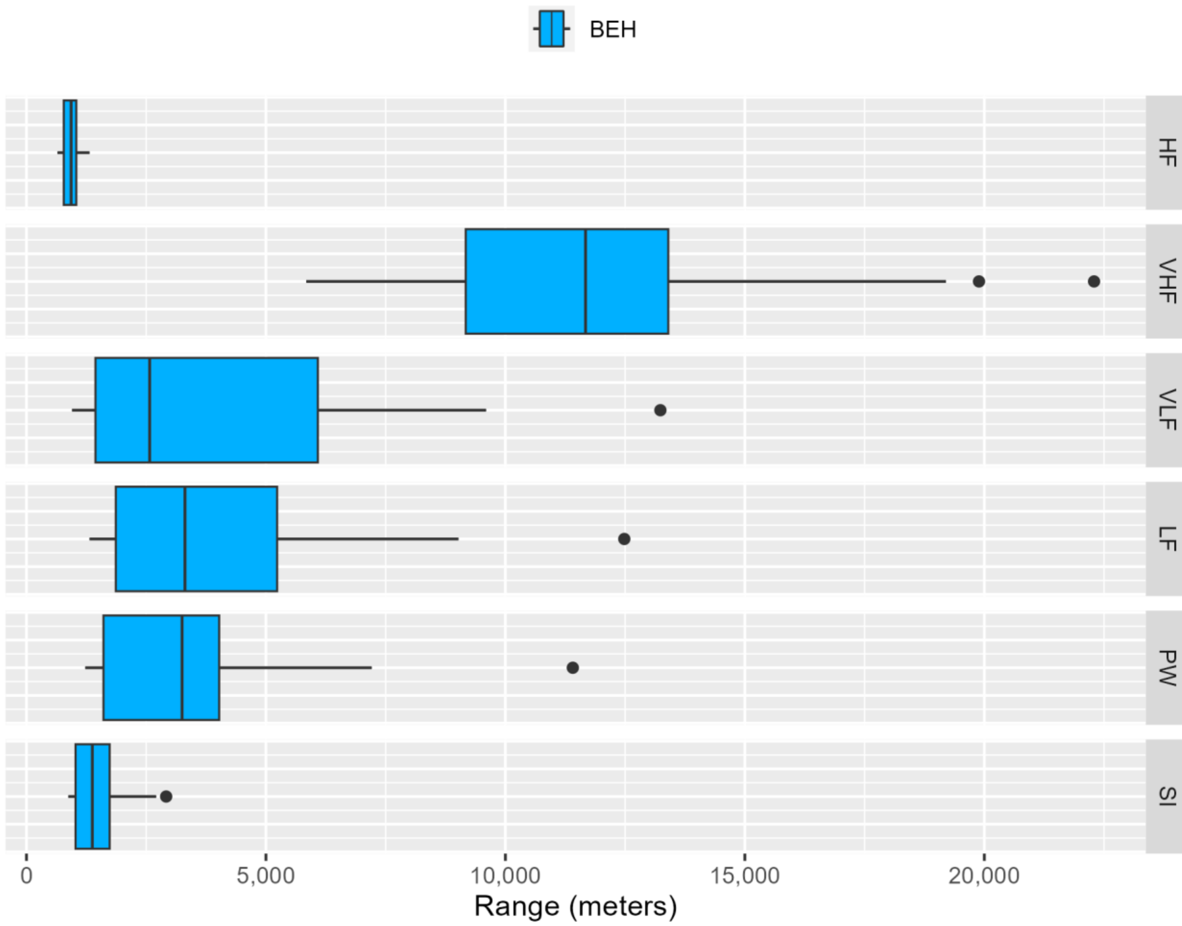


Figure 2.5-19: Marine Mammal Ranges to Behavioral Response for E1 (0.1 - 0.25 lb.)

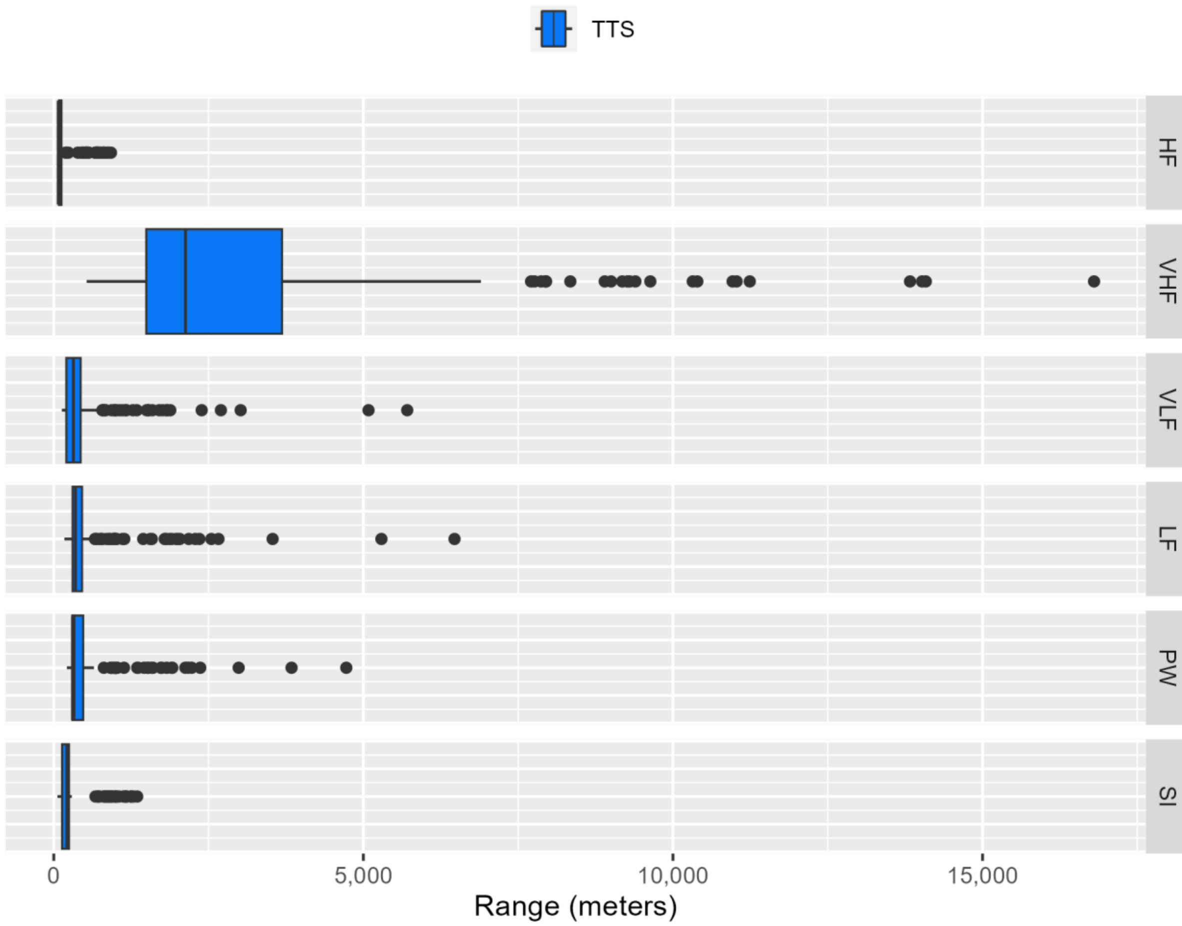


Figure 2.5-20: Marine Mammal Ranges to Temporary Threshold Shift for E1 (0.1 - 0.25 lb.)

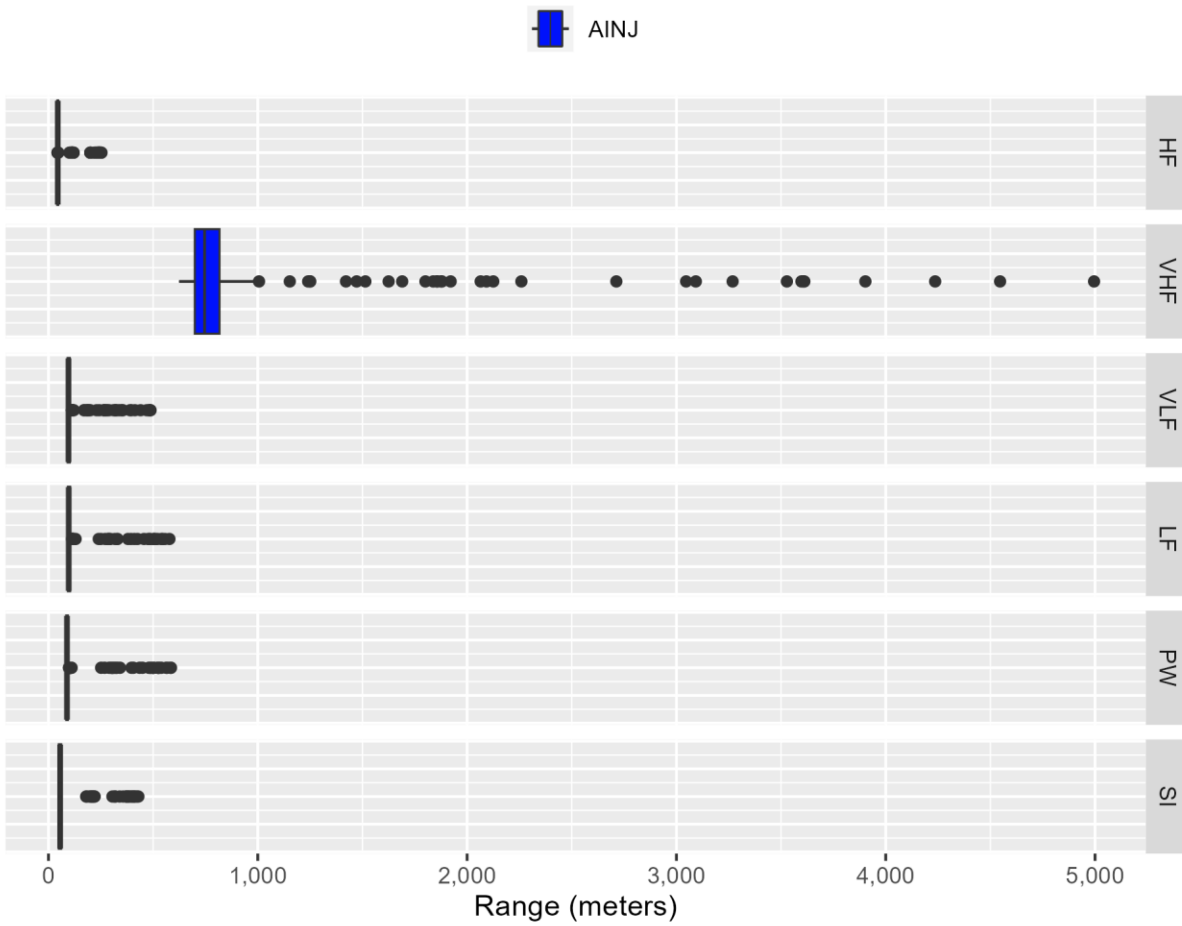


Figure 2.5-21: Marine Mammal Ranges to Auditory Injury for E1 (0.1 - 0.25 lb.)

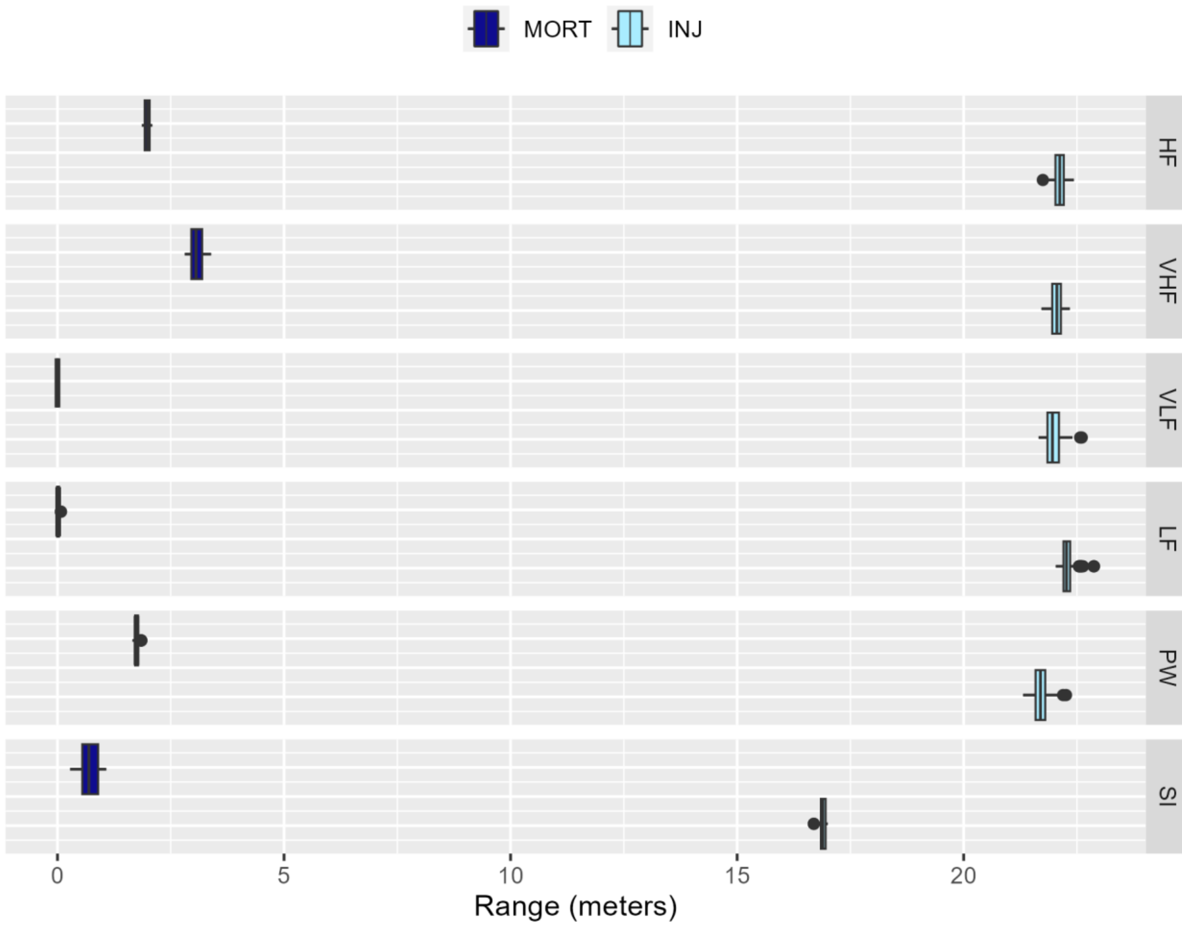


Figure 2.5-22: Marine Mammal Ranges to Mortality and Injury for E1 (0.1 - 0.25 lb.)

2.5.4.2 Bin E2 (>0.25 - 0.5 lb. NEW)

Table 2.5-10: Marine Mammal Ranges to Effects for E2 (>0.25 - 0.5 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	156 m (1 m)	45 m (0 m)	26 m (0 m)	3 m (0 m)
VHF		1	NA	2,375 m (92 m)	648 m (14 m)	25 m (0 m)	4 m (0 m)
VLF		1	NA	293 m (9 m)	98 m (0 m)	26 m (0 m)	0 m (0 m)
LF		1	NA	377 m (6 m)	98 m (0 m)	26 m (0 m)	1 m (0 m)
PW		1	NA	382 m (4 m)	91 m (0 m)	26 m (0 m)	3 m (0 m)
SI		1	NA	283 m (1 m)	76 m (0 m)	19 m (0 m)	3 m (0 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

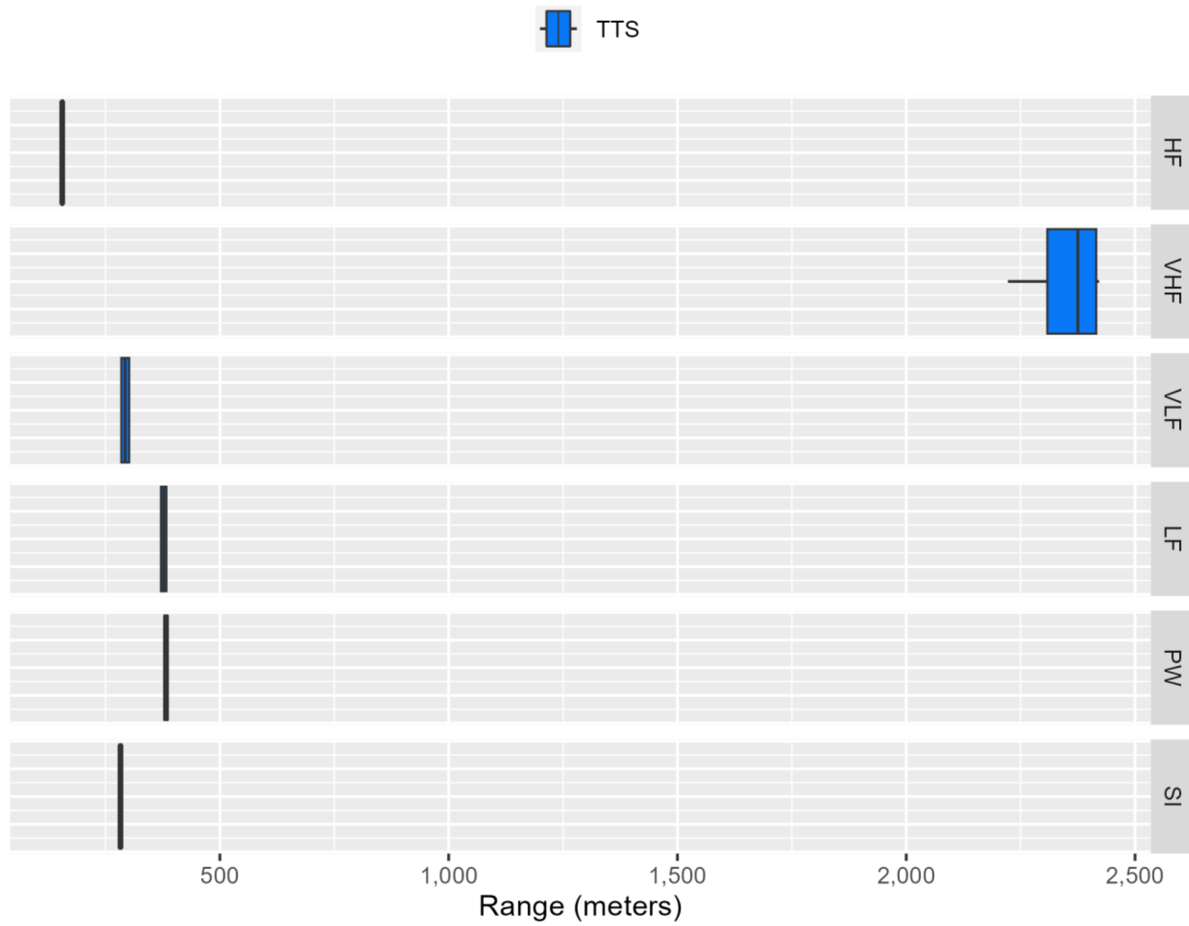


Figure 2.5-23: Marine Mammal Ranges to Temporary Threshold Shift for E2 (>0.25 - 0.5 lb.)

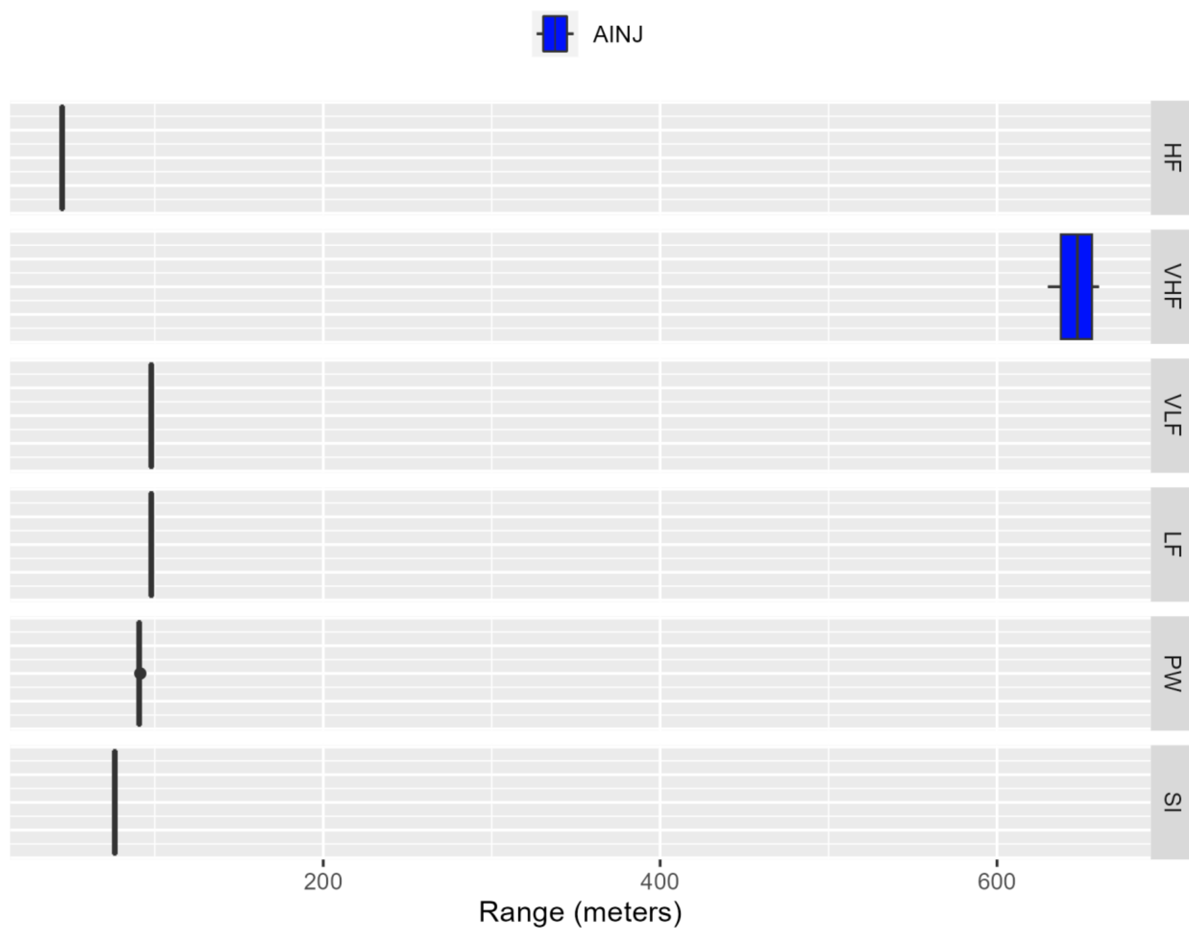


Figure 2.5-24: Marine Mammal Ranges to Auditory Injury for E2 (>0.25 - 0.5 lb.)

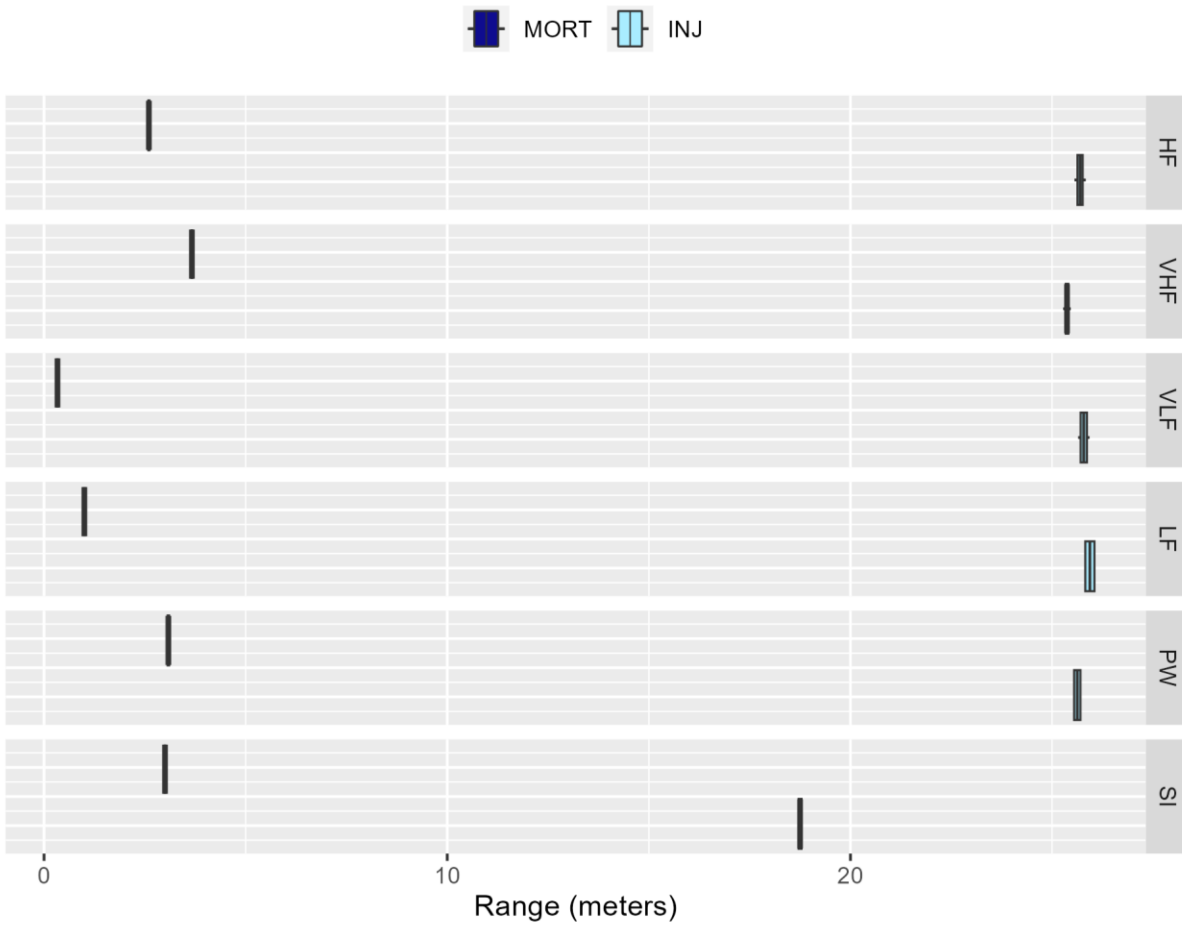


Figure 2.5-25: Marine Mammal Ranges to Mortality and Injury for E2 (>0.25 - 0.5 lb.)

2.5.4.3 Bin E3 (>0.5 - 2.5 lb. NEW)

Table 2.5-11: Marine Mammal Ranges to Effects for E3 (>0.5 - 2.5 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	228 m (57 m)	95 m (4 m)	47 m (1 m)	7 m (1 m)
		10	878 m (202 m)	591 m (113 m)	150 m (14 m)	NA	NA
	>200 m	1	NA	181 m (21 m)	95 m (4 m)	46 m (1 m)	7 m (1 m)
		10	592 m (48 m)	400 m (21 m)	123 m (4 m)	NA	NA
VHF	≤200 m	1	NA	4,236 m (1,988 m)	1,338 m (202 m)	47 m (1 m)	9 m (1 m)
		10	13,044 m (6,193 m)	9,678 m (4,397 m)	2,361 m (1,043 m)	NA	NA
	>200 m	1	NA	3,083 m (2,118 m)	1,415 m (211 m)	46 m (1 m)	9 m (1 m)
		10	8,363 m (3,873 m)	6,123 m (2,817 m)	1,500 m (510 m)	NA	NA
VLF	≤200 m	1	NA	542 m (532 m)	208 m (17 m)	45 m (1 m)	1 m (0 m)
		10	3,792 m (2,929 m)	1,301 m (895 m)	281 m (71 m)	NA	NA
	>200 m	1	NA	460 m (283 m)	210 m (16 m)	45 m (1 m)	1 m (0 m)
		10	1,720 m (771 m)	956 m (267 m)	280 m (41 m)	NA	NA
LF	≤200 m	1	NA	625 m (461 m)	198 m (18 m)	47 m (1 m)	2 m (0 m)
		10	3,259 m (2,505 m)	1,457 m (892 m)	360 m (59 m)	NA	NA
	>200 m	1	NA	574 m (237 m)	200 m (17 m)	47 m (1 m)	3 m (0 m)
		10	1,750 m (1,091 m)	1,091 m (279 m)	318 m (31 m)	NA	NA
PW	≤200 m	1	NA	626 m (275 m)	190 m (15 m)	45 m (1 m)	7 m (1 m)
		10	2,747 m (1,448 m)	1,337 m (593 m)	392 m (49 m)	NA	NA

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
	>200 m	1	NA	487 m (168 m)	191 m (14 m)	45 m (1 m)	8 m (1 m)
		10	1,538 m (829 m)	984 m (158 m)	317 m (7 m)	NA	NA
SI	≤200 m	1	NA	420 m (146 m)	109 m (13 m)	30 m (2 m)	4 m (1 m)
		10	1,375 m (805 m)	953 m (294 m)	260 m (74 m)	NA	NA
	>200 m	1	NA	245 m (168 m)	112 m (13 m)	31 m (2 m)	4 m (1 m)
		10	482 m (451 m)	300 m (220 m)	112 m (13 m)	NA	NA

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

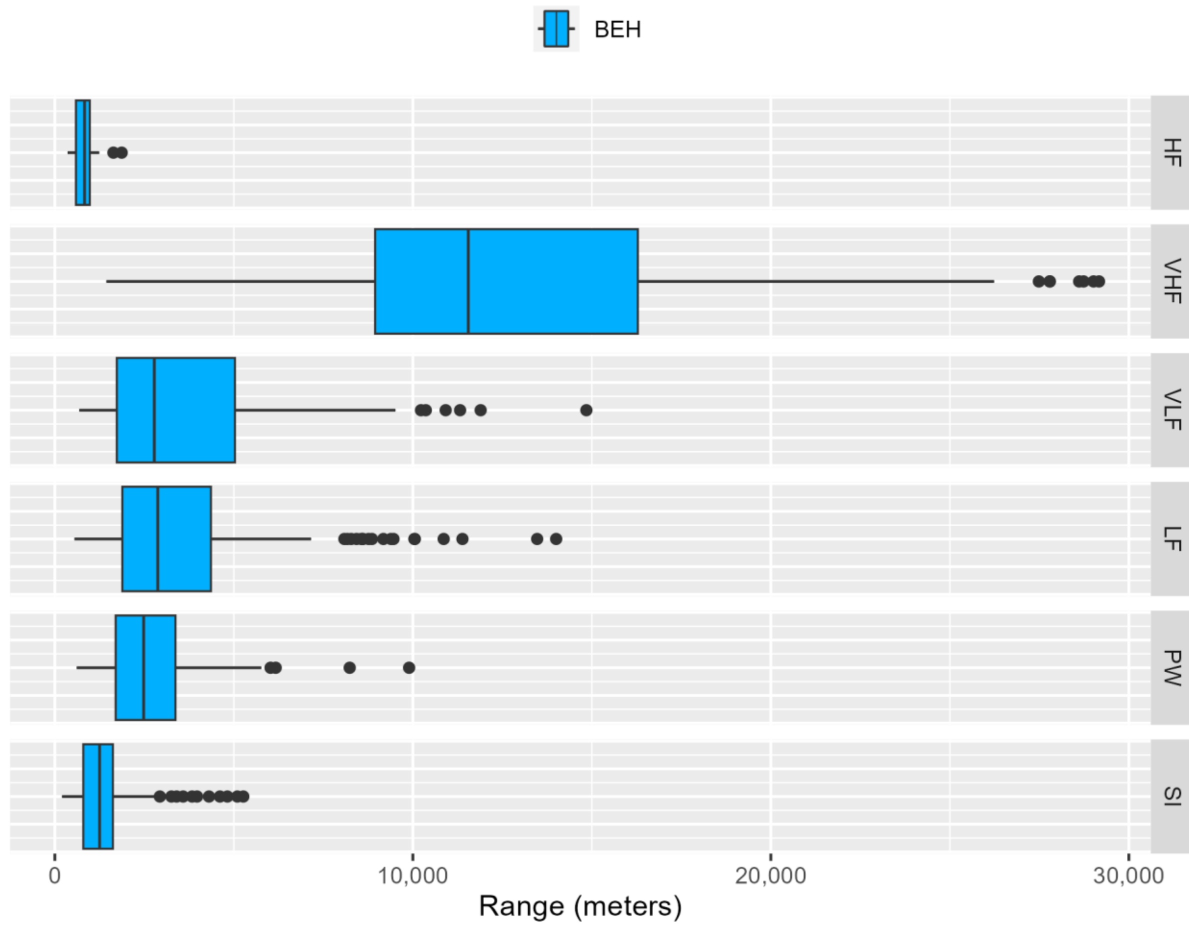


Figure 2.5-26: Marine Mammal Ranges to Behavioral Response for E3 (>0.5 - 2.5 lb.)

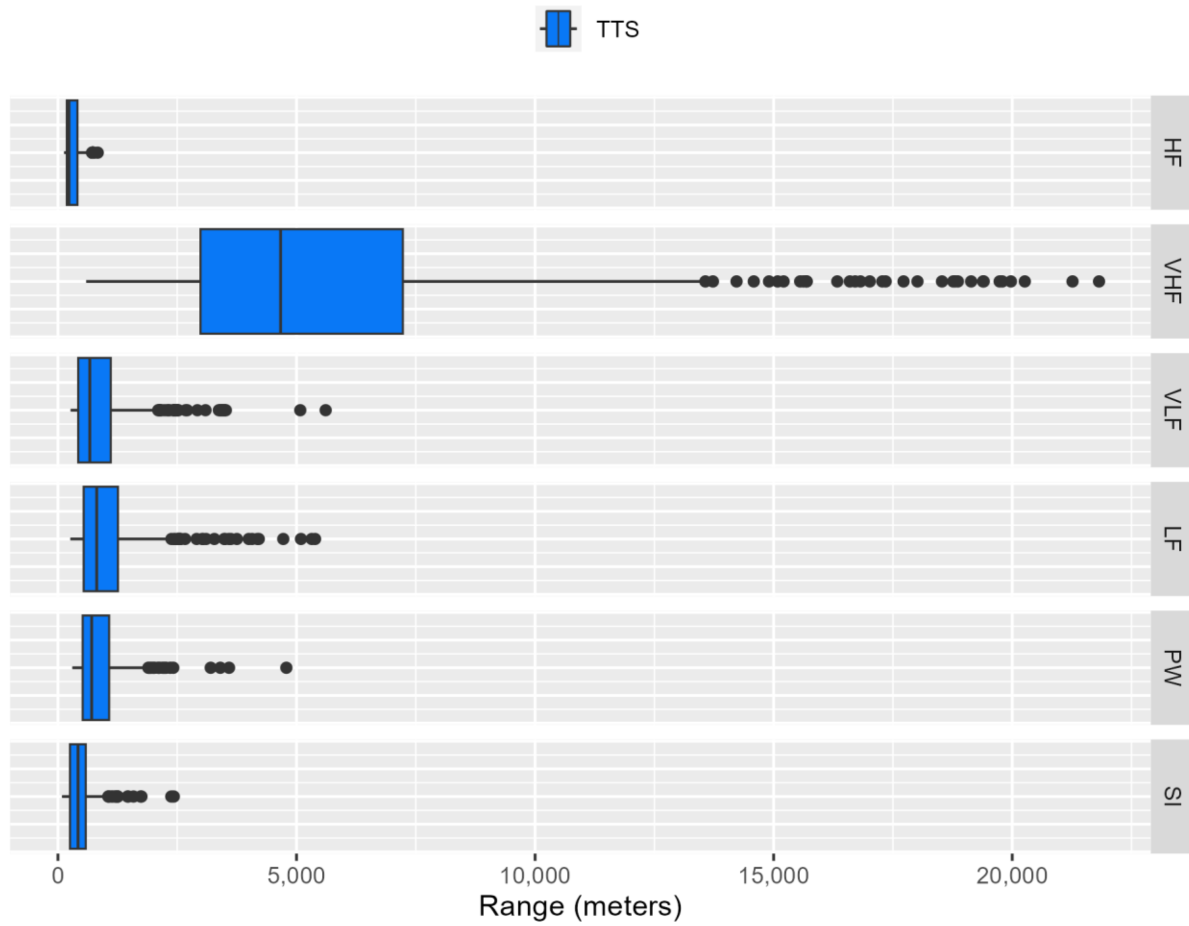


Figure 2.5-27: Marine Mammal Ranges to Temporary Threshold Shift for E3 (>0.5 - 2.5 lb.)

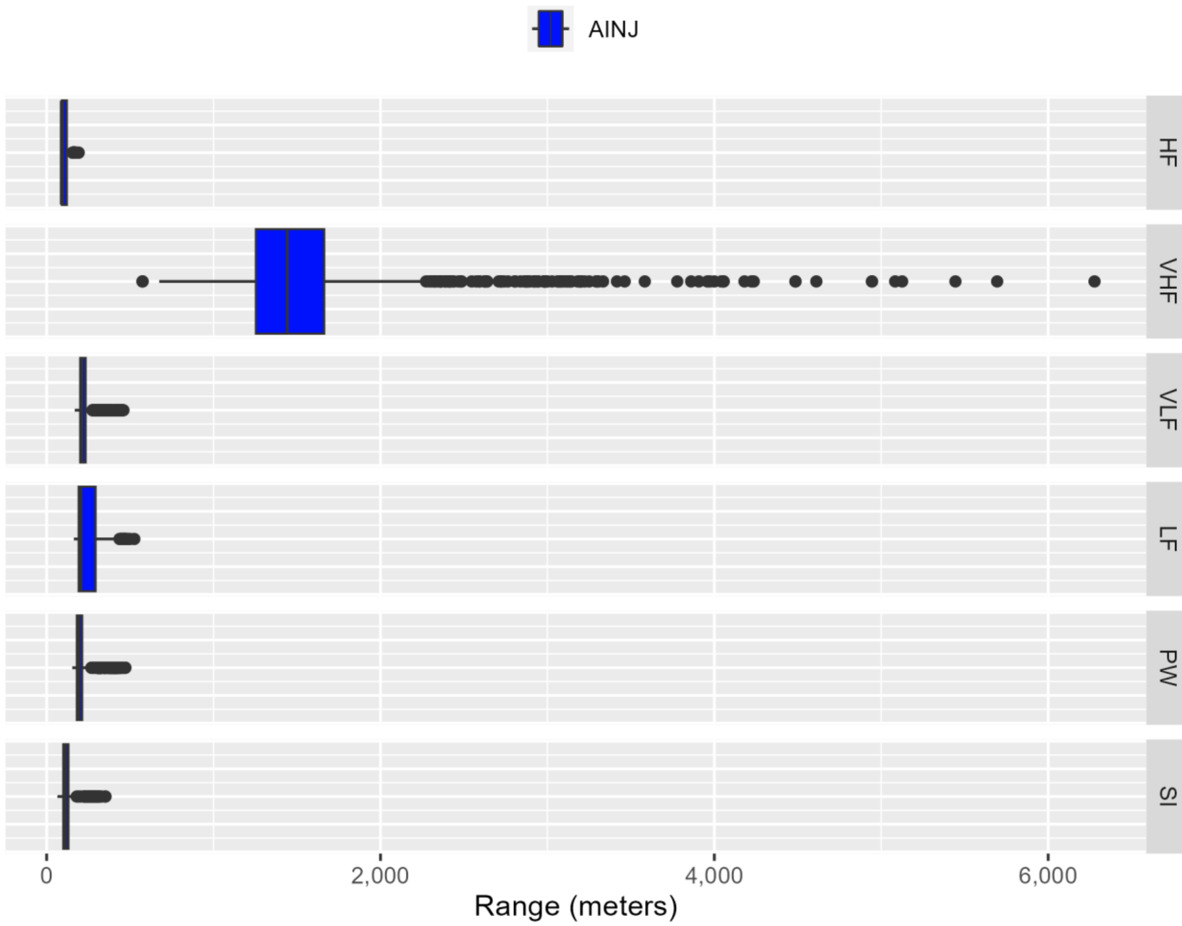


Figure 2.5-28: Marine Mammal Ranges to Auditory Injury for E3 (>0.5 - 2.5 lb.)

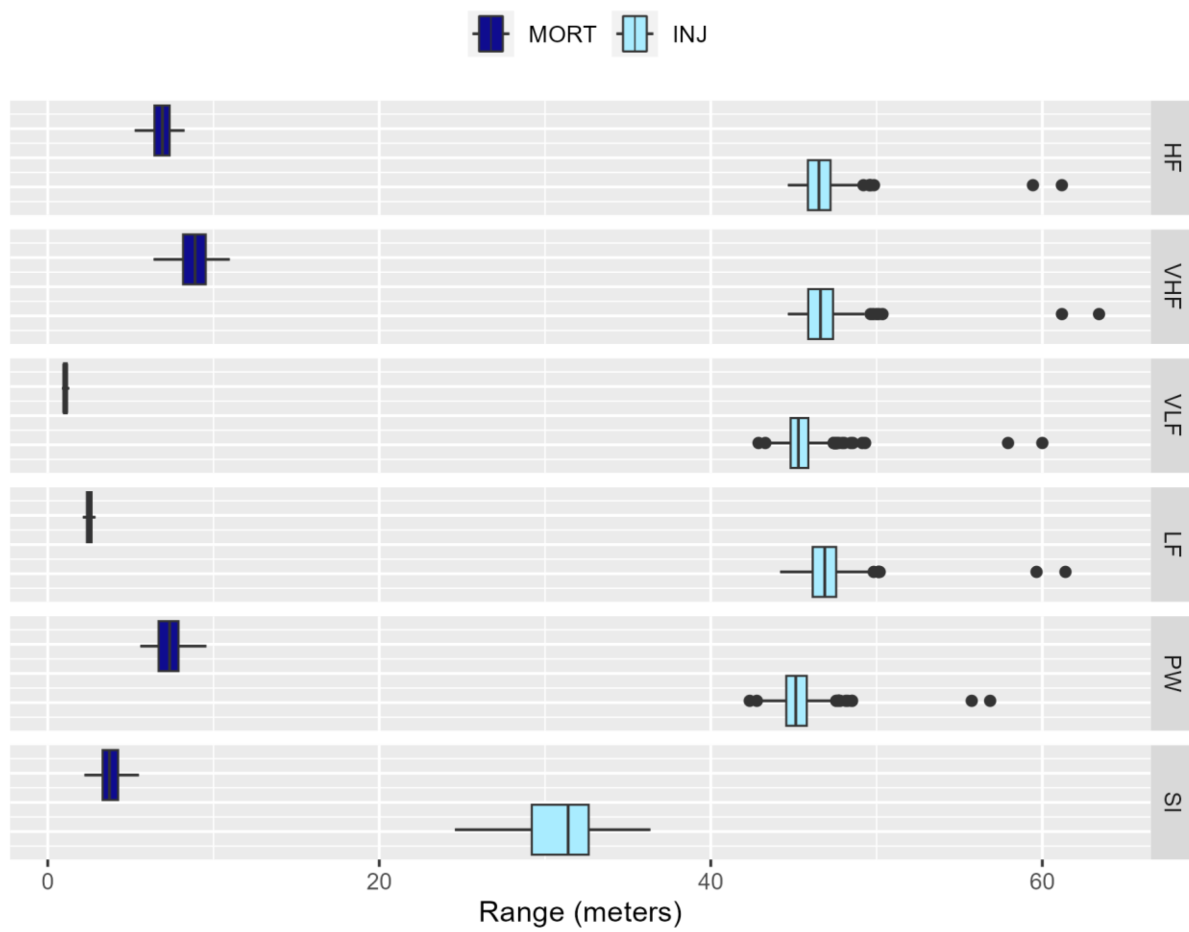


Figure 2.5-29: Marine Mammal Ranges to Mortality and Injury for E3 (>0.5 - 2.5 lb.)

2.5.4.4 Bin E4 (>2.5 - 5 lb. NEW)

Table 2.5-12: Marine Mammal Ranges to Effects for E4 (>2.5 - 5 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	426 m (103 m)	131 m (9 m)	59 m (5 m)	16 m (1 m)
	>200 m	1	NA	279 m (16 m)	125 m (11 m)	58 m (5 m)	15 m (2 m)
VHF	≤200 m	1	NA	8,160 m (3,355 m)	3,713 m (440 m)	58 m (3 m)	19 m (2 m)
	>200 m	1	NA	7,056 m (818 m)	3,716 m (386 m)	56 m (4 m)	17 m (3 m)
VLF	≤200 m	1	NA	2,634 m (1,020 m)	378 m (144 m)	62 m (5 m)	3 m (0 m)
	>200 m	1	NA	1,000 m (102 m)	353 m (26 m)	62 m (4 m)	3 m (1 m)
LF	≤200 m	1	NA	2,349 m (860 m)	354 m (30 m)	59 m (6 m)	6 m (1 m)
	>200 m	1	NA	1,000 m (217 m)	353 m (24 m)	58 m (6 m)	5 m (1 m)
PW	≤200 m	1	NA	1,565 m (623 m)	305 m (29 m)	58 m (6 m)	17 m (2 m)
	>200 m	1	NA	938 m (69 m)	308 m (22 m)	56 m (5 m)	15 m (3 m)
SI	≤200 m	1	NA	731 m (228 m)	217 m (15 m)	53 m (4 m)	14 m (1 m)
	>200 m	1	NA	422 m (22 m)	210 m (16 m)	50 m (5 m)	13 m (1 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

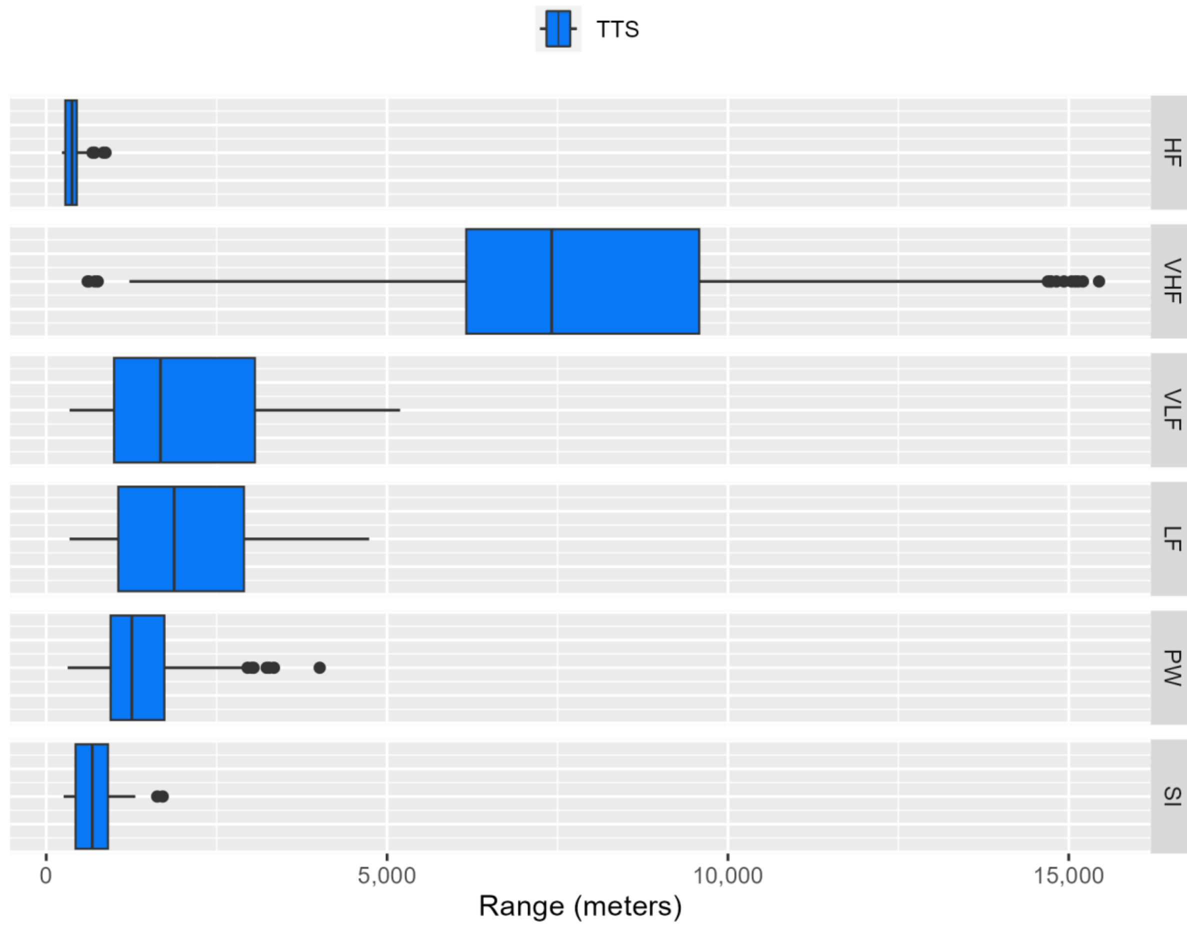


Figure 2.5-30: Marine Mammal Ranges to Temporary Threshold Shift for E4 (>2.5 - 5 lb.)

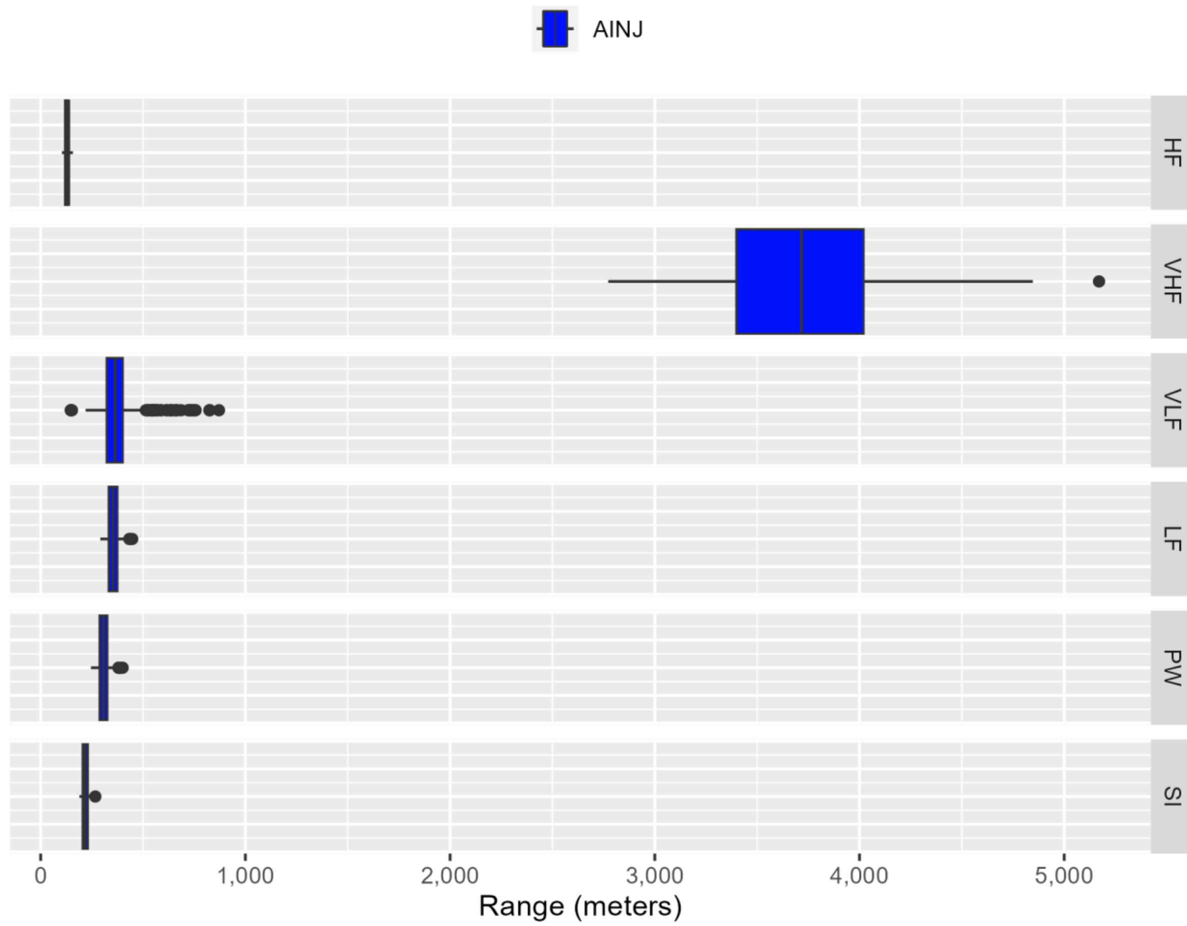


Figure 2.5-31: Marine Mammal Ranges to Auditory Injury for E4 (>2.5 - 5 lb.)

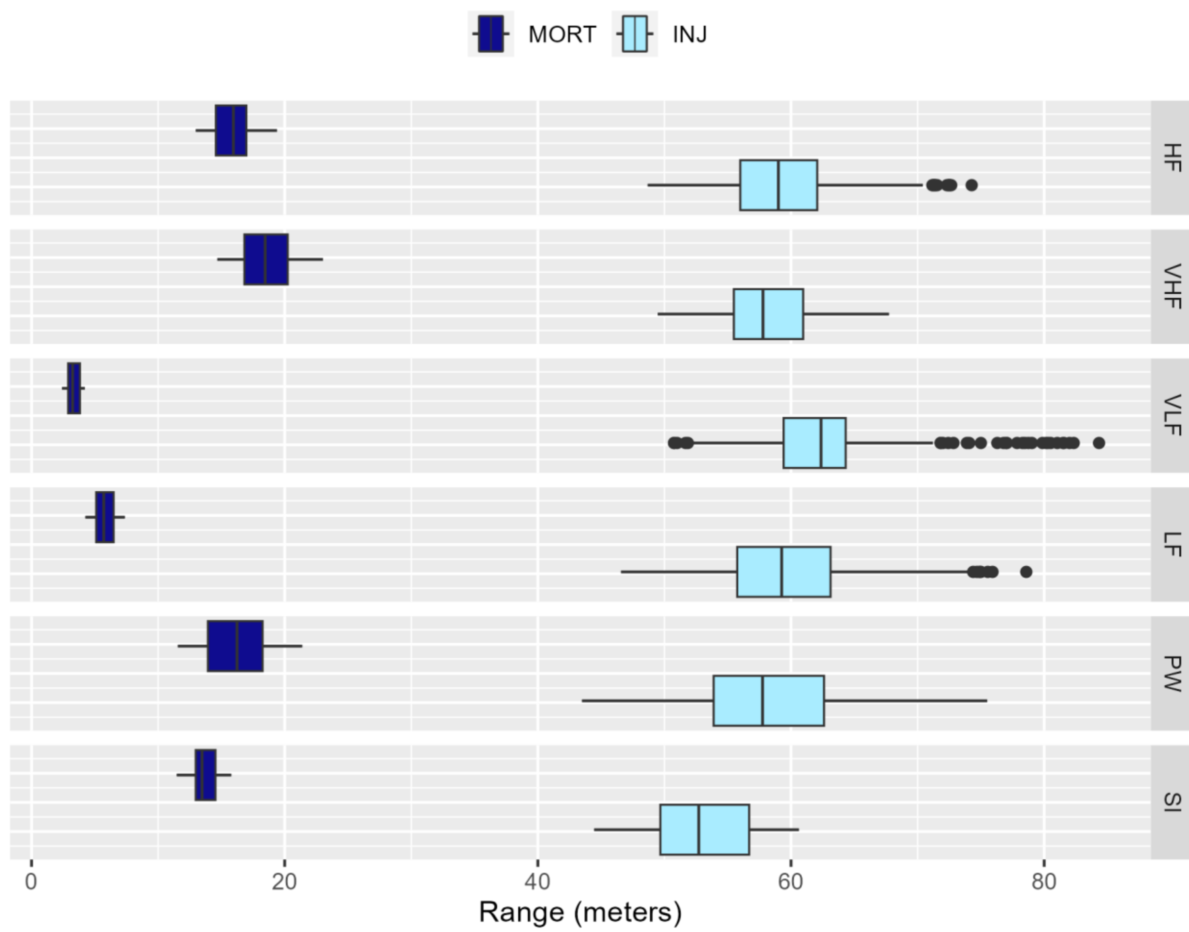


Figure 2.5-32: Marine Mammal Ranges to Mortality and Injury for E4 (>2.5 - 5 lb.)

2.5.4.5 Bin E5 (>5 - 10 lb. NEW)

Table 2.5-13: Marine Mammal Ranges to Effects for E5 (>5 - 10 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	366 m (119 m)	139 m (7 m)	74 m (3 m)	12 m (1 m)
		8	1,085 m (345 m)	780 m (100 m)	218 m (18 m)	NA	NA
	>200 m	1	NA	258 m (6 m)	139 m (7 m)	74 m (3 m)	12 m (1 m)
		8	775 m (36 m)	548 m (30 m)	169 m (1 m)	NA	NA
VHF	≤200 m	1	NA	6,171 m (2,434 m)	2,406 m (573 m)	74 m (3 m)	15 m (2 m)
		8	17,977 m (7,063 m)	13,660 m (4,935 m)	3,727 m (1,527 m)	NA	NA
	>200 m	1	NA	5,250 m (1,027 m)	2,382 m (519 m)	74 m (3 m)	15 m (2 m)
		8	10,718 m (3,879 m)	8,102 m (3,315 m)	2,382 m (519 m)	NA	NA
VLF	≤200 m	1	NA	881 m (1,238 m)	302 m (29 m)	72 m (3 m)	3 m (0 m)
		8	11,553 m (7,533 m)	5,500 m (3,277 m)	394 m (118 m)	NA	NA
	>200 m	1	NA	610 m (169 m)	314 m (32 m)	72 m (3 m)	3 m (0 m)
		8	3,576 m (1,387 m)	1,968 m (380 m)	519 m (86 m)	NA	NA
LF	≤200 m	1	NA	947 m (1,106 m)	288 m (26 m)	74 m (3 m)	5 m (1 m)
		8	9,134 m (5,815 m)	3,707 m (2,488 m)	496 m (75 m)	NA	NA
	>200 m	1	NA	625 m (139 m)	296 m (29 m)	74 m (3 m)	5 m (1 m)
		8	3,622 m (1,942 m)	1,875 m (1,017 m)	501 m (55 m)	NA	NA
PW	≤200 m	1	NA	893 m (732 m)	270 m (24 m)	72 m (3 m)	13 m (2 m)
		8	5,670 m (3,329 m)	2,597 m (1,242 m)	512 m (59 m)	NA	NA

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
	>200 m	1	NA	654 m (53 m)	272 m (26 m)	72 m (3 m)	13 m (2 m)
		8	2,700 m (1,453 m)	1,329 m (930 m)	435 m (15 m)	NA	NA
SI	≤200 m	1	NA	625 m (255 m)	169 m (17 m)	38 m (3 m)	10 m (1 m)
		8	2,340 m (1,816 m)	1,250 m (814 m)	362 m (35 m)	NA	NA
	>200 m	1	NA	326 m (43 m)	177 m (22 m)	38 m (3 m)	11 m (1 m)
		8	627 m (148 m)	461 m (96 m)	177 m (22 m)	NA	NA

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

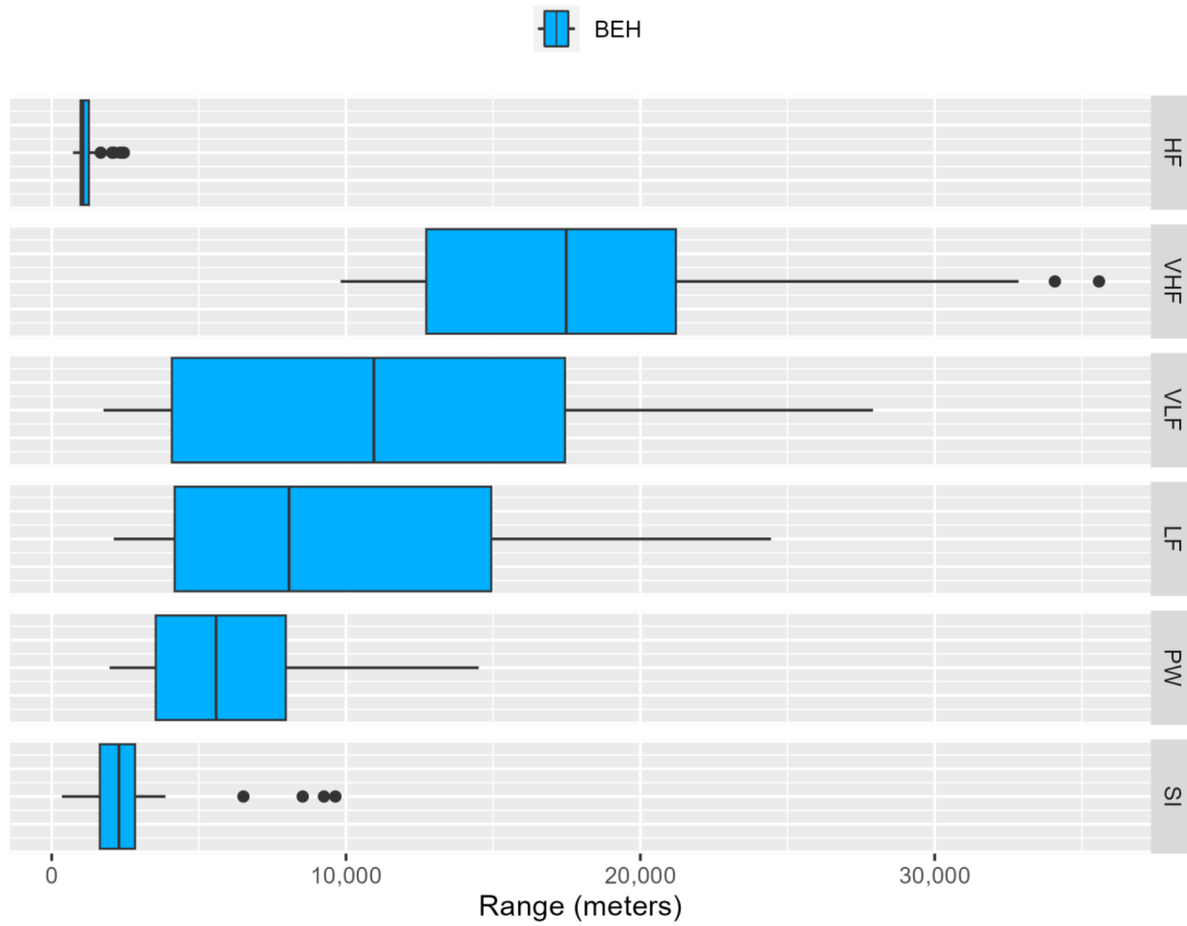


Figure 2.5-33: Marine Mammal Ranges to Behavioral Response for E5 (>5 - 10 lb.)

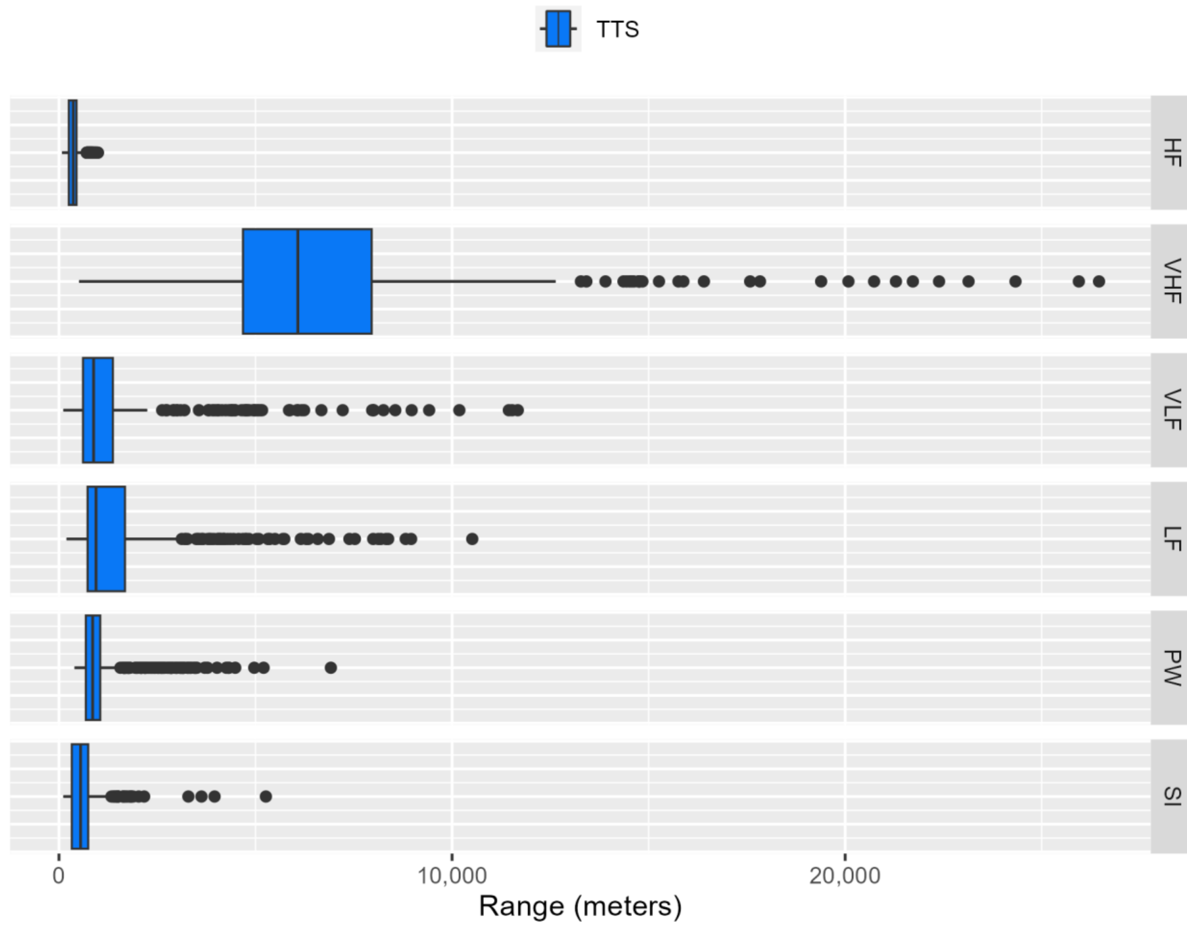


Figure 2.5-34: Marine Mammal Ranges to Temporary Threshold Shift for E5 (>5 - 10 lb.)

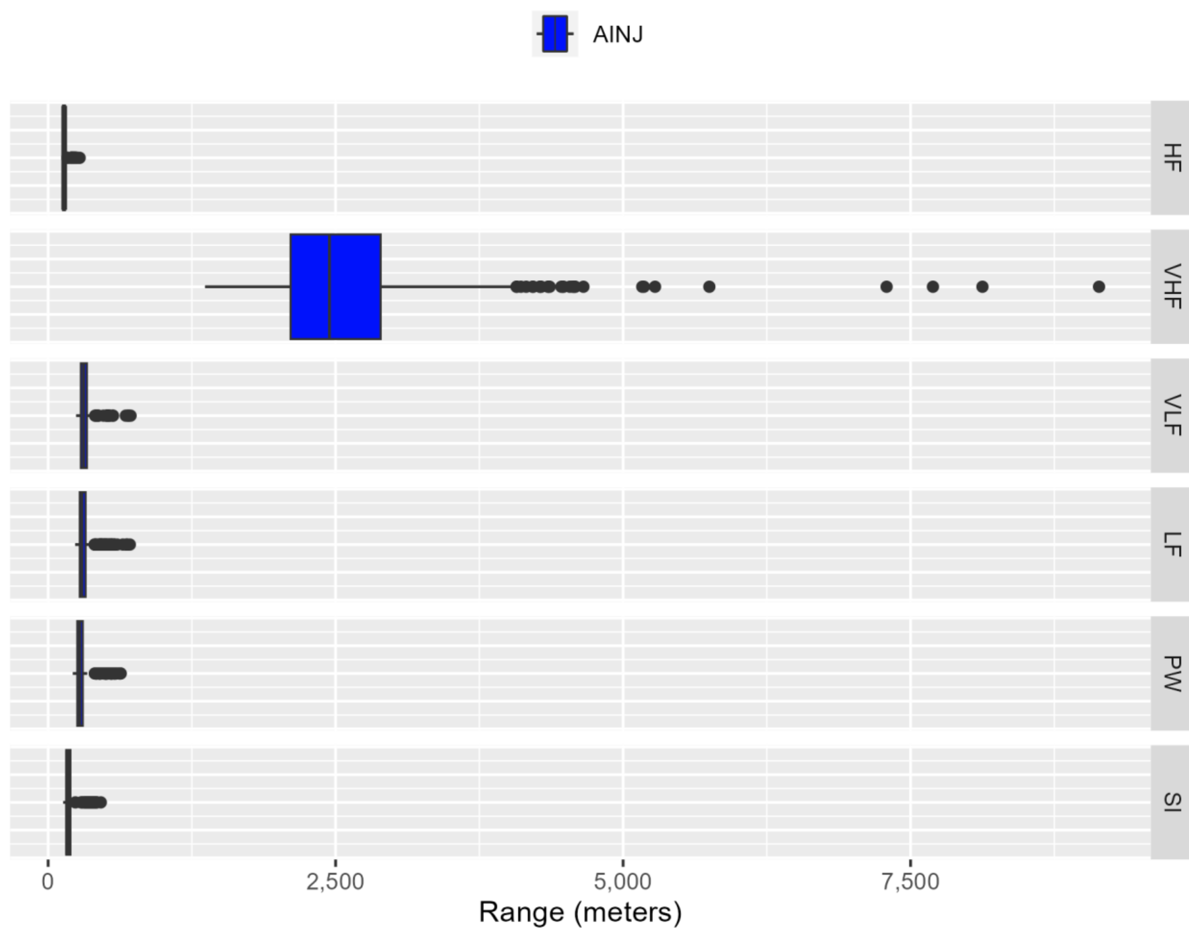


Figure 2.5-35: Marine Mammal Ranges to Auditory Injury for E5 (>5 - 10 lb.)

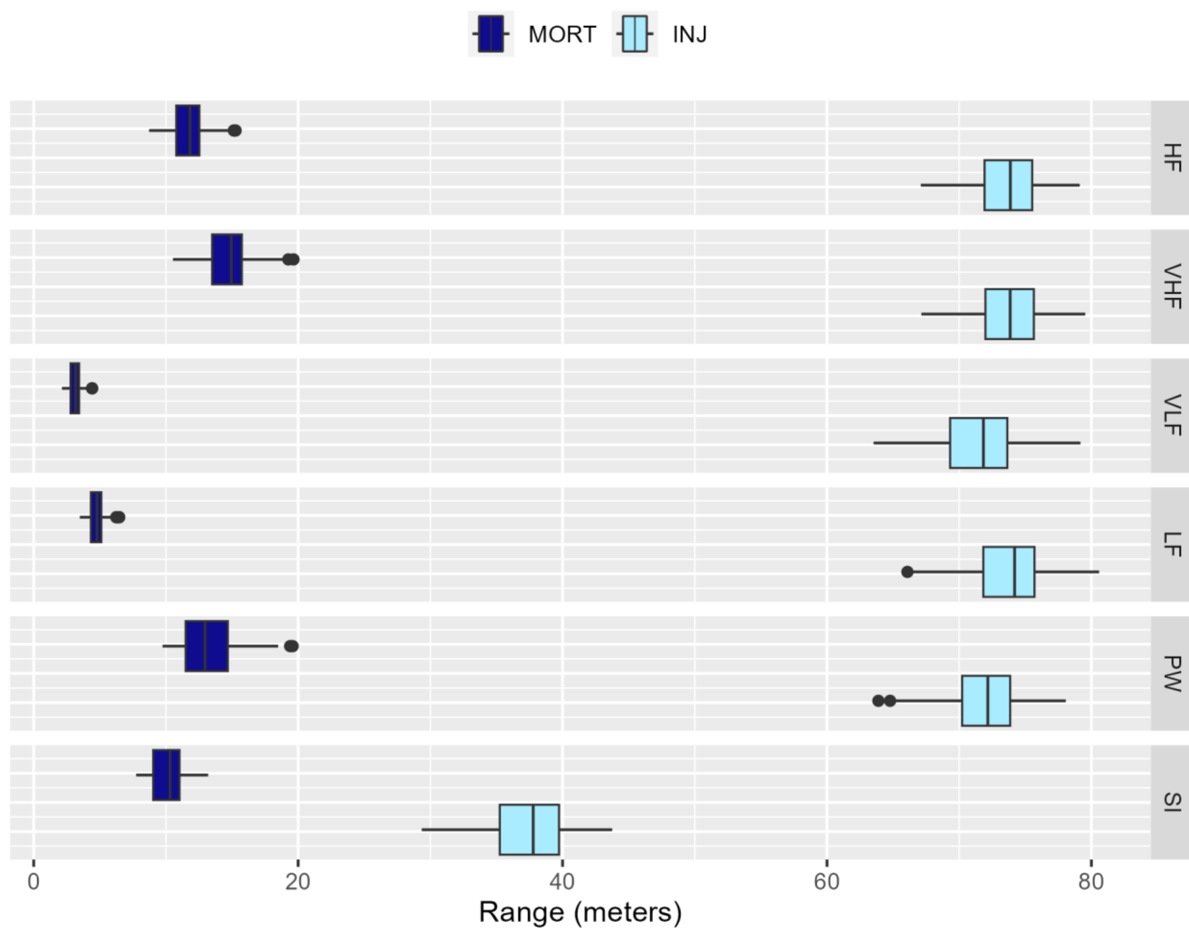


Figure 2.5-36: Marine Mammal Ranges to Mortality and Injury for E5 (>5 - 10 lb.)

2.5.4.6 Bin E6 (>10 - 20 lb. NEW)

Table 2.5-14: Marine Mammal Ranges to Effects for E6 (>10 - 20 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	479 m (175 m)	188 m (13 m)	95 m (4 m)	23 m (4 m)
		4	884 m (127 m)	672 m (101 m)	223 m (19 m)	NA	NA
	>200 m	1	NA	339 m (22 m)	191 m (10 m)	96 m (3 m)	23 m (3 m)
VHF	≤200 m	1	NA	8,405 m (1,808 m)	4,169 m (956 m)	95 m (4 m)	28 m (5 m)
		4	14,243 m (2,228 m)	10,762 m (1,952 m)	4,169 m (956 m)	NA	NA
	>200 m	1	NA	8,245 m (1,618 m)	4,157 m (823 m)	97 m (3 m)	28 m (4 m)
VLF	≤200 m	1	NA	1,434 m (2,312 m)	420 m (46 m)	92 m (4 m)	5 m (1 m)
		4	16,725 m (5,062 m)	7,076 m (3,667 m)	420 m (46 m)	NA	NA
	>200 m	1	NA	736 m (84 m)	420 m (30 m)	92 m (4 m)	5 m (1 m)
LF	≤200 m	1	NA	1,464 m (2,037 m)	412 m (47 m)	94 m (4 m)	9 m (1 m)
		4	11,148 m (4,732 m)	6,000 m (3,144 m)	500 m (54 m)	NA	NA
	>200 m	1	NA	935 m (887 m)	413 m (33 m)	95 m (4 m)	8 m (1 m)
PW	≤200 m	1	NA	1,062 m (1,244 m)	361 m (37 m)	93 m (4 m)	22 m (5 m)
		4	7,394 m (3,351 m)	2,992 m (1,342 m)	489 m (45 m)	NA	NA
	>200 m	1	NA	750 m (78 m)	365 m (25 m)	94 m (4 m)	23 m (5 m)
SI	≤200 m	1	NA	805 m (367 m)	265 m (36 m)	63 m (7 m)	19 m (4 m)
		4	1,250 m (185 m)	902 m (68 m)	359 m (44 m)	NA	NA
	>200 m	1	NA	520 m (65 m)	260 m (27 m)	62 m (7 m)	19 m (3 m)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

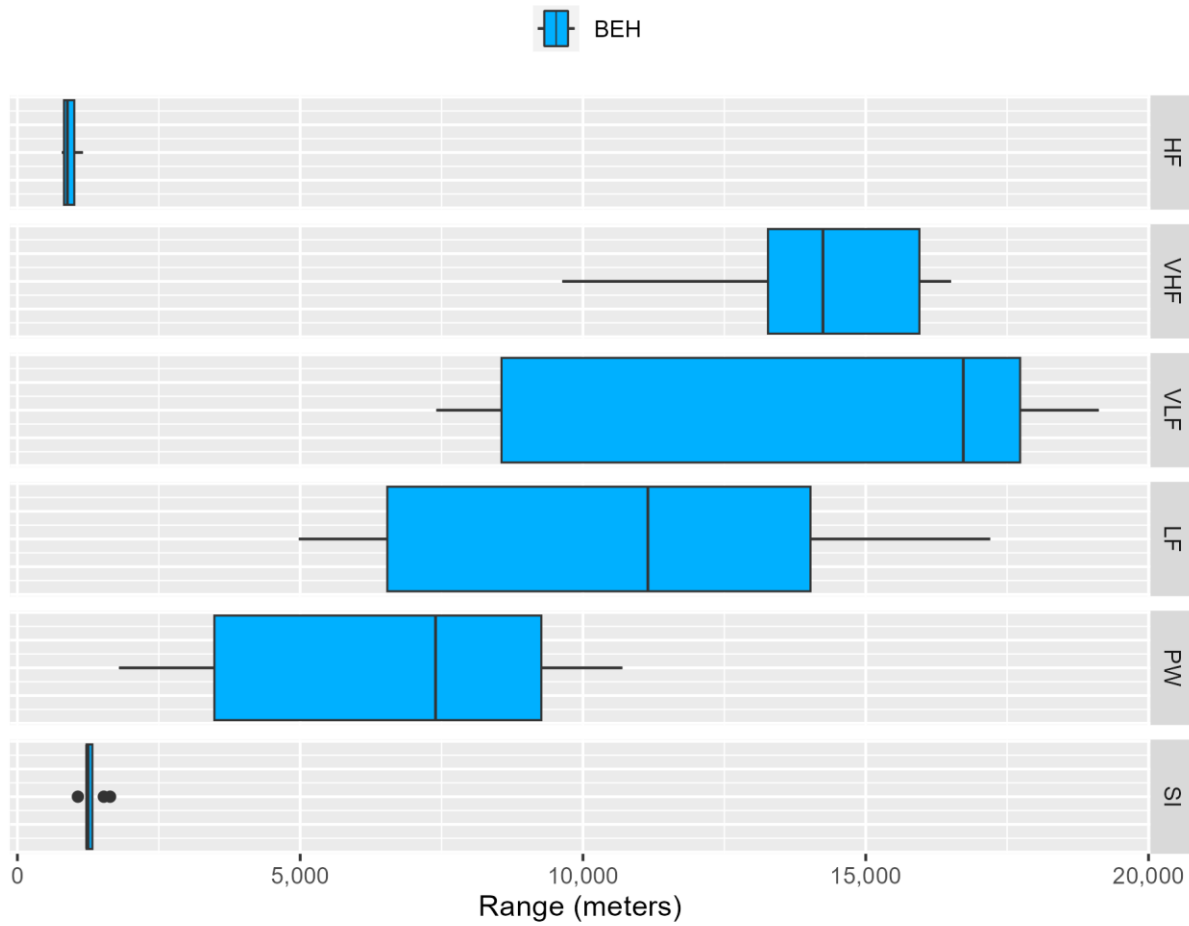


Figure 2.5-37: Marine Mammal Ranges to Behavioral Response for E6 (>10 - 20 lb.)

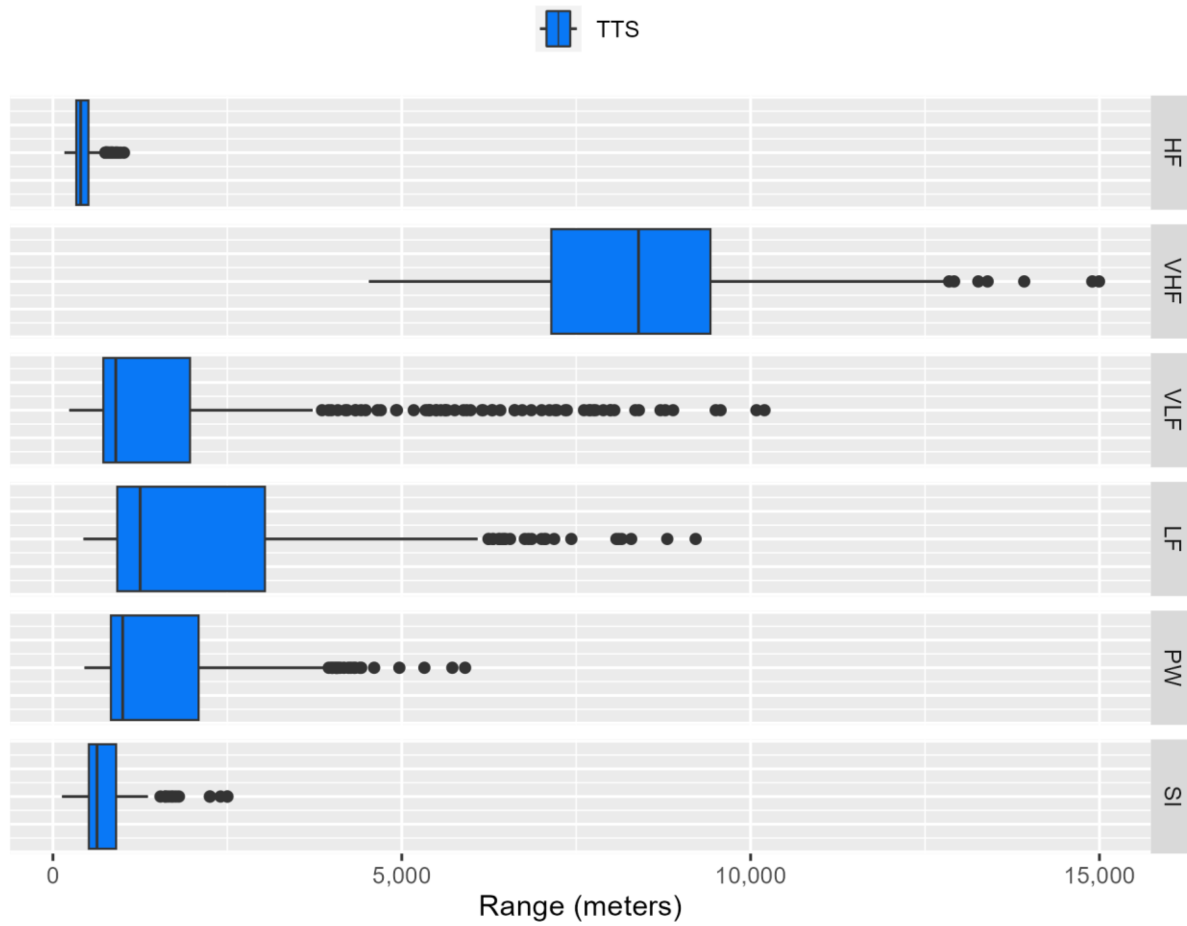


Figure 2.5-38: Marine Mammal Ranges to Temporary Threshold Shift for E6 (>10 - 20 lb.)

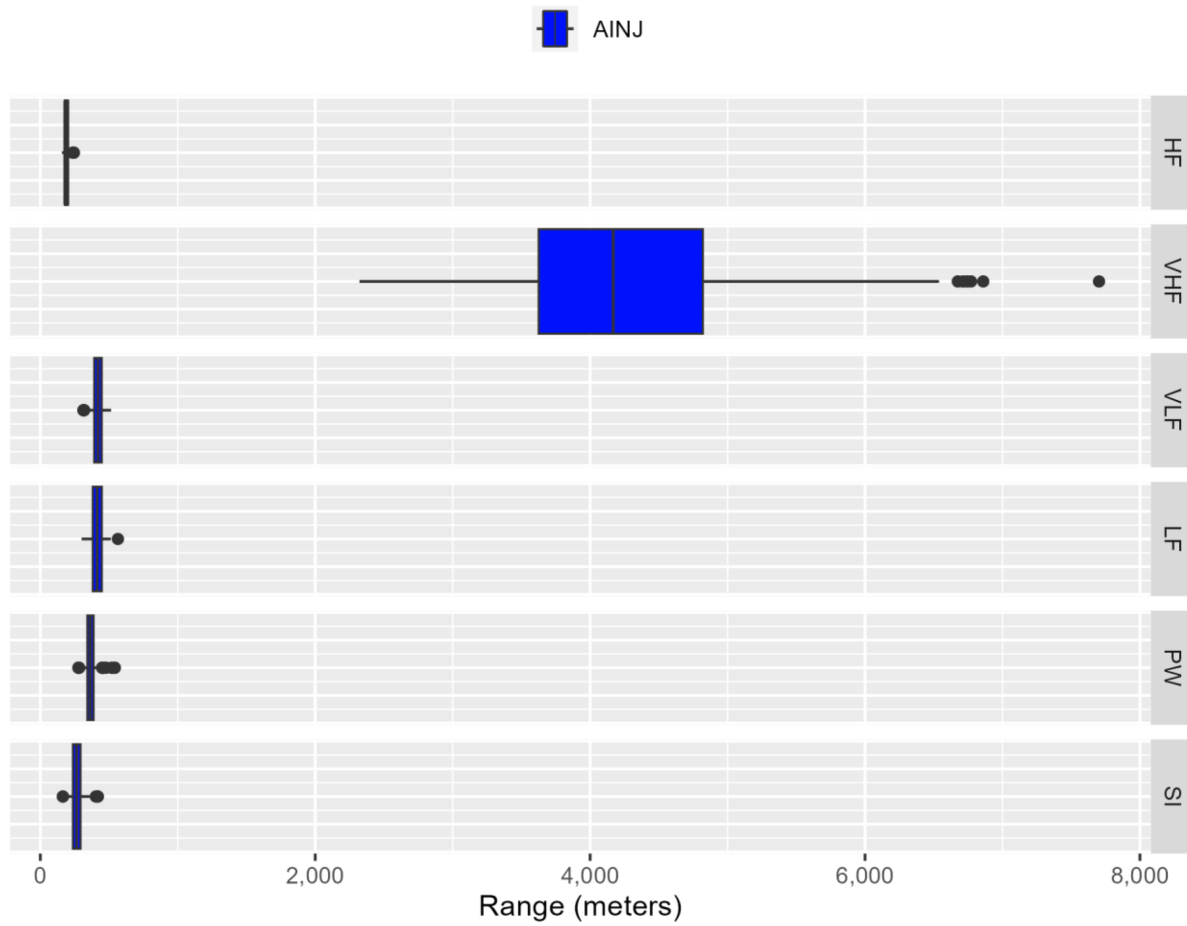


Figure 2.5-39: Marine Mammal Ranges to Auditory Injury for E6 (>10 - 20 lb.)

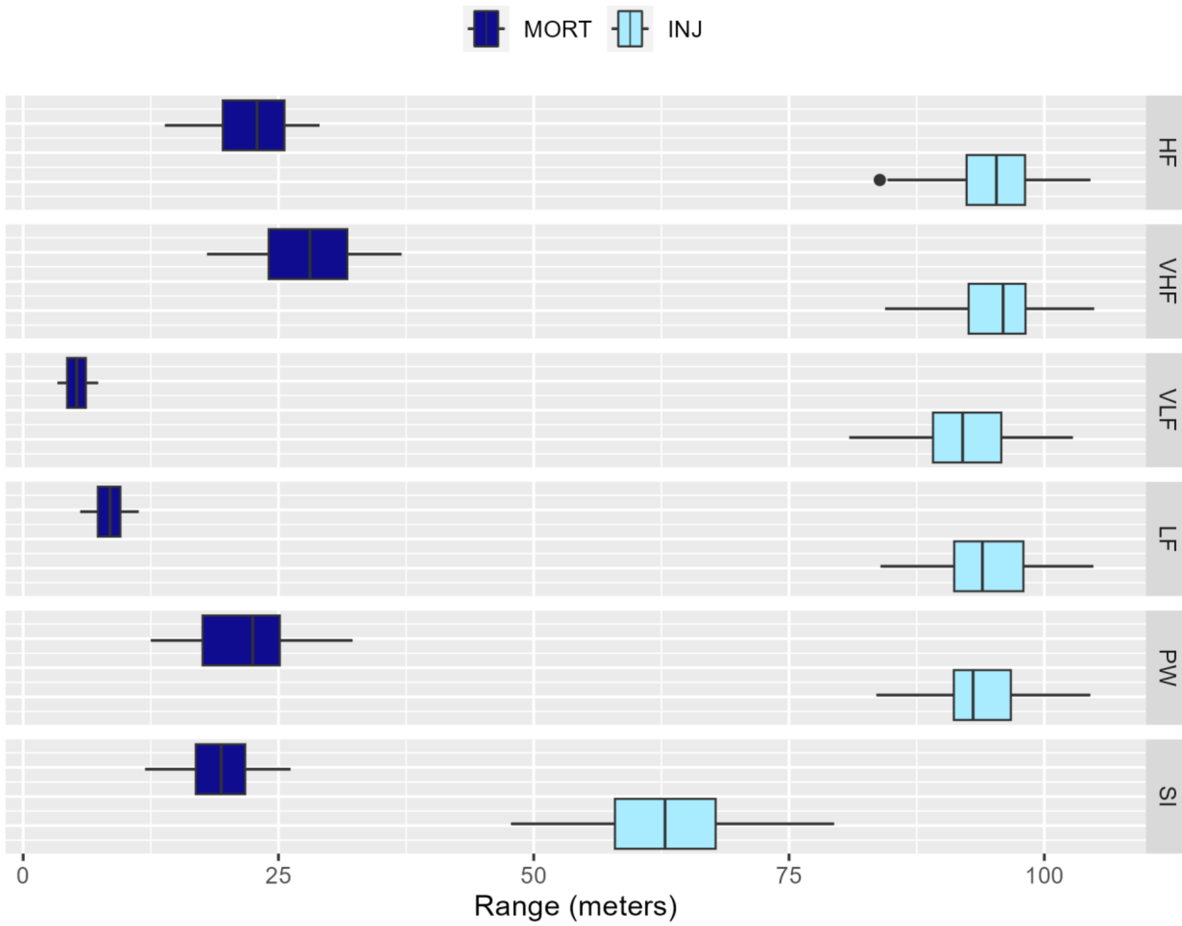


Figure 2.5-40: Marine Mammal Ranges to Mortality and Injury for E6 (>10 - 20 lb.)

2.5.4.7 Bin E7 (>20 - 60 lb. NEW)

Table 2.5-15: Marine Mammal Ranges to Effects for E7 (>20 - 60 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	540 m (58 m)	238 m (14 m)	123 m (5 m)	27 m (5 m)
	>200 m	1	NA	549 m (60 m)	236 m (16 m)	120 m (6 m)	26 m (5 m)
VHF	≤200 m	1	NA	9,953 m (2,464 m)	5,436 m (1,138 m)	125 m (6 m)	35 m (8 m)
	>200 m	1	NA	10,731 m (2,575 m)	5,514 m (1,222 m)	122 m (7 m)	34 m (7 m)
VLF	≤200 m	1	NA	2,666 m (864 m)	505 m (33 m)	120 m (5 m)	7 m (1 m)
	>200 m	1	NA	2,974 m (945 m)	513 m (31 m)	117 m (6 m)	7 m (1 m)
LF	≤200 m	1	NA	2,741 m (609 m)	495 m (35 m)	119 m (6 m)	11 m (2 m)
	>200 m	1	NA	2,732 m (640 m)	506 m (31 m)	117 m (6 m)	11 m (2 m)
PW	≤200 m	1	NA	1,480 m (284 m)	416 m (26 m)	123 m (5 m)	19 m (7 m)
	>200 m	1	NA	1,475 m (277 m)	415 m (26 m)	119 m (6 m)	19 m (6 m)
SI	≤200 m	1	NA	954 m (140 m)	353 m (47 m)	86 m (10 m)	25 m (4 m)
	>200 m	1	NA	924 m (151 m)	364 m (44 m)	94 m (10 m)	24 m (3 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

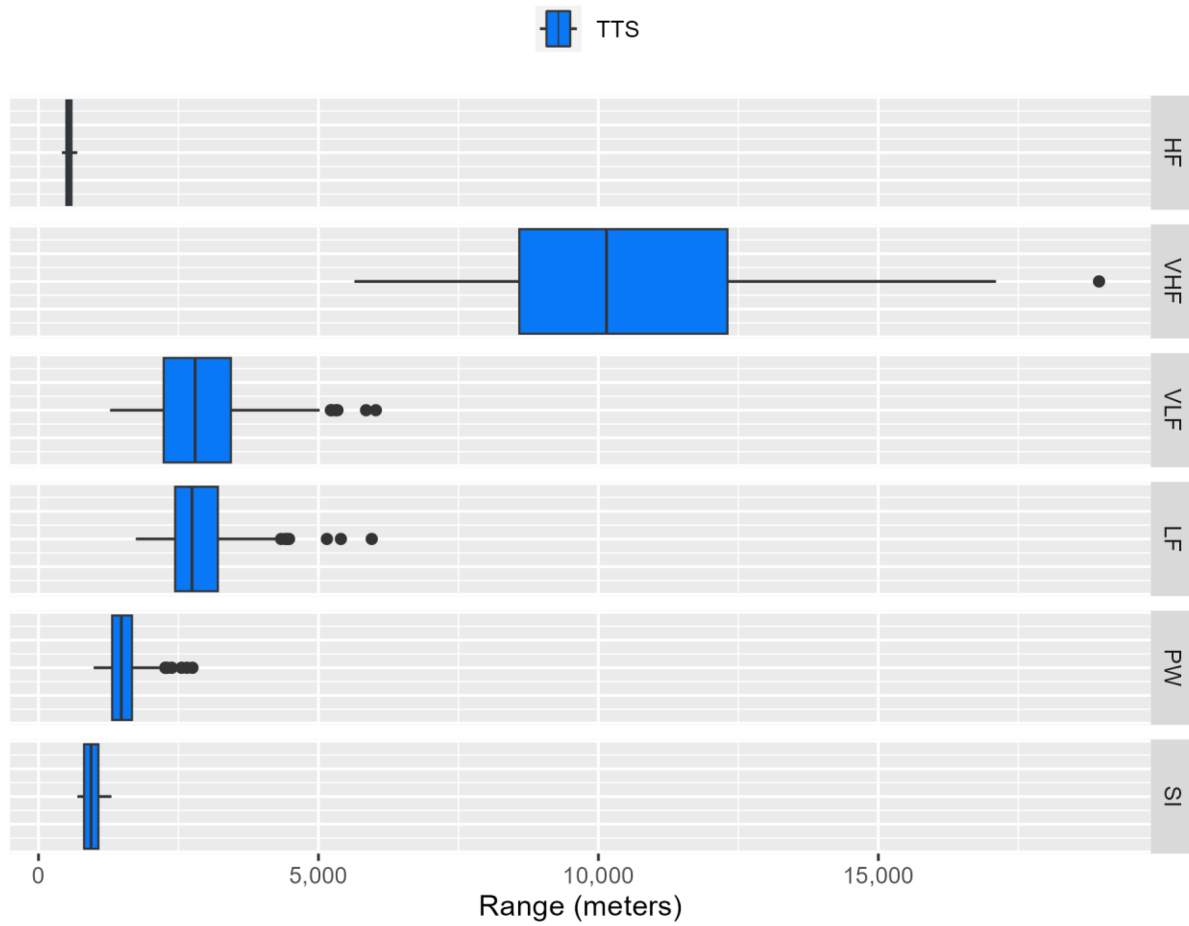


Figure 2.5-41: Marine Mammal Ranges to Temporary Threshold Shift for E7 (>20 - 60 lb.)

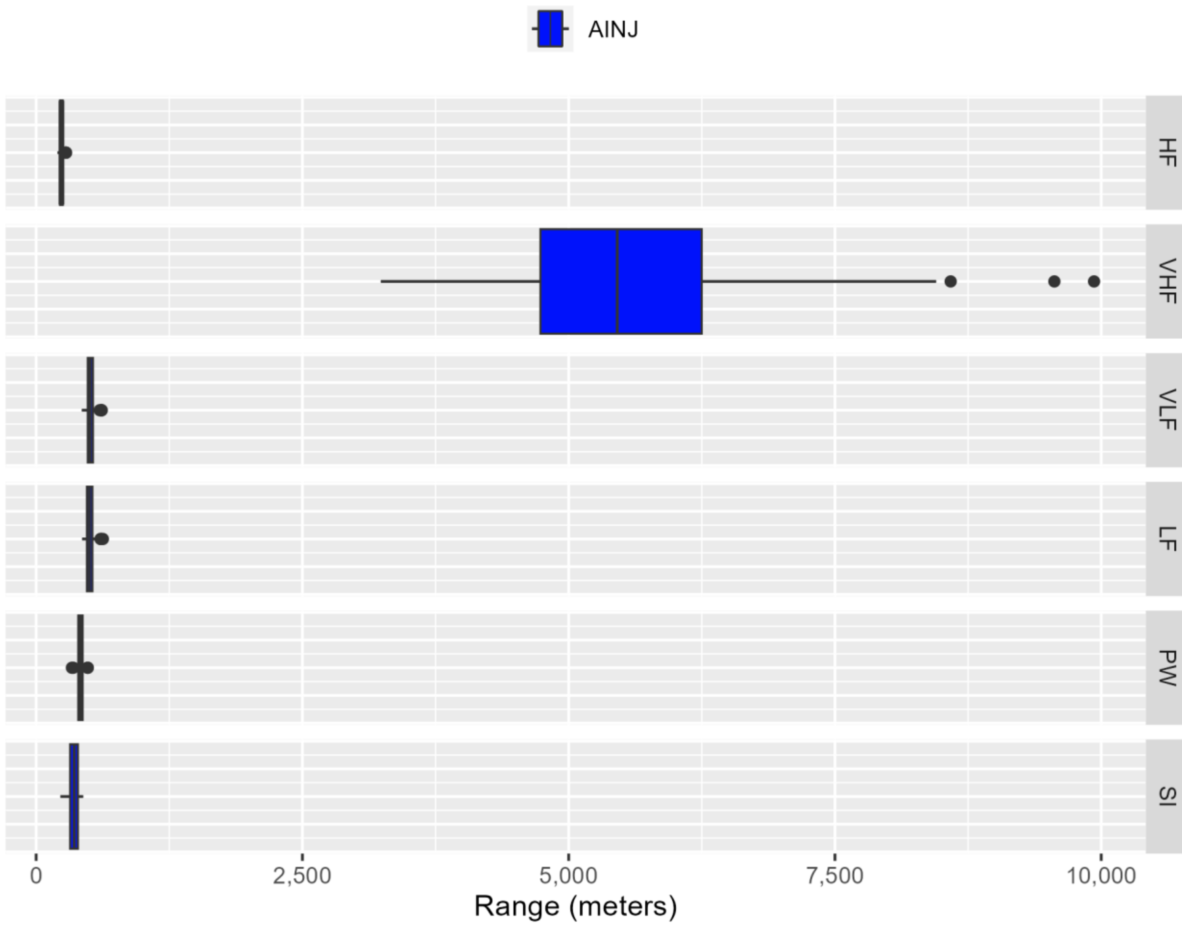


Figure 2.5-42: Marine Mammal Ranges to Auditory Injury for E7 (>20 - 60 lb.)

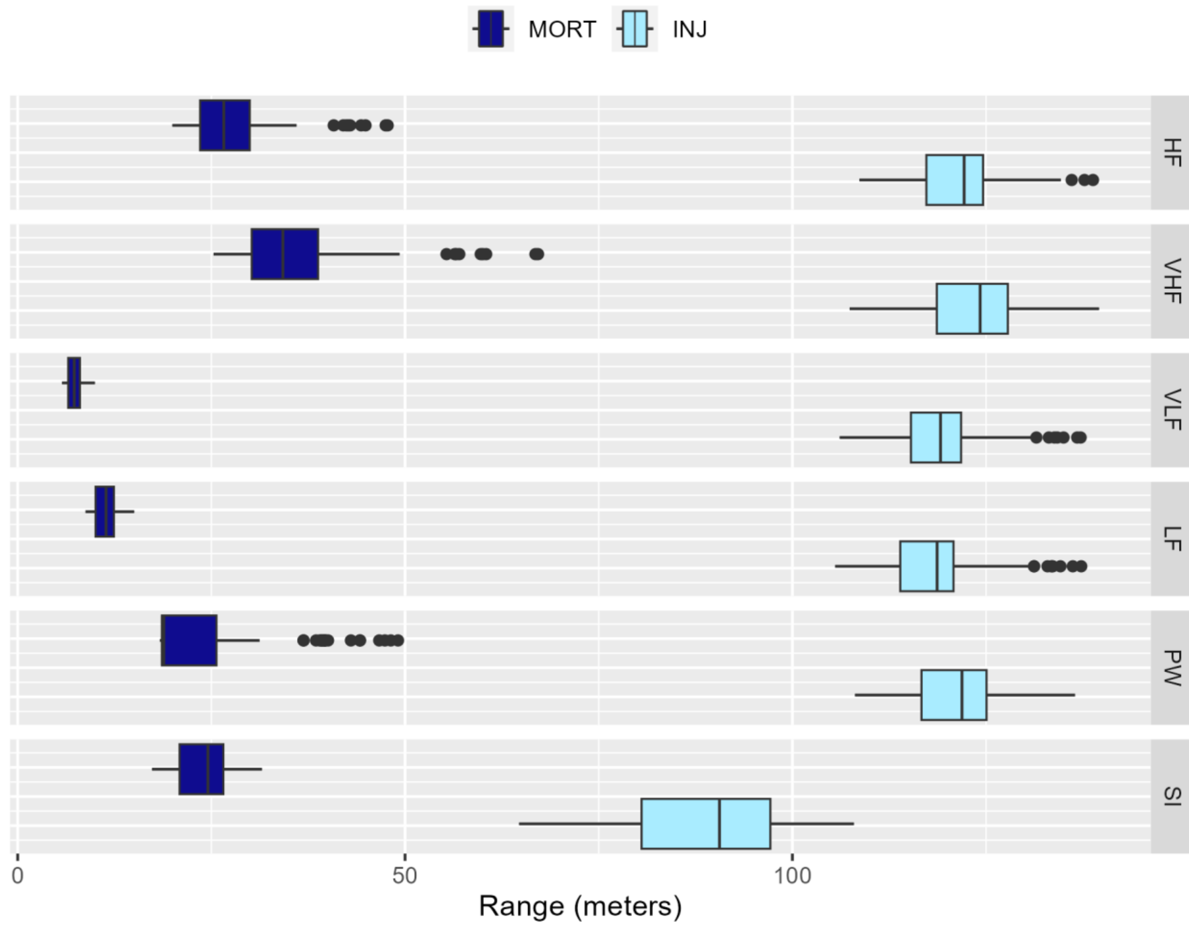


Figure 2.5-43: Marine Mammal Ranges to Mortality and Injury for E7 (>20 - 60 lb.)

2.5.4.8 Bin E8 (>60 - 100 lb. NEW)

Table 2.5-16: Marine Mammal Ranges to Effects for E8 (>60 - 100 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	713 m (56 m)	331 m (25 m)	164 m (11 m)	48 m (6 m)
	>200 m	1	NA	709 m (47 m)	324 m (25 m)	162 m (11 m)	46 m (6 m)
VHF	≤200 m	1	NA	14,065 m (2,794 m)	8,102 m (1,557 m)	178 m (27 m)	65 m (9 m)
	>200 m	1	NA	14,245 m (2,611 m)	7,965 m (1,520 m)	170 m (23 m)	61 m (8 m)
VLF	≤200 m	1	NA	5,774 m (1,816 m)	743 m (89 m)	161 m (12 m)	11 m (1 m)
	>200 m	1	NA	5,264 m (1,786 m)	692 m (89 m)	155 m (12 m)	10 m (1 m)
LF	≤200 m	1	NA	4,811 m (1,168 m)	702 m (73 m)	156 m (11 m)	15 m (2 m)
	>200 m	1	NA	4,199 m (1,129 m)	660 m (65 m)	154 m (12 m)	15 m (2 m)
PW	≤200 m	1	NA	3,073 m (718 m)	655 m (87 m)	165 m (15 m)	44 m (9 m)
	>200 m	1	NA	2,682 m (779 m)	616 m (94 m)	162 m (14 m)	38 m (9 m)
SI	≤200 m	1	NA	1,133 m (160 m)	443 m (39 m)	130 m (9 m)	45 m (6 m)
	>200 m	1	NA	1,126 m (144 m)	443 m (32 m)	126 m (10 m)	43 m (6 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

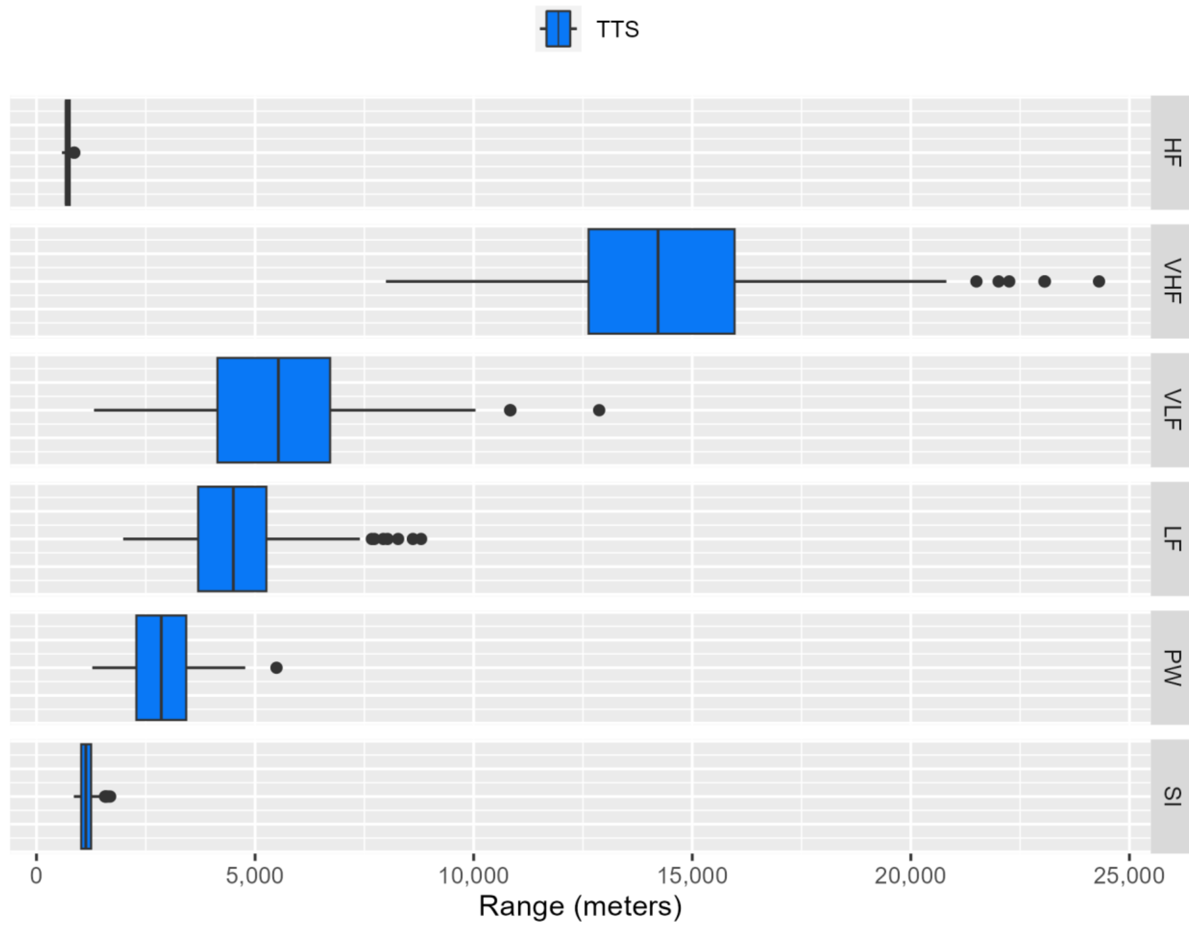


Figure 2.5-44: Marine Mammal Ranges to Temporary Threshold Shift for E8 (>60 - 100 lb.)

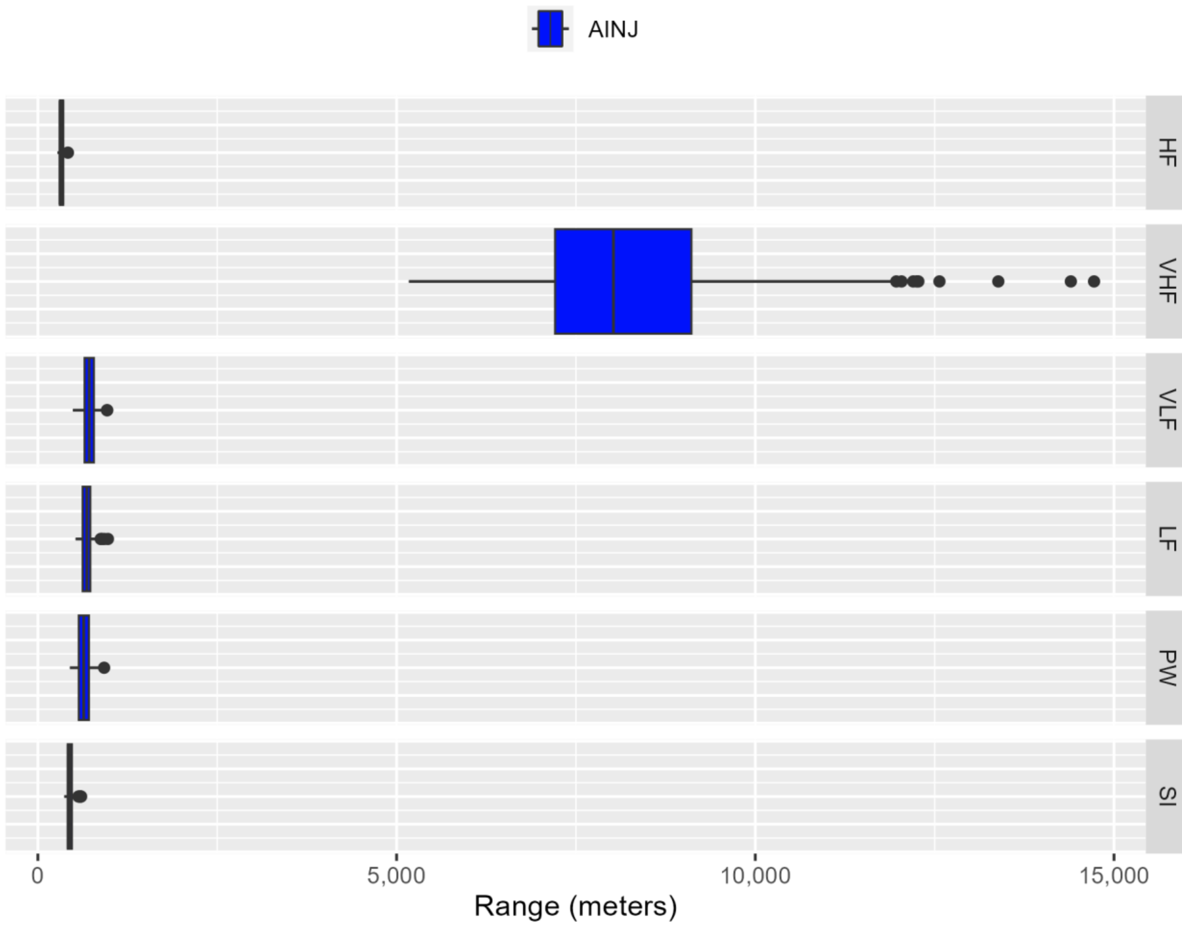


Figure 2.5-45: Marine Mammal Ranges to Auditory Injury for E8 (>60 - 100 lb.)

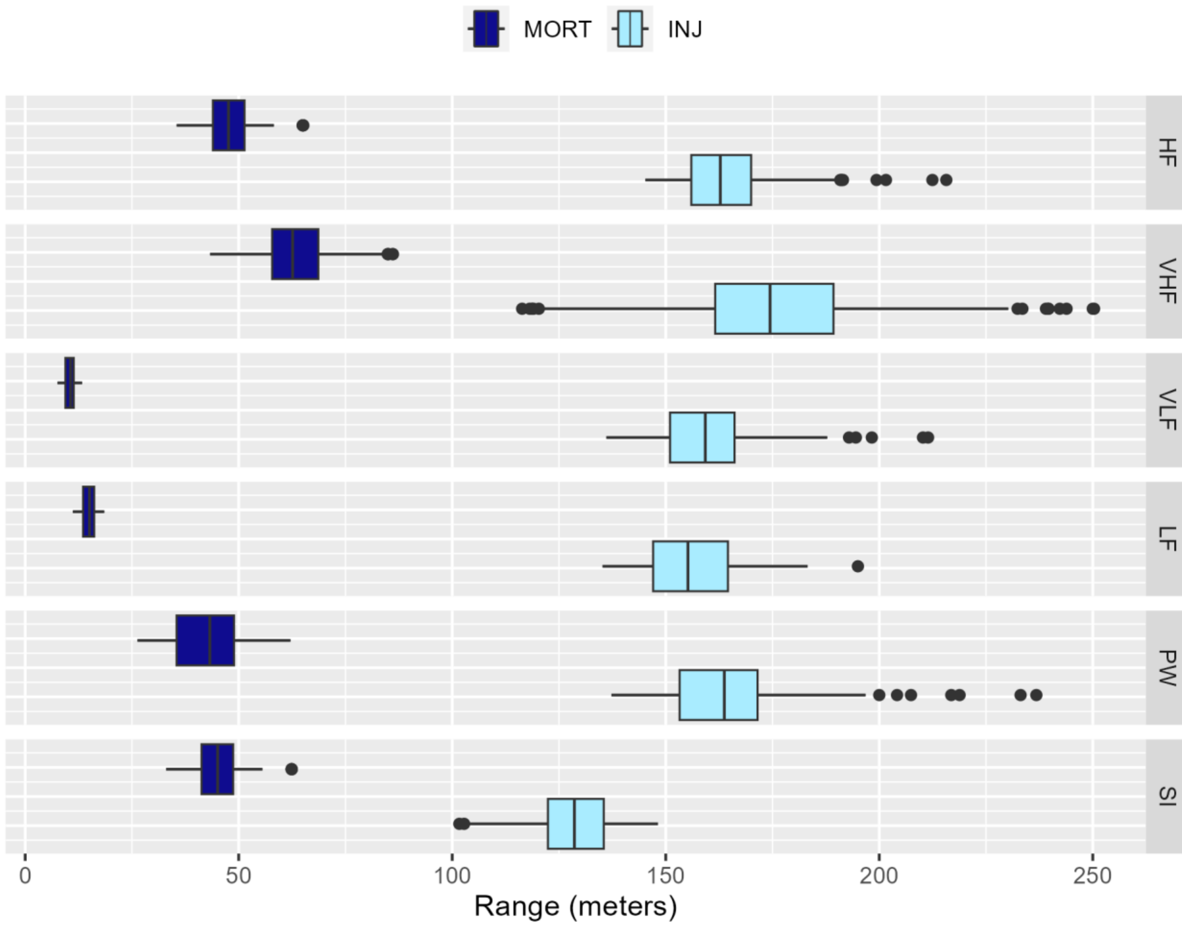


Figure 2.5-46: Marine Mammal Ranges to Mortality and Injury for E8 (>60 - 100 lb.)

2.5.4.9 Bin E9 (>100 - 250 lb., NEW)

Table 2.5-17: Marine Mammal Ranges to Effects for E9 (>100 - 250 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	713 m (67 m)	338 m (20 m)	183 m (6 m)	60 m (14 m)
	>200 m	1	NA	713 m (79 m)	326 m (23 m)	179 m (7 m)	53 m (17 m)
VHF	≤200 m	1	NA	17,121 m (4,181 m)	9,276 m (2,484 m)	190 m (51 m)	70 m (17 m)
	>200 m	1	NA	18,167 m (3,793 m)	9,455 m (2,098 m)	182 m (7 m)	63 m (21 m)
VLF	≤200 m	1	NA	6,627 m (2,992 m)	672 m (78 m)	187 m (8 m)	9 m (0 m)
	>200 m	1	NA	6,179 m (2,958 m)	642 m (73 m)	186 m (11 m)	9 m (0 m)
LF	≤200 m	1	NA	4,982 m (1,848 m)	648 m (67 m)	175 m (5 m)	12 m (0 m)
	>200 m	1	NA	5,146 m (1,948 m)	624 m (70 m)	174 m (6 m)	12 m (0 m)
PW	≤200 m	1	NA	2,739 m (779 m)	610 m (63 m)	193 m (9 m)	39 m (6 m)
	>200 m	1	NA	2,725 m (673 m)	588 m (66 m)	188 m (11 m)	36 m (8 m)
SI	≤200 m	1	NA	1,106 m (282 m)	439 m (76 m)	141 m (21 m)	34 m (12 m)
	>200 m	1	NA	1,201 m (284 m)	424 m (72 m)	133 m (20 m)	31 m (16 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

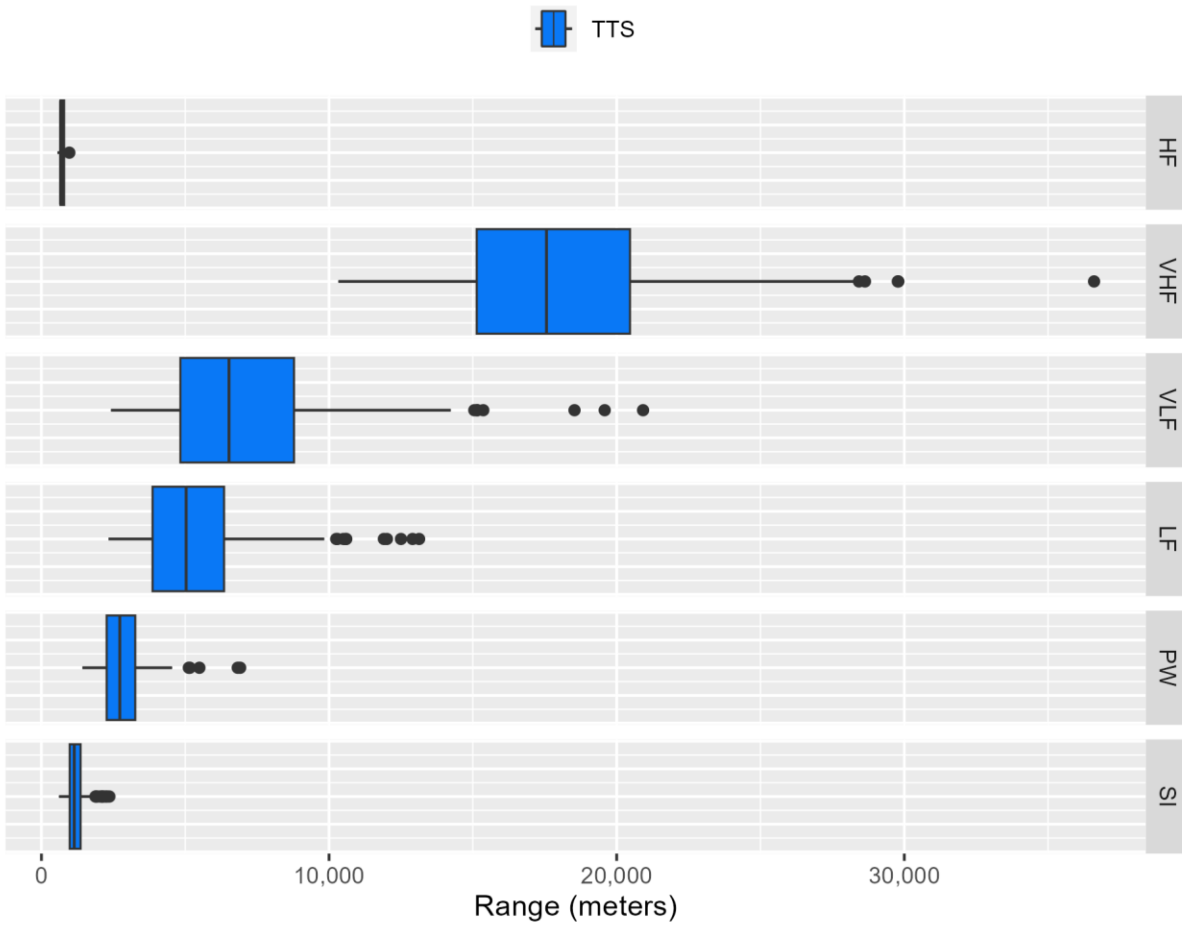


Figure 2.5-47: Marine Mammal Ranges to Temporary Threshold Shift for E9 (>100 - 250 lb.)

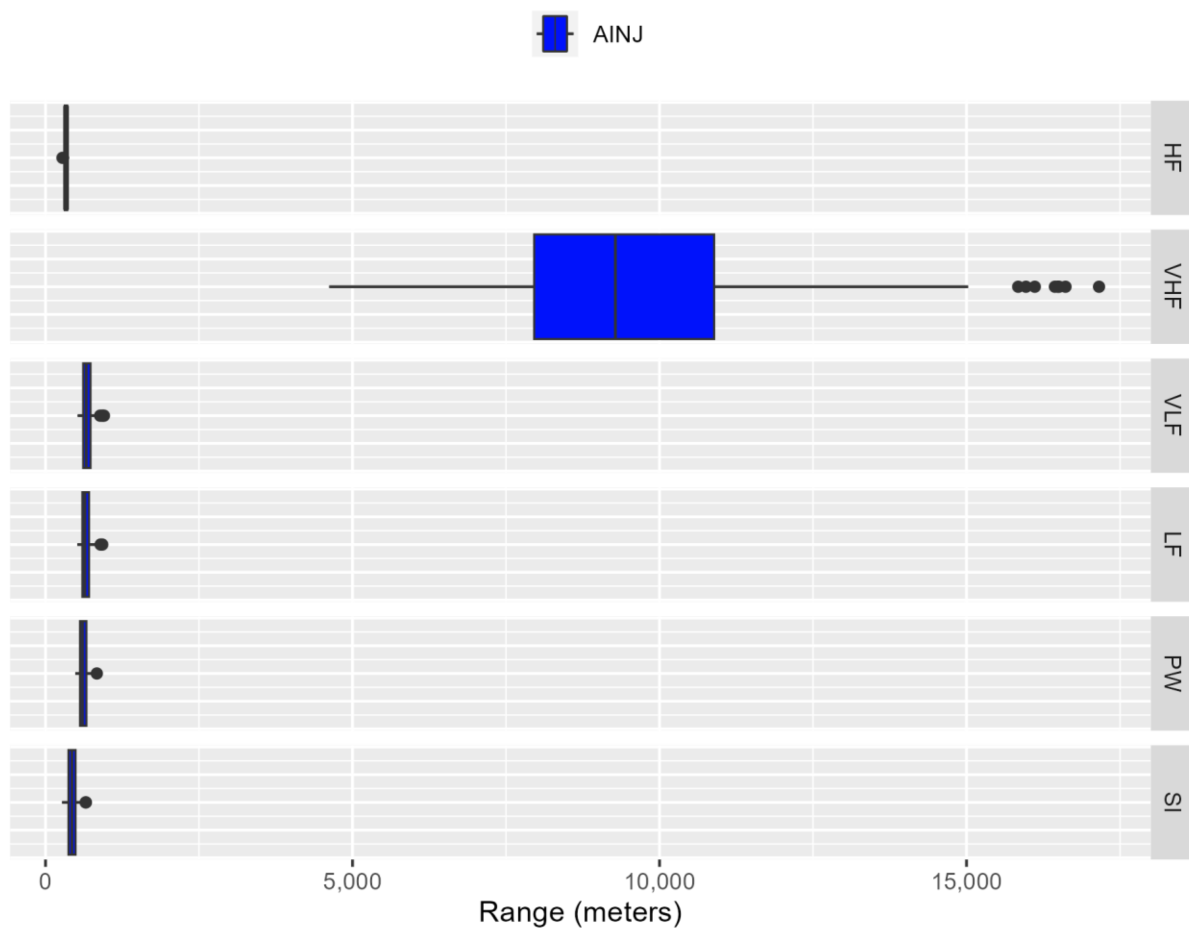


Figure 2.5-48: Marine Mammal Ranges to Auditory Injury for E9 (>100 - 250 lb.)

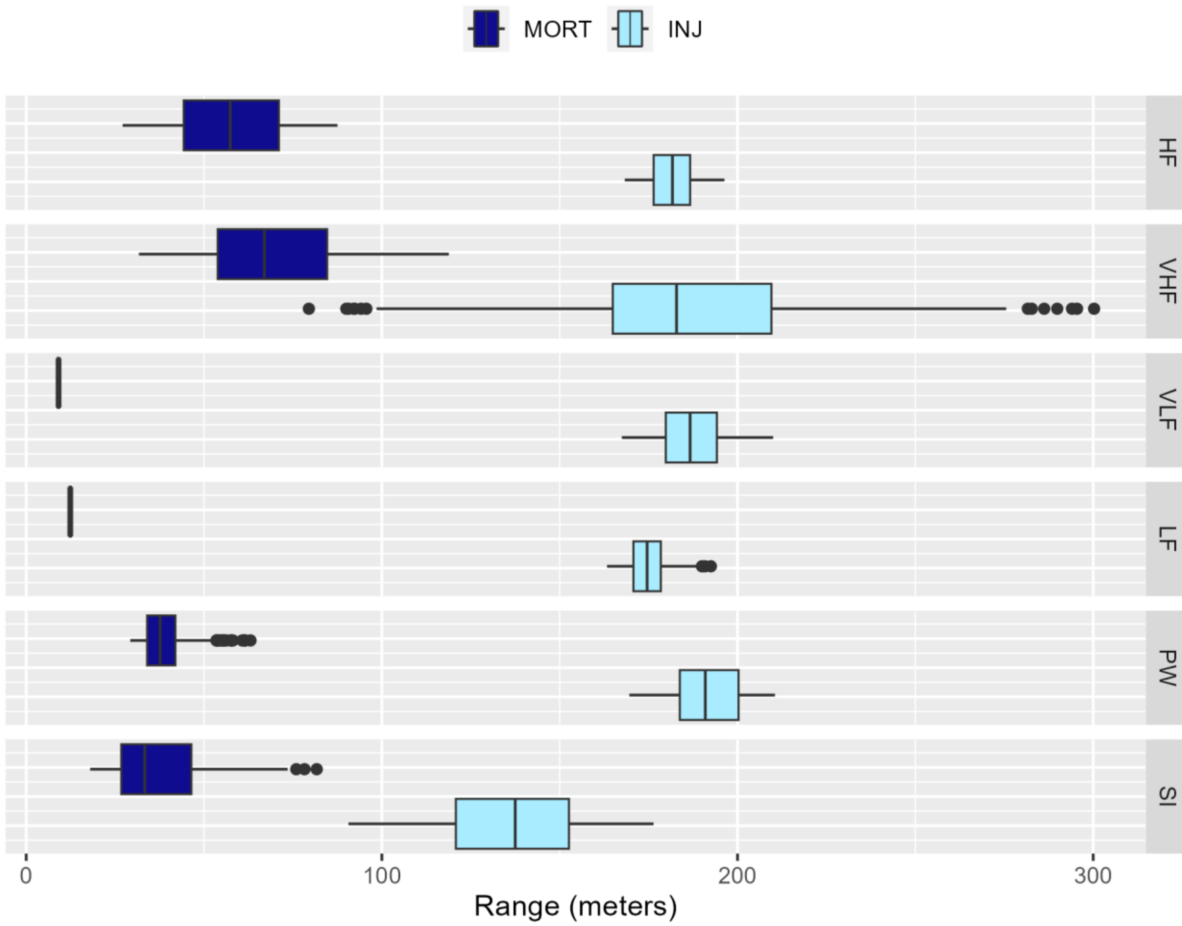


Figure 2.5-49: Marine Mammal Ranges to Mortality and Injury for E9 (>100 - 250 lb.)

2.5.4.10 Bin E10 (>250 - 500 lb. NEW)

Table 2.5-18: Marine Mammal Ranges to Effects for E10 (>250 - 500 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	862 m (69 m)	402 m (28 m)	219 m (9 m)	95 m (18 m)
	>200 m	1	NA	888 m (86 m)	400 m (27 m)	216 m (7 m)	95 m (16 m)
VHF	≤200 m	1	NA	23,693 m (4,814 m)	14,250 m (3,219 m)	270 m (57 m)	124 m (24 m)
	>200 m	1	NA	24,411 m (4,759 m)	14,368 m (3,075 m)	271 m (50 m)	123 m (23 m)
VLF	≤200 m	1	NA	12,773 m (4,287 m)	870 m (361 m)	226 m (9 m)	12 m (0 m)
	>200 m	1	NA	13,007 m (3,589 m)	910 m (150 m)	224 m (9 m)	12 m (0 m)
LF	≤200 m	1	NA	9,545 m (2,507 m)	864 m (115 m)	215 m (8 m)	16 m (0 m)
	>200 m	1	NA	10,098 m (2,494 m)	888 m (127 m)	212 m (8 m)	16 m (0 m)
PW	≤200 m	1	NA	4,939 m (1,170 m)	776 m (101 m)	226 m (10 m)	87 m (19 m)
	>200 m	1	NA	4,982 m (1,067 m)	805 m (133 m)	224 m (10 m)	87 m (18 m)
SI	≤200 m	1	NA	1,832 m (437 m)	542 m (80 m)	197 m (48 m)	89 m (21 m)
	>200 m	1	NA	1,978 m (455 m)	555 m (73 m)	194 m (39 m)	89 m (20 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

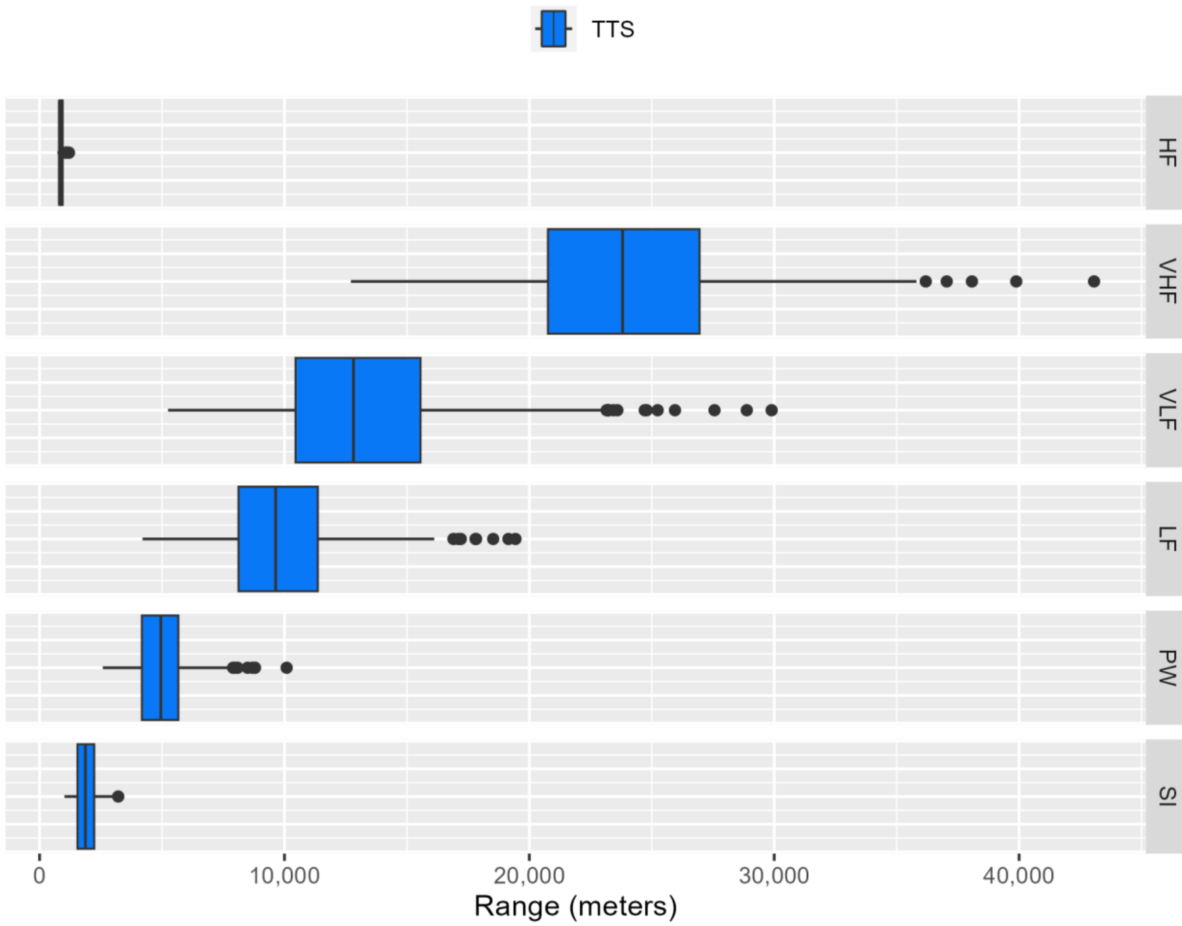


Figure 2.5-50: Marine Mammal Ranges to Temporary Threshold Shift for E10 (>250 - 500 lb.)

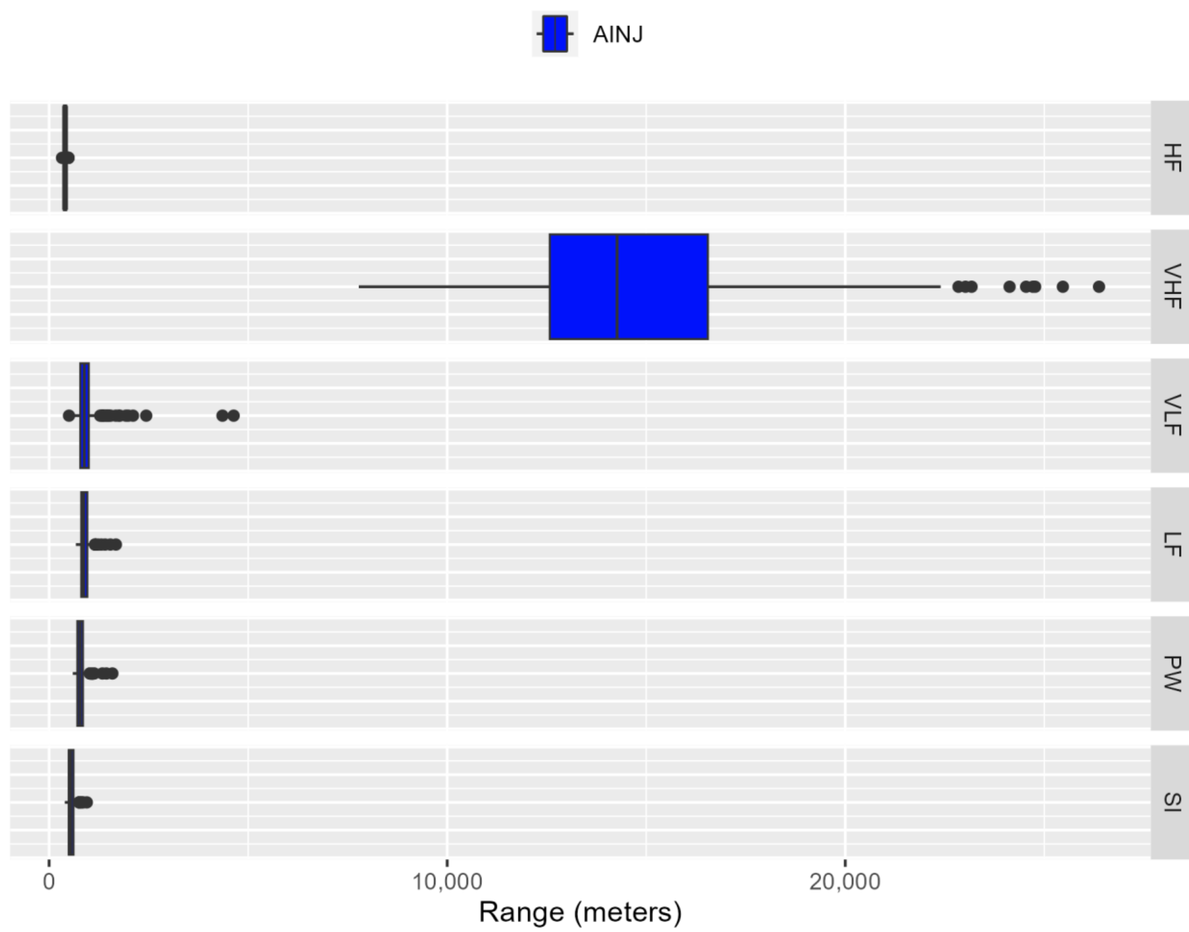


Figure 2.5-51: Marine Mammal Ranges to Auditory Injury for E10 (>250 - 500 lb.)

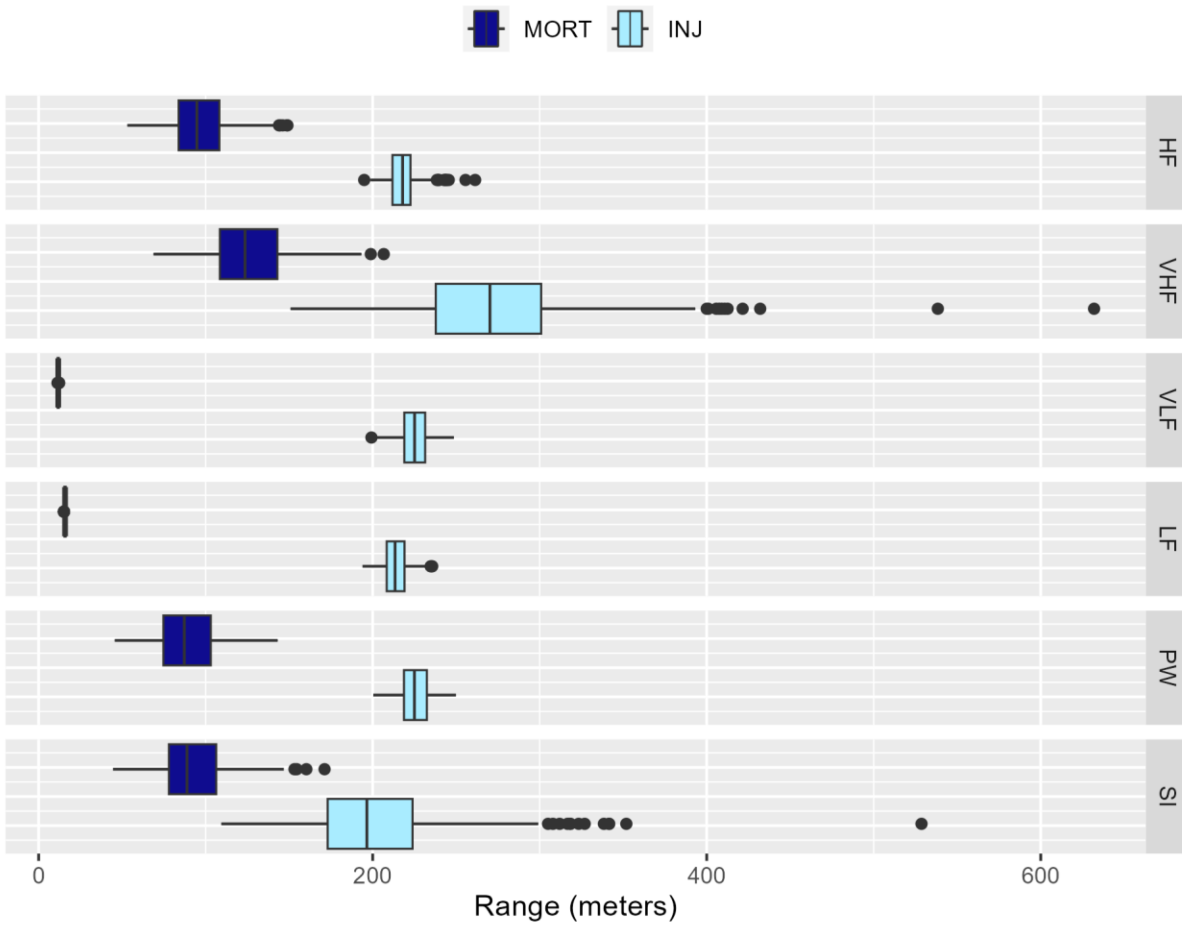


Figure 2.5-52: Marine Mammal Ranges to Mortality and Injury for E10 (>250 - 500 lb.)

2.5.4.11 Bin E11 (>500 - 675 lb. NEW)

Table 2.5-19: Marine Mammal Ranges to Effects for E11 (>500 - 675 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	1,793 m (184 m)	852 m (76 m)	546 m (67 m)	262 m (18 m)
	>200 m	1	NA	1,722 m (184 m)	818 m (60 m)	554 m (45 m)	260 m (15 m)
VHF	≤200 m	1	NA	29,300 m (5,371 m)	18,727 m (3,294 m)	695 m (129 m)	344 m (35 m)
	>200 m	1	NA	28,964 m (5,438 m)	17,803 m (3,619 m)	717 m (99 m)	345 m (28 m)
VLF	≤200 m	1	NA	21,015 m (4,545 m)	3,464 m (651 m)	419 m (61 m)	63 m (1 m)
	>200 m	1	NA	20,582 m (4,618 m)	3,331 m (630 m)	431 m (48 m)	63 m (1 m)
LF	≤200 m	1	NA	15,960 m (2,434 m)	2,513 m (365 m)	398 m (37 m)	96 m (2 m)
	>200 m	1	NA	14,770 m (2,875 m)	2,439 m (346 m)	394 m (31 m)	96 m (4 m)
PW	≤200 m	1	NA	12,433 m (2,813 m)	2,223 m (461 m)	702 m (221 m)	330 m (58 m)
	>200 m	1	NA	12,003 m (3,049 m)	2,167 m (401 m)	741 m (154 m)	341 m (59 m)
SI	≤200 m	1	NA	3,194 m (578 m)	995 m (100 m)	385 m (12 m)	225 m (4 m)
	>200 m	1	NA	2,868 m (482 m)	932 m (85 m)	379 m (11 m)	224 m (4 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

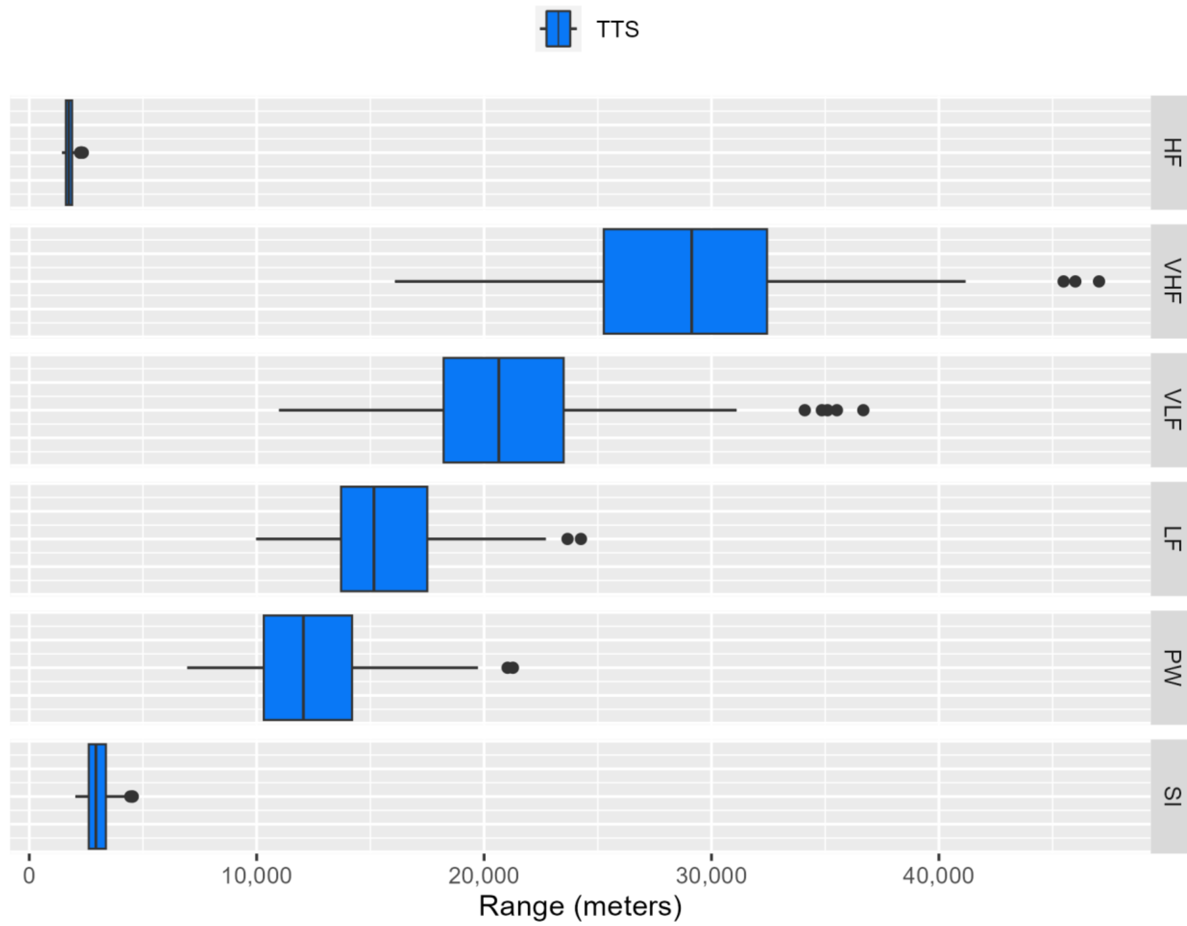


Figure 2.5-53: Marine Mammal Ranges to Temporary Threshold Shift for E11 (>500 - 675 lb.)

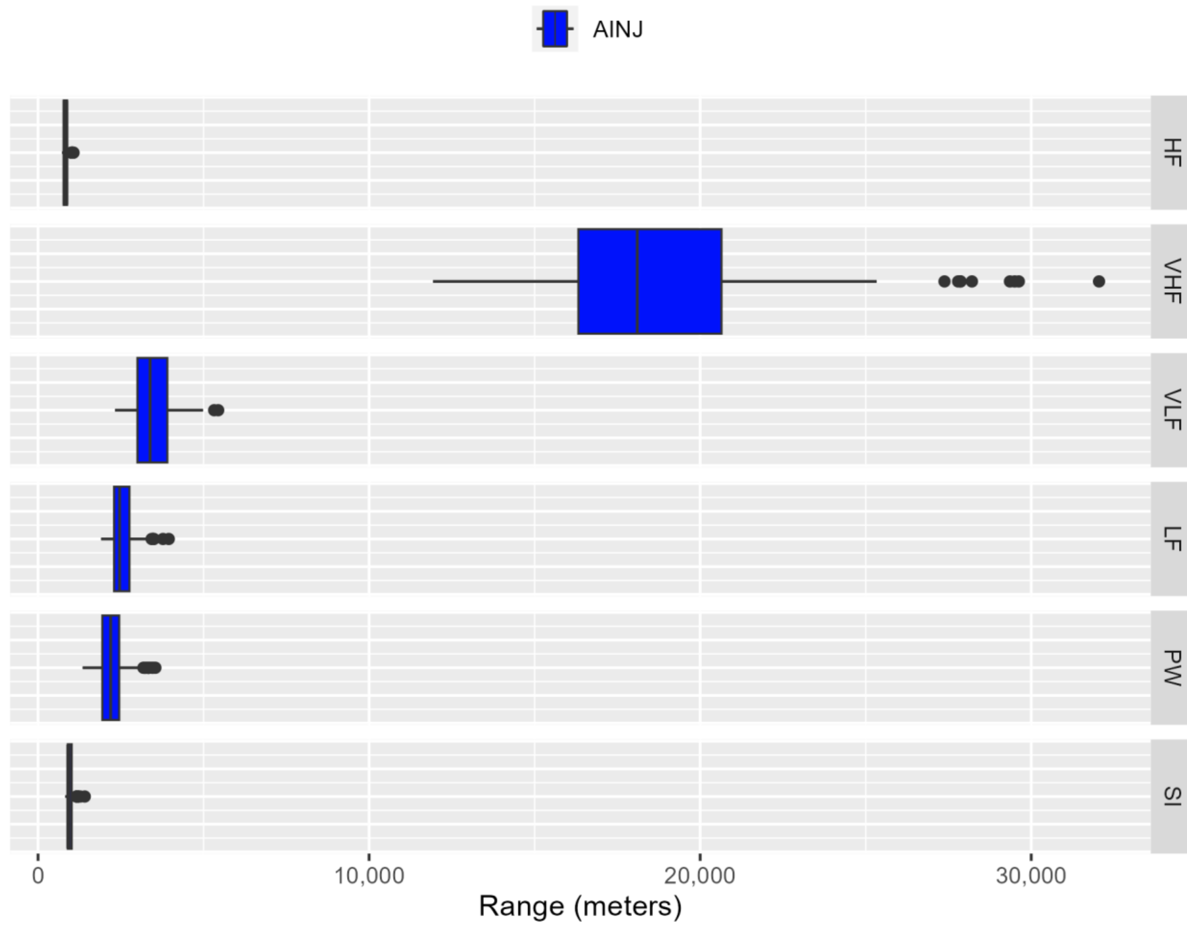


Figure 2.5-54: Marine Mammal Ranges to Auditory Injury for E11 (>500 - 675 lb.)

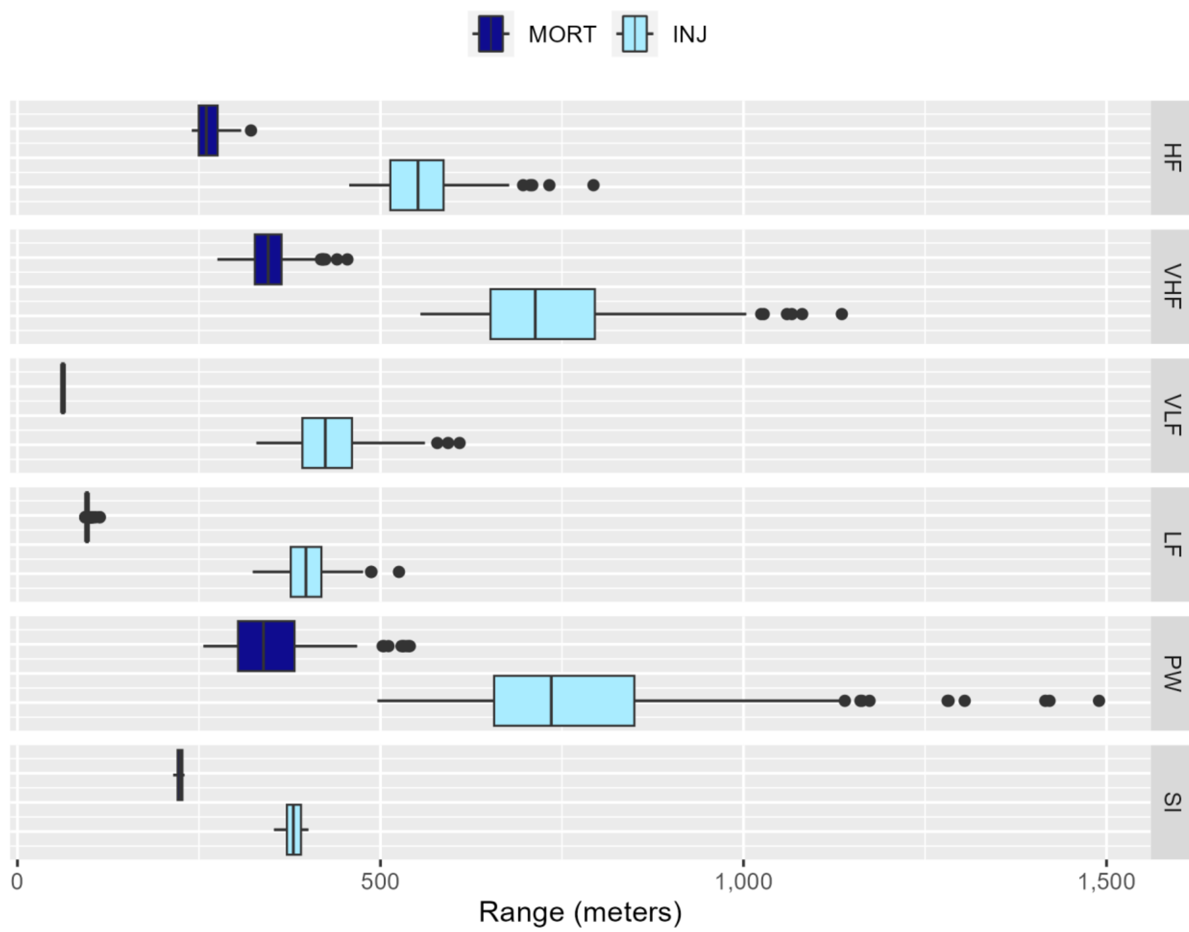


Figure 2.5-55: Marine Mammal Ranges to Mortality and Injury for E11 (>500 - 675 lb.)

2.5.4.12 Bin E12 (>650 - 1,000 lb. NEW)

Table 2.5-20: Marine Mammal Ranges to Effects for E12 (>650 - 1,000 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	≤200 m	1	NA	1,054 m (86 m)	495 m (31 m)	318 m (51 m)	153 m (17 m)
	>200 m	1	NA	1,049 m (58 m)	492 m (22 m)	296 m (47 m)	147 m (17 m)
VHF	≤200 m	1	NA	22,341 m (4,963 m)	13,436 m (3,617 m)	425 m (73 m)	207 m (25 m)
	>200 m	1	NA	23,338 m (4,471 m)	14,163 m (2,935 m)	397 m (64 m)	197 m (25 m)
VLF	≤200 m	1	NA	14,872 m (4,148 m)	1,081 m (464 m)	296 m (11 m)	15 m (0 m)
	>200 m	1	NA	15,741 m (3,588 m)	1,118 m (191 m)	293 m (13 m)	15 m (0 m)
LF	≤200 m	1	NA	11,300 m (2,279 m)	1,019 m (102 m)	264 m (7 m)	20 m (0 m)
	>200 m	1	NA	13,068 m (2,968 m)	984 m (99 m)	262 m (8 m)	20 m (0 m)
PW	≤200 m	1	NA	5,690 m (1,076 m)	900 m (92 m)	316 m (64 m)	131 m (17 m)
	>200 m	1	NA	6,262 m (1,317 m)	889 m (66 m)	304 m (58 m)	127 m (17 m)
SI	≤200 m	1	NA	1,527 m (201 m)	690 m (89 m)	324 m (63 m)	161 m (18 m)
	>200 m	1	NA	1,532 m (185 m)	644 m (64 m)	311 m (55 m)	156 m (20 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

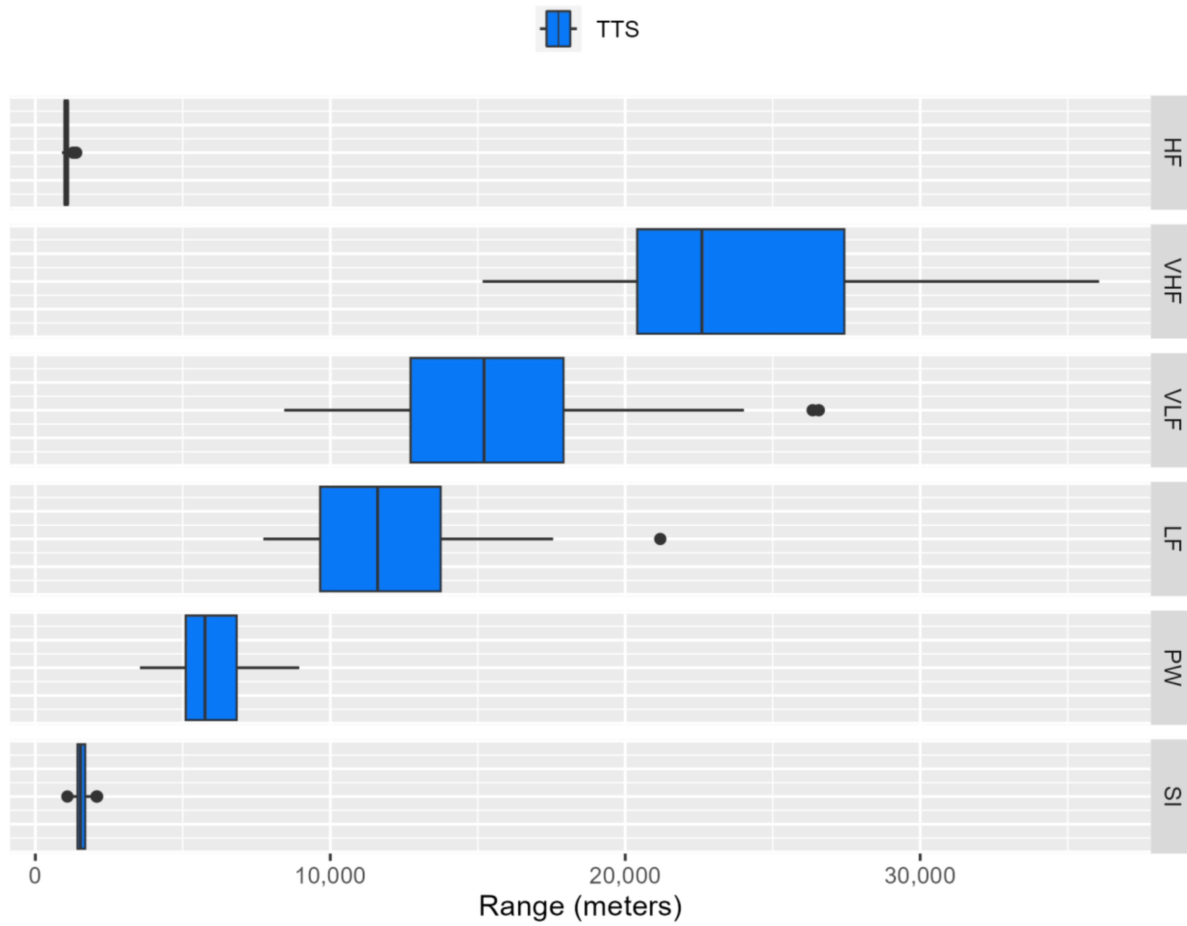


Figure 2.5-56: Marine Mammal Ranges to Temporary Threshold Shift for E12 (>650 - 1,000 lb.)

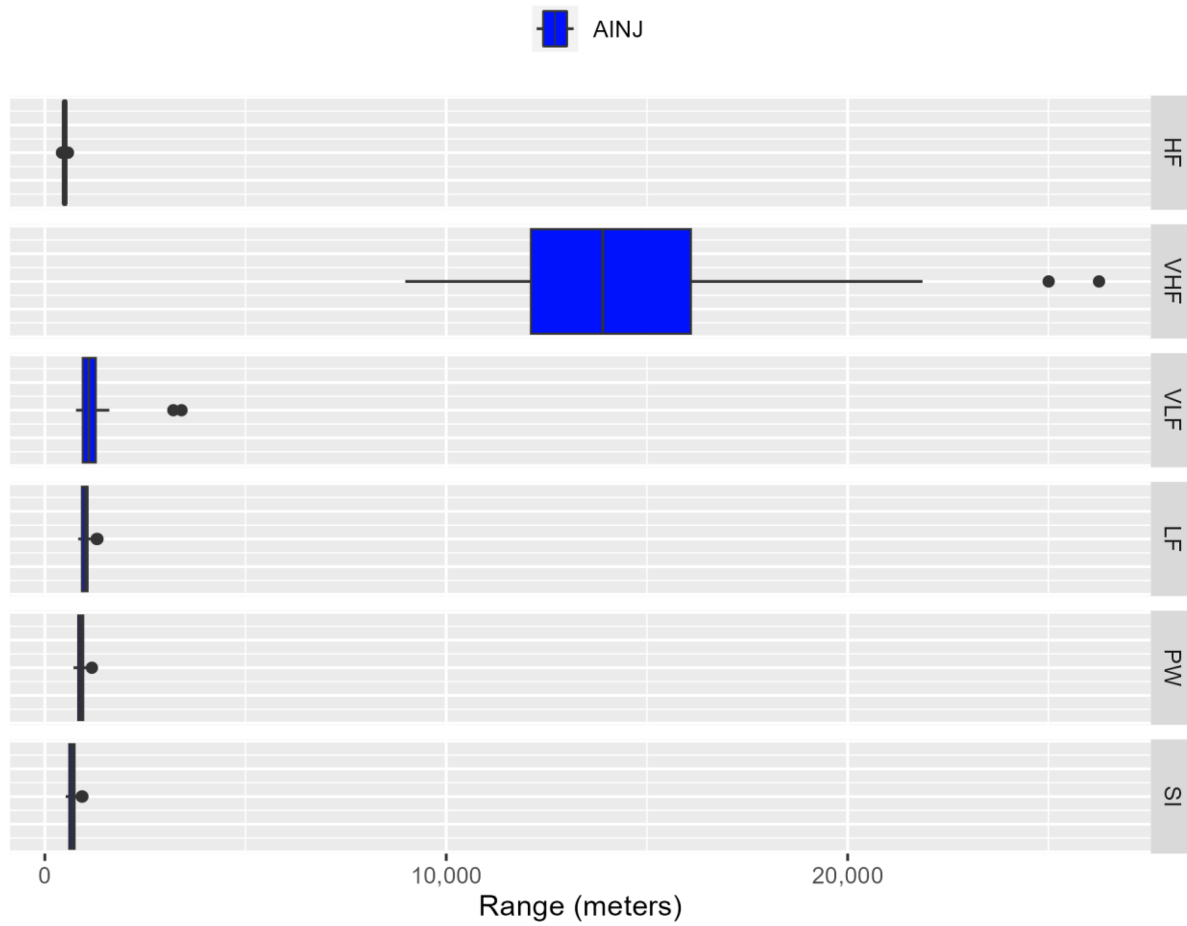


Figure 2.5-57: Marine Mammal Ranges to Auditory Injury for E12 (>650 - 1,000 lb.)

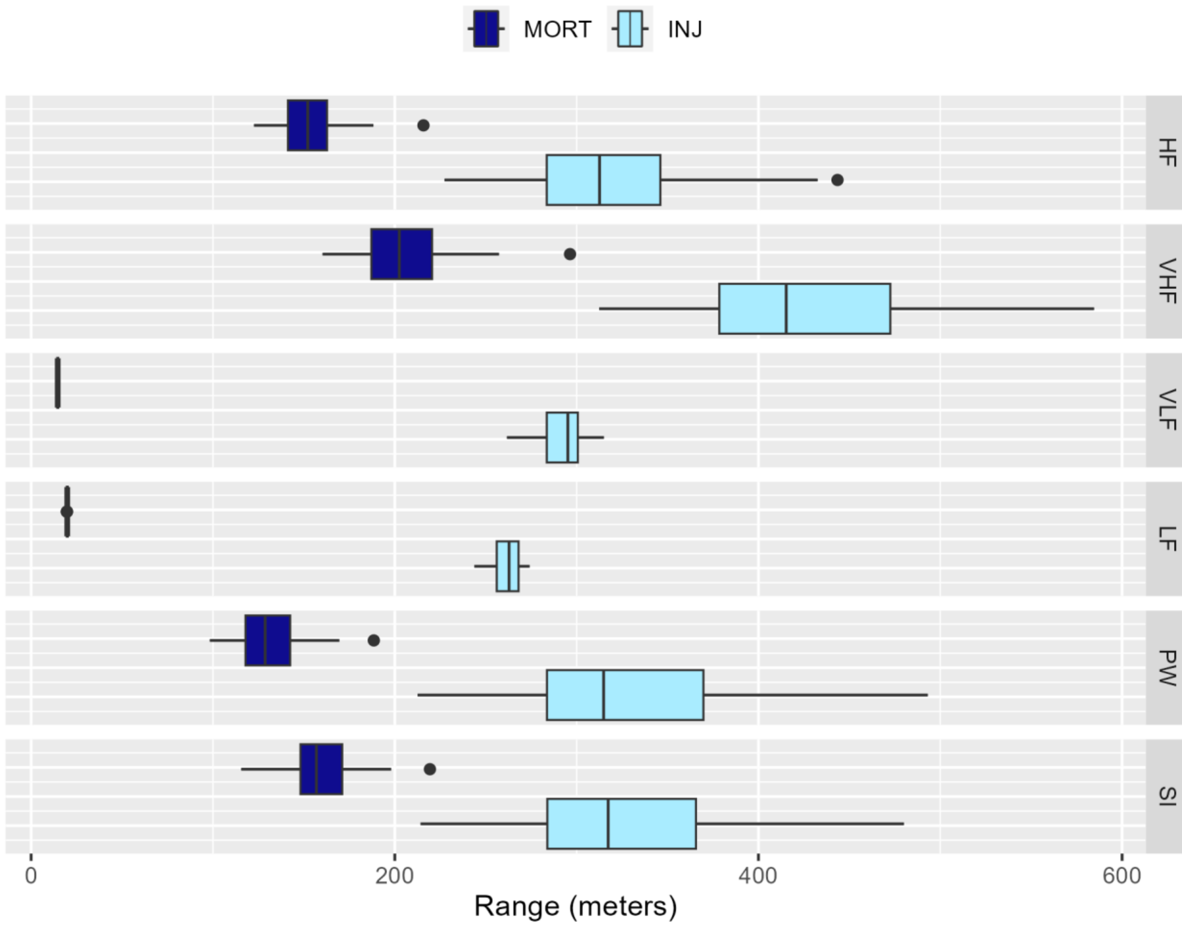


Figure 2.5-58: Marine Mammal Ranges to Mortality and Injury for E12 (>650 - 1,000 lb.)

2.5.4.13 Bin E16 (>7,250 - 14,500 lb. NEW)

Table 2.5-21: Marine Mammal Ranges to Effects for E16 (>7,250 - 14,500 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
HF	>200 m	1	NA	4,231 m (519 m)	1,953 m (251 m)	2,110 m (376 m)	966 m (83 m)
VHF		1	NA	63,838 m (4,791 m)	49,023 m (4,904 m)	3,043 m (654 m)	1,189 m (163 m)
VLF		1	NA	58,678 m (3,595 m)	16,711 m (1,485 m)	1,082 m (111 m)	388 m (12 m)
LF		1	NA	44,253 m (2,856 m)	9,433 m (1,053 m)	1,027 m (73 m)	523 m (21 m)
PW		1	NA	24,186 m (1,908 m)	5,889 m (894 m)	2,378 m (483 m)	1,052 m (151 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all calf masses in the auditory group or the peak pressure range
-MORT = impulse range based on all calf masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

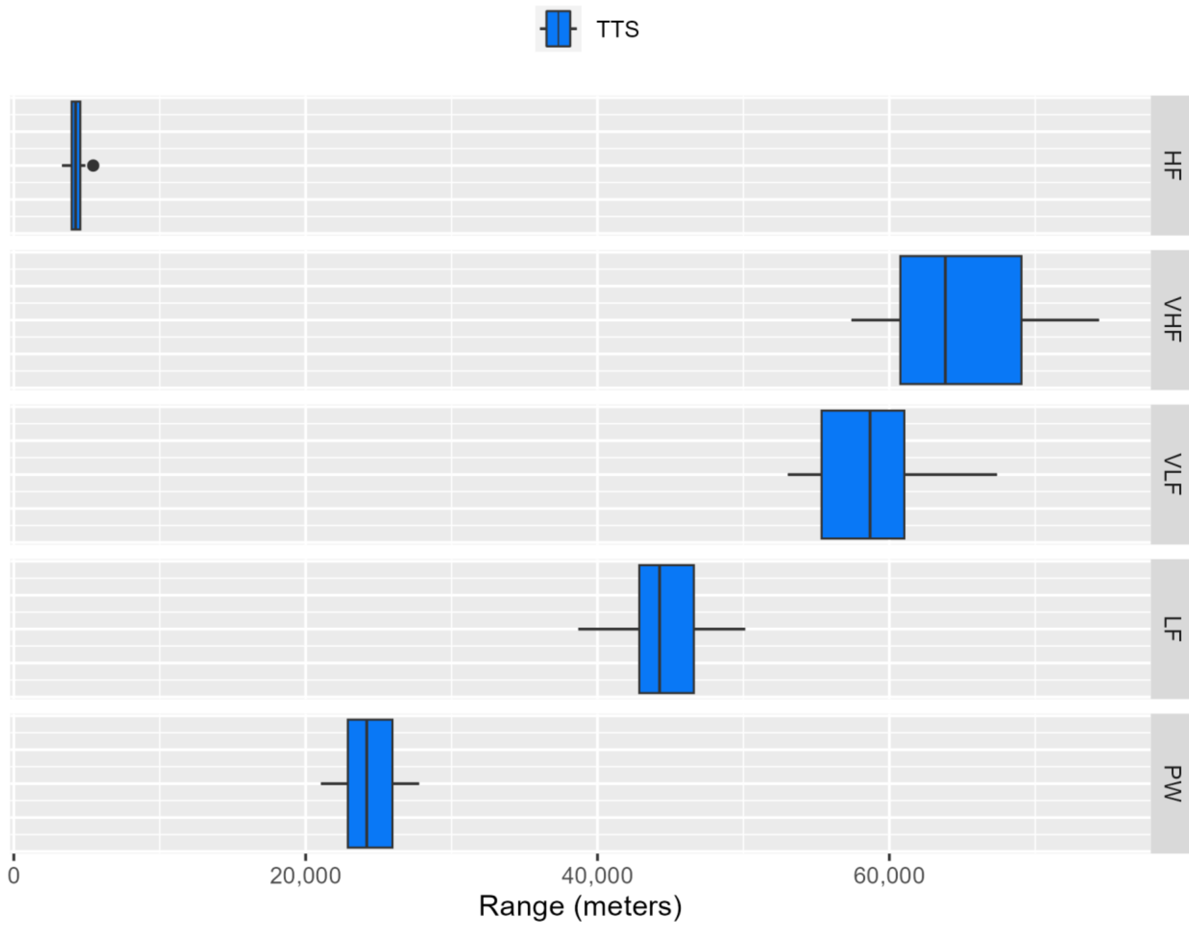


Figure 2.5-59: Marine Mammal Ranges to Temporary Threshold Shift for E16 (>7,250 - 14,500 lb.)

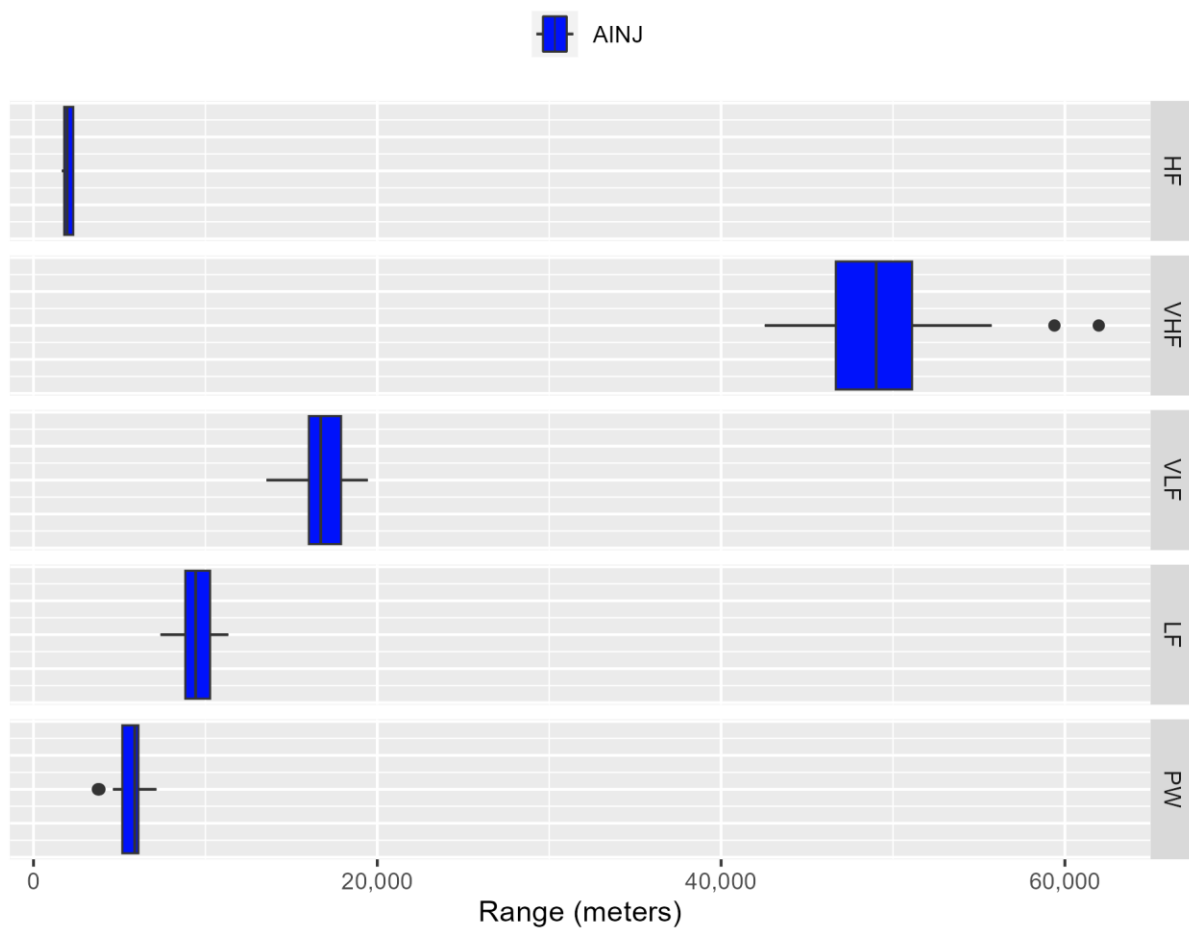


Figure 2.5-60: Marine Mammal Ranges to Auditory Injury for E16 (>7,250 - 14,500 lb.)

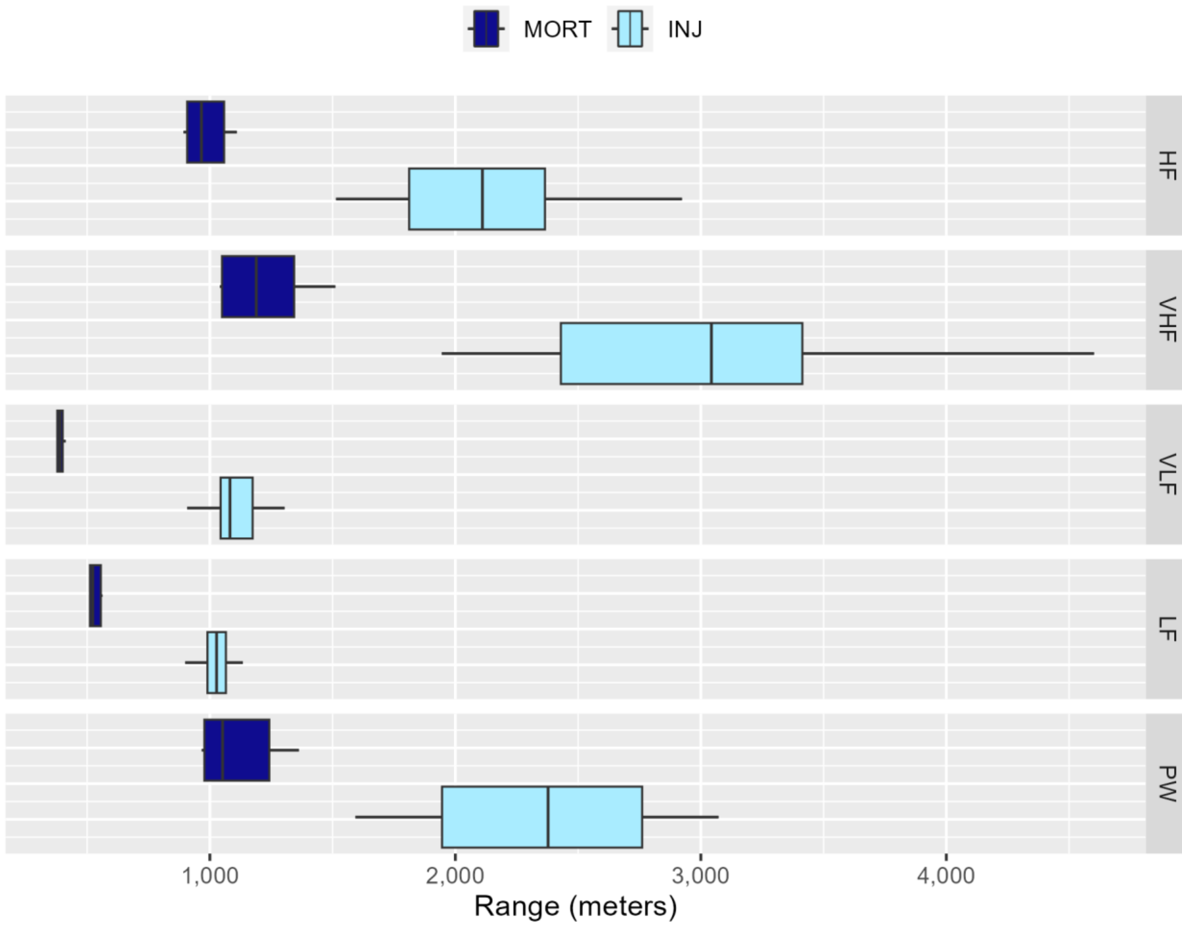


Figure 2.5-61: Marine Mammal Ranges to Mortality and Injury for E16 (>7,250 - 14,500 lb.)

3 IMPACTS TO REPTILES FROM ACOUSTIC AND EXPLOSIVE STRESSORS

Assessing whether a sound may disturb or injure a reptile involves understanding the characteristics of the acoustic sources, the reptiles that may be present in the vicinity of the sources, and the effects that sound may have on the physiology and behavior of reptiles. 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 of the animal to the source of the sound.

The *Reptile Acoustic Background* section summarizes what is currently known about acoustic effects to reptiles. For all acoustic substressors and explosives, the reader is referred to that section for background information on the types of effects that are discussed in the following analysis. In this analysis, impacts are categorized as mortality, non-auditory injury, temporary hearing loss (temporary threshold shift [TTS]), auditory injury (AINJ, including permanent threshold shift [PTS] and auditory neural injury), other physiological response (including stress), masking (occurs when a noise interferes with the detection, discrimination, or recognition of other sounds), and behavioral responses.

This analysis is presented as follows:

- The impacts that would be expected due to each type of acoustic stressor and explosives used in the Proposed Action are described in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives)
- The approach to modeling and quantifying impacts is summarized in Section 3.2 (Quantifying Impacts to Sea Turtles from Acoustic and Explosive Stressors).
- Impacts to ESA-listed species in the Study Area, including predicted instances of harm or harassment, are presented in Section 3.3 (ESA-Listed Species Impact Assessments).

3.1 Impacts Due to Each Acoustic Substressor and Explosives

Details regarding the Navy's Proposed Action and associated acoustic and explosive stressors to support this impact assessment can be found in the following sections:

- The number of activities and the locations they would occur are shown in the *Proposed Activities* section.
- Activities using each of the following acoustic substressors and explosives would be conducted as described in the *Activity Descriptions* section, which lists for each activity: where it would occur and any applicable mitigation measures.
- General categories and characteristics of each acoustic substressor and explosive are described in the *Acoustic Stressors* section along with their general use and quantification of annual use (e.g., sonar hours or counts of explosive ordnance).
- Impacts to individual ESA-listed reptile species in the Study Area are presented in Section 3.3 (ESA-Listed Species Impact Assessments).

3.1.1 Impacts from Sonars and Other Transducers

Characteristics and occurrence of sonars and other transducers (collectively referred to as sonars in this analysis) used under the Proposed Action are described in the *Acoustic Stressors* and *Activity Descriptions* sections. Activities using sonar would generally occur within Navy range complexes, on Navy testing ranges, around inshore locations, and specified ports and piers identified in the *Proposed Activities* section. The types of sonars and the way they are used differ between primary mission areas. For example, sonar systems can be used aboard single source platforms during limited duration events or can be used during multi-day events with multiple sound sources on different platforms. The overall size of the event (i.e., hours versus days, single versus multiple platforms, etc.) in turn influences the potential for impacts to exposed reptiles. The use of these systems would be concentrated, in order from highest to lowest combined number of hours and counts (e.g., sonobuoys) for training and testing activities, in the Jacksonville, Virginia Capes, Northeast, Gulf of Mexico and Navy Cherry Point Range Complexes. Low-frequency sonar would also occur in the high seas under training activities, and in the Naval Surface Warfare Center Panama City, Naval Undersea Warfare Center Newport, and the South Florida Ocean Measurement Facility Testing Ranges under testing. Some low-frequency sonars may also be utilized in the nearshore waters such as Navy piers during equipment testing activities (e.g., Naval Submarine Base New London and Naval Station Norfolk) though these systems are typically operated farther offshore. Overall, low-frequency sources are operated less often than mid- or high-frequency sources throughout the Study Area. Although the general impacts from sonar during testing would be similar in severity to those described during training, there is a higher quantity of sonar usage under testing activities and therefore there may be slightly more impacts during testing activities.

Reptiles are likely only susceptible to hearing loss when exposed to high levels of sound within their limited hearing range (most sensitive from 100–400 Hz and limited over 1 kHz). Only sources within the hearing range of reptiles (<2 kHz) are considered. As discussed in the *Reptile Acoustic Background* section, sea turtles, crocodilians, and terrapins have similar hearing capabilities, mechanisms, and likely usage. Therefore, the types of impacts to crocodilians and terrapins are assessed to be comparable to those for sea turtles. Potential impacts from exposures to sonar are discussed in the *Reptile Acoustic Background* section and include TTS, AINJ, masking, behavioral reactions, and physiological response.

The most probable impacts from exposure to sonar is hearing loss and AINJ, masking, behavioral reactions, and physiological response. Sonar-induced acoustic resonance and bubble formation phenomena are very unlikely to occur under realistic conditions, as discussed in the *Reptile Acoustic Background* section. Non-auditory injury and mortality from sonar are not possible under realistic exposure conditions. Any impact to hearing can reduce the distance over which a reptile detects environmental cues, such as the sound of waves, or the presence of a vessel or predator. A reptile could respond to sounds detected within its hearing range if it is close enough to the source. Use of sonar would typically be transient and temporary, and there is no evidence to suggest that any behavioral response would persist after a sound exposure. In addition, a stress response may accompany any behavioral response. Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. Reptiles may rely on senses other than hearing such as vision or magnetic orientation and could potentially reduce the effects of masking. The use characteristics of most low-frequency sonars include limited bandwidth, beam directionality, beam width, duration of use, and relatively low source levels and low duty cycle. These factors greatly limit the potential for a reptile to detect these sources and the potential for masking of broadband, continuous environmental sounds.

Due to the potential physiological and behavioral responses from reptiles during proposed sonar use, impacts from the use of sonars during military readiness activities are assessed for ESA-listed species further in Section 3.3 (ESA-Listed Species Impact Assessments), along with ESA conclusions.

3.1.2 Impacts from Air Guns

Air guns use bursts of pressurized air to create intermittent, broadband, impulsive sounds. Air gun use by the Navy is limited and is unlike large-scale seismic surveys that use an array with multiple air guns firing simultaneously or sequentially. In Navy events, small air guns would be fired over a limited period within a single day. Air gun use would only occur in two testing activities: Semi-Stationary Equipment Testing and Acoustic and Oceanographic Research. While air gun use during Semi-Stationary Equipment Testing would occur near shore at Newport, RI, air gun use during Acoustic and Oceanographic Research may occur in the Northeast, Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes greater than 3 NM from shore.

Sounds from air guns are impulsive, broadband, dominated by lower frequencies, and are within the hearing range of reptiles. As discussed in the *Reptile Acoustic Background* section, sea turtles, crocodilians, and terrapins have similar hearing capabilities, mechanisms, and likely usage. Therefore, the types of impacts to crocodilians and terrapins are assessed to be comparable to those for sea turtles. Potential impacts from air guns could include TTS, AINJ, behavioral reactions, physiological response, and masking. Ranges to auditory effects for reptiles exposed to air guns are in Section 3.4.2 (Range to Effects for Air Guns). The visual observation distances described in the *Mitigation* section are designed to avoid or substantially reduce the potential for AINJ due to air guns. As shown in Section 3.4.2 (Range to Effects for Air Guns), ranges to AINJ and TTS are relatively short. Furthermore, the mitigation zone (200 yds.) extends beyond these ranges and will help prevent or reduce any potential for AINJ and TTS in sea turtles.

Limited research and observations from air gun studies (see the *Reptile Acoustic Background* section) suggest that if reptiles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist after the sound exposure. Due to the low duration of an individual air gun shot, approximately 0.1 second, and the low duty cycle of sequential shots, the potential for masking from air guns would be low. Additionally, pierside air gun use would only occur several times a year and would use a limited number of air gun shots, limiting any masking, while the use of air guns in offshore waters would not interfere with detection of sounds in nearshore environments.

Due to the potential physiological and behavioral responses from reptiles during proposed air gun use, impacts from the use of air guns during military readiness activities are assessed for ESA-listed species further in Section 3.3 (ESA-Listed Species Impact Assessments), along with ESA conclusions.

3.1.3 Impacts from Pile Driving

Reptiles can be exposed to sounds from impact (installation only) and vibratory (installation and removal) pile driving during Port Damage Repair training activities throughout the year (pile driving would not occur during testing activities). Specifically, Port Damage Repair training would occur over five days, and up to four times per year (20 days total) in Gulfport, Mississippi, a coastal port with potentially high ambient noise levels due to natural and anthropogenic sources (e.g., vessel traffic). At most, sound from pile driving activities could occur over a maximum estimated duration of several hours in each day, though breaks in pile driving are taken frequently to reposition the drivers between piles and not all piles would be driven to completion, minimizing the total time pile driving noise is produced during this activity.

As discussed in the *Activity Descriptions* section, as a standard operating procedure, the Navy performs soft starts at reduced energy during an initial set of strikes from an impact hammer. Soft starts may "warn" sea turtles and cause them to move away from the sound source before impact pile driving increases to full operating capacity. Soft starts were not considered when calculating the number of sea turtles that may be impacted, nor was the possibility that a sea turtle could avoid the construction area.

Sounds from an impact hammer are impulsive, broadband, and dominated by lower frequencies. A vibratory hammer produces sounds that are similar in frequency range as the impact hammer, except the levels are much lower, especially when extracting piles from sandy, nearshore ground, and the sound is continuous while operating. The sounds produced from impact and vibratory pile driving and removal are within the hearing range of reptiles. As discussed in the *Reptile Acoustic Background* section, sea turtles, crocodilians, and terrapins have similar hearing capabilities, mechanisms, and likely usage. Therefore, the types of impacts to crocodilians and terrapins are assessed to be comparable to those for sea turtles. predicted ranges to AINJ, TTS, and behavioral response for sea turtles from exposure to impact and vibratory pile driving are shown in Section 3.4.3 (Range to Effects for Pile Driving) and were determined using the calculations, modeling, and surrogate sound levels described in the *Quantitative Analysis TR*. The mitigation zone (100 yds.) extends beyond the ranges to AINJ and TTS and will help prevent or reduce any potential for AINJ and TTS in sea turtles.

The working group that prepared the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) provide parametric descriptors of sea turtle behavioral responses to impact pile driving. Popper et al. (2014) estimate the risk of sea turtles responding to impact pile driving is high, moderate, and low while at near (tens of meters), intermediate (hundreds of meters), and far (thousands of meters) distances from the source, respectively. Based on prior observations of sea turtle reactions to sound, if a behavioral reaction were to occur, the responses can include increases in swim speed, change of position in the water column, or avoidance of the sound (see the *Reptile Acoustic Background* section). There is no evidence to suggest that any behavioral response would persist after a sound exposure, and it is likely that a stress response would accompany any behavioral response or TTS.

The vibratory hammer produces sounds that could cause some masking in reptiles, but the effect would be temporary, only lasting the duration that piles are driven or extracted. 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 source is operating. For impact pile driving, the rate of strikes (60 per minute) has the potential to result in some masking. However, the effect would be brief and temporary, lasting the amount of time it would take to drive a pile (a few minutes per pile), with pauses before the next pile is driven. Furthermore, Port Damage Repair activities occur in shallow, nearshore commercial port where ambient noise levels are already typically high. 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. Most of the pile driving would occur within the port. Given these factors, significant masking is unlikely to occur in reptiles due to exposure to sound from impact pile driving or vibratory pile driving or extraction.

If reptiles are exposed to sounds from pile driving or extraction, they could potentially react with short-term behavioral reactions and physiological (stress) responses (see the *Reptiles Acoustic Background* section).

Due to the potential physiological and behavioral responses from reptiles during proposed pile driving use, impacts from pile driving during military readiness activities are assessed for ESA-listed species further in Section 3.3 (ESA-Listed Species Impact Assessments), along with ESA conclusions.

3.1.4 Impacts from Vessel Noise

Reptiles may be exposed to vessel-generated noise throughout the Study Area. Military readiness activities with vessel-generated noise would be conducted as described in the *Proposed Activities* section and *Activity Descriptions* sections. Specifically, a study of military vessel traffic found that traffic was heaviest just offshore of Norfolk and Jacksonville, as well as along the coastal waters between the two ports (Mintz, 2012b; Mintz, 2016; Mintz & Filadelfo, 2011) as described in the *Vessel Movement* section, though these activities can occur throughout the Study Area. Vessel movements involve transits to and from ports to various locations within the Study Area, and many ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels), as well as unmanned vehicles. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. Surface combatant ships (e.g., destroyers, guided missile cruisers, and littoral combat ships) and submarines especially are designed to be quiet to evade enemy detection. Characteristics of vessel noise are described in the *Acoustic Habitat* section.

Due to the acoustic characteristics of vessel noise (i.e., moderate- to low-level source levels), vessel noise is unlikely to cause any direct injury or trauma. Furthermore, vessels are transient and would result in brief periods of exposure. Vessels produce continuous broadband noise within the hearing range of reptiles. As discussed in the *Reptile Acoustic Background* section, sea turtles, crocodilians, and terrapins have similar hearing capabilities, mechanisms, and likely usage. Therefore, the types of impacts to crocodilians and terrapins are assessed to be comparable to those for sea turtles.

Based on best available science summarized in the *Reptile Acoustic Background* section, potential impacts to reptiles include masking, behavioral reactions, and physiological response. Vessel source levels are below the sound levels that would cause hearing loss or AINJ. For louder vessels, such as Navy supply ships, it is not clear that reptiles would typically exhibit any reaction other than a brief startle and avoidance reaction if they react at all. Any of these reactions to vessels are not likely to disrupt important behavioral patterns. The size and severity of these impacts would be insignificant, and not rise to the level of measurable impacts. While it is likely that sea turtles may exhibit some behavioral response to vessels, numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls that may have been exacerbated by a sea turtle surfacing reaction or lack of reaction to vessels (Hazel et al., 2007; Lutcavage et al., 1997).

Acoustic masking, especially from larger, non-combatant vessels, is possible. Vessels produce continuous broadband noise, with larger vessels producing sound that is dominant in the lower frequencies (as described in the *Acoustic Habitat* section) where reptile hearing is most sensitive. Smaller vessels emit more energy in higher frequencies, much of which would not be detectable by reptiles. Existing high ambient noise levels in ports and harbors with non-military vessel traffic and in shipping lanes with commercial vessel traffic would limit the potential for masking by military vessels in those areas. In offshore areas with lower ambient noise, the duration of any masking effects in a particular location would depend on the time in transit by a vessel through an area. Exposure to vessel noise could result in short-term behavioral reactions, physiological response, masking, or no response (see the *Reptile Acoustic Background* section). Impacts from vessel noise would be temporary and localized, and such responses would not be expected to compromise the general health or condition of individual reptiles. Therefore, long-term consequences for populations are not expected.

Conclusions regarding impacts from activities that produce vessel noise during military readiness activities for ESA-listed species are provided in Section 3.3 (ESA-Listed Species Impact Assessments).

3.1.5 Impacts from Aircraft Noise

Reptiles may be exposed to aircraft-generated noise throughout the Study Area. Military readiness activities with aircraft would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Fixed- and rotary-wing (e.g., helicopters) aircraft are used for a variety of military readiness activities throughout the Study Area. Tilt-rotor impacts would be like fixed-wing or rotary-wing impacts depending which mode the aircraft is in. Most of these sounds would be concentrated around airbases and fixed ranges within each of the range complexes. Aircraft noise can also occur in the waters immediately surrounding aircraft carriers at sea during takeoff and landing or directly below hovering rotary-wing aircraft that are near the water's surface. Aircraft produce extensive airborne noise from either turbofan or turbojet engines. An infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Rotary-wing aircraft produce low-frequency sound and vibration (Pepper et al., 2003). Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors, but significant acoustic energy is primarily transmitted into the water directly below the aircraft in a narrow cone, as discussed in detail in the *Acoustic Primer* section.

Aircraft noise is within the hearing range of reptiles and activities that produce aircraft noise can occur in areas potentially inhabited by reptiles. As discussed in the *Reptile Acoustic Background* section, sea turtles, crocodilians, and terrapins have similar hearing capabilities, mechanisms, and likely usage. Therefore, the types of impacts to crocodilians and terrapins are assessed to be comparable to those for sea turtles.

In most cases, exposure of a reptile to fixed-wing aircraft presence and noise would be brief as the aircraft quickly passes overhead. Animals would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. Supersonic flight at sea is typically conducted at altitudes exceeding 30,000 ft., limiting the number of occurrences of supersonic flight being audible at the water's surface. Because most overflight exposures from fixed-wing aircraft or transiting rotary-wing aircraft would be brief and aircraft noise would be at low received levels, only startle reactions, if any, are expected in response to low altitude flights. Similarly, the brief duration of most overflight exposures would limit any potential for masking of relevant sounds, and reptiles may dive or move to a different area to reduce potential masking impacts (see the *Reptile Acoustic Background* section).

Daytime and nighttime activities involving rotary-wing aircraft may occur for extended periods of time, up to a couple of hours in some areas. During these activities, rotary-wing aircraft would typically transit throughout an area and may hover over the water. Longer duration activities and periods of time where rotary-wing aircraft hover may increase the potential for behavioral reactions, startle reactions, and stress. Low-altitude flights of rotary-wing aircraft during some activities, which often occur under 100 ft. altitude, may elicit a stronger startle response due to the proximity of a rotary-wing aircraft to the water; the slower airspeed and longer exposure duration; and the downdraft created by a rotary-wing aircraft's rotor. Most fixed-wing aircraft and rotary-wing aircraft activities are transient in nature, although rotary-wing aircraft can also hover for extended periods. The likelihood that a reptile would occur or remain at the surface while an aircraft transits directly overhead would be low. Rotary-wing aircraft that hover in a fixed location for an extended period can increase the potential for exposure. However, impacts from military readiness activities would be highly localized and concentrated in space and duration.

Reptiles may respond to both the physical presence and to the noise generated by aircraft, making it difficult to attribute causation to one or the other stimulus. In addition to noise produced, all low-flying aircraft make shadows, which can cause animals at the surface to react. Rotary-wing aircraft may also produce strong downdrafts, a vertical flow of air that becomes a surface wind, which can also affect an animal's behavior at or near the surface. The amount of sound entering the ocean from aircraft would be very limited in duration, sound level, and affected area. Overall, if reptiles were to respond to aircraft noise, only short-term behavioral or physiological response would be expected. Therefore, impacts to individuals would be unlikely and long-term consequences for populations are not expected.

Conclusions regarding impacts from activities that produce aircraft noise during military readiness activities for ESA-listed species are provided in Section 3.3 (ESA-Listed Species Impact Assessments).

3.1.6 Impacts from Weapons Noise

Reptiles may be exposed to sounds caused by the firing of weapons, objects in flight, and inert impact of non-explosive munitions on the water's surface. Military readiness activities using weapons and deterrents would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Generally, the use of weapons during proposed activities would occur in the range complexes, with greatest use of most types of munitions in the Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes. Most activities involving large caliber naval gunfire, or the launching of targets, missiles, bombs, or other munitions are conducted more than 12 NM from shore. The Action Proponents will implement mitigation to avoid or reduce potential impacts from weapon firing noise during large-caliber gunnery activities, as discussed in the *Mitigation* section. For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed separately.

In general, weapons noise includes impulsive sounds generated in close vicinity to or at the water surface, except for items that are launched underwater, and are within the hearing range of reptiles. Weapons noise would be brief, lasting from less than a second for a blast or inert impact, to a few seconds for other launch and object travel sounds. As discussed in the *Reptile Acoustic Background* section, sea turtles, crocodilians, and terrapins have similar hearing capabilities, mechanisms, and likely usage. Therefore, the types of impacts to crocodilians and terrapins are assessed to be comparable to those for sea turtles.

Most incidents of impulsive sounds produced by weapon firing, launch, or inert object impacts would be single events. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for reptiles in the area over the short duration of the event. It is expected that these sounds may elicit brief startle reactions or diving, with avoidance being more likely with the repeated exposure to sounds during gunfire events. It is likely that reptile behavioral responses would cease following the exposure event, and the risk of a corresponding sustained stress response would be low. Similarly, exposures to impulsive noise caused by these activities would be so brief that risk of masking relevant sounds would be low. These activities would not typically occur in nearshore habitats where reptiles may use their limited hearing to sense broadband, coastal sounds. Behavioral reactions, startle reactions, and physiological response due to weapons noise are likely to be brief and minor, if they occur at all due to the low probability of co-occurrence between weapon activity and individual reptiles.

Conclusions regarding impacts from activities that produce weapons noise during military readiness activities for ESA-listed species are provided in Section 3.3 (ESA-Listed Species Impact Assessments).

3.1.7 Impacts from Explosives

Reptiles may be exposed to sound and energy from explosions in the water and near the water's surface. Activities using explosives would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Most explosive activities would occur in the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes, although activities with explosives would also occur in other areas as described in *Activity Descriptions*. Most activities involving in-water explosives associated with large caliber naval gunfire, or the launching of missiles, bombs, or other munitions, are conducted more than 12 NM from shore. Small Ship Shock Trials could occur in Virginia Capes, Jacksonville, or the Gulf of Mexico Range Complexes greater than 12 NM from shore as shown in the *Proposed Activities* section. Sinking Exercises are conducted greater than 50 NM from shore as shown in the *Proposed Activities* section. Certain activities with explosives may be conducted closer to shore at locations identified in *Activity Descriptions*, including Mine Neutralization Explosive Ordnance Disposal training activities, Semi-Stationary Equipment Testing activities and Line Charge testing.

Characteristics, quantities, and net explosive weights of in-water explosives used during military readiness activities are provided in the *Acoustic Stressors* section. The use of in-water explosives would generally decrease from the prior analysis for both training and testing activities. There is a reduction in the use of most of the largest explosive bins for both training and testing, and a large decrease in in-water explosives associated with medium-caliber gunnery (bin E1 [0.1–0.25 pounds (lb.) net explosive weight (NEW)]). There would be notable increases in three bins (E4 [> 2.5–5 lb. NEW], E7 [> 20–60 lb. NEW], and E9 [> 100–250 lb. NEW]). For testing, there would be no use of bin E17 (> 14,500–58,000 lb. NEW) because no Large Ship Shock Trials are proposed, and there would be reduced use of bin E16 (> 7,250–14,500 lb. NEW) for Small Ship Shock Trials.

The majority (96%) of explosive munitions used during military readiness activities would occur at or above the water's surface including those used during Surface Warfare activities which would typically detonate at or within 9 m (30 ft) above the water surface. The only detonations that would occur exclusively in-water would be from Mine Countermeasures (E4 [> 2.5–5 lb. NEW]), Torpedo Testing (E11 [> 500–675 lb. NEW]) and Ship Shock Trials (E16 [> 7,250–14,500 lb. NEW)]. Therefore, impacts to reptiles are over-estimated in this analysis by modeling in-air or near surface explosions as underwater explosions. Sound and energy from in-air detonations at higher altitudes would be reflected at the water surface and therefore are not analyzed further in this section and would have no effect on reptiles.

Characteristics, quantities, and net explosive weights of in-water explosives used during military readiness activities are provided in the *Acoustic Stressors* section. Explosives produce loud, impulsive, broadband sounds. Potential impacts from exposures to explosives are discussed in the *Reptile Acoustic Background* section and include masking, behavioral reactions, hearing loss, AINJ, non-auditory injury, and mortality. Estimated behavioral reactions, auditory impacts, non-auditory impacts, and mortality were modeled. Impact ranges for reptiles exposed to explosive sound and energy are shown in Section 3.4.4 (Range to Effects for Explosives). As discussed in the *Mitigation* section, the Action Proponents will implement mitigation to relocate, delay, or cease detonations when a reptile is sighted within or entering a mitigation zone to avoid or reduce potential explosive impacts. The visual observation distances described in the *Mitigation* section are designed to cover the distance to mortality and reduce the potential for injury due to explosives. The median ranges to non-auditory injury and mortality for reptiles in Section 3.4.4 (Range to Effects for Explosives) due to each explosive bin are encompassed by the applicable cease fire mitigation zones (200 yd., 500 yd., 600 yd., 900 yd., 1,000 yd., 2,000 yd., 2,100 yd., 2,500 yd., 2.5 NM, and 3.5 NM) in the *Mitigation* section.

As discussed in the *Reptile Acoustic Background* section, sea turtles, crocodilians, and terrapins have similar hearing capabilities, mechanisms, and likely usage. Therefore, the types of impacts to crocodilians and terrapins are assessed to be comparable to those for sea turtles. Impacts including TTS, AINJ, and non-auditory injury can reduce the fitness of an individual animal, causing a reduction in foraging success, reproduction, or increased susceptibility to predators. This reduction in fitness would be temporary for recoverable impacts, such as TTS. There may be long-term consequences to some individuals, however, no population-level impact is expected due to the low number of potential injuries or mortalities for any reptile species relative to total population size. Recovery from a hearing threshold shift begins almost immediately after the noise exposure ceases. Full recovery from a temporary threshold shift is expected to take a few minutes to a few days, depending on the severity of the initial shift (see *Criteria and Thresholds TR*). If any hearing loss remains after recovery, that remaining hearing threshold shift is permanent. Because explosions produce broadband sounds with low-frequency content, hearing loss due to explosive sound could occur across a reptile's hearing range, reducing the distance over which relevant sounds may be detected for the duration of the threshold shift.

A reptile's behavioral response to a single detonation or explosive cluster is expected to be limited to a short-term startle response or other behavioral responses, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (see the *Reptile Acoustic Background* section) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist after the sound exposure. Because the duration of most explosive events is brief, the potential for masking is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions and is also likely the case for crocodilians and terrapins.

A physiological response is likely to accompany any injury, hearing loss, or behavioral reaction. A stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. While the stress response is a normal function for an animal dealing with natural stressors in their environment, chronic stress responses can reduce an individual's fitness. However, explosive activities are generally displaced over space and time and would not likely result in repeated exposures to individuals over a short period of time (hours to days).

Due to the potential physiological and behavioral responses from reptiles during proposed explosive use, impacts from the use of explosives during military readiness activities are assessed for ESA-listed species further in Section 3.3 (ESA-Listed Species Impact Assessments), along with ESA conclusions.

3.2 Quantifying Impacts on Reptiles from Acoustic and Explosive Stressors

The following section provides an overview of key components of the modeling methods used to quantify impacts in this analysis. As a note, the quantitative impact analyses below are only performed for sea turtles. The following technical reports go into more detail on the quantitative process and show specific data inputs to the models.

- The modeling methods used to quantify impacts are described in detail in the *Quantitative Analysis TR*. Impacts due to sonar, air guns, and explosives were quantified using the Navy Acoustic Effects Model. Impacts due to pile driving were modeled outside of the Navy Acoustic Effects Model using a static area-density model.
- The development of criteria and thresholds used to predict impacts is shown in the *Criteria and Thresholds TR.*
- The spatial density models for each sea turtle species are described in the *Density TR*. The density models have been updated with new data since the prior analysis. The density technical report includes figures that show a species-by-species comparison (where applicable) of the density estimates used in the 2018 Final Atlantic Fleet Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement and this analysis. Areas where densities changed are characterized as either no to minimal change, an increase, or a decrease.
- The dive profile for each species is shown in *the Dive Profile and Group Size TR*. There are no substantive changes from the prior analysis.

3.2.1 The Navy's Acoustic Effects Model

The Navy Acoustic Effects Model was developed by the Navy to conduct a comprehensive acoustic impact analysis for use of sonars, air guns, and explosives in the marine environment. This model considers the physical environment, including bathymetry, seafloor composition/sediment type, wind speed, and sound speed profiles, to estimate propagation loss. The propagation information combined with data on the locations, numbers, and types of military readiness activities and marine resource densities provides estimated numbers of effects to each stock.

Individual sea turtles are represented as "animats," which function as dosimeters and record acoustic energy from all active underwater sources during a simulation of a training or testing event. Each animat's depth changes during the simulation according to the typical depth pattern observed for each species. During any individual modeled event, impacts on individual animats are considered over 24-hour periods.

Because limited data are available on crocodilian and terrapin hearing, and most activities using acoustic substressors and explosives would not occur in crocodilian and terrapin habitat, impacts on crocodilians and terrapins due to military readiness activities are qualitatively analyzed.

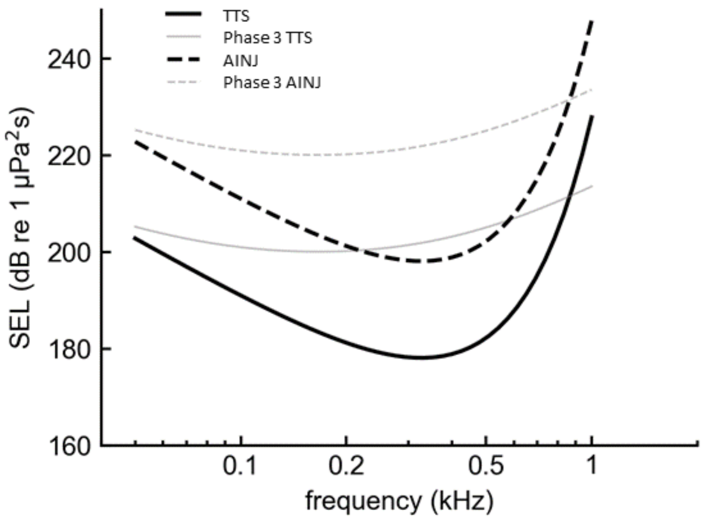
The model estimates the number of instances in which an effect threshold was exceeded over the course of a year, it does not estimate the number of times an individual in a population may be impacted over a year. Some sea turtles may be impacted multiple times, while others may not experience any impact.

3.2.2 Quantifying Impacts on Hearing

The auditory criteria and thresholds used in this analysis have been updated since the prior assessment of impacts due to military readiness activities in the Study Area. The auditory criteria and thresholds used in this analysis incorporate the latest and best available science and is discussed in the *Criteria and Thresholds TR*.

The best way to illustrate frequency-dependent susceptibility to auditory effects is an exposure function. Exposure functions for TTS and AINJ incorporate both the shape of the auditory weighting function and its weighted threshold value for either TTS or AINJ. Exposure functions that are updated for this analysis are shown in Figure 3.2-1.

Figure 3.2-1: Sea Turtle Exposure Function for Non-Impulsive TTS and AINJ



Note: TTS = temporary threshold, AINJ = auditory injury.

Estimated auditory impacts increased due to the following changes to the TTS and AINJ thresholds:

- The weighted non-impulsive SEL thresholds decreased by 22 dB (re 1 µPa^{2}s).
- The weighted impulsive SEL thresholds decreased by 20 dB (re 1 µPa^{2}s).
- The impulsive peak SPL thresholds decreased by 2 dB (re 1 µPa).

Table 3.2-1 lists the values for all auditory impact thresholds. For a detailed description of how these thresholds were determined, see the *Criteria and Thresholds TR*.

In contrast to the prior analysis, sea turtle avoidance of repeated high-level exposures from sonar was not applied in this analysis.

Table 3.2-1: Phase 3 and Phase 4 TTS and AINJ Onset Levels for Sonar (Non-Impulsive) and Explosive (Impulsive) Sound Sources in Sea Turtles.

	Phase 3		*Phase 4*	
	TTS	***AINJ***	***TTS***	***AINJ***
Non-impulsive onset SEL (dB re 1 µPa^{2}s weighted)[1]	200	220	178	198
Impulsive onset SEL (dB re 1 µPa^{2}s weighted) [1]	189	204	169	184
Impulsive onset Peak SPL (dB re 1 µPa)	226	232	224	230

Note: TTS = temporary threshold, AINJ = auditory injury, SEL = sound exposure level, SPL = sound pressure level.

[1]The weighted non-impulsive thresholds by themselves only indicate the TTS/AINJ threshold at the most susceptible frequency (the exposure function shape for non-impulsive sources is shown in

Figure 3.2-1).

3.2.3 Quantifying Behavioral Impacts

The behavioral thresholds for sonars, air guns, and pile driving are the same as the prior assessment of impacts due to military readiness activities in the Study Area and is discussed in the *Criteria and Thresholds TR*. For exposures to single and multiple explosions, SEL-based thresholds were developed that are consistent with how marine mammal behavioral response thresholds were developed for exposures to single and multiple explosions. Table 3.2-2 lists the behavioral response thresholds for sea turtles used in this analysis.

Table 3.2-2: Behavioral Response Thresholds for Sea Turtles

Source	dB SPL rms (unweighted)	dB SEL (cumulative; weighted)
Air guns	175	-
Pile driving	175	-
Sonar ≤ 2 kHz	175	-
Explosives[1]	-	164

Note: SPL = sound pressure level, SEL = sound exposure level, rms = root mean square. Weighted cumulative SEL thresholds in dB re 1 µPa^{2}s and unweighted SPL rms thresholds in dB re 1 µPa. The root mean square and sound exposure level calculations are based on the duration defined by the 5% and 95% points along the cumulative energy curve and captures 90% of the cumulative energy in the impulse.

[1]For a single explosion the behavioral response threshold is set to the impulsive TTS onset threshold of 169 dB re 1 µPa^{2}s SEL

3.2.4 Quantifying Non-Auditory Injury due to Explosives

The criterion for mortality is based on severe lung injury derived from (Goertner, 1982) and the criteria for non-auditory injury are based on slight lung injury or gastrointestinal tract injury. Mortality and slight lung injury impacts to sea turtles will be predicted using thresholds for both juvenile and adult weights (see *Criteria and Thresholds TR*). An additional criterion for non-auditory injury is onset of gastrointestinal tract injury, which is the same for all species and age classes for explosive impacts. The onset (i.e., 1%) thresholds will be used to calculate impacts and model ranges to effect to inform mitigation assessment. This differs from the prior analysis where the 50% criterion (the level at which 50% of animals would be expected to have the response) was used to estimate the number of mortalities and non-auditory injuries. The updated threshold is more conservative (i.e., overpredicts numbers of effects) and will result in a small increase in the predicted non-auditory injuries and mortalities for the same event compared to prior analyses. Thresholds are provided in Table 3.2-3 for use in non-auditory injury assessment for sea turtles exposed to underwater explosives.

Table 3.2-3: Thresholds for Estimating Ranges to Potential Effect for Non-Auditory Injury.

Onset effect for mitigation consideration	*Threshold*
Onset Mortality - Impulse	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury - Impulse (Non-auditory)	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury - Peak Pressure (Non-auditory)	237 dB re 1 µPa peak

Note: Where M is animal mass (kg), and D is animal depth (m).

3.3 ESA-Listed Species Impact Assessments

The following sections analyze impacts to reptiles under the Proposed Action and show model-predicted estimates of take for sea turtles. The methods used to quantify impacts for each substressor are described above in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives). The methods used to assess significance of individual impacts and risks to reptile populations are described above in Section 3.2 (Quantifying Impacts on Reptiles from Acoustic and Explosive Stressors). For each sea turtle species, a multi-sectioned table (Table 3.3-1: Estimated effects to green sea turtles over a maximum year of proposed activities (Table 3.3-1 through Table 3.3-4) quantifies impacts as follows:

Section 1

The first section shows the number of instances of each effect type that could occur due to each substressor (sonar, air guns, or explosives) over a maximum year of activity. Impacts are shown by type of activities (Navy training, U.S. Coast Guard training activities only, or testing activities).

The number of instances of effect is not the same as the number of individuals that could be affected, as some individuals could be affected multiple times, whereas others may not be affected at all. The instances of effect are those predicted by the Navy's Acoustic Effects Model and are not further reduced to account for visual observation mitigation that would reduce effects near some sound sources and explosives as described in the *Mitigation* section.

In the modeling, instances of effect are calculated within 24-hour periods of each individually modeled event. Impacts are assigned to the highest order threshold exceeded at the animat, which is a dosimeter in the model that represents an animal of a particular species. Non-auditory injuries are assumed to outrank auditory effects, and auditory effects are assumed to outrank behavioral responses. In all instances, any auditory impact or injury are assumed to represent a concurrent behavioral response. For example, if a behavioral response and TTS are predicted for the same animat in a modeled event, the effect is counted as a TTS in the table.

For most activities, total impacts are based on multiplying the average expected impacts at a location by the number of times that activity is expected to occur. This is a reasonable method to estimate impacts for activities that occur every year and multiple times per year. There are two exceptions to that approach in this analysis: Civilian Port Defense (a training activity using sonar) and Small Ship Shock Trial (a testing activity using explosives). These two activities do not occur every year, have a very small number of total events over seven years, and could occur at one of many locations. Notably, Civilian Port Defense is the only proposed activity at certain port locations. Instead of using averaged impacts across locations for these two activities, the maximum impacts to any species at any of the possible locations is used. While this approach results in unrealistically high estimates of impacts for some species for these two activities, it ensures that this analysis appropriately assesses potential impacts where these rare events may occur.

The summation of instances of effect includes all fractional values caused by averaging multiple modeled iterations of individual events. Impacts are only rounded to whole numbers at the level of substressor and type of activities. Rounding follows standard rounding rules, in which values less than 0.5 round down to the lower whole number, and values equal to or greater than 0.5 round up to the higher whole number. A zero value (0) indicates that the sum of impacts is greater than true zero but less than 0.5. A dash (-) indicates that no impacts are predicted (i.e., a “true” zero). This would occur when there is no overlap of an animat in the modeling with a level of acoustic exposure that would result in any possibility of take during any activity. Non-auditory injury and mortality are only associated with use of explosives; thus, these types of effects are also true zeroes for any other acoustic substressor.

The summation of impacts across seven years is shown in Section 3.3.7 (Impact Summary Tables). The seven-year sum accounts for any variation in the annual levels of activities. The seven-year sum includes any fractional impact values predicted in any year, which is then rounded following standard rounding rules. That is, the seven-year impacts are not the result of summing the rounded annual impacts. If a seven-year sum was larger than the annual impacts multiplied by seven, the annual maximum impacts were increased by dividing the seven-year sum of impacts by seven then rounding up to the nearest integer. For example, this could happen if maximum annual impacts are 1.34 (rounds to 1 annually) and seven-year impacts are 8.60 (rounds to 9), where 9 divided by 7 years (9 ÷ 7 = 1.29) is greater than the estimated annual maximum of 1. In this instance, the maximum annual impacts would be adjusted from one to two based on rounding up 1.29 to 2. In multiple instances, this approach resulted in increasing the maximum annual impacts predicted by the Navy’s Acoustic Effects Model.

Section Two

The second section shows the percent of total impacts that would occur within seasons and general geographic areas. The general geographic areas are Northeast (Atlantic waters north of New Jersey), Mid-Atlantic (Atlantic waters from New Jersey to North Carolina), Southeast (Atlantic waters from South Carolina to Florida), Key West (areas around the southernmost portion of Florida), Gulf of Mexico, and High Seas (areas of the Atlantic east of the range complexes, outside of the U.S. Exclusive Economic Zone).

Section Three

The third section shows which activities are most impactful to a stock. Activities that cause five percent or more of total impacts to a species are shown.

Section Four (when applicable)

The fourth section shows impacts in critical habitats where they are designated for ESA-listed species. If a species does not have designated ESA critical habitat in the Study Area, then Section 4 is not shown in the tables.

3.3.1 Green Sea Turtle

In U.S. Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore waters from Texas to Maine. In the late spring and early summer, green turtles migrate to mid-Atlantic foraging grounds (Barco et al., 2018). Peak occurrence in the Northeast U.S. Continental Shelf Large Marine Ecosystem is likely in September (Berry et al., 2000). Juveniles use the estuarine and nearshore waters of the panhandle of Florida throughout the year (Lamont et al., 2015; Lamont & Iverson, 2018; Renaud et al., 1995; Seminoff et al., 2015). In the northern Gulf of Mexico, green sea turtles prefer the coastal habitats (e.g., lagoons, channels, inlets, bays) of southern Texas (Renaud et al., 1995; Wildermann et al., 2019).

Green turtles from the North Atlantic Ocean distinct population segment (DPS) may be exposed to sonar, air guns, pile driving, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the impacts from vessel noise, aircraft noise, and weapons noise on green turtles relies on the information under the respective acoustic substressor in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives). While the abundance of the North Atlantic Ocean DPS of green turtles is not known, the estimated number of nesting females is over 167,000 (Seminoff et al., 2015).

Designated green turtle critical habitat on the northern coast of the main island of Puerto Rico, and around Culebra, Vieques, Mona, and the U.S. Virgin Islands do not overlap with the use of acoustic and explosive stressors. Green turtle critical habitat proposed by NMFS is along the coasts of Florida, North Carolina, Texas, Puerto Rico, and the U.S. Virgin Islands. It is comprised of five different habitat types which are reproductive, migratory, benthic foraging/resting, and surface-pelagic foraging/resting. The use of sonar, air guns, and explosives, and activities that produce vessel, aircraft, and weapons noise have a pathway to impact the physical and biological features of the reproductive and migratory habitats from the mean high-water line to 20 m depth by producing noise from military activities. The impacts on these habitats would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features. Activities that use sonars, air guns, and explosives, and activities that produce vessel noise, aircraft noise, and weapons noise are typically transient, and most sonar sources are outside of sea turtle hearing range which is most sensitive from 100–400 Hz and limited over 1 kHz. Pile driving activities do not overlap with proposed reproductive and migratory critical habitat. For reproductive habitat, activities would not obstruct nearshore waters adjacent to nesting beaches in Florida and Puerto Rico, which are proposed as critical habitat by USFWS, for transit, mating, or internesting. For migratory habitat, activities would not restrict transit between benthic foraging/resting and reproductive areas. The physical and biological features of benthic foraging/resting habitat from the mean high-water line to 20 m depth are underwater refugia and food resources of sufficient condition, distribution, diversity, abundance, and density to support survival, development, growth, and/or reproduction. The physical and biological features of benthic foraging/resting habitat would not be impacted by the sound from the use of sonars, air guns, pile driving, and explosives, and activities that produce vessel, aircraft, and weapons noise. The physical and biological features of surface-pelagic foraging/resting habitat extend from waters greater than 10 m depth to the outer boundary of the U.S. Exclusive Economic Zone and includes convergence zones, frontal zones, surface-water downwelling areas, the margins of major boundary currents, other areas that result in concentrated components of *Sargassum*-dominated drift communities, as well as the currents that carry turtles to *Sargassum*-dominated drift communities. *Sargassum*-dominated drift communities provide food, refugia, and offshore transport provides food. Sargassum drift communities in waters >10 m depth provide food, refugia, and offshore transport to support the survival and growth of post-hatchlings and surface-pelagic juveniles. *Sargassum* habitat would not be impacted by the sound from the use of sonars, air guns, pile driving, and explosives, and activities that produce vessel, aircraft, and weapons noise due to procedural mitigation of floating vegetation.

Results from the Navy Acoustics Effects Model (Table 3.3-1) shows that green sea turtles in the Study Area may exhibit behavioral reactions, TTS, and AINJ from sonar, air guns, and explosives over the course of a year. The largest contributor of impacts from sonar (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Southeast during winter, the Mid-Atlantic during fall, the Northeast during fall, and the Gulf of Mexico during fall and summer. The largest contributor of impacts from air gun use (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Mid-Atlantic during summer, and the Southeast during spring. The largest contributor of impacts from explosives (in order of level of impacts) are due to Bombing Exercise Air-to-Surface training activities in the Mid-Atlantic during fall, the Southeast during winter, and the Gulf of Mexico during fall; and Surface Warfare testing activities in the Southeast during spring, and the Mid-Atlantic during fall. Pile driving exposure modeling estimates no impacts to green sea turtles.

Estimated behavioral and TTS impacts from sonar, air guns, and explosives are expected to be short term and would not result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success, or species recruitment, for an individual and would not result in population-level impacts. Estimated AINJ from sonar and explosives may have deleterious effects on the fitness of an individual turtle, and potential population level effects may be influenced by the life stage of affected individuals. Due to the slow growth rate, time to mature, and long lifespan for turtles, reoccurring high levels of auditory injuries may have more impactful population level effects if it occurs to mature female turtles rather than hatchlings, which naturally have lower rates of survival mainly due to predation. Low levels of estimated injuries and mortalities from explosives are not expected to impact the fitness of enough individuals to cause population level effects.

Based on the analysis presented above, the use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities <u>may affect</u> the North Atlantic Ocean DPS of green sea turtles.

The use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities are <u>not applicable</u> to designated critical habitat for the North Atlantic Ocean DPS of green sea turtles.

The use of sonar, air guns, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities <u>may affect</u> proposed critical habitat for the North Atlantic Ocean DPS of green sea turtles. The use of pile driving during military readiness activities is <u>not applicable</u> to proposed critical habitat for the North Atlantic Ocean DPS of green sea turtles.

Table 3.3-1: Estimated effects to green sea turtles over a maximum year of proposed activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	-	1	0	-	-
Explosive	Navy Training	2,442	886	21	2	1
Explosive	Navy Testing	910	760	12	1	0
Explosive	USCG Training	1	1	0	-	-
Sonar	Navy Testing	33	6,423	33	-	-
Maximum Annual Total		**3,386**	**8,071**	**66**	**3**	**1**

Season	Percent of Total Impacts: Northeast	Mid-Atlantic	Southeast
Winter	0%	0%	25%
Spring	0%	7%	22%
Summer	1%	8%	3%
Fall	1%	18%	15%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	58%
Bombing Exercise Air-to-Surface	Navy Training	21%
Surface Warfare Testing	Navy Testing	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
Table Created: 03 Jun 2024 4:39:38 PM

3.3.2 Hawksbill Sea Turtle

Hawksbills are in general considered extralimital north of Florida, and have regularly been observed along the coasts of Texas and Florida, and to a lesser extent along other Gulf of Mexico and Atlantic states (Avens et al., 2021; Gorham et al., 2014; Rester & Condrey, 1996; Witzell, 1983). In Florida, hawksbills regularly occur in the nearshore waters off the southeastern coast, in the Florida Keys. Juvenile hawksbills have been observed along the jetties near Port Aransas, Texas and within the coral reefs at the Flower Garden Banks National Marine Sanctuary in the western Gulf of Mexico (Avens et al., 2021).

Hawksbill turtles may be exposed to sonar, air guns, pile driving, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the impacts from vessel noise, aircraft noise, and weapons noise on hawksbill turtles relies on the information under the respective acoustic substressor in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives). While the abundance of hawksbill turtles is not known, an estimated 22,004 to 29,035 turtles nest each year in the Atlantic, Indian, and Pacific oceans. Of these, 3,626 to 6,108 occur in the Atlantic Ocean (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013). Hawksbill turtle critical habitat in Puerto Rico does not overlap with the use of acoustic and explosive stressors. Hawksbill turtles are not frequently observed within the Study Area and are considered in general extralimital north of Florida, but are occasionally sighted off the Florida Panhandle, Mississippi and Texas. Due to lack of hawksbill sightings in the survey data, impacts for hawksbill turtles were not estimated with the Navy Acoustics Effects Model.

Since hawksbill turtles are generally considered extralimital north of Florida, any impacts would likely occur in the Gulf of Mexico or Key West Range Complexes, or the southern portion of the Jacksonville Range Complex. Any potential behavioral and TTS impacts from sonar, air guns, pile driving, and explosives are expected to be short term and would not result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success, or species recruitment, for an individual and would not result in population-level impacts. Any potential AINJ from sonar, air guns, pile driving, and explosives may have deleterious effects on the fitness of an individual turtle, and potential population level effects may be influenced by the life stage of affected individuals. Due to the slow growth rate, time to mature, and long lifespan for turtles, reoccurring high levels of auditory injuries may have more impactful population level effects if it occurs to mature female turtles rather than hatchlings, which naturally have lower rates of survival mainly due to predation. Any potential injuries and mortalities from explosives are not expected to impact the fitness of enough individuals to cause population level effects.

Based on the analysis presented above, the use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities may affect hawksbill sea turtles.

The use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities are not applicable to designated critical habitat for hawksbill sea turtles.

3.3.3 Kemp's Ridley Sea Turtle

Kemp's ridleys are distributed along the Gulf of Mexico and U.S. Atlantic seaboard, from Florida to New England. Adult Kemp's ridleys primarily occupy nearshore coastal (neritic) habitats in the Gulf of Mexico that include muddy or sandy bottoms. Males and females can loop along the U.S. continental shelf large marine ecosystem in the spring, and back down the southeast U.S. continental shelf in the fall. From nesting beaches in the Gulf of Mexico, the migratory corridor traverses neritic areas of the Mexico and U.S. Gulf coasts from late May through August with a peak in June (Shaver et al., 2016). Juveniles in the Gulf of Mexico make seasonal east, west, and south migrations and move further offshore during the winter when water temperature drops.

Kemp's ridley turtles may be exposed to sonar, air guns, pile driving, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the impacts from vessel noise, aircraft noise, and weapons noise on Kemp's ridley turtles relies on the information under the respective acoustic substressor in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives). Gallaway et al. (2016) estimated the Kemp's ridley population includes about a quarter-million adults and sub-adults.

Results from the Navy Acoustics Effects Model (Table 3.3-2) shows that Kemp's ridley sea turtles in the Study Area may experience behavioral reactions, TTS, and AINJ from sonar, air guns, and explosives over the course of a year. The largest contributor of impacts from sonar (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Gulf of Mexico during winter, the Southeast during winter, the Mid-Atlantic during fall, and the Northeast during fall. The largest contributor of impacts from air gun use (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Southeast during spring, and the Mid-Atlantic during summer. The largest contributors of impacts from explosives (in order of level of impacts) are due to Line Charge testing activities in the Gulf of Mexico during winter; and Mine Countermeasure and Neutralization testing activities in the Gulf of Mexico during winter, and the Mid-Atlantic during Spring. Pile driving exposure modeling estimates no impacts to Kemp's ridley sea turtles.

Estimated behavioral and TTS impacts from sonar, air guns, and explosives are expected to be short term and would not result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success, or species recruitment, for an individual and would not result in population-level impacts. Estimated auditory injuries from sonar and explosives may have deleterious effects on the fitness of an individual turtle, and potential population level effects may be influenced by the life stage of affected individuals. Due to the slow growth rate, time to mature, and long lifespan for turtles, reoccurring high levels of auditory injuries may have more impactful population level effects if it occurs to mature female turtles rather than hatchlings, which naturally have lower rates of survival mainly due to predation.

Based on the analysis presented above, the use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities may affect Kemp's ridley sea turtles.

Table 3.3-2: Estimated effects to Kemp's ridley sea turtles over a maximum year of proposed activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	-	1	-	-	-
Explosive	Navy Training	789	410	7	1	-
Explosive	Navy Testing	5,785	2,448	45	1	0
Explosive	USCG Training	10	-	-	-	-
Sonar	Navy Testing	13	4,996	10	-	-
Maximum Annual Total		**6,597**	**7,855**	**62**	**2**	**0**

Season	Percent of Total Impacts: Mid-Atlantic	Southeast	Gulf of Mexico
Winter	0%	4%	40%
Spring	0%	4%	25%
Summer	0%	1%	13%
Fall	1%	4%	9%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Line Charge Testing	Navy Testing	35%
Acoustic and Oceanographic Research (ONR)	Navy Testing	35%
Mine Countermeasure and Neutralization Testing (NAVSEA)	Navy Testing	19%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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3.3.4 LOGGERHEAD SEA TURTLE

Loggerhead turtles occur in U.S. waters in habitats ranging from coastal estuaries to waters far beyond the continental shelf. Within neritic habitats, juveniles commonly forage in nearshore coastal waters, coastal inlets, sounds, bays, estuaries, lagoons, and along the continental shelf during spring, summer, and fall months from Cape Cod, south to Florida, and into the Gulf of Mexico; during winter, they are found off the coast from North Carolina to Florida. Subadult and adult loggerhead turtles tend to inhabit deeper offshore feeding areas along the western Atlantic coast, from mid-Florida to New Jersey. As late juveniles and adults, loggerhead sea turtles most often occur on the continental shelf and along the shelf break of the U.S. Atlantic and Gulf coasts, as well as in coastal estuaries and bays.

Loggerhead turtles from the Northwest Atlantic Ocean DPS may be exposed to sonar, air guns, pile driving, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the impacts from vessel noise, aircraft noise, and weapons noise on loggerhead turtles relies on the information under the respective acoustic substressor in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives). The number of adult females in the Northwest Atlantic Ocean DPS of loggerhead turtles is estimated to be 30,000 individuals (Turtle Expert Working Group, 2009).

Designated critical habitat for the loggerhead turtle is comprised of five different habitat types, which are nearshore reproductive, overwintering, breeding, constricted migratory, and *Sargassum* habitat. The use of sonars, air guns, and explosives, and activities that produce vessel, aircraft, and weapons noise have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing “noise pollution” from military activities (79 *Federal Register* 132). The impacts on this habitat would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features as activities would not prevent a turtle from migrating since they are not continuous, and most sources are outside of sea turtle hearing range which is most sensitive from 100–400 Hz and limited over 1 kHz. Pile driving activities do not overlap with constricted migratory critical habitat. The use of sonars, air guns, pile driving, and explosives, and activities that produce vessel, aircraft, and weapons noise would not impact the physical and biological features identified for the nearshore reproductive, overwintering, breeding and *Sargassum* habitats. Nearshore reproductive habitat is located adjacent to high density nesting beaches and surrounding beaches from the mean high-water line to 1.6 km (0.86 NM) offshore, and the use of sonars, air guns, pile driving, and explosives, and activities that produce vessel, aircraft, and weapons noise would not impact habitat conditions of the physical and biological features that allow for hatchling egress to open water or nesting female transit. Overwintering habitat includes physical and biological features of water temperature and depth, which would not be affected by the use of sonars, air guns, pile driving, and explosives, and activities that produce vessel, aircraft, and weapons noise. The physical and biological features of loggerhead breeding habitat are high densities of reproductive male and female loggerheads. Activities that use sonars, air guns, pile driving, and explosives, and activities that produce vessel, aircraft, and weapons noise are typically transient, and therefore, are not expected to impact the physical and biological features of breeding habitat by affecting high densities of reproductive male and female loggerheads. *Sargassum* concentrations and prey abundance of *Sargassum* habitat would not be impacted by the sound from the use of sonars, air guns, pile driving, and explosives, and activities that produce vessel, aircraft, and weapons noise due to procedural mitigation of floating vegetation.

Results from the Navy Acoustics Effects Model (Table 3.3-3) shows that loggerhead sea turtles in the Study Area may experience behavioral reactions, TTS, and AINJ from sonar, air guns, and explosives over the course of a year. The largest contributor of impacts from sonar (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Southeast, Gulf of Mexico, Mid-Atlantic, and Northeast, all during winter. The largest contributor of impacts from air gun use (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Southeast during winter, the Gulf of Mexico during spring, the Mid-Atlantic during fall, and equally in the Northeast during fall, spring, and summer. The largest contributors of impacts from explosives (in order of level of impacts) are due to Line Charge testing activities in the Gulf of Mexico during winter, and Bombing Exercise Air-to-Surface training activities in the Southeast during winter, the Mid-Atlantic during fall, and the Gulf of Mexico during winter. Pile driving exposure modeling estimates no impacts to loggerhead sea turtles. Results in Table 3.3-3 also show impacts that would occur in designated critical habitat. The largest contributor of impacts from sonar that would occur in critical habitat (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Gulf of Mexico, Southeast, and Mid-Atlantic, all during winter. The largest contributor of impacts from air gun use (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Gulf of Mexico during spring, Mid-Atlantic during fall, and the Southeast during spring. The largest contributor of impacts from explosives that would occur in critical habitat (in order of level of impacts) are due to Bombing Exercise Air-to-Surface training activities in the Southeast during winter, the Mid-Atlantic during spring, and the Gulf of Mexico during winter.

Estimated behavioral and TTS impacts from sonar, air guns, and explosives are expected to be short term and would not result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success, or species recruitment, for an individual and would not result in population-level impacts. Estimated auditory injuries from sonar and explosives may have deleterious effects on the fitness of an individual turtle, and potential population level effects may be influenced by the life stage of affected individuals. Due to the slow growth rate, time to mature, and long lifespan for turtles, reoccurring high levels of auditory injuries may have more impactful population level effects if it occurs to mature female turtles rather than hatchlings, which naturally have lower rates of survival mainly due to predation. Low levels of estimated non-auditory injuries and mortalities from explosives are not expected to impact the fitness of enough individuals to cause population level effects.

Based on the analysis presented above, the use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities may affect the Northwest Atlantic Ocean DPS of loggerhead sea turtles.

The use of sonar, air guns, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities may affect designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtles. The use of pile driving during military readiness activities is not applicable to designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtles.

Table 3.3-3: Estimated effects to loggerhead sea turtles over a maximum year of proposed activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	-	2	0	-	-
Explosive	Navy Training	11,404	3,330	55	7	2
Explosive	Navy Testing	14,265	7,322	171	2	1
Explosive	USCG Training	3	1	1	-	-
Sonar	Navy Training	0	1	-	-	-
Sonar	Navy Testing	83	34,569	178	-	-
Maximum Annual Total		**25,755**	**45,225**	**405**	**9**	**3**

Season	Percent of Total Impacts: Mid-Atlantic	Southeast	Gulf of Mexico
Winter	3%	24%	13%
Spring	3%	20%	8%
Summer	1%	4%	4%
Fall	4%	10%	4%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	50%
Line Charge Testing	Navy Testing	17%
Bombing Exercise Air-to-Surface	Navy Training	14%

Area Type	Area Name (Active Months)	BEH	TTS	AINJ	INJ	MORT
Critical Habitat	Northwest Atlantic Ocean (All)	8,047	20,871	141	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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3.3.5 Leatherback Sea Turtle

The leatherback turtle is distributed worldwide in tropical and temperate waters (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020). Leatherbacks are known to forage in nearshore environments off Virginia and North Carolina during the summer, and have been observed annually in the Chesapeake Bay, mainly from May through October (Barco & Lockhart, 2015). In the Gulf of Mexico, main foraging sites include the northeast corner from Louisiana to Florida, the coastal shelf of southwest Florida, and eastern side of Campeche Bay (Aleksa et al., 2018).

Leatherback turtles may be exposed to sonar, air guns, pile driving, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the impacts from vessel noise, aircraft noise, and weapons noise on leatherback turtles relies on the information under the respective acoustic substressor in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives). The North Atlantic population is estimated to range between 34,000 and 94,000 adult leatherbacks (Turtle Expert Working Group, 2007). Critical habitat for the leatherback turtle is designated for waters next to Sandy Point, St. Croix, U.S. Virgin Islands and does not overlap with the use of acoustic and explosive stressors.

Results from the Navy Acoustics Effects Model (Table 3.3-4) show that leatherback sea turtles in the Study Area may experience behavioral reactions, TTS, and AINJ from sonar and explosives over the course of a year. The largest contributor of impacts from sonar (in order of level of impacts) are due to Acoustic and Oceanographic testing activities in the Southeast and Northeast during fall, the Mid-Atlantic during summer, and the Gulf of Mexico during spring. No impacts to leatherback sea turtles from air gun use were modeled to occur. The largest contributor of impacts from explosives (in order of level of impacts) are due to Small Ship Shock Trial testing activities in the Mid-Atlantic during summer; Bombing Exercise Air-to-Surface training activities in the Southeast and Mid-Atlantic during fall, and the Gulf of Mexico during winter; and Mine Countermeasure and Neutralization testing activities in the Gulf of Mexico and Mid-Atlantic during summer. Pile driving exposure modeling estimates no impacts to leatherback sea turtles.

Estimated behavioral and TTS impacts from sonar and explosives are expected to be short term and would not result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success, or species recruitment, for an individual and would not result in population-level impacts. Estimated auditory injuries from sonar and explosives may have deleterious effects on the fitness of an individual turtle, and potential population level effects may be influenced by the life stage of affected individuals. Due to the slow growth rate, time to mature, and long lifespan for turtles, reoccurring high levels of auditory injuries may have more impactful population level effects if it occurs to mature turtles rather than hatchlings, which naturally have lower rates of survival mainly due to predation. Low levels of estimated non-auditory injuries and mortalities from explosives are not expected to impact the fitness of enough individuals to cause population level effects.

Based on the analysis presented above, the use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities <u>may affect</u> leatherback sea turtles.

The use of sonar, air guns, pile driving, and explosives, and production of vessel, aircraft, and weapons noise during military readiness activities are <u>not applicable</u> to designated critical habitat for leatherback sea turtles.

Table 3.3-4: Estimated effects to leatherback sea turtles over a maximum year of proposed activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Air gun	Navy Testing	-	0	-	-	-
Explosive	Navy Training	348	191	7	1	-
Explosive	Navy Testing	386	3,363	63	3	1
Explosive	USCG Training	0	0	0	-	-
Sonar	Navy Training	0	1	-	-	-
Sonar	Navy Testing	11	1,943	9	-	-
Maximum Annual Total		**745**	**5,498**	**79**	**4**	**1**

Season	Percent of Total Impacts			
	Northeast	Mid-Atlantic	Southeast	Gulf of Mexico
Winter	1%	1%	7%	1%
Spring	1%	1%	10%	1%
Summer	3%	15%	7%	4%
Fall	6%	12%	28%	1%

Activities with 5 Percent or More of Total Impacts	Category	Percent of Total Impacts
Acoustic and Oceanographic Research (ONR)	Navy Testing	48%
Small Ship Shock Trial	Navy Testing	24%
Bombing Exercise Air-to-Surface	Navy Training	8%
Mine Countermeasure and Neutralization Testing (NAVSEA)	Navy Testing	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, and MORT annual estimated impacts: Zero (0) impacts indicate total less than 0.5 and a dash (-) is a true zero.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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3.3.6 American Crocodile

American crocodiles occur in South Florida, which is the northern extent of their range. They live in brackish or saltwater areas, and can be found in ponds, coves, creeks in mangrove swamps, and are occasionally encountered inland in freshwater areas of the southeast Florida coast. Designated critical habitat for the American crocodile is Florida Bay and its associated brackish marshes, swamps, creeks, and canals.

American crocodiles may be exposed to sonar, vessel noise, aircraft noise, and explosives associated with military readiness activities throughout the year. Analysis of the impacts from vessel and aircraft noise on American crocodiles relies on the information under the respective acoustic substressor in Section 3.1 (Impacts Due to Each Acoustic Substressor and Explosives). Vessel noise and aircraft noise overlap with but would not impact American crocodile critical habitat. Sonar and explosives would not be used in American crocodile critical habitat. American crocodiles and their critical habitat would not overlap with activities that use air guns, pile driving, or produce weapons noise. Therefore, impacts from these stressors are not analyzed further for American crocodiles.

The use of sonar would overlap with American crocodile habitat in Tampa, Florida for Civilian Port Defense training activities and at Truman Annex in the Key West Range Complex Inshore areas for Semi-Stationary Equipment Testing. However, sonar used during these activities operate at frequencies higher than the hearing range for American crocodiles (i.e., >2 kHz) and therefore a pathway for sonar to impact American crocodiles does not exist.

The only activities involving explosions that would occur in American crocodile habitat are Mine Neutralization Explosive Ordnance Disposal training at Demolition Key and Semi-Stationary Equipment Testing at Truman Annex in the Key West Range Complex Inshore areas. Impacts, if any, to American crocodiles would be low due to the low probability of occurrence and nature of the confined and restricted detonation locations. Other training and testing activities that involve underwater detonations and explosive munitions would typically be conducted on range complexes and testing ranges that are more than 12 NM from shore and do not overlap with American crocodile habitat.

Exposures, if any, would be insignificant and effects would be so minor, they could not be meaningfully evaluated and would not rise to the level of measurable impacts. Because impacts on individual crocodilians, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any crocodilian populations.

Based on the analysis presented above, the use of explosives, and production of vessel and aircraft noise during military readiness activities may affect American crocodiles. The use of air guns, pile driving, and production of weapons noise during military readiness activities are not applicable to American crocodiles. The use of sonar during military readiness activities would have no effect on American crocodiles.

The use of sonar, air guns, pile driving, and explosives, and production of weapons noise during military readiness activities are not applicable to designated critical habitat for American crocodiles. The production of vessel noise and aircraft noise during military readiness activities would have no effect on designated critical habitat for American crocodiles.

3.3.7 Impact Summary Tables

The tables in in this section show impacts to all species for the following:

- Maximum annual and seven-year total impacts due to sonar use during Navy training activities, during U.S. Coast Guard training activities only, and during testing activities. The maximum annual impacts per species are the same values presented in each species impact assessment above. See Table 3.3-5 through Table 3.3-10.
- Maximum annual and seven-year total impacts due to air gun use during testing activities. (Note: No air gun use is proposed during training activities.) See Table 3.3-11 and Table 3.3-12.
- Maximum annual and seven-year total impacts due to explosives during Navy training activities, during U.S. Coast Guard training activities only, and during testing activities (including Ship Shock Trials). Consistent with previous analyses, the impacts due to a maximum year of Ship Shock Trials (two events) are also shown separately. See Table 3.3-13 through Table 3.3-18.
- Maximum annual and seven-year total impacts due to Small Ship Shock Trials, part of Navy testing. Note that these results are included in the overall explosive results but broken out in these tables for clarity. See Table 3.3-19.

The seven-year impacts are created by summing seven years of impacts considering any variation in the annual levels of activities and including any fractional values. The final summed seven-year value is then rounded following standard rounding rules. That is, the seven-year impacts are not the result of summing the rounded annual results. If a seven-year sum was larger than multiplying the rounded maximum annual value by seven, the Navy increased the annual maximum value above the value predicted by the model results. This was done by dividing the seven-year sum of impacts by seven then rounding up, rather than following standard rounding rules, to estimate the annual impacts. For example, this could happen if maximum annual results are 1.34 (rounds to 1 annually) and seven-year results are 8.60 (rounds to 9), where 9 over seven years is greater than seven times 1. In this instance, the maximum annual impacts would be adjusted from one to two based on rounding up the quotient of dividing the seven-year impacts by seven. In no cases does implementing this approach result in reducing the impacts predicted by the Navy's Acoustic Effects Model.

3.3.7.1 Sonar Impact Summary Tables

Table 3.3-5: Estimated Effects to Sea Turtles from Sonar and Other Active Transducers Over One Year of Maximum Navy Training

Species	BEH	TTS	AINJ
Green sea turtle	-	-	-
Kemp's ridley sea turtle	-	-	-
Leatherback sea turtle	0	1	-
Loggerhead sea turtle	0	1	-

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Table 3.3-6: Estimated Effects to Sea Turtles from Sonar and Other Active Transducers Over Seven Years of Navy Training

Species	BEH	TTS	AINJ
Green sea turtle	-	-	-
Kemp's ridley sea turtle	-	-	-
Leatherback sea turtle	0	4	-
Loggerhead sea turtle	0	2	-

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Table 3.3-7: Estimated Effects to Sea Turtles from Sonar and Other Active Transducers Over One Year of Maximum Navy Testing

Species	BEH	TTS	AINJ
Green sea turtle	33	6,423	33
Kemp's ridley sea turtle	13	4,996	10
Leatherback sea turtle	11	1,943	9
Loggerhead sea turtle	83	34,569	178

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Table 3.3-8: Estimated Effects to Sea Turtles from Sonar and Other Active Transducers Over Seven Years of Navy Testing

Species	BEH	TTS	AINJ
Green sea turtle	204	42,488	228
Kemp's ridley sea turtle	81	32,247	66
Leatherback sea turtle	66	12,811	57
Loggerhead sea turtle	516	232,109	1,226

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Table 3.3-9: Estimated Effects to Sea Turtles from Sonar and Other Active Transducers Over One Year of Maximum U.S. Coast Guard Training

Species	BEH	TTS	AINJ
Green sea turtle	-	-	-
Kemp's ridley sea turtle	-	-	-
Leatherback sea turtle	-	-	-
Loggerhead sea turtle	-	-	-

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Table 3.3-10: Estimated Effects to Sea Turtles from Sonar and Other Active Transducers Over Seven Years of U.S. Coast Guard Training

Species	BEH	TTS	AINJ
Green sea turtle	-	-	-
Kemp's ridley sea turtle	-	-	-
Leatherback sea turtle	-	-	-
Loggerhead sea turtle	-	-	-

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3.3.7.2 Air Gun Impact Summary Tables

Table 3.3-11: Estimated Effects to Sea Turtles from Air Guns Over One Year of Maximum Navy Testing

Species	BEH	TTS	AINJ
Green sea turtle	-	1	0
Kemp's ridley sea turtle	-	1	-
Leatherback sea turtle	-	0	-
Loggerhead sea turtle	-	2	0

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Table 3.3-12: Estimated Effects to Sea Turtles from Air Guns Over Seven Years of Navy Testing

Species	BEH	TTS	AINJ
Green sea turtle	-	4	0
Kemp's ridley sea turtle	-	1	-
Leatherback sea turtle	-	0	-
Loggerhead sea turtle	-	10	0

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3.3.7.3 Explosives Impact Summary Tables

Table 3.3-13: Estimated Effects to Sea Turtles from Explosives Over One Year of Maximum Navy Training

Species	BEH	TTS	AINJ	INJ	MORT
Green sea turtle	2,442	886	21	2	1
Kemp's ridley sea turtle	789	410	7	1	-
Leatherback sea turtle	348	191	7	1	-
Loggerhead sea turtle	11,404	3,330	55	7	2

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Table 3.3-14: Estimated Effects to Sea Turtles from Explosives Over Seven Years of Navy Training

Species	BEH	TTS	AINJ	INJ	MORT
Green sea turtle	17,094	6,197	143	14	4
Kemp's ridley sea turtle	5,519	2,870	43	1	-
Leatherback sea turtle	2,431	1,333	44	2	-
Loggerhead sea turtle	79,828	23,308	382	49	8

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Table 3.3-15: Estimated Effects to Sea Turtles from Explosives Over One Year of Maximum Navy Testing

Species	BEH	TTS	AINJ	INJ	MORT
Green sea turtle	910	760	12	1	0
Kemp's ridley sea turtle	5,785	2,448	45	1	0
Leatherback sea turtle	386	3,363	63	3	1
Loggerhead sea turtle	14,265	7,322	171	2	1

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Table 3.3-16: Estimated Effects to Sea Turtles from Explosives Over Seven Years of Navy Testing

Species	BEH	TTS	AINJ	INJ	MORT
Green sea turtle	5,468	2,861	67	2	0
Kemp's ridley sea turtle	40,246	16,737	310	1	0
Leatherback sea turtle	2,511	9,010	173	8	3
Loggerhead sea turtle	94,788	42,405	1,049	11	2

Table Created: 2024-06-03 16:39:47

Table 3.3-17: Estimated Effects to Sea Turtles from Explosives Over One Year of Maximum U.S. Coast Guard Training

Species	BEH	TTS	AINJ	INJ	MORT
Green sea turtle	1	1	0	-	-
Kemp's ridley sea turtle	10	-	-	-	-
Leatherback sea turtle	0	0	0	-	-
Loggerhead sea turtle	3	1	1	-	-

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Table 3.3-18: Estimated Effects to Sea Turtles from Explosives Over Seven Years of U.S. Coast Guard Training

Species	BEH	TTS	AINJ	INJ	MORT
Green sea turtle	3	1	0	-	-
Kemp's ridley sea turtle	69	-	-	-	-
Leatherback sea turtle	0	0	0	-	-
Loggerhead sea turtle	16	7	3	-	-

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Table 3.3-19: Estimated Effects to Sea Turtles from Small Ship Shock Trials over a Maximum Year of Navy Testing (2 Events)

Species	TTS	AINJ	INJ	MORT
Green sea turtle	478	1	-	-
Kemp's ridley sea turtle	48	1	-	-
Leatherback sea turtle	3,209	60	3	1
Loggerhead sea turtle	1,538	23	1	1

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3.4 RANGE TO EFFECTS

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the acoustic and explosive criteria in the *Criteria and Thresholds TR*, and the acoustic and explosive propagation calculations from the Navy Acoustic Effects Model described in the *Quantitative Analysis TR*. The ranges to effects are shown for representative sonar systems, air guns, and explosive bins from E1 (0.1–0.25 lb. NEW) to E16 (>7,500–14,500 lb. NEW). Ranges are determined by modeling the distance that noise from a source will need to propagate to reach exposure level thresholds specific to a hearing group that will cause behavioral response, TTS, AINJ, non-auditory injury, and mortality. Ranges to effects were calculated for sea turtle species only and are utilized to help predict impacts from acoustic and explosive sources and assess the benefit of mitigation zones.

Tables present median and standard deviation ranges to effects for each hearing group, source or bin, bathymetric depth intervals of ≤200 m and >200 m to represent areas on an off the continental shelf, exposure duration (sonar), and representative cluster size (air guns and explosives). Ranges to effects consider propagation effects of sources modeled at different locations (i.e., analysis points), seasons, source depths, and radials (i.e., each analysis point considers propagation effects in different x-y directions by modeling 18 radials in azimuthal increments of 20° to obtain 360° coverage around an analysis point). The exception to this is ranges to effects for pile driving, which were calculated outside of the Navy Acoustic Effects Model, do not have variance in ranges, and are not presented as a summary statistic (e.g., median and standard deviation).

Boxplots visually present the distribution, variance, and outlier ranges for a given combination of a source or bin, hearing group, and effect. On the boxplots, outliers are plotted as dots, the lowest and highest non-outlier ranges are the extent of the left and right horizontal lines respectively that extend from the sides of a colored box, and the 25th, 50th (i.e., median), and 75th percentiles are the left edge, center line, and right edge of a colored box respectively.

3.4.1 RANGE TO EFFECTS FOR SONARS AND OTHER TRANSDUCERS

The six representative sonar systems with ranges to effects are not applicable to reptiles since they produce sound at frequencies greater than the upper hearing range of reptiles (i.e., > 2 kHz).

3.4.2 RANGE TO EFFECTS FOR AIR GUNS

Ranges to effects for air guns were determined by modeling the distance that sound would need to propagate to reach exposure level thresholds specific to a hearing group that would cause behavioral response, TTS, and AINJ, as described in the *Criteria and Thresholds TR*. The air gun ranges to effects for TTS and AINJ that are in the tables are based on the metric (i.e., SEL or SPL) that produced longer ranges, and the boxplots present the SEL- and SPL-based ranges for comparison.

Table 3.4-1: Sea Turtle Ranges to Effects for Air Guns

FHG	Depth	Cluster Size	BEH	TTS	AINJ
ST	≤200 m	1	21 m (1 m)	21 m (0 m)	3 m (0 m)
	>200 m	1	21 m (1 m)	21 m (0 m)	3 m (0 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-Median ranges with standard deviation ranges in parentheses
-No ranges for depths <200 m or >200 m unless shown

3.4.3 Range to Effects for Pile Driving

Table 3.4-2 shows the predicted ranges to AINJ, TTS, and behavioral response for sea turtles from exposure to impact and vibratory pile driving. These ranges were estimated based on activity parameters described in the *Acoustic Stressors* section and using the calculations described in the *Quantitative Analysis TR.*

Table 3.4-2: Sea Turtle Ranges to Effects for Pile Driving

Pile Type/Size and Method	AINJ	TTS	BEH
16" Timber/Plastic Piles using Impact Methods	5 m	46 m	5 m
16" Timber/Plastic Piles using Vibratory Methods	1 m	16 m	1 m
24" Steel Sheet Piles using Vibratory Methods	0 m	10 m	1 m

Note: AINJ = auditory injury, TTS = temporary threshold shift

3.4.4 Range to Effects for Explosives

Ranges for explosives were determined by modeling the distance that noise from an explosion would need to propagate to reach exposure level thresholds specific to a hearing group that would cause behavioral response, TTS, AINJ, non-auditory injury, and mortality, as described in the *Criteria and Thresholds TR*.

The tables below provide the ranges for a representative cluster size for each bin. Ranges for behavioral response are only provided if more than one explosive cluster occurs. Single explosions at received sound levels below TTS and AINJ thresholds are most likely to result in a brief alerting or orienting response. Due to the lack of subsequent explosions, a significant behavioral response is not expected for a single explosive cluster. 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 AINJ 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. The explosive ranges to effects for TTS and AINJ that are in the tables are based on the metric (i.e., SEL or SPL) that produced longer ranges.

For non-auditory injury in the tables, the larger of the range to slight lung injury or gastrointestinal tract injury was used as a conservative estimate, and the boxplots present ranges for both metrics for comparison. Animals within water volumes encompassing the estimated range to non-auditory injury 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.

3.4.4.1 Bin E1 (0.1 - 0.25 lb. NEW)

Table 3.4-3: Sea Turtle Ranges to Effects for E1 (0.1 - 0.25 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	99 m (56 m)	44 m (0 m)	22 m (0 m)	3 m (0 m)
		25	175 m (189 m)	135 m (105 m)	44 m (0 m)	NA	NA
		100	662 m (462 m)	235 m (206 m)	44 m (0 m)	NA	NA
	>200 m	1	NA	99 m (38 m)	44 m (0 m)	22 m (0 m)	3 m (0 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

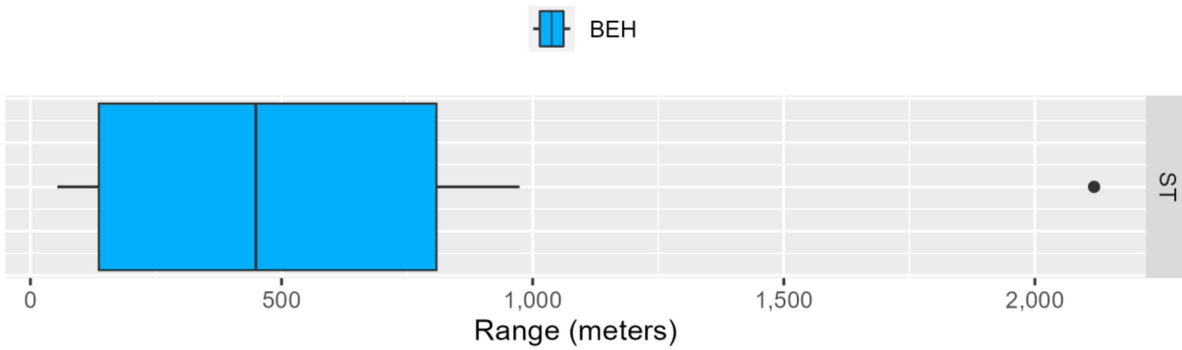

Figure 3.4-1: Sea Turtle Ranges to Behavioral Response for E1 (0.1 - 0.25 lb.)

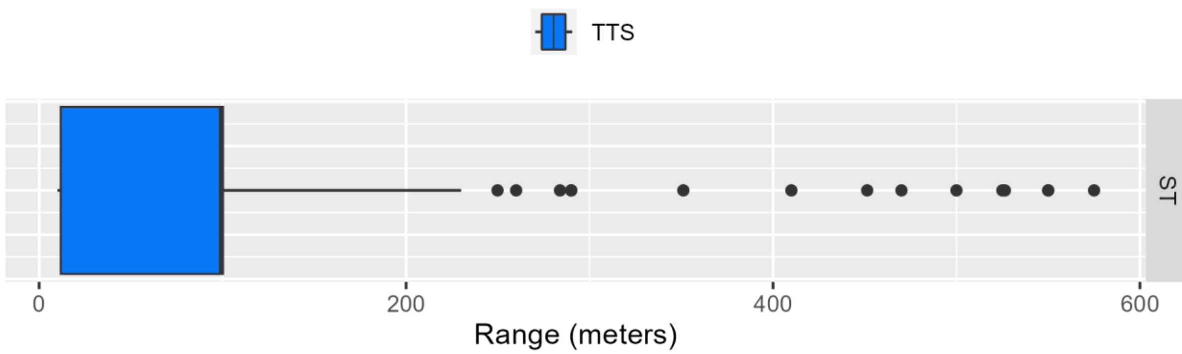

Figure 3.4-2: Sea Turtle Ranges to Temporary Threshold Shift for E1 (0.1 - 0.25 lb.)

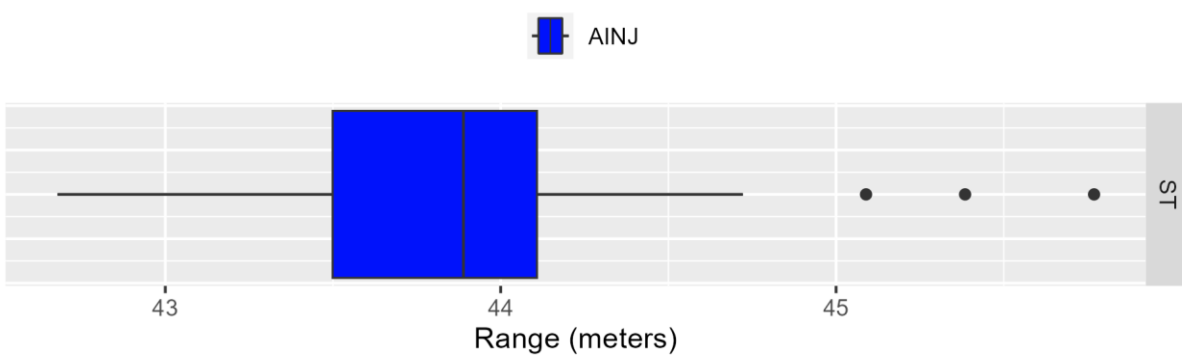

Figure 3.4-3: Sea Turtle Ranges to Auditory Injury for E1 (0.1 - 0.25 lb.)

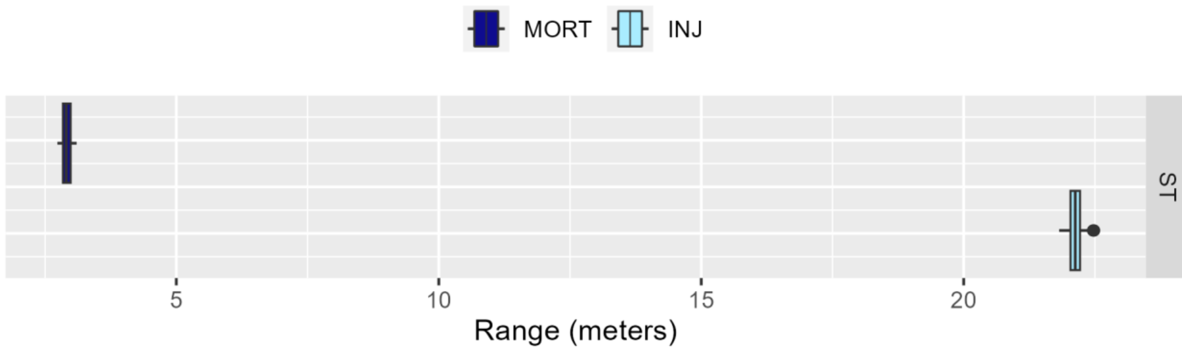

Figure 3.4-4: Sea Turtle Ranges to Mortality and Injury for E1 (0.1 - 0.25 lb.)

3.4.4.2 Bin E2 (>0.25 - 0.5 lb. NEW)

Table 3.4-4: Sea Turtle Ranges to Effects for E2 (>0.25 - 0.5 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	84 m (0 m)	45 m (0 m)	26 m (0 m)	4 m (0 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

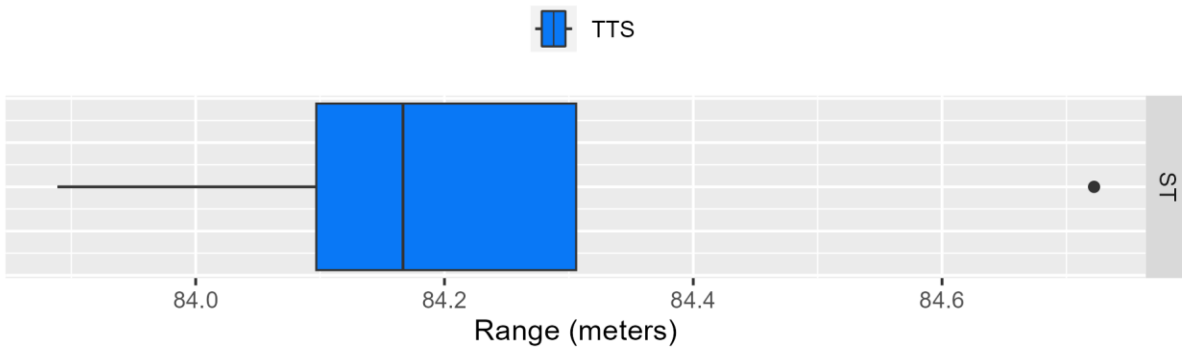

Figure 3.4-5: Sea Turtle Ranges to Temporary Threshold Shift for E2 (>0.25 - 0.5 lb.)

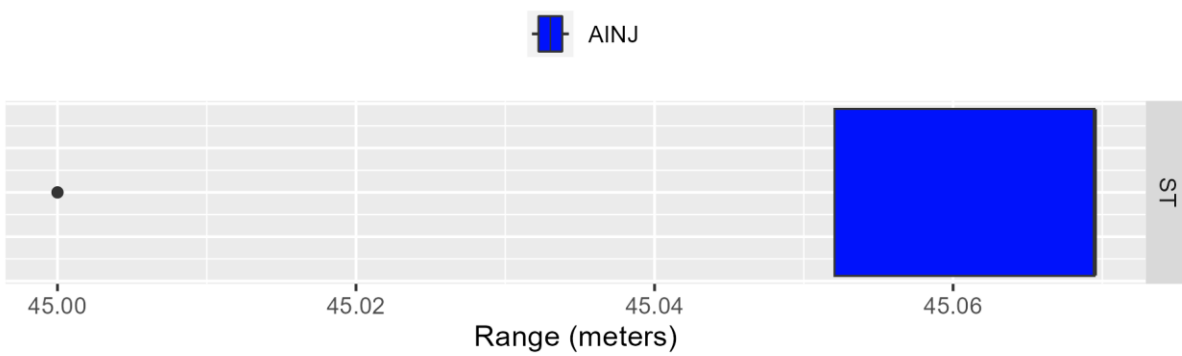

Figure 3.4-6: Sea Turtle Ranges to Auditory Injury for E2 (>0.25 - 0.5 lb.)

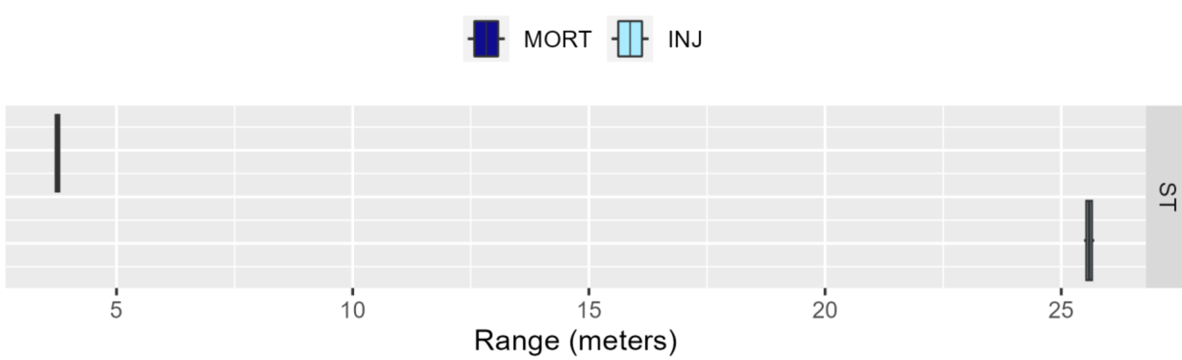

Figure 3.4-7: Sea Turtle Ranges to Mortality and Injury for E2 (>0.25 - 0.5 lb.)

3.4.4.3 Bin E3 (>0.5 - 2.5 lb. NEW)

Table 3.4-5: Sea Turtle Ranges to Effects for E3 (>0.5 - 2.5 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	158 m (10 m)	92 m (4 m)	46 m (1 m)	9 m (1 m)
		10	412 m (364 m)	220 m (206 m)	92 m (4 m)	NA	NA
	>200 m	1	NA	159 m (9 m)	92 m (3 m)	46 m (1 m)	9 m (1 m)
		10	446 m (373 m)	252 m (182 m)	92 m (3 m)	NA	NA

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

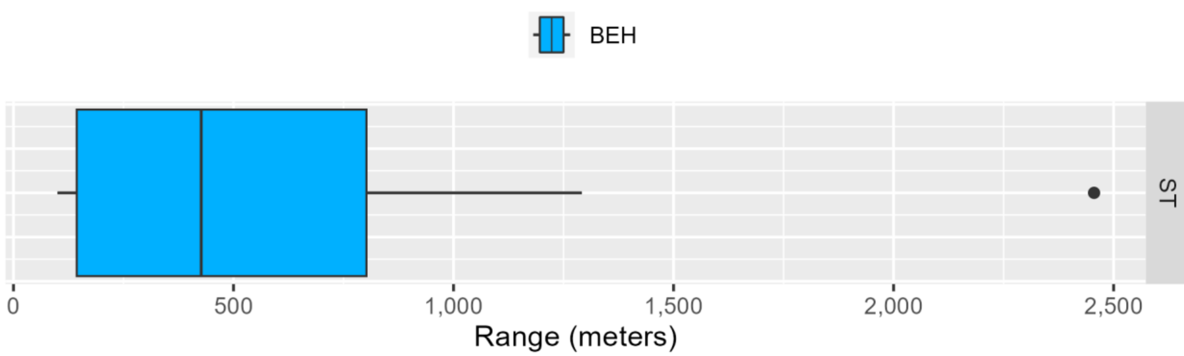

Figure 3.4-8: Sea Turtle Ranges to Behavioral Response for E3 (>0.5 - 2.5 lb.)

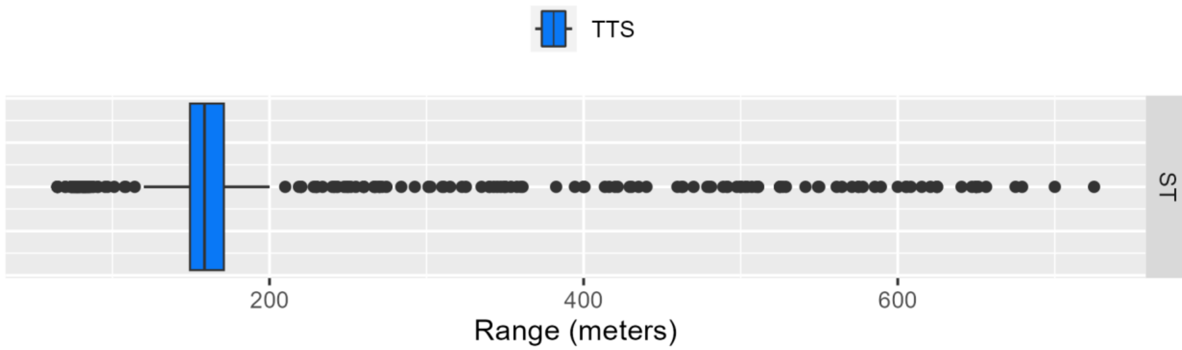

Figure 3.4-9: Sea Turtle Ranges to Temporary Threshold Shift for E3 (>0.5 - 2.5 lb.)

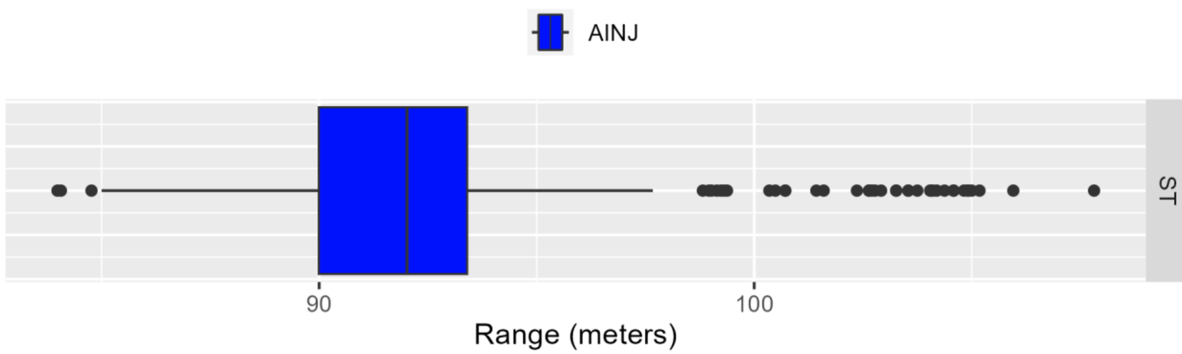

Figure 3.4-10: Sea Turtle Ranges to Auditory Injury for E3 (>0.5 - 2.5 lb.)

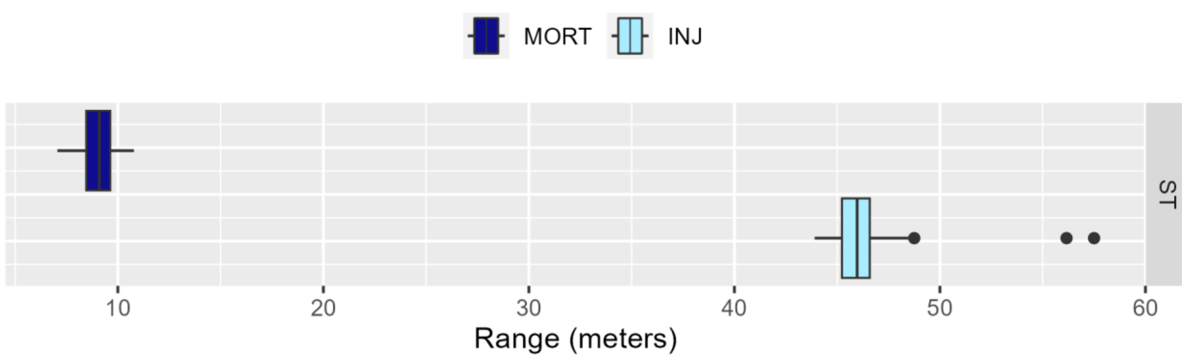

Figure 3.4-11: Sea Turtle Ranges to Mortality and Injury for E3 (>0.5 - 2.5 lb.)

3.4.4.4 Bin E4 (>2.5 - 5 lb. NEW)

Table 3.4-6: Sea Turtle Ranges to Effects for E4 (>2.5 - 5 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	804 m (222 m)	131 m (9 m)	60 m (5 m)	21 m (2 m)
	>200 m	1	NA	430 m (24 m)	126 m (11 m)	58 m (5 m)	21 m (2 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

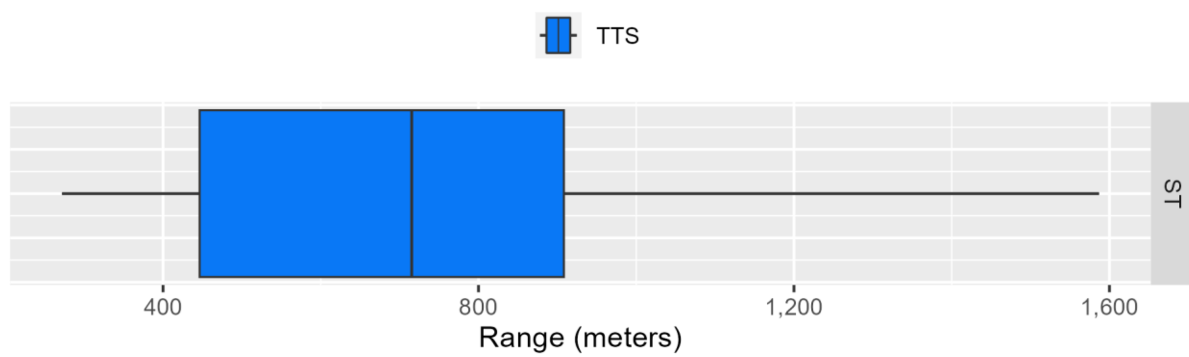

Figure 3.4-12: Sea Turtle Ranges to Temporary Threshold Shift for E4 (>2.5 - 5 lb.)

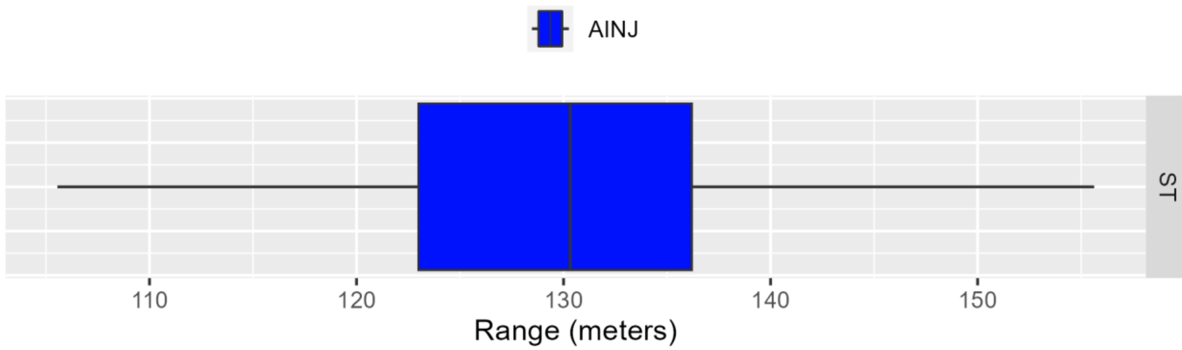

Figure 3.4-13: Sea Turtle Ranges to Auditory Injury for E4 (>2.5 - 5 lb.)

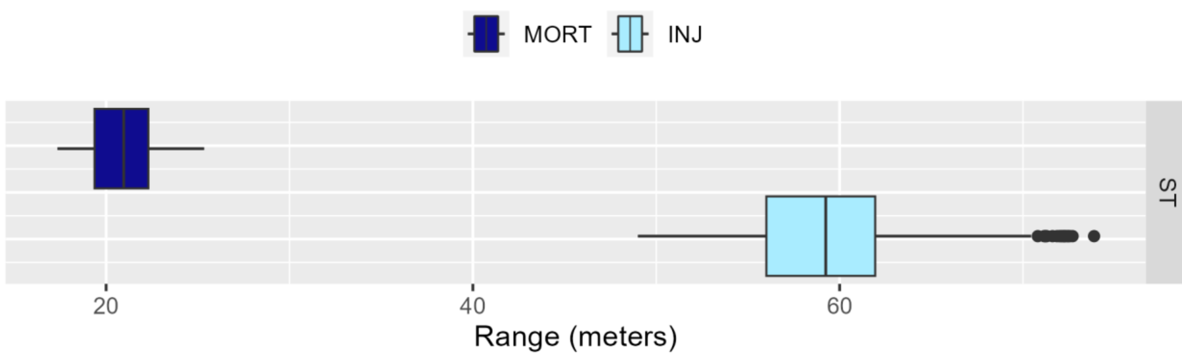

Figure 3.4-14: Sea Turtle Ranges to Mortality and Injury for E4 (>2.5 - 5 lb.)

3.4.4.5 Bin E5 (>5 - 10 lb. NEW)

Table 3.4-7: Sea Turtle Ranges to Effects for E5 (>5 - 10 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	252 m (481 m)	131 m (7 m)	72 m (3 m)	15 m (2 m)
		8	1,889 m (1,811 m)	471 m (369 m)	131 m (7 m)	NA	NA
	>200 m	1	NA	235 m (17 m)	132 m (7 m)	72 m (3 m)	16 m (2 m)
		8	1,750 m (490 m)	1,030 m (343 m)	181 m (35 m)	NA	NA

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

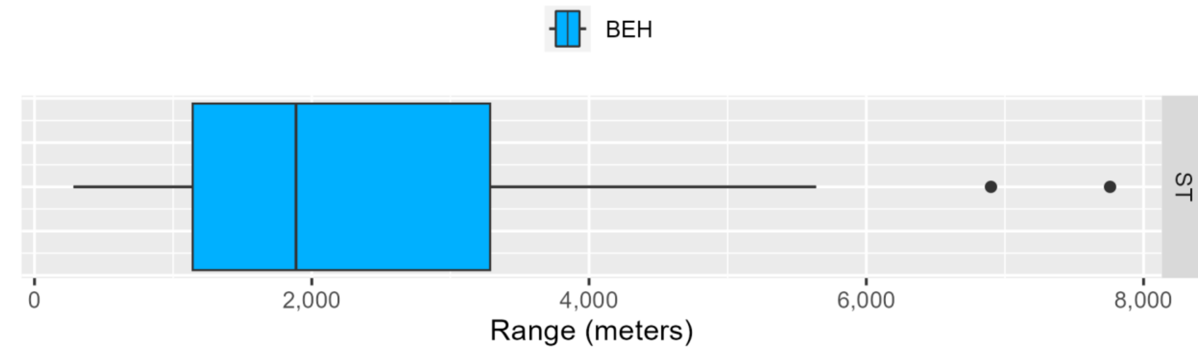

Figure 3.4-15: Sea Turtle Ranges to Behavioral Response for E5 (>5 - 10 lb.)

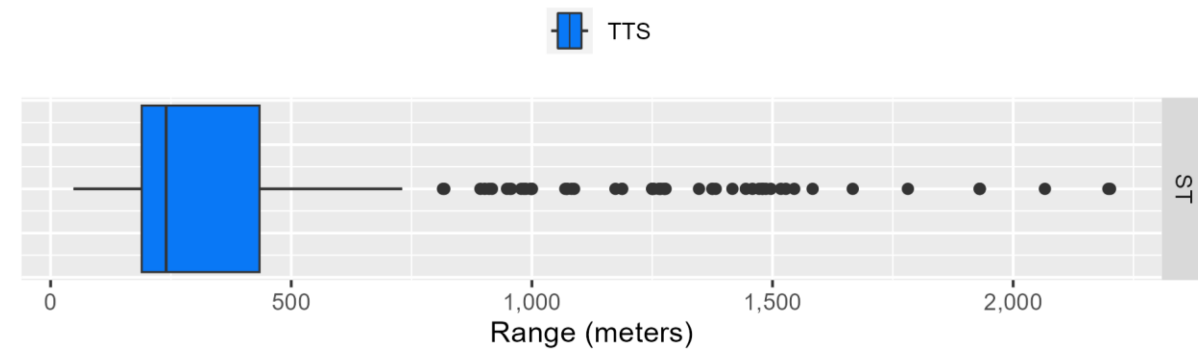

Figure 3.4-16: Sea Turtle Ranges to Temporary Threshold Shift for E5 (>5 - 10 lb.)

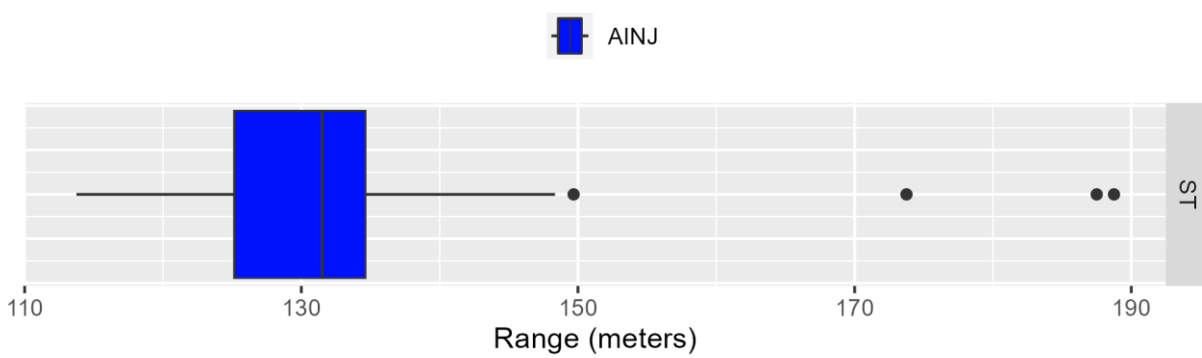

Figure 3.4-17: Sea Turtle Ranges to Auditory Injury for E5 (>5 - 10 lb.)

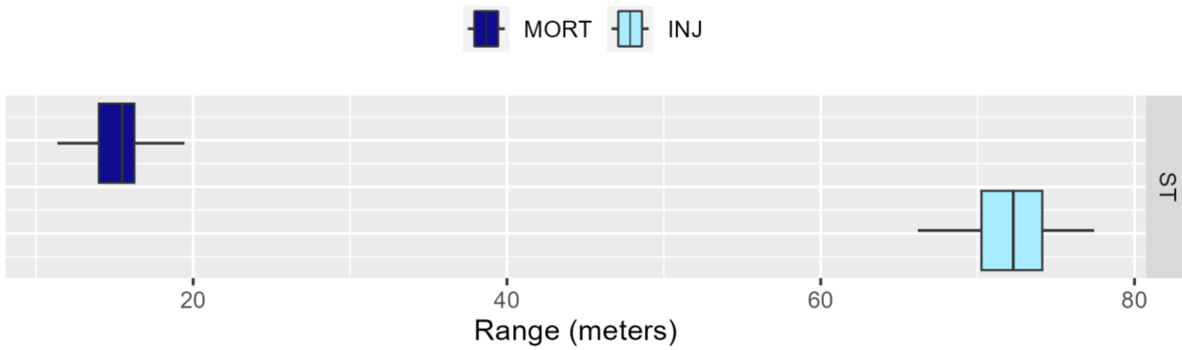

Figure 3.4-18: Sea Turtle Ranges to Mortality and Injury for E5 (>5 - 10 lb.)

3.4.4.6 Bin E6 (>10 - 20 lb. NEW)

Table 3.4-8: Sea Turtle Ranges to Effects for E6 (>10 - 20 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	549 m (945 m)	183 m (16 m)	93 m (4 m)	30 m (5 m)
		4	3,099 m (2,544 m)	891 m (520 m)	183 m (16 m)	NA	NA
	>200 m	1	NA	351 m (304 m)	187 m (12 m)	95 m (4 m)	30 m (4 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

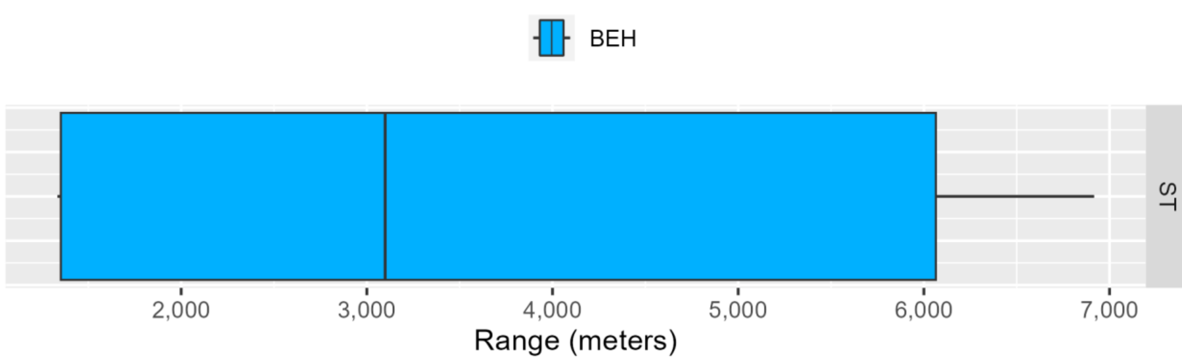

Figure 3.4-19: Sea Turtle Ranges to Behavioral Response for E6 (>10 - 20 lb.)

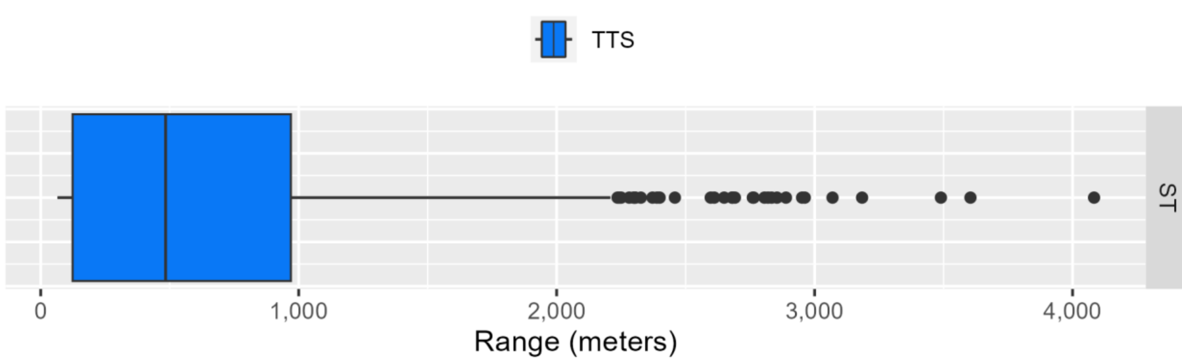

Figure 3.4-20: Sea Turtle Ranges to Temporary Threshold Shift for E6 (>10 - 20 lb.)

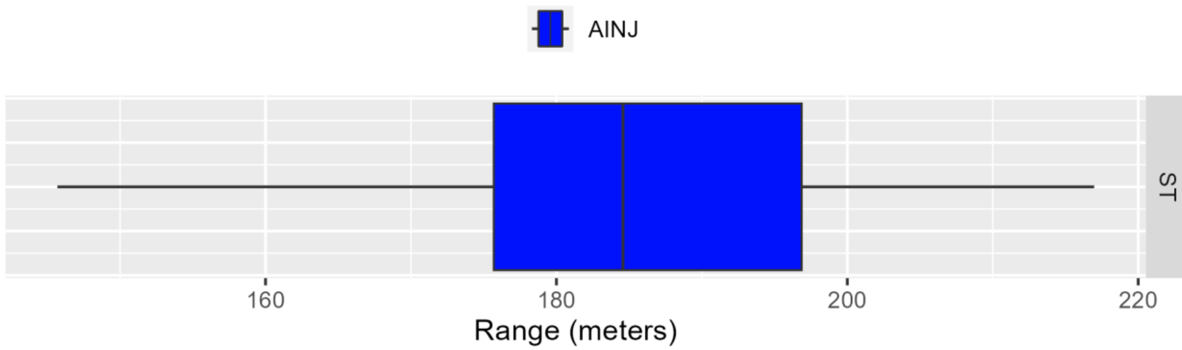

Figure 3.4-21: Sea Turtle Ranges to Auditory Injury for E6 (>10 - 20 lb.)

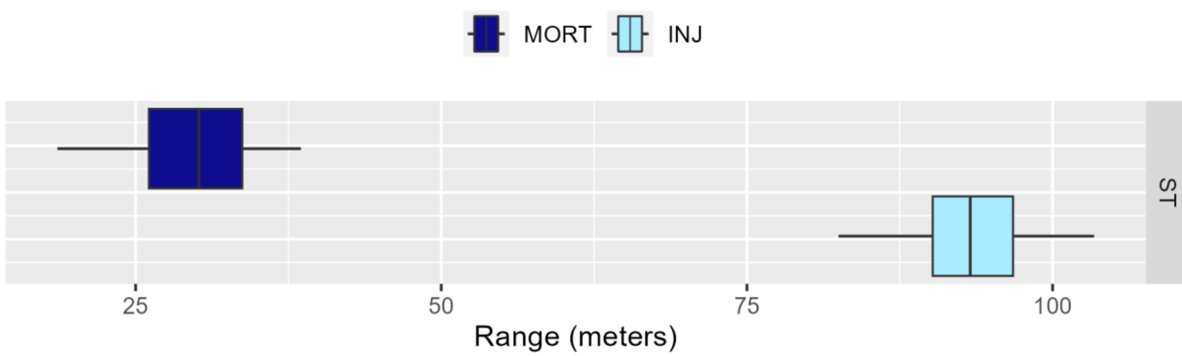

Figure 3.4-22: Sea Turtle Ranges to Mortality and Injury for E6 (>10 - 20 lb.)

3.4.4.7 Bin E7 (>20 - 60 lb. NEW)

Table 3.4-9: Sea Turtle Ranges to Effects for E7 (>20 - 60 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	1,113 m (286 m)	234 m (20 m)	118 m (7 m)	37 m (8 m)
	>200 m	1	NA	1,062 m (391 m)	232 m (21 m)	117 m (7 m)	36 m (7 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

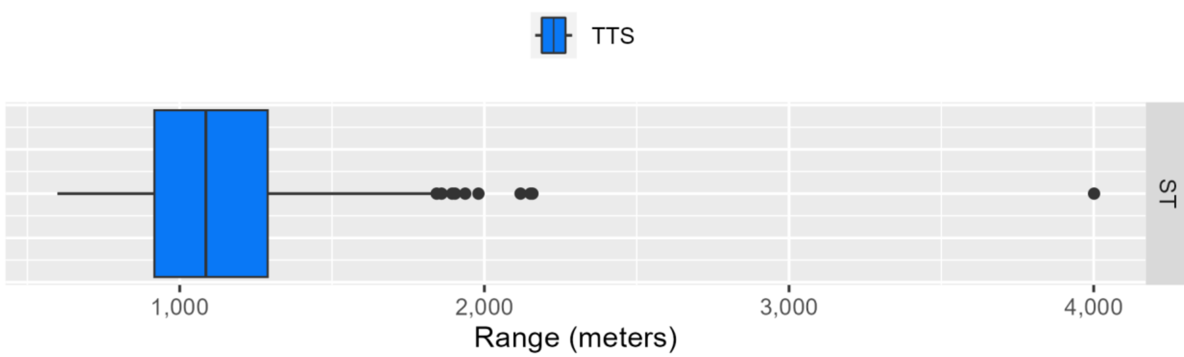

Figure 3.4-23: Sea Turtle Ranges to Temporary Threshold Shift for E7 (>20 - 60 lb.)

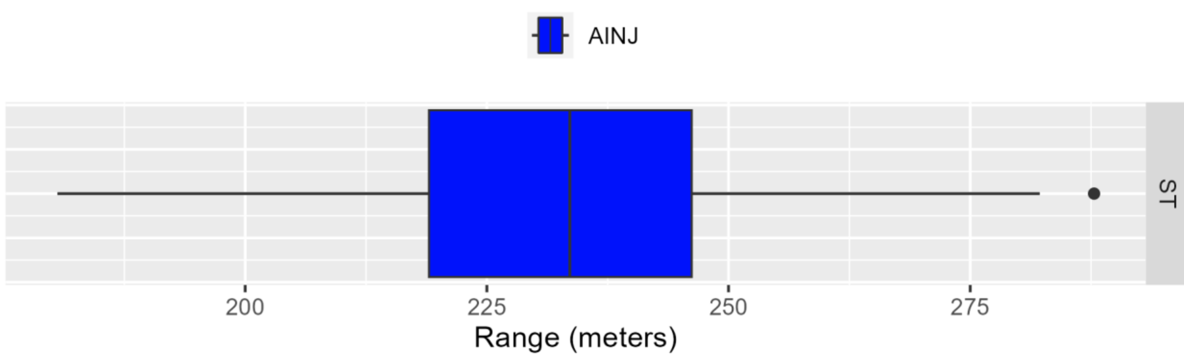

Figure 3.4-24: Sea Turtle Ranges to Auditory Injury for E7 (>20 - 60 lb.)

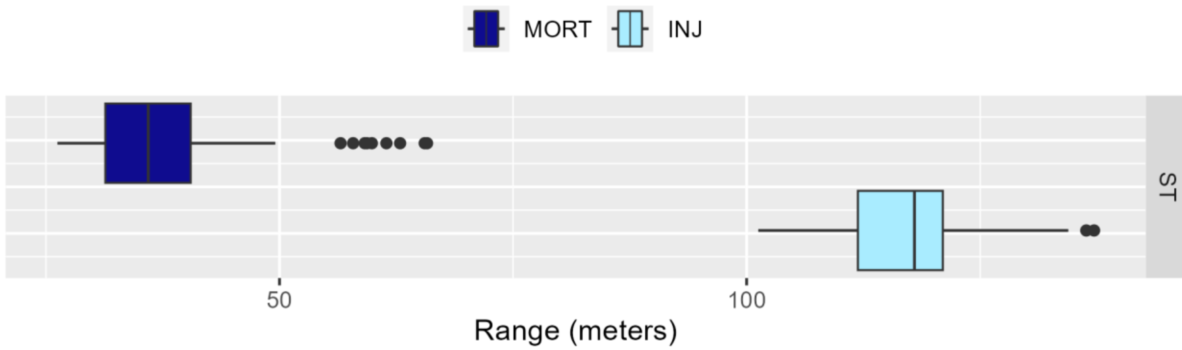

Figure 3.4-25: Sea Turtle Ranges to Mortality and Injury for E7 (>20 - 60 lb.)

3.4.4.8 Bin E8 (>60 - 100 lb. NEW)

Table 3.4-10: Sea Turtle Ranges to Effects for E8 (>60 - 100 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	2,280 m (536 m)	344 m (46 m)	180 m (21 m)	65 m (8 m)
	>200 m	1	NA	2,140 m (468 m)	334 m (38 m)	175 m (17 m)	62 m (7 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

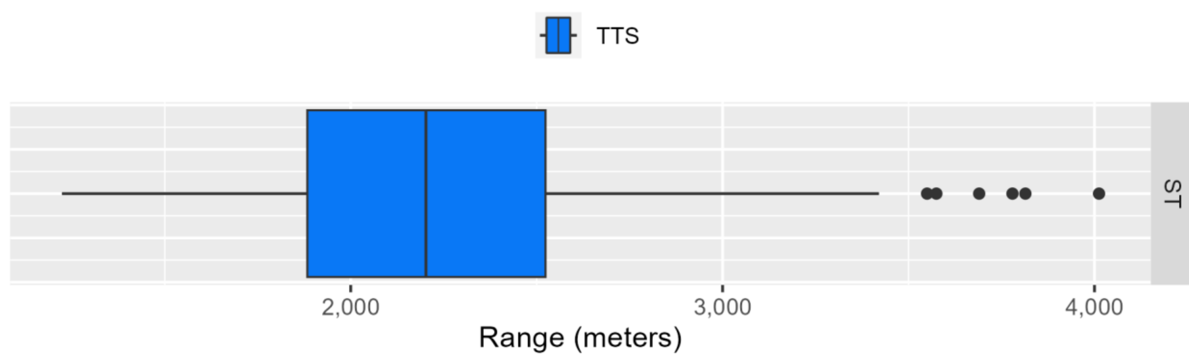

Figure 3.4-26: Sea Turtle Ranges to Temporary Threshold Shift for E8 (>60 - 100 lb.)

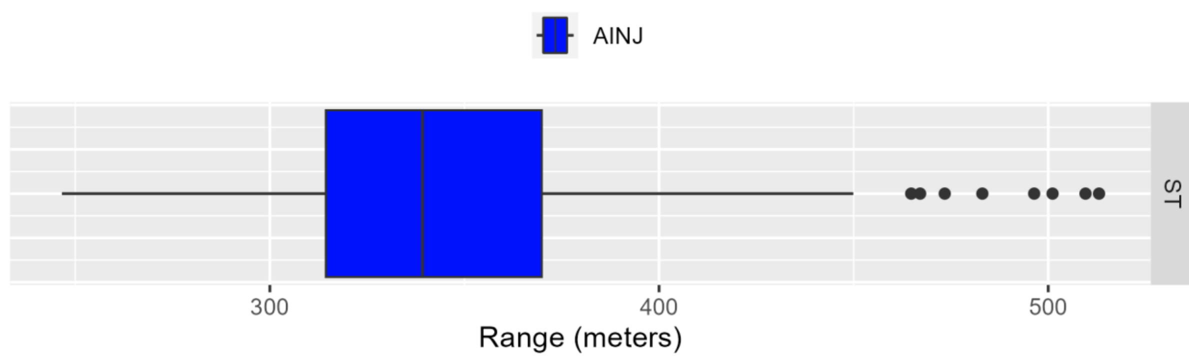

Figure 3.4-27: Sea Turtle Ranges to Auditory Injury for E8 (>60 - 100 lb.)

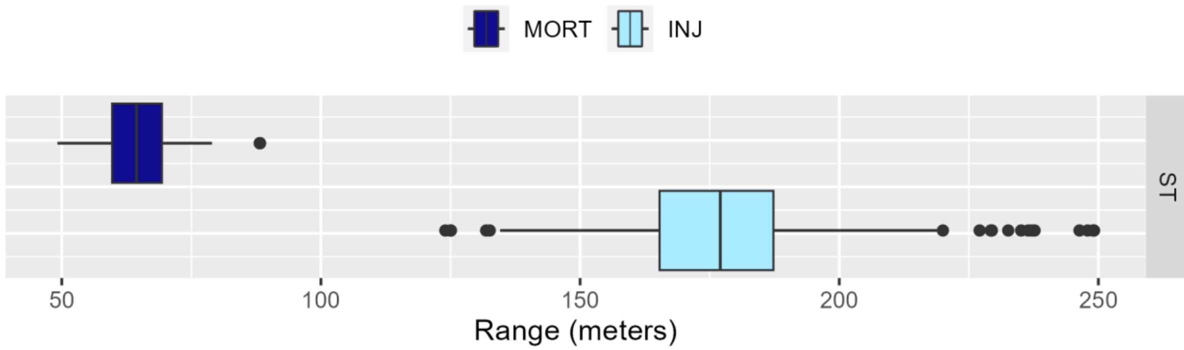

Figure 3.4-28: Sea Turtle Ranges to Mortality and Injury for E8 (>60 - 100 lb.)

3.4.4.9 Bin E9 (>100 - 250 lb. NEW)

Table 3.4-11: Sea Turtle Ranges to Effects for E9 (>100 - 250 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	2,050 m (1,213 m)	324 m (24 m)	186 m (55 m)	87 m (23 m)
	>200 m	1	NA	2,098 m (1,377 m)	314 m (27 m)	171 m (8 m)	74 m (28 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

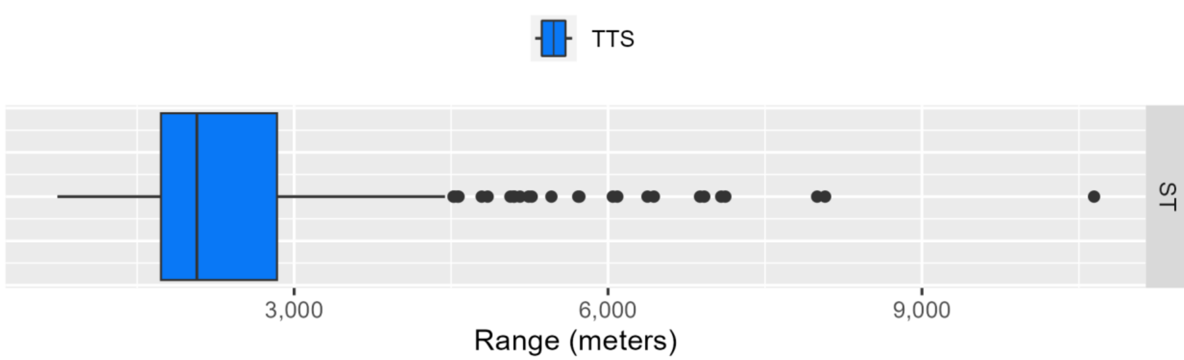

Figure 3.4-29: Sea Turtle Ranges to Temporary Threshold Shift for E9 (>100 - 250 lb.)

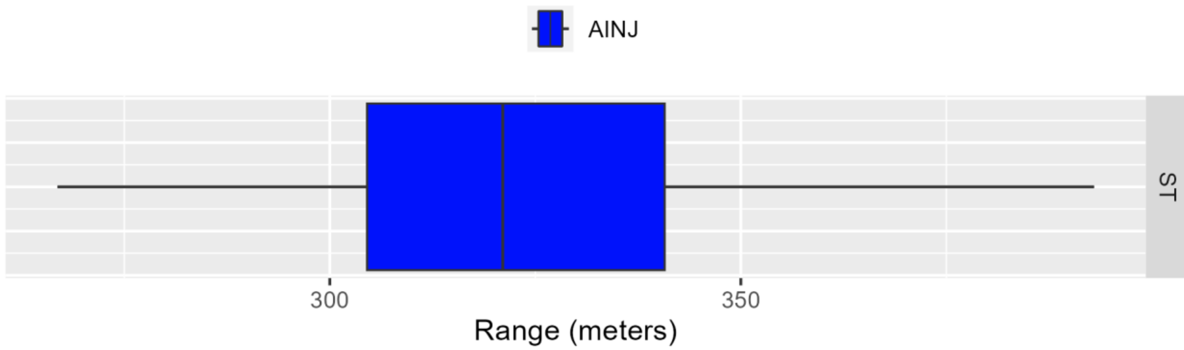

Figure 3.4-30: Sea Turtle Ranges to Auditory Injury for E9 (>100 - 250 lb.)

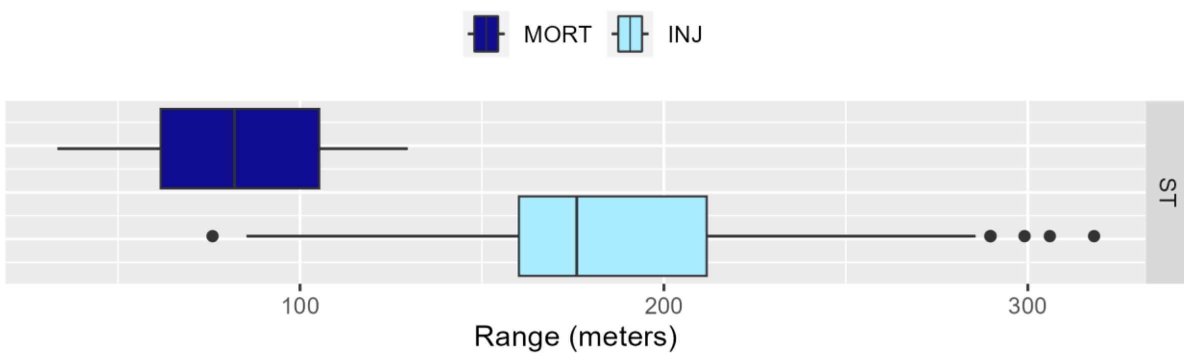

Figure 3.4-31: Sea Turtle Ranges to Mortality and Injury for E9 (>100 - 250 lb.)

3.4.4.10 Bin E10 (>250 - 500 lb. NEW)

Table 3.4-12: Sea Turtle Ranges to Effects for E10 (>250 - 500 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	6,505 m (2,291 m)	389 m (31 m)	259 m (60 m)	128 m (26 m)
	>200 m	1	NA	6,952 m (2,477 m)	390 m (29 m)	263 m (48 m)	126 m (23 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

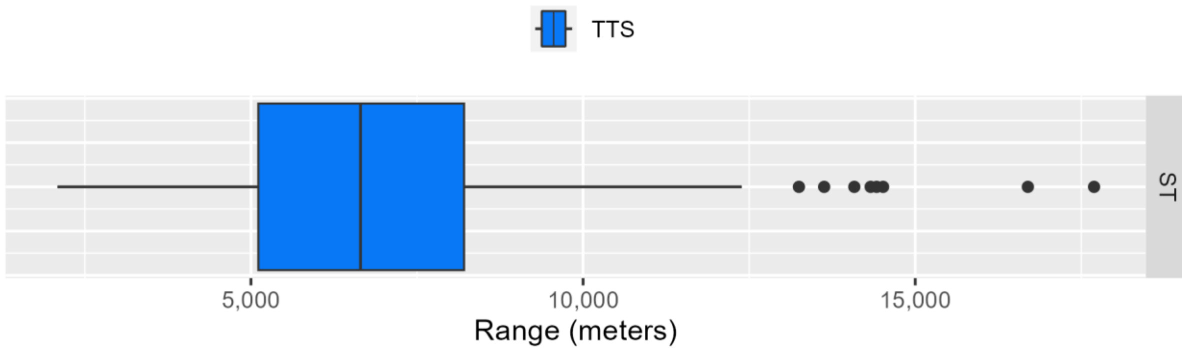

Figure 3.4-32: Sea Turtle Ranges to Temporary Threshold Shift for E10 (>250 - 500 lb.)

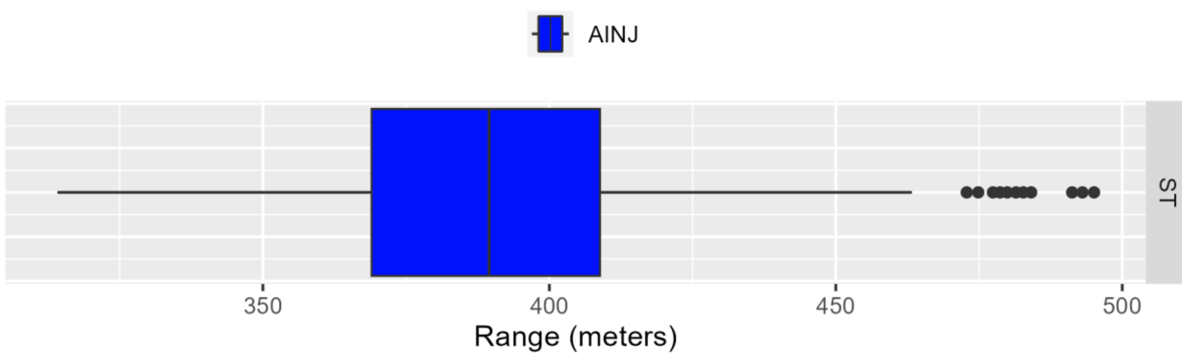

Figure 3.4-33: Sea Turtle Ranges to Auditory Injury for E10 (>250 - 500 lb.)

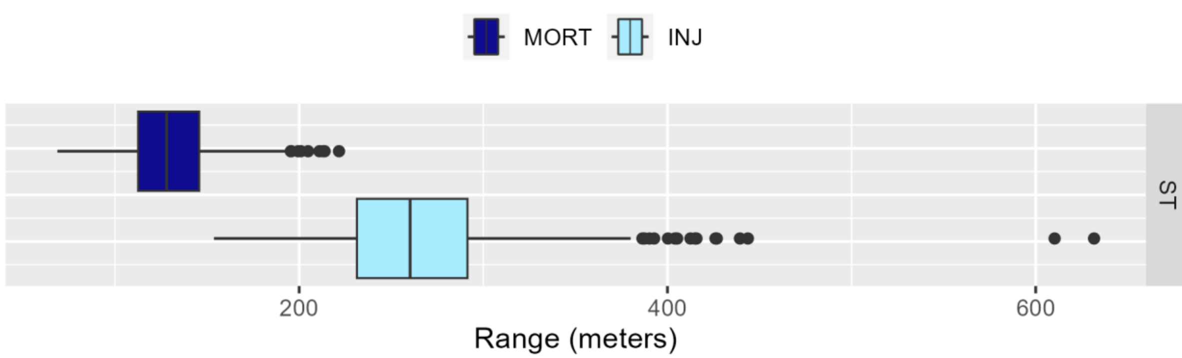

Figure 3.4-34: Sea Turtle Ranges to Mortality and Injury for E10 (>250 - 500 lb.)

3.4.4.11 Bin E11 (>500 - 675 lb. NEW)

Table 3.4-13: Sea Turtle Ranges to Effects for E11 (>500 - 675 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	10,672 m (1,556 m)	1,522 m (136 m)	639 m (66 m)	327 m (17 m)
	>200 m	1	NA	9,832 m (1,819 m)	1,464 m (158 m)	634 m (44 m)	317 m (14 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

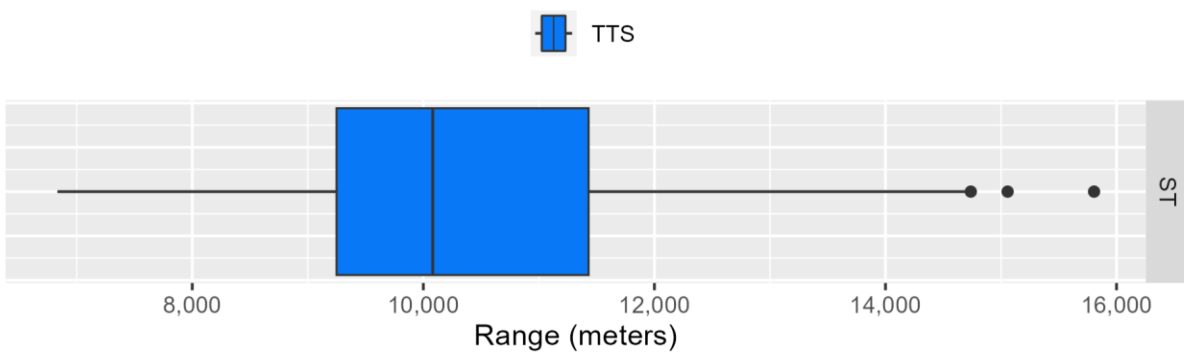

Figure 3.4-35: Sea Turtle Ranges to Temporary Threshold Shift for E11 (>500 - 675 lb.)

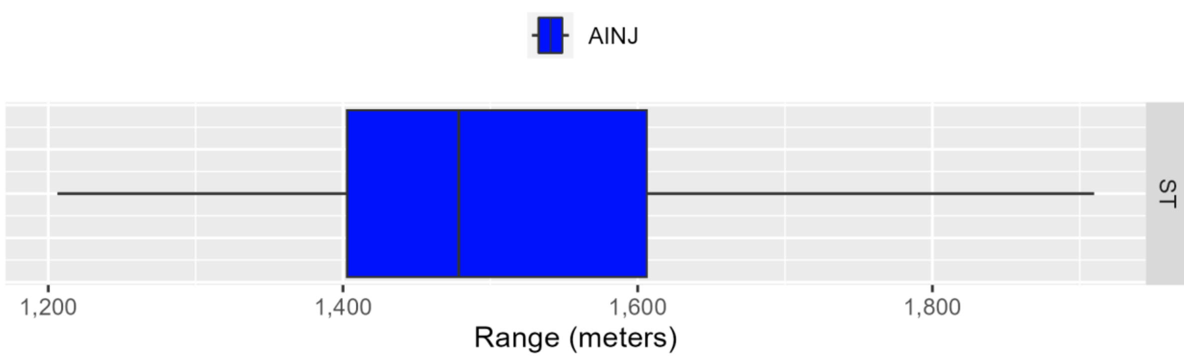

Figure 3.4-36: Sea Turtle Ranges to Auditory Injury for E11 (>500 - 675 lb.)

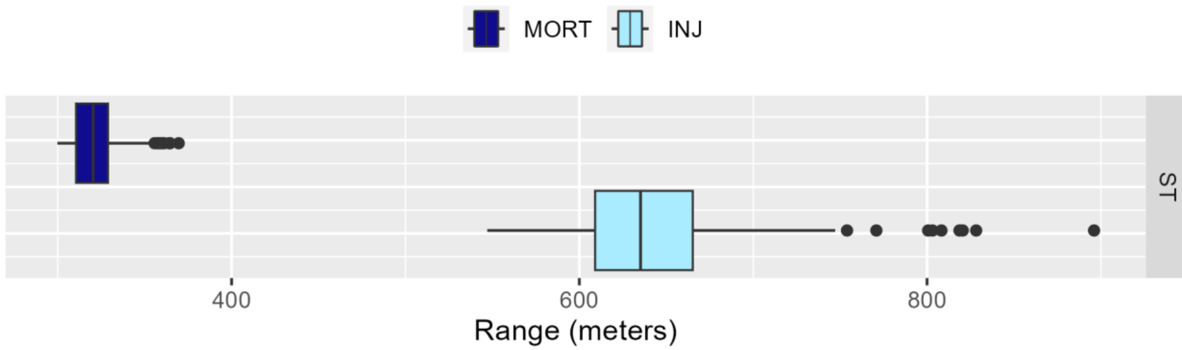

Figure 3.4-37: Sea Turtle Ranges to Mortality and Injury for E11 (>500 - 675 lb.)

3.4.4.12 Bin E12 (>650 - 1,000 lb. NEW)

Table 3.4-14: Sea Turtle Ranges to Effects for E12 (>650 - 1,000 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	≤200 m	1	NA	9,334 m (2,716 m)	564 m (126 m)	419 m (79 m)	202 m (25 m)
	>200 m	1	NA	10,791 m (2,850 m)	482 m (28 m)	383 m (68 m)	190 m (27 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

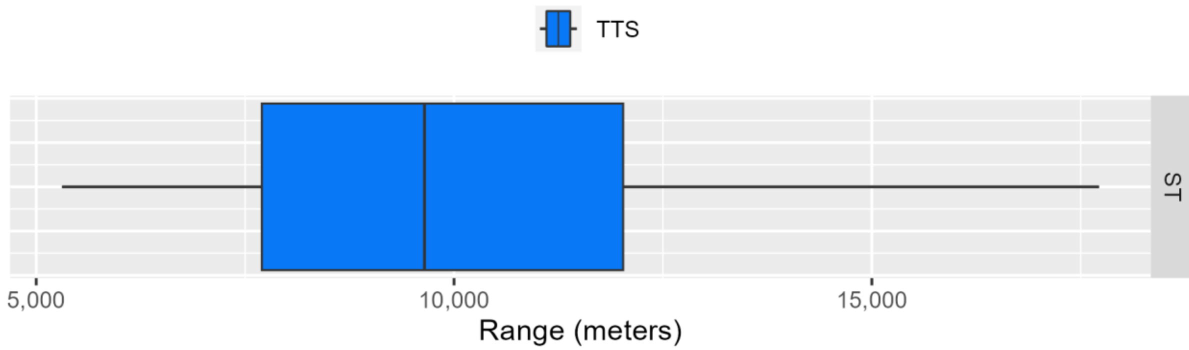

Figure 3.4-38: Sea Turtle Ranges to Temporary Threshold Shift for E12 (>650 - 1,000 lb.)

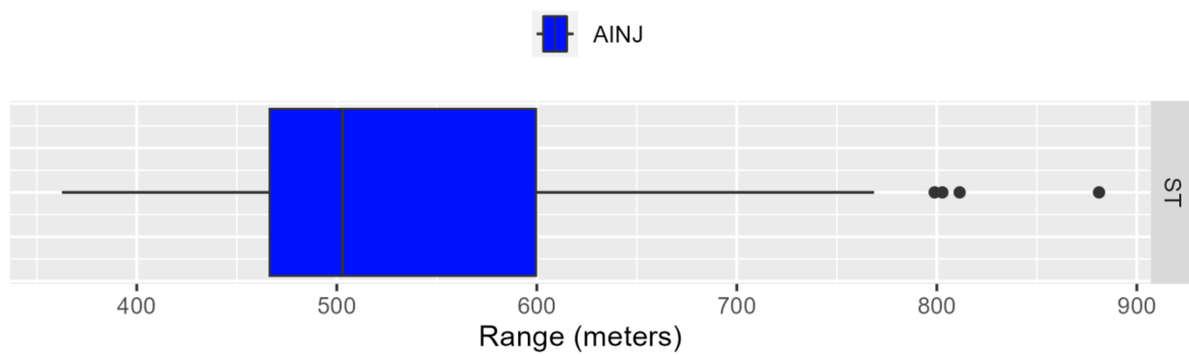

Figure 3.4-39: Sea Turtle Ranges to Auditory Injury for E12 (>650 - 1,000 lb.)

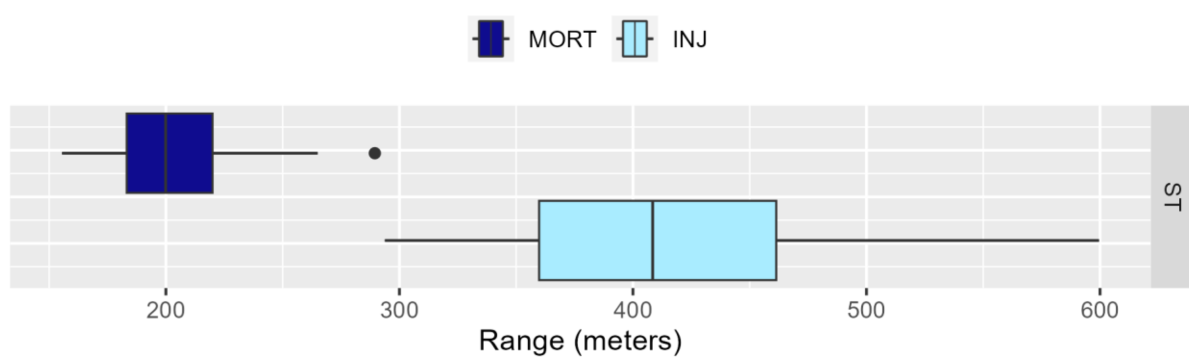

Figure 3.4-40: Sea Turtle Ranges to Mortality and Injury for E12 (>650 - 1,000 lb.)

3.4.4.13 Bin E16 (>7,250 - 14,500 lb. NEW)

Table 3.4-15: Sea Turtle Ranges to Effects for E16 (>7,250 - 14,500 lb.)

FHG	Depth	Cluster Size	BEH	TTS	AINJ	INJ	MORT
ST	>200 m	1	NA	48,125 m (2,610 m)	9,304 m (1,215 m)	2,843 m (649 m)	1,089 m (103 m)

-TTS and AINJ = the greater of respective SPL and SEL ranges
-INJ = greater of the impulse range based on all juvenile masses in the auditory group or the peak pressure range
-MORT = impulse range based on all juvenile masses in the auditory group
-Behavioral response criteria are applied to explosive clusters >1
-lb. = pounds in net explosive weight (NEW)
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown

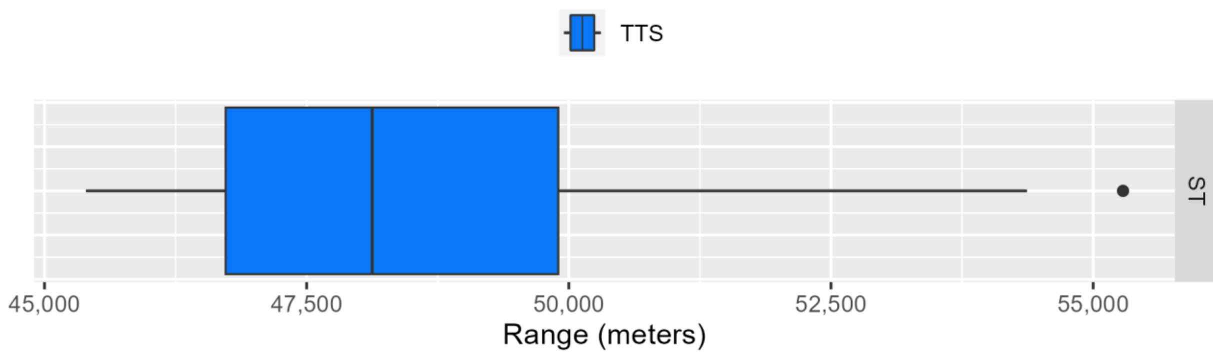

Figure 3.4-41: Sea Turtle Ranges to Temporary Threshold Shift for E16 (>7,250 - 14,500 lb.)

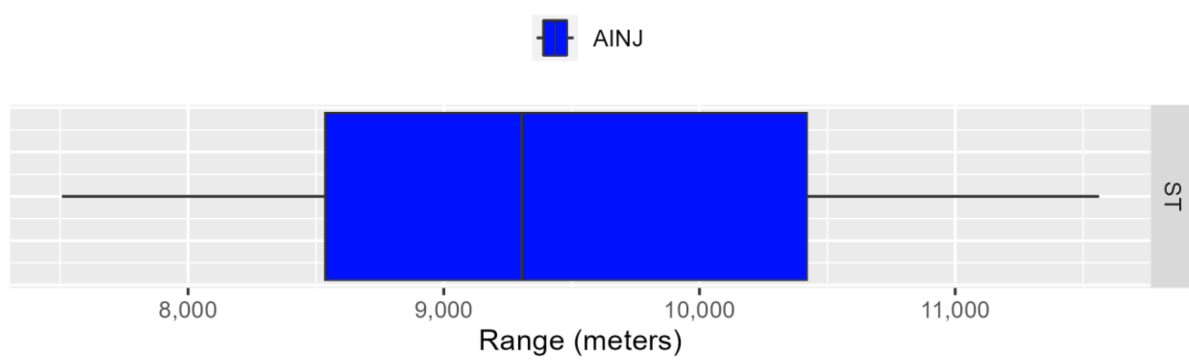

Figure 3.4-42: Sea Turtle Ranges to Auditory Injury for E16 (>7,250 - 14,500 lb.)

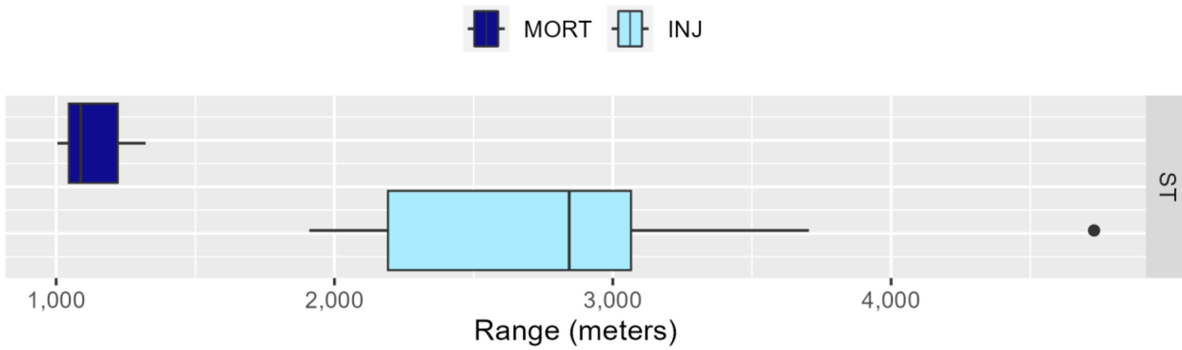

Figure 3.4-43: Sea Turtle Ranges to Mortality and Injury for E16 (>7,250 - 14,500 lb.)

4 IMPACTS TO FISHES FROM ACOUSTIC AND EXPLOSIVE STRESSORS

This section analyzes the potential impacts from acoustic and explosive stressors on fishes. There are many factors that contribute to how a fish will respond to sound, such as the frequency and received sound level, the duration of the sound-producing activity, the animal's behavioral activity at the time of exposure (e.g., feeding, traveling, resting), and proximity of the animal to the source of the sound.

For what is known about the effects of all acoustic substressor and explosives on fishes, refer to the *Fishes Acoustic Background* section. In this analysis, impacts are categorized as mortality, non-auditory injury, temporary hearing loss (temporary threshold shift [TTS]), auditory injury (AINJ, including auditory neural injury), other physiological response (including stress), masking (occurs when a noise interferes with the detection, discrimination, or recognition of other sounds), and behavioral responses.

This analysis is presented as follows:

- The impacts to fish populations that would be expected due to each type of acoustic substressor and explosives used in the Proposed Action are described in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives).
- Impacts to ESA-species (Distinct Population Segments [DPSs] and Evolutionarily Significant Unit [ESUs]) in the Study Area, including predicted instances of harm or harassment, are presented in Section 4.3 (ESA-Listed Species Impact Assessments).

4.1 QUANTIFYING IMPACTS ON FISHES FROM ACOUSTIC AND EXPLOSIVE STRESSORS

Although the impact analysis presented below is largely qualitative, a quantitative analysis was performed to estimate ranges to effects for fishes exposed to activities that involve the use of some acoustic substressors (sonar, pile driving, and air guns) and explosives. As such, this section is organized differently than the preceding analyses for marine mammals and reptiles because the quantitative aspects of the analysis are included in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives) when considering impacts to fish populations, not just ESA- species (as analyzed in Section 4.3 [ESA-Listed Species Impact Assessments]).

Ranges for sonar, air guns, and explosives were estimated using fish sound exposure criteria and thresholds described below and sound propagation modeling performed in the Navy’s Acoustic Effects Model. Ranges to effects for pile driving (Section 4.1.3) also use the criteria described below but were modeled outside of the Navy’s Acoustic Effects Model (see the *Quantitative Analysis TR* for details). Note, although ranges to effects are estimated for some stressors, density data for fishes throughout the Study Area are not available; therefore, it is not possible to estimate the total number of individuals that may be affected by Navy acoustic and explosive stressors.

Sound exposure criteria for the current analysis are largely consistent with thresholds used during previous assessments of impacts due to military readiness activities in the Study Area, with new data and modifications from previous phases described in detail below (i.e., explosive injury criteria). The literature used to derive proposed criteria and thresholds are summarized in the *Fishes Acoustic Background* section. The data presented herein represent current best available science.

4.1.1 Quantifying Hearing Impacts from Sonars

Most of the available research on the effects of non-impulsive sound sources on fishes utilize tonal or broadband signals (e.g., white noise). However, experiments that utilize these types of sound sources are often not analogous to potential exposures to Navy sonars due to differences in the test stimuli and environment (i.e., tanks or aquariums). Additionally, the overall exposure durations often exceed many hours or even days, time frames that are much longer than the likely exposures fish may experience due to transiting Naval vessels that operate sonar and other transducers. The only three studies that have documented potential threshold shifts in fishes exposed to actual Naval sonar are summarized in Table 4.1-1. This data was used to derive interim sound exposure criteria consistent with proposed thresholds in the ANSI Sound Exposure Guideline technical report (Popper et al., 2014).

Table 4.1-1: TTS Data for Fishes Exposed to Sonar

Reference	Reported SPL (dB RMS)	Exposure Duration (seconds)	Calculated cSEL [1]	Species	Significant TTS (Y/N)
Mid Frequency Sonar					
Halvorsen et al. (2012c)	210	15	222	Channel catfish (*Ictalurus punctatus*)[2]	Y
	210	15	222	Rainbow trout (*Oncorhynchus mykiss*)	N
Low Frequency Sonar					
Popper et al. (2007)	193	324	218	Rainbow trout (*Oncorhynchus mykiss*)	Y
	193	648	221	Rainbow trout (*Oncorhynchus mykiss*)	Y
(Halvorsen et al., 2013)	195	324	220	Channel catfish (*Ictalurus punctatus*)[2]	Y
				Largemouth bass (*Micropterus salmoides*)	N
				Yellow perch (*Perca flavescens*)	N

Notes: SPL = sound pressure level; dB RMS = decibel root mean square; cSEL = cumulative sound exposure level; TTS = temporary threshold shift. Significance is defined and reported in each publication as a statistically significant threshold shift compared to baseline data (regardless of the amount of dB shift).

[1] Calculated cumulative sound exposure level = Reported SPL + 10 log (Duration)

[2] Hearing specialist, fishes with a swim bladder involved in hearing

As shown in Table 4.1-1, significant threshold shifts were reported in channel catfish (a hearing specialist) when exposed to mid-frequency sonar at a maximum sound pressure level of 210 dB for a total duration of 15 seconds (Halvorsen et al., 2012c). However, the same effect was not observed in rainbow trout (a hearing generalist). Based on limited data, the Navy calculated the cumulative sound exposure level, then rounded down for a final proposed threshold of 220 dB re 1 µPa^{2}s for all hearing specialists (see Table 4.1-2). This threshold is consistent with criteria presented in the *ANSI Sound Exposure Guideline* technical report which is reported in dB RMS. No numeric criteria are proposed for hearing generalists (including fishes without a swim bladder) as species within these fish categories do not sense pressure well and likely cannot hear frequencies above 2 kHz. Furthermore, hearing generalists are less susceptible to hearing impairment from sound exposures compared to hearing specialists (Halvorsen et al., 2012c; Popper et al., 2014).

A hearing specialist and at least one example of a hearing generalist showed signs of TTS after exposure to low-frequency sonars (see Table 4.1-1). Specifically, threshold shifts in channel catfish and rainbow trout were reported after exposure to a maximum received sound pressure level of 193 dB re 1 µPa (criteria presented in the *ANSI Sound Exposure Guideline* technical report) for 324 seconds, but not in largemouth bass or yellow perch (Halvorsen et al., 2013; Popper et al., 2007). Because the results were variable, and because most fishes are sensitive to low-frequency sound, the Navy's threshold for TTS from exposure to low-frequency sonar for all fishes with a swim bladder was rounded down to a cumulative sound exposure level of 210 dB re 1 µPa^2-s (see Table 4.1-2). Furthermore, based on available data and the assumption that generalists are less susceptible to hearing loss than specialists, the onset of TTS is presumed to occur above this proposed threshold for hearing generalists (as evident by the greater than sign).

Table 4.1-2: Thresholds to TTS in Fishes from Sonar

Hearing Group	*Fish Category*	Mid-Frequency Sonar	Low-Frequency Sonar
Generalist	Fishes without a swim bladder	NC	NC
	Fishes with a swim bladder not involved in hearing	NC	> 210
Specialist	Fishes with a swim bladder involved in hearing	220	210
	Fishes with a swim bladder and with high-frequency hearing[1]	220	210

Notes: cSEL = cumulative sound exposure level (dB re 1 µPa2-s); NC = effects from exposure to sonar are not likely, therefore no criteria are proposed; ">" indicates that the given effect would occur above the reported threshold.

[1] Some species within this category can detect sound pressure up to 10 or 100 kHz. All other fishes have an upper frequency cutoff at 2kHz.

4.1.2 Quantifying Injury and Hearing Impacts from Air Guns and Pile Driving

Criteria and thresholds used to estimate impacts from sound produced by impact pile driving and air gun activities are presented in Table 4.1-3. Consistent with the ANSI Sound Exposure Guideline technical report (Popper et al., 2014), dual metric sound exposure criteria and cumulative sound exposure metrics are utilized to estimate ranges to mortality, non-auditory injury, and TTS (respectively) from impulsive sources.

Table 4.1-3: Sound Exposure Criteria for Air Guns and Pile Driving

Fish Category	Mortality		Injury		TTS
	cSEL	*peak SPL*	*cSEL*	*peak SPL*	*cSEL*
Pile Driving / Air Guns					
Fishes without a swim bladder	> 219	> 213	> 216	> 213	NC
Fishes with a swim bladder	210	> 207	203	> 207	> 186
Fishes with a swim bladder involved in hearing and those with high-frequency hearing[1]	207	> 207	203	> 207	186

[1] Hearing specialists. All other groups are considered hearing generalists.
Notes: cSEL = cumulative sound exposure level (dB re 1 µPa2-s); peak SPL = average single strike peak sound pressure level (dB re 1 µPa); TTS = temporary threshold shift; NC = effects from exposure to impulsive sources are unlikely, therefore no criteria are proposed; ">" indicates that the given effect would occur above the reported threshold.

Due to the lack of detailed data on injury thresholds in fishes exposed to air guns, thresholds from impact pile driving exposures were used as a proxy for this analysis (Halvorsen et al., 2012a; Halvorsen et al., 2011, 2012b). However, it is important to note that the thresholds derived from pile driving experiments are likely specific to the test conditions under which the criteria were derived, and therefore may not accurately predict ranges to effects from exposure to other impulsive sound sources. As discussed in the *Fishes Acoustic Background* section, injury and mortality in fishes exposed to impulsive sources may vary depending on the presence or absence, and type, of swim bladder. Injury and mortal injury have not been observed in fishes without a swim bladder because of exposure to impulsive sources. Therefore, these effects would likely occur above the thresholds in Table 4.1-3.

Overall, PTS has not been known to occur in fishes. Any hearing loss in a fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (Popper et al., 2014; Popper et al., 2005; Smith et al., 2006). The lowest sound exposure level at which TTS has been observed in fishes with a swim bladder involved in hearing is 186 dB re 1 µPa2-s (Popper et al., 2005). Hearing generalists would be less susceptible to hearing loss (i.e., TTS) than hearing specialists, even at higher levels and longer durations. As a result, the proposed interim thresholds in the ANSI Sound Exposure Guideline technical report (Popper et al., 2014) for hearing generalists would be greater than (>) or much greater than (>>) 186 dB re 1 µPa2-s for fishes with a swim bladder not involved and those without a swim bladder, respectively. However, the threshold for TTS for fishes without a swim bladder was not carried forward in this analysis as fishes without a swim bladder generally have not shown signs of TTS from exposure to sound and therefore this effect is considered unlikely to occur.

4.1.3 Quantifying Mortality, Injury, and Hearing Impacts from Explosives

Criteria and thresholds to estimate impacts from sound and energy produced by explosive activities are presented below (Table 4.1-4) These thresholds were applied in the Navy's previous analysis of impacts in the Study Area. The mortality threshold is the lowest value recommended for explosives in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014). The guidelines provide qualitative criteria for injury due to explosives and do not suggest any thresholds. Instead, the peak pressure injury threshold of 220 dB is based on available explosive literature. An explanation of the development of this threshold is provided below. The TTS threshold for fishes with a swim bladder is the value suggested in the guidelines for impulsive sounds other than explosives, as no data on explosive impacts on fish hearing is available. Consistent with the recommendations in the guidelines, fishes without a swim bladder would not be susceptible to TTS and therefore no criteria are proposed.

Table 4.1-4: Sound Exposure Criteria for Fishes Exposed to Underwater Explosives

Fish Category	***Mortality***	***Injury***	***TTS***
	peak SPL	***peak SPL***	***cSEL***
Fishes without a swim bladder	229	220	NC
Fishes with a swim bladder	229	220	> 186

Notes: CSEL = cumulative sound exposure level (dB re 1 μPa2-s); peak SPL = peak sound pressure level (dB re 1 μPa); TTS = temporary threshold shift; NC = effects from exposure to explosives are not likely, therefore no criteria are proposed; ">" indicates that the given effect would occur above the reported threshold.

It is not appropriate to utilize the SPL or SEL injury thresholds developed for pile driving to estimate impacts from explosives. The peak sound pressure levels reported in the pile driving literature, upon which the guidelines injury thresholds were based, were not actually correlated with injury (Casper et al., 2017; Casper et al., 2013a; Casper et al., 2012; Casper et al., 2013b; Halvorsen et al., 2012a; Halvorsen et al., 2011, 2012b). Rather, these were the highest peak pressures achieved in the test apparatus that produced the specific SELs desired by the researchers. This was done by modifying the number of strikes per exposure while maintaining the same average single strike peak SPL. Injuries were only reported following exposure to many strikes (i.e., the lowest number of strikes in any of these experimental exposures was 960, over exposure durations of 40-60 minutes) and were correlated to cumulative SEL. It is not possible to discern from these datasets what peak pressure would correlate to injury in a single strike exposure, only that it would likely be higher than the peak pressure used in these experiments.

Additionally, sound from pile driving is not directly comparable to that produced by an explosion. It is likely that the much more rapid and sharper pressure changes make exposure to an explosion more injurious than exposures to multiple pile driving strikes of equal energy. The cumulative SEL metric derived for multiple pile driving strikes should not be applied to single explosives or clusters of explosives (with number of impulses several orders of magnitude lower than studied for pile driving). Although the Navy initially considered pile driving thresholds for explosives in the previous analysis, the injury threshold was revised to better analyze explosive impacts as described herein.

While several metrics have been used in the literature to characterize explosive exposure (e.g., peak pressure and impulse), peak pressure is the most consistently documented metric. As a conservative measure, the absolute lowest peak SPL for larval fishes exposed to explosions that resulted in injury (Settle et al., 2002) was selected to represent the threshold to injury. Recent explosive exposure data also support the threshold with reported rates of injury significantly different than controls starting at peak SPLs of 226 dB (Dahl et al., 2020; Jenkins et al., 2022; Jenkins et al., 2023).

The injury threshold is applied to all fishes due to the lack of rigorous data for multiple species. Since thresholds were selected from exposures of larval fishes, this threshold likely overestimates impacts for larger or adult fishes. Additionally, fishes exposed to received levels higher than 220 dB peak SPL have shown no signs of injury (e.g., Gaspin et al., 1976; Settle et al., 2002; Yelverton et al., 1975).

As data from the most recent series of explosive experiments are still being analyzed (Dahl et al., 2020; Jenkins et al., 2022; Jenkins et al., 2023), the Navy will continue to consider newer data sets for potential refinement of this threshold in the future. It is important that the development of future criteria consider statistical analyses when robust data sets are available as selecting the lowest reported received level at which an effect is observed may be an inaccurate representation of potential effects on the environment.

4.2 Impacts Due to Each Acoustic Substressor and Explosives

Details regarding the Navy's Proposed Action and associated acoustic and explosive stressors to support this impact assessment can be found in the following sections:

- The number of activities and the locations they would occur are shown in the *Proposed Activities* section.
- Activities using each of the following acoustic substressor and explosives would be conducted as described in the *Activity Descriptions* section, which lists for each activity: where they would occur and any applicable mitigation measures.
- General categories and characteristics of each acoustic substressor and explosive are described in the *Acoustic Stressors* section along with their general use and quantification of annual use (e.g., sonar hours or counts of explosive ordnance).

4.2.1 Impacts from Sonar and Other Transducers

Sonars and other transducers (collectively referred to as sonars in this analysis) emit sound waves into the water to detect objects, safely navigate, and communicate. Sonars are considered non-impulsive and vary in source level, frequency, duration (the total time that a source emits sound including any silent periods between pings), duty cycle (the portion of time a sonar emits sound when active, from infrequent to continuous), beam width (narrow beam to omnidirectional), and movement (stationary or on a moving platform). Characteristics and occurrence of sonar and other transducers used under the Proposed Action are described in the *Acoustic Stressors* and *Activity Descriptions* section.

As discussed in the *Fishes Acoustic Background* section, direct injury (e.g., barotrauma) has not been documented in fish exposed to sonar. Therefore, injury from sonar is highly unlikely and is not considered further in this analysis. Impacts from exposure to sonar could include TTS, masking, physiological response (including stress), and behavioral reactions.

The *Fishes Acoustic Background* section also discusses that different fish species are not equally sensitive to all sound frequencies. Most marine fishes are hearing generalists or lack a swim bladder, including all ESA-listed species within the Study Area, and would be unable to detect frequencies greater than approximately 2 kHz. Therefore, most marine species would not be susceptible to effects (e.g., TTS, behavioral response) from these sound sources. Some marine fishes are hearing specialists (all non-ESA-listed), which are more sensitive to sound detection and potential impacts than other hearing groups; although fishes within this group would still have to be very close to a relatively high-level low-frequency sonar source to experience TTS. Only a few species of shad (all non-ESA-listed) can detect high-frequency sonar (greater than 10 kHz), although the overlap is very limited between high-frequency sonar use and estuarine areas where shad species concentrate. Additionally, sound from high-frequency sonar systems attenuates below detectable levels (i.e., close to or below ambient sound levels) over a short range in shallow water. Thus, most species in the Study Area (including all ESA-listed species) may only detect low-frequency sonar systems with higher source levels within a few kilometers; and most other, less powerful low-frequency sonar systems, at much shorter ranges.

Military readiness activities that involve the use of sonar could occur throughout the Study Area, although use would generally occur in Navy range complexes and testing ranges, or around inshore locations, and specified ports and piers identified in the *Proposed Activities* section. Impacts from sonar to fish species within the Study Area would be limited to systems with low-frequency energy below 2 kHz, primarily from low-frequency sonars. Low-frequency and low- to mid-frequency broadband, and some lower mid-frequency sources (less than 2 kHz) may also be detectable to some fish species. The use of these systems would be concentrated in the Jacksonville, Virginia Capes, Northeast, Gulf of Mexico, and Navy Cherry Point Range Complexes. Low-frequency sonar would also occur in the high seas (offshore, outside the Navy's primary range complexes) under training activities, and in the Naval Surface Warfare Center Panama City, Naval Undersea Warfare Center Newport, and South Florida Ocean Measurement Facility Testing Ranges under testing. Some low-frequency sonars could also be utilized in the nearshore waters such as Navy piers during equipment testing activities (e.g., Naval Submarine Base New London and Naval Station Norfolk) though these systems are typically operated farther offshore. Overall, low-frequency sources are operated less often than higher frequency sources throughout the Study Area. Although the general impacts from sonar during testing would be similar in severity to those described during training, there is a higher quantity of sonar usage under testing activities and therefore there may be slightly more impacts during testing activities.

Active sonars used in the Study Area that are within the hearing range of marine fishes are unlikely to substantially mask key environmental sounds due to the intermittent and infrequent use of these systems at most locations within the Study Area. High and continuous duty cycle systems may increase the risk of masking for biologically important sounds, including some fish vocalizations, that overlap in frequency over the brief period these systems are used in any given location within the Study Area. Although some species may be able to produce sound at frequencies greater than 2 kHz, most vocal marine fishes communicate well below this frequency, below the range of most Navy sonar sources. For these reasons, any masking effects would be temporary and infrequent.

Although low-frequency systems generally lack the power necessary to generate TTS in fish, a quantitative analysis was performed using the Navy Acoustic Effects Model and varying potential exposure durations (1, 30, 60 and 120 seconds) to estimate ranges to TTS for fishes exposed to Navy sonars. Calculated ranges to TTS from low-frequency sources, regardless of exposure duration (1 to 120 s), resulted in estimated ranges of zero meters for all fishes and therefore TTS is not anticipated.

As discussed in the *Fishes Acoustic Background* section, fishes that can detect sonars could experience physiological responses or behavioral reactions such as startle or avoidance responses, although the relative risk of these effects at any distance from sonars are expected to be low. In fact, available research showed very little response of both captive and wild Atlantic herring (hearing specialists) to sonar (e.g., no avoidance). Such data suggests a low probability of behavioral reactions to sonar for most fishes; therefore, sonar is unlikely to affect fish populations. It is more likely that fish located near, or attracted to, a moving platform operating sonar (e.g., vessel or in-water device), would avoid the source due to the physical presence of the platform. In addition, there is the potential for some low-frequency sonars to mask biologically important sounds, including some fish vocalizations, that overlap in frequency content with the system that is operated. Such effects could limit the distance over which fishes can communicate or detect important signals, or fish may respond by altering their vocalizations to compensate for the noise, but only if the sound source is louder than the biological signals and lasts long enough to impact transmission and receipt of those signals. Due to the transient nature of most sonar operations, impacts, if any, would be localized and infrequent, only lasting a few seconds or minutes.

Overall, sonar use is unlikely to impact individuals. If impacts do occur, they are expected to be insignificant; therefore, long-term consequences for fish populations would not be expected.

Conclusions regarding impacts from the use of sonar and other transducers during military readiness activities for ESA-listed species is provided in Section 4.3 (ESA-Listed Species Impact Assessments).

4.2.2 Impacts from Air guns

Air guns use bursts of pressurized air to create intermittent, broadband, impulsive sounds. Air gun use by the Navy is limited and is unlike large-scale seismic surveys that use multiple air guns. In Navy events, small air guns would be fired over a limited period (seconds to minutes) within a single day. Characteristics and occurrence of air guns used under the Proposed Action are described in the *Acoustic Stressors* and *Activity Descriptions* section*.*

Air gun use would only occur nearshore at Newport, Rhode Island, and typically greater than 3 NM from shore in the Northeast, Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes. Table 4.2-1 shows the number of days in a maximum year that air guns would be estimated to occur during testing activities. Air guns would only be used during a few days per year in any given locations within the study area. Some testing events could occur in any one of the multiple listed range complexes and therefore the total number of days is distributed between them for the assessment of impacts.

Table 4.2-1: Number of Days per Year Air Guns Could Occur Under Testing Activities

Location	*Days per Year*
Gulf of Mexico Range Complex	11-12
Jacksonville Range Complex	11-12
Northeast Range Complexes	11-12
Virginia Capes Range Complex	11-12
Newport, RI	4

Most marine fishes are generalists and hear primarily below 2 kHz and would be able to detect broadband signals produced by air guns. Exposure of fishes to air guns could result in direct injury, hearing loss, masking, physiological response, or behavioral reactions.

Impulses from air guns lack the strong shock wave and rapid pressure increases known to cause primary blast injury or barotrauma during explosive events and (to a lesser degree) impact pile driving (see the *Fishes Acoustic Background* section for details). Although data from impact pile driving are often used as a proxy to estimate effects to fish from air guns, using such data may not accurately estimate potential impacts due to the differences in the sound characteristics (e.g., the rise times between the two types of impulsive sources). Typically, impact pile driving signals have a much steeper rise time and higher peak pressure than air gun signals.

To determine whether mortality, injury, or TTS would occur from air gun activities, a quantitative analysis was performed using the Navy Acoustic Effects Model to estimate ranges to effects for fishes exposed to air guns. However, modeling resulted in small estimated ranges to mortality, injury and TTS (less than 20 m) for the most sensitive fishes (i.e., those with a swim bladder, see Section 4.4.2, Range to Effects for Air Guns for details). Based on these short, predicted ranges, most fish would likely avoid the source prior to entering the area of effect due to the physical presence of the system or the platform from which the air gun is operated, further reducing the potentials for impacts. Although some individuals could be present within these small footprints, impacts would be limited to the few fish that are co-located with the air guns during operation of the system. The isolated and infrequent use of air guns would further reduce the potential for impacts to individuals.

Due to the brief nature of each pulse (approximately 0.1 second), it is unlikely that fishes within relatively close distance tens to hundreds of meters of the source would experience masking effects. If masking occurred, it is more likely to happen at farther distances from the source where signals may sound continuous. Such effects could limit the distance over which fishes can communicate or detect important signals, or fish may respond by altering their vocalizations to compensate for the noise, but only if the sound source is louder than the biological signals and lasts long enough to impact transmission and receipt of those signals. However, air gun signals at farther distances (e.g., 100s of meters) are unlikely detectable over existing ambient noise levels and thus are unlikely to cause impacts to individuals or populations.

Fishes may exhibit signs of physiological response or alterations in natural behavior. Some fish species with high site fidelity such as reef fish may show initial startle reactions, returning to normal behavioral patterns within a matter of a few minutes. Pelagic and schooling fishes that typically show less site fidelity may avoid the immediate area for the duration of the event. Multiple exposures to individuals (across days) in the offshore portions of the Study Area are unlikely as air guns are not operated in the same areas from day to day, but rather would be utilized in different areas over time. The exception would be the use of air guns at pierside locations, but these tests are rare in any given year further reducing the potential for multiple exposures of individuals.

Due to the limited use and relatively small footprint of air guns, although some individuals may be harmed if they are co-located with air gun activities, impacts to individual fish are expected to be minor and insignificant and long-term population level consequences would not be expected.

Conclusions regarding impacts from the use of air guns during military readiness activities for ESA-listed species is provided in Section 4.3 (ESA-Listed Species Impact Assessments).

4.2.3 Impacts from Pile Driving

Fishes could be exposed to sounds from impact (installation only) and vibratory (install and removal) pile driving during Port Damage Repair training activities at Gulfport, Mississippi throughout the year (pile driving would not occur during testing activities). Port Damage Repair training would occur over five days and up to four times per year (20 days total). At most, sound from pile driving activities could occur over a maximum estimated duration of several hours in each day, though breaks in pile driving are taken frequently to reposition the drivers between piles and not all piles would be driven to completion, minimizing the total time pile driving noise is produced during this activity. Depending on where the activity occurs at Gulfport, transmission of pile driving noise may be reduced by earthen pier structures.

As discussed in *Activities Description* section, as a standard operating procedure, the Navy performs soft starts at reduced energy during an initial set of strikes from an impact hammer. Soft starts may "warn" fishes and cause them to move away from the sound source before impact pile driving increases to full operating capacity. Soft starts were not during these calculations, nor was the possibility that fish could avoid the construction area. Therefore, not all fishes within the calculated ranges to effect would likely receive those effects.

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, especially when extracting piles from sandy, nearshore ground, and the sound is continuous while operating.

Ranges to effects for fishes exposed to impact pile driving were determined using the calculations, sound propagation modeling, and surrogate sound levels described in the *Quantitative Analysis TR*. Where effects are anticipated to occur above the designated criteria (see Section 4.1.2, Quantifying Injury and Hearing Impacts from Air Guns and Pile Driving), the estimated ranges to that effect would be less than those displayed in the table. Note, sound exposure criteria are based on impulsive pile driving therefore there are only ranges to effects for activities involving the use of impact pile driving. Currently, there are no proposed criteria for vibratory pile driving and therefore these activities are analyzed based on available literature and observed reactions.

Because of the static nature of pile driving activities, two exposure times were used when calculating potential range to effects for different types of fish (e.g., transient, or migratory species versus resident species or those with high site fidelity). This analysis assumes transient fishes would likely move through the area during pile driving activities, resulting in low exposure durations. Therefore, range to effects for these species are estimated based on a cumulative exposure time of 5 minutes (60 strikes per minute * 5 minutes = 300 strikes). However, calculations based on this exposure period resulted in an estimated range of zero meters for both mortality and injury. Although it was estimated that TTS could occur within 8 m or less for hearing specialists, TTS would be very unlikely due to the short, estimated range to effect.

In contrast, this analysis assumes resident fishes may stay in the area during pile driving activities and therefore may receive a higher cumulative exposure. As such, ranges were calculated based on an estimated exposure period of one day (4 piles per day * 300 strikes per pile = 1,200 strikes per day). Due to the low modeled source levels for each pile type, ranges to mortality and injury are not anticipated and TTS would only occur within 21 m of the pile. Single day range to effects are provided in Section 4.4.3 (Range to Effects for Pile Driving).

Considering the footprint of the injury zone (less than one meter) and the standard operating procedure for soft starts, mortality and injury are unlikely to occur. Furthermore, hearing loss is unlikely to occur because fishes would have to remain within 21 m of the pile for the full duration of the activity over the course of a single day. Even those that remained in the area for a full day would likely experience some recovery of any potential hearing loss during the pauses in pile driving activity when the driver is repositioned. Fishes that experience hearing loss may have a reduced ability to detect biologically relevant sounds until their hearing recovers (likely within a few minutes to days depending on the amount of threshold shift). If masking occurred, it is more likely to happen at farther distances from the source where signals may sound continuous. Such effects could limit the distance over which fishes can communicate or detect important signals, or fish may respond by altering their vocalizations to compensate for the noise, but only if the sound source is louder than the biological signals and lasts long enough to impact transmission and receipt of those signals. As reported during behavioral response experiments using impulsive sources, it is more likely that fish may startle or avoid the immediate area surrounding a pile driving activity or would habituate and return to normal behaviors after initial exposure (see the *Fishes Acoustic Background* section for more details).

Fishes exposed to vibratory driving or extraction would not result in mortality, injury, or TTS based on the low source level and limited duration of these activities. Based on the predicted noise levels, fishes may exhibit other responses such as temporary masking, physiological response, or behavioral reactions. Vibratory pile extraction is more likely than impact pile driving to cause masking of environmental sounds; however, due to its low source level, the masking effect would only be relevant in a small area around the activity. Fishes may also react by changing their swimming speed, moving away from the source, or not responding at all.

Overall, impacts to individual fish would be intermittent and temporary due to the tempo of the training. The localized nature of the event would also limit the number of individuals exposed to those that occur in the vicinity during the times of year that pile driving occurs. Although resident fishes or those with high site fidelity would have a higher risk of exposure and various effects from impact pile driving, these impacts would also be minor. Therefore, long-term consequences to fishes (migratory or resident), and therefore population consequences are not expected.

Conclusions regarding impacts from the use of pile driving during military readiness activities for ESA-listed species is provided in Section 4.3 (ESA-Listed Species Impact Assessments).

4.2.4 Impacts from Vessel Noise

Fishes may be exposed to vessel-generated noise throughout the Study Area. Military readiness activities with vessel-generated noise would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Specifically, a study of military vessel traffic found that traffic was heaviest just offshore of Norfolk and Jacksonville, as well as along the coastal waters between the two ports (Mintz, 2012a; Mintz, 2016; Mintz & Filadelfo, 2011) as described in the *Vessel Movement* section, though these activities could occur throughout the Study Area. Vessel movements involve transits to and from ports to various locations within the Study Area, and many ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels), as well as unmanned vehicles. Activities involving vessel movements occur intermittently and are variable in duration, with some activities ranging from a few hours up to two weeks in a particular location. Surface combatant ships (e.g., destroyers, guided missile cruisers, and littoral combat ships) and submarines especially are designed to be quiet to evade enemy detection.

Characteristics of vessel noise are described in the *Acoustic Habitat* section. Moderate- to low-level passive sound sources including vessel noise are unlikely to cause any direct injury or trauma due to characteristics of the sounds and the moderate source levels. Furthermore, vessels are transient and would result in brief periods of exposure.

All fishes would be able to detect vessels which produce continuous broadband noise, with larger vessels producing sound that is dominant in the lower frequencies where fish hearing is most sensitive. Smaller vessels emit more energy in higher frequencies, much of which would not be detectable by fishes. Although hearing loss due to exposure to continuous sound sources has been reported, the test environment for these experiments (i.e., long-term exposures in a small tank or aquaculture facility) is not representative of Navy vessel transits. Injury and hearing loss because of exposure to vessel noise is not discussed further in this analysis.

Best available science on responses to vessel noise, including behavioral responses, stress, and masking, is summarized in the *Fishes Acoustic Background* section. Vessel noise can potentially mask vocalizations and other biologically relevant sounds (e.g., sounds of prey, predators, or conspecifics) that fishes may rely on, especially in nearshore areas where Navy vessel traffic is high (near ports, harbors and within designated shipping lanes). However, existing high ambient noise levels in ports and harbors with non-Navy vessel traffic and in shipping lanes with commercial vessel traffic would limit the potential for masking by naval vessels in those areas. In offshore areas with lower ambient noise, the duration of any masking effects in a particular location would depend on the time in transit by a vessel through an area. Masking by Navy vessel movements would only occur during the timeframe that the Navy vessel is within a detectable range of a fish. Such effects could limit the distance over which fishes can communicate or detect important signals, or fish may respond by altering their vocalizations to compensate for the noise. Some species may also avoid these areas or modify their behavior (e.g., the Lombard effect) to account for the overall increased noise levels in areas of high anthropogenic activity.

Exposure to vessel noise could result in short-term behavioral reactions, physiological response, masking, or no response. Fishes are more likely to react to nearby vessel noise (i.e., within tens of meters) than to vessel noise emanating from a distance. Fishes may experience physiological response from vessel noise, but responses would likely recover quickly as vessels pass by. Although research indicate prolonged reactions could occur from exposure to chronic noise, it is unlikely that the level of Navy vessel movements would provide a meaningful contribution to the elevated ambient noise levels in industrialized areas and shipping channels. It is more likely brief reactions would occur in quiet, open ocean environments to passing vessels.

Overall, impacts from vessel noise would be temporary and localized, and such responses would not be expected to compromise the general health or condition of individual fish. Therefore, long-term consequences for populations are not expected.

Conclusions regarding impacts from activities that produce vessel noise during military readiness activities for ESA-listed species is provided in Section 4.3 (ESA-Listed Species Impact Assessments).

4.2.5 Impacts from Aircraft Noise

Fishes may be exposed to aircraft-generated noise throughout the Study Area. Military readiness activities with aircraft would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Fixed- and rotary-wing (helicopters) aircraft are used for a variety of military readiness activities throughout the Study Area. Tilt-rotor impacts would be like fixed-wing or helicopter impacts depending on which mode the aircraft is in. Most of these sounds would be concentrated around airbases and fixed ranges within each of the range complexes. Aircraft noise could also occur in the waters immediately surrounding aircraft carriers at sea during takeoff and landing or directly below hovering helicopters that are near the water’s surface.

Aircraft produce extensive airborne noise from either turbofan or turbojet engines. An infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Rotary-wing aircraft produce low-frequency sound and vibration (Pepper et al., 2003). Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors, but significant acoustic energy is primarily transmitted into the water directly below the craft in a narrow cone, as discussed in detail in the *Acoustic Primer* section*.* Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft.

Sounds from aircraft activities, including occasional sonic booms, lack the amplitude or duration to cause injury in fishes underwater. Furthermore, aircraft noise would only result in brief periods of exposure that lack the duration and cumulative energy necessary to cause hearing loss. Due to the brief and dispersed nature of aircraft overflights, the risk of masking is very low. If masking occurred, it would only be during periods of time where a fish is near the surface while directly under a hovering helicopter or aircraft overflight.

In most cases, exposure of fishes to fixed-wing aircraft presence and noise would be brief as the aircraft quickly passes overhead. Supersonic flight at sea is typically conducted at altitudes exceeding 30,000 ft., limiting the number of occurrences of supersonic flight being audible at the water surface. Because most aircraft would pass quickly overhead and helicopters may hover for a few minutes at a time over the ocean, fish at or near the surface have the highest likelihood of exposure to sound.

Due to their low sound levels in water, fixed-wing aircraft or transiting helicopters may not be detectable beyond a short distance (10s of meters) beneath the flight path and therefore it is unlikely that most fish would respond. Those that do respond would likely startle or avoid the immediate area. Daytime and nighttime activities involving helicopters may occur for extended periods of time, up to a couple of hours in some areas, potentially increasing the overall risk of noise exposure. During these activities, helicopters would typically transit throughout an area and may hover over the water. Longer activity durations and periods of time where helicopters hover may increase the potential for behavioral reactions, startle reactions, and physiological response. Low-altitude flights of helicopters during some activities, which often occur under 100 ft. altitude, may elicit a stronger response due to the proximity of a helicopter to the water; the slower airspeed and longer exposure duration; and the downdraft created by a helicopter's rotor.

Overall, if fish were to respond to aircraft noise, only short-term behavioral or physiological response would be expected. Therefore, impacts to individuals would be unlikely and long-term consequences for populations are not expected.

Conclusions regarding impacts from activities that produce aircraft noise during military readiness activities for ESA-listed species is provided in Section 4.3 (ESA-Listed Species Impact Assessments).

4.2.6 Impacts from Weapon Noise

Fishes may be exposed to sounds caused by the firing of weapons, objects in flight, and inert impact of non-explosive munitions on the water's surface. Military readiness activities using weapons and deterrents would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections*.* Generally, the use of weapons during proposed activities would occur in the range complexes, with greatest use of most types of munitions in the Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes. Most activities involving large caliber naval gunfire, or the launching of targets, missiles, bombs, or other munitions are conducted more than 12 NM from shore. The Navy will implement mitigation to avoid or reduce potential impacts from weapon firing noise during large-caliber gunnery activities, as discussed in the *Mitigation* section. For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed separately.

In general, these are impulsive sounds generated in close vicinity to or at the water surface, except for items that are launched underwater. Fishes at the surface of the water, in a narrow footprint under a weapons trajectory, could be exposed to naval gunfire sound. Sound due to missile and target launches is typically at a maximum during initiation of the booster rocket and rapidly fades as the missile or target travels downrange. Furthermore, many missiles and targets are launched from aircraft, which would produce minimal sound in the water due to the altitude of the aircraft at launch. Objects that are dropped and impact the water with great force could produce a loud broadband sound at the water's surface. Large-caliber non-explosive projectiles, non-explosive bombs, and intact missiles and targets could also produce a large impulse upon impact with the water surface. These activities would have the highest potential for impacts to nearby fishes. Although reactions by fishes to these specific stressors have not been recorded, fishes would be expected to react to weapons noise, as they would other transient sounds.

Sound from these sources generally lack the duration and high intensity to cause mortality or injury therefore, these effects are not discussed further. Although TTS could potentially occur, the probability is low of a non-explosive munition landing within a few meters of a fish while it is near the surface. Animals within the area may hear the impact of objects on the surface of the water and would likely alert, dive, or avoid the immediate area. Due to the brief and dispersed nature of weapons noise, masking is also unlikely and not discussed further in this analysis.

Overall, fishes that are exposed to weapons noise may only exhibit brief behavioral reactions such as startle reactions or avoidance, or no reaction at all. Due to the short-term, transient nature of gunfire and launch activities, animals may be exposed to multiple shots within a few seconds but are unlikely to be exposed multiple times within a short period (minutes or hours) as fish would likely avoid the area after initial exposure to these sounds. Behavioral reactions, if they occur, would likely be short term (minutes) and are unlikely to lead to substantial costs or long-term consequences for individuals or populations.

Conclusions regarding impacts from activities that produce weapons noise during military readiness activities for ESA-listed species is provided in Section 4.3 (ESA-Listed Species Impact Assessments).

4.2.7 Impacts from Explosives

Fishes could be exposed to sound and energy from explosions in the water and near the water's surface associated with proposed military readiness activities throughout the Study Area. Activities using explosives would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Most explosive activities would occur in the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes, although activities with explosives would also occur in other areas as described in *Activity Descriptions*. Most activities involving in-water explosives associated with large caliber naval gunfire, or the launching of targets, missiles, bombs, or other munitions, are conducted more than 12 NM from shore. Small Ship Shock Trials could occur in Virginia Capes, Jacksonville, or the Gulf of Mexico Range Complexes greater than 12 NM from shore as shown in the *Proposed Activities* section. Sinking Exercises are conducted greater than 50 NM from shore as shown in the *Proposed Activities* section. Generally, large explosives (bin E6 [> 10–20 pounds (lb.) net explosive weight (NEW) or above] are used less often throughout the Study Area compared to smaller detonations.

Certain activities with explosives may be conducted closer to shore at locations identified in *Activity Descriptions*, including the training activity Mine Neutralization Explosive Ordnance Disposal and testing activities Semi-Stationary Equipment Testing and line charge testing. However, there are far fewer detonations conducted in these inshore locations compared to the offshore portions of the Study Area, all of which would utilize explosives categorized as bin E5 (> 5–10 lb. NEW) or below. Note, the Action Proponents will implement mitigation to avoid impacts from explosive military readiness activities on shallow-water coral reefs, artificial reefs, live hard bottom, submerged aquatic vegetation, and shipwrecks throughout the Study Area (see the *Mitigation* section for details), which consequently, will help avoid potential impacts on fishes that shelter and feed within those habitats.

Characteristics, quantities, and net explosive weights of in-water explosives used during military readiness activities are provided in the *Acoustic Stressors* section. The use of in-water explosives would generally decrease from the prior analysis for both training and testing activities. There is a reduction in the use of most of the largest explosive bins for both training and testing, and a large decrease in in-water explosives associated with medium-caliber gunnery (bin E1 [0.1–0.25 lb. NEW]). There would be notable increases in three bins (E4 [> 2.5–5 lb. NEW], E7 [> 20–60 lb. NEW], and E9 [> 100–250 lb. NEW]). For testing, there would be no use of bin E17 (> 14,500–58,000 lb. NEW) because no Large Ship Shock Trials are proposed, and there would be reduced use of bin E16 (> 7,250–14,500 lb. NEW) for Small Ship Shock Trials.

The majority (96%) of explosive munitions used during military readiness activities would occur at or above the water's surface including those used during Surface Warfare activities which would typically detonate at or within 9 m (30 ft) above the water surface. The only detonations that would occur exclusively in-water would be from Mine Countermeasures (E4 [> 2.5–5 lb. NEW]), Torpedo Testing (E11 [> 500–675 lb. NEW]) and Ship Shock Trials (E16 [> 7,250–14,500 lb. NEW)]. Therefore, impacts to fishes are over-estimated in this analysis by modeling in-air or near surface explosions as underwater explosions. Sound and energy from in-air detonations at higher altitudes would be reflected at the water surface and therefore are not analyzed further in this section and would have no effect on fishes.

Sound and energy from explosions could result in mortality and injury, on average, for hundreds or thousands of meters from some of the largest explosions (see Section 4.4.4, Range to Effects for Explosives). Generally, explosives that belong to larger bins (with large net explosive weights) and those calculated based on SPL sound exposure criteria (for single detonations) produce longer ranges within each effect category. However, some ranges vary depending upon several other factors (e.g., cluster size, depth of the water, depth of the charge, etc.) Fishes without a swim bladder, adult fishes, and larger species would generally be less susceptible to injury and mortality from sound and energy associated with explosive activities than small, juvenile, or larval fishes. Additionally, fish may experience brief periods of masking, physiological response, or behavioral reactions, depending on the level and duration of exposure.

The death of an animal would remove them from the population. Removal of individuals with high reproductive potential (e.g., adult females) would result in a larger impact to the overall population than potential loss of many larval or juvenile fishes, which tend to occur in high numbers (i.e., spawning) and have naturally high mortality rates. Exposures that result in non-auditory injuries may limit an animal's ability to find food, communicate with other animals, interpret the surrounding environment, or detect and avoid predators. Impairment of these abilities can decrease an individual's chance of survival or affect its ability to reproduce depending on the severity of the impact. Though TTS can impair an animal's abilities, individuals may recover quickly with little significant effect. Based on available research, any present hearing effects may be accompanied by higher order impacts such as barotrauma or other internal injuries (e.g., inner ear tissue) with the likelihood of these reactions decreasing with increasing distance from the source (see the *Fishes Acoustic Background* section for details).

Fish could also experience masking, physiological response, and behavioral reactions within or beyond the estimated ranges to injury or TTS, with the likelihood of response lower at farther distances from the source (thousands of meters). Due to the nature of single explosive detonations, masking would be unlikely, and any stress or behavioral reactions would be brief (seconds to minutes) during the onset of the explosive signal. Multiple detonations that occur within a few seconds could pose an increased risk of impacts to nearby fishes, though many would likely avoid the source during the first few impulses. Although clustered shots could result in a higher risk of masking, this would likely happen at farther distances from the source where individual detonations might sound more continuous. If an individual fish were repeatedly exposed throughout a day or over multiple days to sound and energy from in-water explosions that caused alterations in natural behavioral patterns or physiological response, these impacts could lead to long-term consequences for the individual such as reduced survival, growth, or reproductive capacity depending on the overall severity and duration of the exposure.

Overall, military readiness activities involving explosions are generally dispersed in space and time. Consequently, repeated exposure of individual fishes to sound and energy from in-water explosions over the course of a day or multiple days is unlikely. Exposure to multiple detonations over the course of a day would most likely lead to an alteration of natural behavior or the avoidance of that specific area. However, most behavioral effects are expected to be short term (seconds or minutes) and localized, regardless of the size of the explosion. Non-injurious impacts are expected to be short-term, and fish would likely return to their natural behavior shortly after exposure.

Conclusions regarding impacts from the use of explosives during military readiness activities for ESA-listed species is provided in Section 4.3 (ESA-Listed Species Impact Assessments).

4.3 ESA-Listed Species Impact Assessments

This section relies on the analysis of acoustic and explosive stressors on fish populations described above in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives). Available research on reactions of fishes to underwater sound largely suggest that different species may respond similarly to the same sound source, especially similar types of fishes (e.g., migratory versus resident) and those that share similar anatomical features (see the *Fishes Acoustic Background* section). Although many of the ESA-listed species present in the Study Area may overlap locations where acoustic and explosive stressors occur (see the *Fishes Background* section for details*)*, several acoustic substressors (sonar, vessel, aircraft, and weapons noise) were determined to have minor and insignificant effects on fish populations. For example, injurious effects have not been reported in fishes exposed to non-impulsive, tonal, or broadband signals. This is because the characteristics of these non-impulsive sources lack the amplitude and the overall duration to result in physical damage. Therefore, it is not anticipated that non-impulsive acoustic stressors would result in injurious effects to ESA-listed species.

Overall, the described effects from these substressors would be minor, are unlikely to lead to a significant disruption of normal behavioral patterns such as breeding, feeding, or sheltering, and are unlikely to lead to harm. Impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, sonar, vessel, aircraft, and weapons noise are not analyzed for each ESA-listed species below, but rather rely on the analysis provided in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives).

Air guns, pile driving, and explosives could potentially injure or harm ESA-listed fishes that overlap in space and time with these stressors. As such, a full analysis is provided for each ESA-listed species in the sections below. Additionally, each assessment examines the overlap and potential pathways for effects to proposed and designated critical habitat.

4.3.1 Atlantic Salmon

The Gulf of Maine DPS of Atlantic salmon only occur in the Northeastern portion of the Study Area. Specifically, Atlantic salmon would occur in the Northeast Range Complexes, the Naval Undersea Warfare Center Newport Testing Range and nearby rivers and estuaries including some inshore locations within the Study Area (e.g., Bath, Maine). Both juvenile (smolt) and adult life stages could be present in portions of the Study Area throughout the year depending on seasonal migrations. Although smolt primarily occur in coastal, nearshore waters (i.e., within 3 NM) after hatching and rearing in the spring, they may also travel farther offshore. Adults can occur in both coastal and offshore areas during migrations in and out of natal streams in the spring and summer, and to foraging grounds farther north in Canadian waters during the late fall and winter. Schooling Atlantic salmon would typically occur in the upper 3 m (10 ft.) of the water column, though they may also occur in deeper waters.

As analyzed in 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although Atlantic salmon could be exposed to sonar, vessel, aircraft, or weapons noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected, therefore these substressors are not analyzed further. Additionally, Atlantic salmon would not occur in areas where pile driving is conducted and therefore would not be impacted by these activities.

Although Atlantic salmon may be exposed to sound from air guns associated with testing activities, exposures would only occur in the Northeast Range Complexes and in Newport, Rhode Island. As summarized in Table 4.2-1, air guns would only be used on average in a maximum year during 4 days at pierside locations, or up to 12 days in the offshore portion of the Northeast Range Complexes. Due to the isolated and infrequent use of air guns, exposures to air guns would be minimal. Furthermore, based on the small, estimated ranges (see Section 4.4.2, Range to Effects for Air Guns), mortality, injury, and TTS are highly unlikely to occur. If exposures occur, Atlantic salmon may exhibit impacts such as behavioral reactions or physiological response depending on their proximity to the activity, though reactions would be brief and Atlantic salmon would likely return quickly to their normal behavior or avoid the immediate area where the sound source is located. Masking effects are unlikely from single air gun pulses due to the short pulse length but may occur at farther distances from the source (100s of meters) if multiple shots were fired in succession and the signal was detectable above ambient noise levels. Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Atlantic salmon could also be exposed to sound and energy from explosives associated with military readiness activities in the Northeastern portion of the Study Area. Specifically, exposures would be limited to spawning and migrating adults that are present beyond 3 NM from shore within the Northeast Range Complexes and the Naval Undersea Warfare Center Newport Testing Range, or those that migrate past Naval Submarine Base New London. Although Atlantic salmon may be exposed to detonations placed throughout the water column (i.e., on the bottom, mid-water, etc.), they are more likely to be exposed to explosives detonated at the water’s surface due to their preference for the upper portion of the water column (upper 3m).

Explosive activities are generally dispersed in space and time. Overall, there are very few activities that utilize explosives in the Northeast portion of the Study Area compared to other locations. The only activity that could occur in some inshore locations is Semi-Stationary Equipment Testing at Naval Submarine Base New London. However, the munitions used during this test are considered small (E4 [> 2.5–5 lb. NEW]), and this activity would only be conducted two to three times at one of several locations over a seven-year period, limiting potential impacts to Atlantic salmon in this area. Most explosives used farther offshore in the Northeast Range Complexes and the Naval Undersea Warfare Center Newport Testing Range are considered small (E4 [> 2.5–5 lb. NEW] or below). The only activity that would utilize large munitions (E8 [> 60–100 lb. NEW] or E11 [> 500–675 lb. NEW]) in this portion of the Study Area would be Torpedo Testing, which would also occur a limited number of times over a seven-year period.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), Atlantic salmon that are co-located with explosive activities in these described areas may experience TTS, injury or mortality. The potential for masking from single or multiple detonations would be low due to the very brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, Atlantic salmon are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. If a school of salmon were present within the vicinity of an explosive, this could result in a larger number of individuals affected depending on their proximity to the source. Although some individuals may be impacted, long-term consequences to ESA-listed Atlantic salmon populations are not expected.

Designated critical habitat for Atlantic salmon is restricted to rivers within Maine and generally does not overlap areas where acoustic and explosive stressors are used. While the waters immediately surrounding Bath, Maine, are excluded from the critical habitat designation, sound produced by passing vessels within the Kennebec River under testing activities may travel into designated critical habitat. However, there is no pathway for sound to affect the physical and biological features (i.e., substrate composition and water quality) associated with this habitat.

The use of sonars, air guns, explosives and production of vessel, aircraft, and weapons noise during military readiness activities, <u>may affect</u> the Gulf of Maine DPS of Atlantic salmon. The use of pile driving is <u>not applicable</u> to Atlantic salmon due to lack of geographic overlap with the stressor.

The use of sonars, air guns, pile driving, explosives, and production of vessel, aircraft, and weapons noise during military readiness activities is <u>not applicable</u> to designated critical habitat for the Gulf of Maine DPS of Atlantic salmon due to lack of geographic overlap.

4.3.2 ATLANTIC STURGEON

Five DPSs of Atlantic sturgeon (the ESA-threatened Gulf of Maine Distinct Population Segment, and the ESA-endangered New York Bight, Chesapeake, Carolina, and South Atlantic Distinct Population Segments of Atlantic sturgeon) occur in many of the inshore locations associated with Navy range complexes in the Atlantic portion of the Study Area (i.e., as far north as the Northeast Range Complexes and south as the South Florida Ocean Measurement Facility). Although Atlantic sturgeon prefer shallow water habitats and were thought to only inhabit nearshore coastal areas, recent data suggest they could also occur beyond the continental shelf. However, sturgeon occurrence in offshore waters seems to be seasonal (with higher occurrence in the winter and fall) and the number of individuals that have been detected farther from shore seems to decrease with increasing depth. Most of their time is spent on the bottom, though some Atlantic sturgeon could occur throughout the water column and have been known to breach. All age classes are anticipated to occur in the Study Area except for larval sturgeon that would only occur in riverine environments.

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although Atlantic sturgeon could be exposed to sonar, vessel, aircraft, or weapons noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, these substressors are not analyzed further. Additionally, Atlantic sturgeon would not occur in areas where pile driving is conducted and therefore would not be impacted by these activities.

Atlantic sturgeon could be exposed to sound from air guns associated with testing activities in the Northeast, Virginia Capes and Jacksonville Range Complexes, and in Newport, Rhode Island. As summarized in Table 4.2-1, air guns would only be used on average in a maximum year during 4 days at pierside locations, or up to 12 days in the offshore portions of the previously listed range complexes. Due to the isolated and infrequent use of air guns, exposures to air guns would be minimal. Furthermore, based on the small, estimated ranges (see Section 4.4.2, Range to Effects for Air Guns), mortality, injury, and TTS are highly unlikely to occur. If exposures occur, Atlantic sturgeon may exhibit impacts such as behavioral reactions or physiological response depending on their proximity to the activity, though reactions would be brief and Atlantic sturgeon would likely return quickly to their normal behavior or avoid the immediate area where the sound source is located. Masking effects are unlikely from single air gun pulses due to the short pulse length but may occur at farther distances from the source (100s of meters) if multiple shots were fired in succession and the signal was detectable above ambient noise levels. Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals, or sturgeon may respond by altering their vocalizations to compensate for the noise. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Atlantic sturgeon could also be exposed to sound and energy from explosives associated with military readiness activities along the Atlantic coast throughout the year. Exposures would be limited to adult and sub-adults as juvenile and larval sturgeon are only present in estuarine and riverine systems where explosives do not occur. Although sturgeon spend most of their time on the seafloor, resulting in the potential exposures to detonations placed on the bottom or at depth, some individuals that occasionally move throughout the water column could also be exposed to surface or near surface munitions.

Explosive activities are generally dispersed in space and time. Although Atlantic sturgeon are most likely to occur in nearshore coastal areas, there are very few military readiness activities in these areas. Specifically, exposures could only occur in Virginia Capes Range Complex Inshore under training activities, and in Mayport and Port Canaveral, Florida, and Naval Submarine Base New London under testing activities. Detonations in each of these areas are considered small (E0 [< 0.1 lb. NEW] or E4 [> 2.5–5 lb. NEW]). Sturgeon that travel offshore could encounter explosives in the Virginia Capes, Jacksonville, Navy Cherry Point, and Northeast Range Complexes, and potentially in the high seas though sturgeon occurrence likely decreases with increasing water depth limiting the number of individuals that may be present in the offshore portions of these range complexes. Most of the explosive munitions used in these areas would be considered small (E5 [> 5–10 lb. NEW] or below). Although larger detonations could occur in these same locations, they would be used much less often than smaller detonations and would only occur beyond 12 NM from shore where sturgeon presence is not likely.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), Atlantic sturgeon that are co-located with explosive activities in these described areas may experience TTS, injury or mortality. Although highly unlikely, some sturgeon that travel beyond 12 NM from shore may be exposed Ship Shock Trials, these activities would be conducted no more than five times over a seven-year period, therefore reducing the probability of exposure. The potential for masking from single or multiple detonations would be low due to the extremely brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, Atlantic sturgeon are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. Although some individuals may be impacted, long-term consequences to ESA-listed Atlantic sturgeon populations are not expected.

Designated critical habitat for Atlantic sturgeon are within estuarine and river systems along the Atlantic seaboard and does not overlap areas where air guns and pile driving occur. Military readiness activities involving the use of sonar and other transducers, explosives, and those that produce vessel, aircraft, or weapons noise may overlap designated critical habitat in some inshore locations (e.g., the James River at Naval Station Norfolk in Norfolk, Virginia, and in the Kennebec River at Bath Iron Works in Bath, Maine). Specifically, some explosives could occur in the Virginia Capes Range Complex Inshore location under mine neutralization explosive ordnance disposal training activities and Semi-Stationary Equipment Testing activities. Specifically, some explosives could occur in the Virginia Capes Range Complex Inshore location under Mine Neutralization Explosive Ordnance Disposal training activities and Semi-Stationary Equipment Testing activities. However, the NEW associated with these activities would be small (E0 [< 0.1 lb. NEW] or E4 [> 2.5–5 lb. NEW], respectively) and would not likely impact the substrate within the designated habitat. Furthermore, training activities that involve the use of explosives would not occur directly in sturgeon critical habitat (i.e., in the York River), and testing activities would only occur in Virginia Capes Range Complex Inshore location a few times over the course of a seven-year period, further limiting the potential for explosives to occur within or near sturgeon critical habitat. For all other acoustic stressors, there is no pathway for sound to affect most of the physical and biological features (i.e., substrate composition and water quality) associated with this habitat. Although sound is described as a potential physical barrier to passage, sonar, explosives, vessel, aircraft, and weapons noise would be infrequent and transient and would not prevent sturgeon from reaching important habitat features.

The use of sonars, explosives, and the production of vessel, aircraft, and weapons noise <u>may affect</u> the ESA-threatened Gulf of Maine Distinct Population Segment, and the ESA-endangered New York Bight, Chesapeake, Carolina, and South Atlantic Distinct Population Segments of Atlantic sturgeon. For testing activities, the use of air guns <u>may affect</u> all Atlantic sturgeon DPSs. The use of pile driving is <u>not applicable</u> to any Atlantic sturgeon DPSs due to lack of geographic overlap with the stressor.

The use of explosives during training and testing activities <u>may affect</u> designated critical habitat for all Atlantic sturgeon DPSs. The use of sonars and the production of vessel noise during training and testing activities will have <u>no effect</u> on designated critical habitat for all Atlantic sturgeon DPSs. The production of aircraft and weapons noise during training will have <u>no effect</u> on designated critical habitat for all Atlantic sturgeon DPSs. The use of air guns and pile driving during training or testing activities is <u>not applicable</u> to designated critical habitat for all Atlantic sturgeon DPSs due to lack of geographic overlap with the stressors. The production of aircraft and weapons noise during testing is <u>not applicable</u> to designated critical habitat for all Atlantic sturgeon DPSs due to lack of geographic overlap with the stressors.

4.3.3 Shortnose Sturgeon

Shortnose sturgeon would occur in the nearshore coastal waters within the Atlantic portion of the Study Area (i.e., as far north as the Northeast Range Complexes, south to the Jacksonville Range Complex). Specifically, shortnose sturgeon may be present in the inshore locations associated with the Navy's range complexes including the Kennebec, Piscataqua, James, Cooper, Savannah, St. Mary's, and St. Johns rivers. Although most of their time is spent on the bottom, shortnose sturgeon could occur throughout the water column during occasional visits to the surface. Juvenile shortnose sturgeon would be limited to rivers and estuaries, particularly in the St. Johns River in Florida, and adults that enter the marine environment would remain close to shore primarily in waters that are 10 to 30 m in depth (depending on the season).

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although shortnose sturgeon could be exposed to sonar, vessel, or aircraft noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, these substressors are not analyzed further. Additionally, shortnose sturgeon would not occur in areas where pile driving, or weapons firing are conducted and therefore would not be impacted by these activities.

Shortnose sturgeon could be exposed to testing activities that involve the use of air guns. Although some individuals may occur in water depths up to 30 m, most sturgeon would not occur beyond 3 NM from shore. It is more likely that sturgeon could be exposed to air guns operated pierside in Newport, Rhode Island. As summarized in Table 4.2-1, air guns would only be used during four days at pierside locations in a maximum year of activity. Due to the isolated and infrequent use, exposures to air guns would be minimal. Furthermore, based on the small, estimated ranges (see Section 4.4.2, Range to Effects for Air Guns), mortality, injury, and TTS are highly unlikely to occur. If exposures occur, sturgeon may exhibit impacts such as behavioral reactions or physiological response depending on their proximity to the activity, though reactions would be brief and shortnose sturgeon would likely return quickly to their normal behavior or avoid the immediate area where the sound source is located. Masking effects are unlikely from single air gun pulses due to the short pulse length but may occur at farther distances from the source (100s of meters) if multiple shots were fired in succession and the signal was detectable above ambient noise levels. Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals, or sturgeon may respond by altering their vocalizations to compensate for the noise. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Shortnose sturgeon could also be exposed to sound and energy from explosives associated with military readiness activities along the Atlantic coast, however, exposures would be rare as shortnose sturgeon are primarily restricted to nearshore, coastal waters (rivers and estuaries) with infrequent excursions into the marine environment. Although sturgeon spend most of their time on the seafloor, resulting in potential exposures to detonations placed on the bottom or at depth, some individuals that occasionally move throughout the water column could also be exposed to surface or near surface munitions.

Explosive activities are generally dispersed in space and time. Shortnose sturgeon that travel beyond 12 NM from shore could be exposed to large explosives in the offshore portions of the Navy range complexes, but this is considered so unlikely as to be discountable due to their preference for nearshore, coastal habitats. Although the highest potential for impacts to shortnose sturgeon would be in the nearshore portions of the Study Area, there are very few military readiness activities in these areas. Specifically, exposures could only occur in one inshore location in the Virginia Capes Range Complex Inshore under training activities, and in Mayport and Port Canaveral, Florida, and Naval Submarine Base New London under testing activities. Detonations in each of these areas are considered small (E0 [< 0.1 lb. NEW] or E4 [> 2.5–5 lb. NEW]).

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), shortnose sturgeon that are co-located with explosive activities in these described areas may experience TTS, injury or mortality. The potential for masking from single or multiple detonations would be low due to the very brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, shortnose sturgeon are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. Although some individuals may be impacted, long-term consequences to ESA-listed shortnose sturgeon populations are not expected.

The use of sonars, explosives, and production of vessel, aircraft, and weapons noise may affect shortnose sturgeon. The use of air guns during testing may affect shortnose sturgeon. The use of pile driving is not applicable to shortnose sturgeon due to lack of geographic overlap with the stressor.

4.3.4 Gulf Sturgeon

Gulf sturgeon are only anticipated to occur in the north central and western portion of the Gulf of Mexico. Specifically, gulf sturgeon would occur in coastal nearshore waters from Florida to Louisiana though some individuals have on occasion been sighted in deeper offshore waters. Juvenile, sub adult and adult gulf sturgeon may occur in these portions of the Study Area with some seasonal migrations to nursery habitats in nearby rivers and estuaries.

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although Gulf sturgeon could be exposed to sonar, vessel, aircraft, or weapons noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, these substressors are not analyzed further.

Although Gulf sturgeon could be exposed to sound from air guns associated with testing activities, exposures could only occur in the Gulf of Mexico Range Complex. As summarized in Table 4.2-1, air guns would only be used during up to 12 days in a maximum year in the offshore portion of the Gulf of Mexico Range Complex. Due to the isolated and infrequent use of air guns, exposures to air guns would be minimal. Furthermore, based on the small, estimated ranges (see Section 4.4.2, Range to Effects for Air Guns), mortality, injury, and TTS are highly unlikely to occur. If exposures occur, Gulf sturgeon may exhibit impacts such as behavioral reactions or physiological response depending on their proximity to the activity. Masking effects are unlikely from single air gun pulses due to the short pulse length but may occur at farther distances from the source (100s of meters) if multiple shots were fired in succession and the signal was detectable above ambient noise levels. Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals, or sturgeon may respond by altering their vocalizations to compensate for the noise. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Pile driving activities conducted in Gulfport, Mississippi, have the potential to overlap areas where Gulf sturgeon would occur. Assuming sturgeon may behave similarly to other resident or demersal fishes in nearshore areas, there is the potential for Gulf sturgeon to be exposed to pile driving for longer durations compared to species that are more pelagic and may transit through the area. However, considering the small, estimated ranges to effect for injury and mortality, even from a full day of pile driving (see Section 4.4.3, Range to Effects for Pile Driving), it is unlikely Gulf sturgeon would be injured during this activity. Although TTS could occur for Gulf sturgeon within 21 m of impact pile driving, sturgeon would need to remain within this range during all impact pile driving (up to four piles in a day) to receive this effect. Furthermore, the use of soft start procedures would reduce any of these effects as Gulf sturgeon would likely avoid the immediate area as the activity ramps up. More likely, some minor behavioral reactions (e.g., increasing their swimming speed, moving away from the source, or not responding at all), physiological stress, or masking may occur during impact or vibratory pile driving activities. Such effects would be expected to be brief, lasting the duration it takes to drive a pile, and would only occur a maximum of 20 days in a year. Additionally, masking from impulsive sounds from impact pile driving would be low due to the extremely brief duration of each individual impulse. More likely, masking effects could occur during installation or removal of piles using vibratory methods. However, these effects would be limited to the time the vibratory hammer is operated (several minutes at most) during which the pile driving noise could temporarily limit the distance over which fishes can communicate or detect important signals, or sturgeon may respond by altering their vocalizations to compensate for the noise. Overall, these reactions are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Gulf sturgeon could also be exposed to sound and energy from explosives associated with military readiness activities within the Gulf of Mexico throughout the year. Adult and sub-adult Gulf sturgeon typically occur in nearshore areas, bays, and estuaries, but can occasionally move into deeper, offshore areas. It is unlikely that juvenile or larvae sturgeon, which primarily occur in estuarine and riverine systems, would be exposed to sound and energy from explosives. Although sturgeon spend most of their time on the seafloor, resulting in potential exposures to detonations placed on the bottom or at depth, some individuals that occasionally move throughout the water column could also be exposed to surface or near surface munitions.

Explosive activities are generally dispersed in space and time. Although Gulf sturgeon are most likely to occur in nearshore coastal areas, training activities that involve the use of explosives would not occur in the inshore locations. However, some testing activities could occur close to shore in the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range. To avoid potential impacts during one activity that occurs close to shore in Gulf sturgeon habitat (line charge testing), the Navy will implement mitigation that includes avoiding line charge testing in nearshore waters in the Naval Surface Warfare Center, Panama City Division Testing Range (except within the designated location on Santa Rosa Island) between October and March. The mitigation would help avoid impacts from explosives during Gulf sturgeon migrations from the Gulf of Mexico winter and feeding grounds to the spring and summer natal (hatching) rivers (the Yellow, Choctawhatchee, and Apalachicola Rivers). Gulf sturgeon that travel beyond 12 NM from shore could also be exposed to explosives in the offshore portions of the Gulf of Mexico Range Complex. Most of the explosive munitions used in this area would be considered small and categorized in bin E5 (> 5–10 lb. NEW) or below. Although larger detonations could occur in this same location, they would be used much less often than smaller detonations.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), Gulf sturgeon that are co-located with explosive activities in these described areas may experience TTS, injury or mortality. The potential for masking from single or multiple detonations would be low due to the extremely brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, Gulf sturgeon are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. Although some individuals may be impacted, long-term consequences to ESA-listed Gulf sturgeon populations are not expected.

Much of the designated critical habitat for Gulf sturgeon are restricted to nearshore and riverine environments, with only a portion of the habitat that overlaps the marine environment within the Study Area. Specifically, designated critical habitat occurs within one mile of the coastline in the eastern Gulf of Mexico, including in the Panama City OPAREA, and at Gulfport, Mississippi. Military readiness activities that produce vessel, aircraft, and weapons noise, and those that use sonar, pile driving, and explosives could occur in the critical habitat. Air guns are not anticipated to occur within designated critical habitat. Most of the physical and biological features of the critical habitat are generally not applicable to the Study Area since they occur within the riverine habitat for this species. Features that do occur within the Study Area include abundant prey items (e.g., amphipods, polychaetes, gastropods), sediment quality, and safe and unobstructed migratory pathways within the marine portion of the habitat. However, sonars and the production of vessel, aircraft, and weapons noise would be infrequent and transient and would not impact the overall abundance and availability of prey items and would not prevent sturgeon from reaching important habitat features (i.e., act as a barrier for passage). Additionally, there are no pathways for effect from these stressors on sediment quality. Therefore, these acoustic stressors would have no effect on any of the physical and biological features that have been identified.

Although the use of pile driving within the critical habitat may affect a small number of prey items (i.e., injure or harm), a significant reduction in overall prey availability is not anticipated due to the small footprint, limited timeframe (20 days per year), and infrequent nature of pile driving activities. Additionally, all piles would be removed at the end of each activity, therefore any disturbance to the seafloor and sediment would be temporary. Sound produced during pile driving activities would be intermittent and short-term and would not act as a physical barrier or prevent access to important habitat features.

Explosions placed on the seafloor, such as those used during mine neutralization training or line charge testing, may result in disturbance of the sediment (i.e., craters). However, these activities are conducted in the nearshore, shallow waters of the Panama City OPAREA which consist of soft bottom habitats that are regularly disturbed by natural processes (e.g., waves and currents). Displaced sediment would be filled and smoothed by waves and long-shore currents over time. The time required to fill craters would depend on the size and depth, with deeper craters likely requiring more time to fill. Explosive activities could also injure or kill prey items. However, there are a low number of explosives used in this inshore location and the detonations used in this area are considered small (E5 [> 5–10 lb. NEW] or below). As displaced sediment is redistributed, the disturbed area would likely be recolonized by recruitment from the surrounding invertebrate community. Although some prey items may be impacted, long term population effects on invertebrate populations are not anticipated and there is unlikely to be a measurable reduction in abundance and availability of prey. Although gulf sturgeon may react to explosive activities, sound and energy from explosives would be brief, and dispersed in space and time, and would not act as a physical barrier or prevent access to important habitat features. The Action Proponents will implement mitigation that would prevent line charge testing in nearshore waters in the

Naval Surface Warfare Center, Panama City Division Testing Range (except within the designated location on Santa Rosa Island) between October and March when feeding subadult and adult gulf sturgeon would be present.

The use of sonar, explosives, and production of vessel, aircraft, and weapons noise may affect Gulf sturgeon. For training activities, the use of pile driving may affect Gulf sturgeon. For testing activities, the use of air guns may affect Gulf sturgeon.

The use of explosives during training and testing may affect designated critical habitat for gulf sturgeon. The use of pile driving during training activities may affect designated critical habitat for Gulf sturgeon. The use of sonars and production of vessel, aircraft, and weapons noise will have no effect on designated critical habitat for Gulf sturgeon. For testing activities, the use of air guns will have no effect on designated critical habitat for Gulf sturgeon.

4.3.5 Smalltooth Sawfish

Although historical data indicate that smalltooth sawfish could occur as far north as Cape Hatteras, North Carolina and throughout the Gulf of Mexico, new data suggest they would typically be present in Southern Florida region including the nearshore portions of the Key West Range Complex and the South Florida Ocean Measurement Facility. Although less likely, smalltooth sawfish could also occur in western portion of the Gulf of Mexico Range Complex (i.e., the Naval Surface Warfare Center, Panama City Division Testing Range) and the southernmost portion of the Jacksonville Range Complex. Juvenile and adult smalltooth sawfish typically inhabit shallow estuarine and marine waters though some individuals may be present in waters up to 120 m depth.

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although smalltooth sawfish could be exposed to sonar, vessel, aircraft, or weapons noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, these substressors are not analyzed further.

Although smalltooth sawfish may be exposed to sound from air guns associated with testing activities, exposures would only occur in the Gulf of Mexico Range Complex, with a low probability of exposure in the Jacksonville Range Complex. As summarized in Table 4.2-1, air guns would only be used on average in a maximum year up to 12 days in the offshore portion of the Gulf of Mexico Range Complex. Due to the isolated and infrequent use of air guns, exposures to air guns would be minimal. Furthermore, based on the small, estimated ranges (see Section 4.4.2, Range to Effects for Air Guns), mortality, injury, and TTS are highly unlikely to occur. If exposures occur, smalltooth sawfish may exhibit impacts such as behavioral reactions or physiological response depending on their proximity to the activity. Masking effects are unlikely from single air gun pulses due to the short pulse length but may occur at farther distances from the source (100s of meters) if multiple shots were fired in succession and the signal was detectable above ambient noise levels. Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Pile driving activities conducted in Gulfport, Mississippi, have the potential to overlap areas where smalltooth sawfish could occur. However, smalltooth sawfish primarily occur in southern Florida therefore co-occurrence with pile driving during the limited time pile driving activities occur (up to 20 days per year) would be unlikely. If some individuals are present during pile driving activities, and assuming sawfish may behave similarly to other resident or demersal fishes in nearshore areas, there is the potential for smalltooth sawfish to be exposed to pile driving for longer durations compared to species that are more migratory and may transit through the area. However, considering the small, estimated ranges to effect for injury and mortality, even from a full day of pile driving (see Section 4.4.3, Range to Effects for Pile Driving), it is unlikely smalltooth sawfish would be injured during this activity. Although TTS could occur for smalltooth sawfish within 21 m of impact pile driving, sawfish would need to remain within this range during all impact pile driving (up to four piles in a day) to receive this effect. Furthermore, the use of soft start procedures would reduce any of these effects as smalltooth sawfish would likely avoid the immediate area as the activity ramps up. More likely, some minor behavioral reactions (e.g., increasing their swimming speed, moving away from the source, or not responding at all), physiological stress, or masking may occur during impact or vibratory pile driving activities. Such effects would be expected to be brief, lasting the duration it takes to drive a pile, and would only occur a maximum of 20 days in a year. Additionally, masking from impulsive sounds from impact pile driving would be low due to the extremely brief duration of each individual impulse. More likely, masking effects could occur during installation or removal of piles using vibratory methods. However, these effects would be limited to the time the vibratory hammer is operated (several minutes at most) during which the pile driving noise could temporarily limit the distance over which fishes can communicate or detect important signals, or sawfish may respond by altering their vocalizations to compensate for the noise. Overall, these reactions are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Smalltooth sawfish could be exposed to sound and energy from explosives associated with training activities throughout the year in the Key West and the Gulf of Mexico Range Complexes. There is also a small probability that smalltooth sawfish could occur in southern portions of the Jacksonville Range Complex, but this would be a very rare occurrence as smalltooth sawfish primarily occur in southern Florida. Typically, adult sawfish are known to spend more of their time in shallow habitats than in deeper waters.

Explosive activities are generally dispersed in space and time. Smalltooth sawfish are most likely to occur in nearshore coastal areas, however, very few training activities would be conducted in the Key West Range Complex Inshore, limiting potential overlap with this stressor. Specifically, exposures could occur in Mayport and Port Canaveral, FL, Key West Range Complex Inshore, and the Naval Surface Warfare Center, Panama City Division Testing Range. Detonations in each of these areas are considered small E5 (> 5–10 lb. NEW).

Although unlikely, smalltooth sawfish that travel beyond 12 NM from shore could also be exposed to explosives in the offshore portions of the Key West and Gulf of Mexico Range Complexes, with exposures in the Jacksonville Range Complex considered so unlikely as to be discountable. Most of the explosive munitions used in the Key West and Gulf of Mexico Range complexes would be considered small and categorized in bin E5 (> 5–10 lb. NEW) or below. Although larger detonations could occur in these same locations, they would be used much less often than smaller detonations.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), smalltooth sawfish that are co-located with explosive activities in these described areas may experience TTS, injury or mortality. The potential for masking from single or multiple detonations would be low due to the brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, smalltooth sawfish are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. Although some individuals may be impacted, long-term consequences to smalltooth sawfish populations are not expected.

Designated critical habitat for smalltooth sawfish is restricted to nearshore, shallow waters (less than 1 m) around the tip of Florida and does not overlap areas where acoustic and explosive stressors are used.

The use of sonars, explosives, and production of vessel, aircraft, and weapons noise may affect smalltooth sawfish. The use of pile driving for training activities and air guns for testing activities may affect smalltooth sawfish.

The use of sonars, air guns, pile driving, explosives, and production of vessel, aircraft, and weapons noise during training and testing activities is not applicable to designated critical habitat for smalltooth sawfish due to lack of geographic overlap with the stressors.

4.3.6 Giant Manta Ray

Giant manta rays could occur throughout the Study Area. Specifically, manta rays would occur along the continental shelf and offshore near oceanic islands, pinnacles, and seamounts. Though some manta rays have been observed in estuarine waters near oceanic inlets, they are much less likely to occur in the inshore waters associated with the Navy range complexes compared to other portions of the Study Area. Recent seasonal aggregations of feeding and breeding manta rays have also been observed along the east coast of Florida and southern Georgia from March through May. Giant manta rays can occur throughout the water column or along the seafloor in water depth ranging from approximately 10 to 1000 m. Known age classes that could be present in the Study Area include young of the year, juveniles, and adults during migrating, foraging, and mating.

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although giant manta rays could be exposed to sonar, vessel, aircraft, or weapons noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, these substressors are not analyzed further.

Giant manta rays could be exposed to sound from air guns associated with testing activities throughout the Study Area. Specifically, most air guns would be used beyond 12 NM from shore in the Northeast, Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes. Pier side testing activities that use air guns would have no impact on giant manta rays due to the lack of overlap with suitable habitat. As summarized in Table 4.2-1, air guns would only be used on average in a maximum year up to 12 days in each offshore area. Due to the isolated and infrequent use of air guns, exposures to air guns would be minimal. Furthermore, based on the small (see Section 4.4.2, Range to Effects for Air Guns), estimated ranges, mortality, injury, and TTS are highly unlikely to occur. If exposures occur, manta rays may exhibit impacts such as behavioral reactions or physiological response depending on their proximity to the activity. Masking effects are unlikely from single air gun pulses due to the short pulse length but may occur at farther distances from the source (100s of meters) if multiple shots were fired in succession and the signal was detectable above ambient noise levels. Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Pile driving activities conducted in Gulfport, Mississippi, and have the potential to overlap areas where giant manta rays could occur. Assuming giant manta rays would behave similarly to other transitory or migratory fishes in nearshore areas, potential exposures would be brief (a few minutes) as they move through the area, minimizing the potential impacts. Based on the estimated ranges to effect (see Section 4.4.3, Range to Effects for Pile Driving), it is unlikely that giant manta rays would experience mortality, injury or TTS. However, if giant manta rays are present during pile driving operations, the use of soft start procedures would reduce any of these effects as they would likely avoid the immediate area as the activity ramps up. Impacts, if they occur, would be limited to some minor behavioral reactions (e.g., increasing their swimming speed, moving away from the source, or not responding at all), physiological stress, or masking may occur during impact or vibratory pile driving activities. Such effects would be expected to be brief, lasting the duration it takes to drive a pile, and would only occur a maximum of 20 days in a year. Additionally, masking from impulsive sounds from impact pile driving would be low due to the very brief duration of each individual impulse. More likely, masking effects could occur during installation or removal of piles using vibratory methods. However, these effects would be limited to the time the vibratory hammer is operated (several minutes at most) during which the pile driving noise could temporarily limit the distance over which fishes can communicate or detect important signals. Overall, these reactions are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Giant manta rays could be exposed to sound and energy from explosives associated with military readiness activities throughout the Study Area, including seasonal aggregations of manta rays known to occur in the Jacksonville Range Complex and the Cape Canaveral OPAREA from March through May each year. Although giant manta rays could occur in nearshore coastal areas, there are very few military readiness activities that involve the use of explosives in the inshore locations compared to the offshore portions of the Navy’s range complexes. Most of the explosive munitions used throughout the Study Area would be considered small (E5 (> 5–10 lb. NEW) or below). Although larger detonations could occur, they would be used much less often than smaller detonations. Large detonations would also typically occur > 12 NM from shore, which would not overlap areas where manta rays have been observed feeding and breeding off the coast of Florida (within 8 km from shore). Though some smaller detonations could occur in this portion of the study area under Semi-Stationary Equipment Testing activities, this activity would only be conducted a few times over seven years, if at all.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), giant manta rays that are co-located with explosive activities (including Ship Shock Trials) in these described areas may experience TTS, injury or mortality. Although Ship Shock Trials are conducted in offshore areas where giant manta rays may occur (beyond 12 NM from shore), these activities would be conducted no more than five times over a seven-year period, therefore reducing the probability of exposure. The potential for masking from single or multiple detonations would be low due to the extremely brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, giant manta rays are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. If a school of giant manta rays were present within the vicinity of an explosive, this could result in a larger number of individuals affected depending on their proximity to the source. Although some individuals may be impacted, long-term consequences to ESA-listed giant manta ray populations are not expected.

The use of sonars, explosives, and production of vessel, aircraft, and weapons noise <u>may affect</u> giant manta ray. The use of pile driving during training activities and air guns during testing activities <u>may affect</u> giant manta ray.

4.3.7 Nassau Grouper

Nassau grouper only occur in coastal areas within the southern portion of the Study Area between Florida and Puerto Rico. Specifically, Nassau grouper could occur throughout the Key West Range Complex, Key West Range Complex Inshore, and along the east coast of Florida including the South Florida Ocean Measurement Facility and possibly as far north as Port Canaveral, Florida. Preferred habitat for adult grouper includes coastal coral reefs and rocky bottom in water depths less than 100 m. Larval groupers are pelagic and could typically occur in open ocean environments. Nassau grouper are benthic oriented and solitary outside of spawning aggregations.

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although Nassau grouper could be exposed to sonar and vessel and noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. As a benthic species, Nassau grouper would unlikely be exposed to aircraft or weapons noise. Therefore, these substressors are not analyzed further. Furthermore, Nassau grouper would not occur in areas where air guns or pile driving are conducted and therefore would not be impacted by these activities.

Nassau grouper could be exposed to sound and energy from explosives associated with military readiness activities throughout the year in the southern portion of the Study Area. Specifically, exposures would be limited to the Key West Range Complex and at Port Canaveral, Florida. However, there are very few activities that utilize explosives in this portion of the Study Area compared to other locations. Additionally, Semi-Stationary Equipment Testing activities in Port Canaveral would only be conducted two to three times at one of several locations over a seven-year period, limiting potential impacts to Nassau grouper in this area. Most military readiness activities in the Key West Range Complex would occur beyond 12 NM from shore, beyond areas where Nassau grouper typically are present. One exception would be some mine neutralization activities that occur in the Key West Range Complex inshore location; however, these activities would only use small explosive detonations (E5 (> 5–10 lb. NEW) or below). Nassau grouper that are present in areas where explosives are used would occur on the seafloor (i.e., preferred coral or rocky habitat) and therefore would unlikely experience injurious effects from surface or near surface detonations. Furthermore, Nassau grouper that occur on or near reefs would be protected from exposure due to mitigation measures that prevent explosives on seafloor resources (see the *Mitigation* section for details). Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals. Overall, due to the limited overlap of Nassau grouper habitat and areas where explosive munitions would be used, impacts to Nassau grouper would be so unlikely as to be discountable.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), in the unlikely event Nassau grouper are co-located with explosive activities in these described areas, they may experience TTS, injury or mortality. The potential for masking from single or multiple detonations would be low due to the extremely brief duration of an individual detonation. More likely, if exposures occur, they could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, Nassau grouper are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. Although some individuals may be impacted, long-term consequences to ESA-listed Nassau grouper populations are not expected.

Designated critical habitat for Nassau grouper are limited to coastal and coral reef habitats around the south of Florida and Florida Keys and does not overlap areas where air guns, pile driving, aircraft overflights, or weapons firing occur. Military readiness activities involving the use of sonars, explosives, and those that produce vessel noise may overlap designated critical habitat in some inshore locations (e.g., near the South Florida Ocean Management Facility Testing Range, Key West OPAREA, or the Key West Range Complex Inshore). However, there is no pathway for sonar or vessel noise to affect the physical and biological features (i.e., substrate type and composition) associated with this habitat. Although explosives have the potential to alter some physical features, impacts would be avoided or reduced due to existing mitigation areas that limit in-water explosives on sensitive habitat types (e.g., shallow-water coral reefs, live hard bottom).

The use of sonars, explosives, and production of vessel, aircraft, and weapons noise may affect Nassau grouper. The use of air guns during testing activities and pile driving during training activities is not applicable to Nassau grouper due to lack of geographic overlap with the stressors.

The use of explosives during military readiness activities may affect designated critical habitat for Nassau grouper. The use of sonars and production of vessel, aircraft, and weapons noise during training and testing will have no effect on designated critical habitat for Nassau grouper. The use of air guns during testing activities and pile driving during training activities is not applicable to designated critical habitat for Nassau grouper due to lack of geographic overlap with the stressors.

4.3.8 Oceanic Whitetip Shark

Oceanic whitetip sharks could occur throughout the Study Area. Although they are occasionally sighted in nearshore waters and along the continental shelf, they are typically found in deep, open-ocean environments. As such, oceanic whitetip sharks would not be expected to occur in any of the inshore locations associated with the Navy's range complexes. Typically, oceanic whitetip sharks are found in warmer waters in the southern portions of the Study Area (e.g., the Gulf of Mexico, Key West, and Jacksonville Range Complexes) with occasional seasonal migrations to higher latitudes in the summer (e.g., the Virginia Capes and potentially as far as the Northeast Range Complexes). Oceanic whitetip sharks are surface oriented though they may also travel to deeper depths at night. Known age classes that could be present in the southern portion of the Study Area include young of the year, juveniles, and adults.

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although oceanic whitetip sharks could be exposed to sonar, vessel, aircraft, or weapons noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, these substressors are not analyzed further. Additionally, oceanic whitetip sharks would not occur in areas where pile driving is conducted and therefore would not be impacted by these activities.

Oceanic whitetip sharks could be exposed to sound from air guns associated with testing activities throughout the Study Area. Specifically, most air guns would be used beyond 3 NM from shore in the Northeast, Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes. Oceanic whitetip sharks in deeper waters spend much of their time at the surface, potentially increasing the risk of exposure to air guns towed or suspended from vessels. Pier side testing activities that use air guns would have no impact on oceanic whitetip sharks due to the lack of overlap with suitable habitat. As summarized in Table 4.2-1, air guns would only be used on average in a maximum year up to 12 days in each offshore area. Due to the isolated and infrequent use of air guns, exposures to air guns would be minimal. Furthermore, based on the small, estimated ranges (see Section 4.4.2, Range to Effects for Air Guns), mortality, injury, and TTS are highly unlikely to occur. If exposures occur, whitetip sharks may exhibit impacts such as behavioral reactions or physiological response depending on their proximity to the activity. Masking effects are unlikely from single air gun pulses due to the short pulse length but may occur at farther distances from the source (100s of meters) if multiple shots were fired in succession and the signal was detectable above ambient noise levels. Masking at greater distances from the source could temporarily limit the distance over which fishes can communicate or detect important signals. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding, or sheltering, and are unlikely to lead to injury.

Oceanic whitetip sharks could be exposed to sound and energy from explosives associated with military readiness activities throughout the offshore portions of the Study Area. Oceanic whitetip sharks in deeper, offshore waters spend much of their time at the surface, potentially increasing the risk of exposure to surface detonations. However, military readiness explosive activities are generally dispersed in space and time potentially reducing the overall likelihood of overlap with individuals. Most of the explosive munitions used throughout the Study Area would be considered small (E5 (> 5–10 lb. NEW) or below). Although larger detonations could occur, they would be used much less often than smaller detonations.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), oceanic whitetip sharks that are co-located with explosive activities (including Ship Shock Trials) in these described areas may experience TTS, injury or mortality. Although Ship Shock Trials are conducted in offshore areas where oceanic whitetip sharks may occur, these activities would be conducted no more than five times over a seven-year period, therefore reducing the probability of exposure to these large detonations. The potential for masking from single or multiple detonations would be low due to the brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, Oceanic whitetip sharks are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. If a school of sharks were present within the vicinity of an explosive, this could result in a larger number of individuals affected depending on their proximity to the source. Although some individuals may be impacted, long-term consequences to ESA-listed Oceanic whitetip shark populations are not expected.

The use of sonars, explosives, and production of vessel, aircraft, and weapons noise during training and testing activities <u>may affect</u> oceanic whitetip sharks. The use of air guns during testing activities <u>may affect</u> oceanic whitetip sharks. The use of pile driving is <u>not applicable</u> to oceanic whitetip sharks due to lack of geographic overlap with the stressor.

4.3.9 Scalloped Hammerhead Shark

The Central and Southwest Atlantic DPS of scalloped hammerhead shark only occurs in the southern part of the Study Area and in the vicinity of Puerto Rico. Specifically, scalloped hammerhead sharks could occur in the Key West Range Complex and the South Florida Ocean Measurement Facility, and potentially in the southern portion of the high seas. Both juvenile and adult scalloped hammerhead sharks could occur in these portions of the Study Area. Scalloped hammerhead sharks are known to school and are largely surface oriented but may occur at deeper depths at night.

As analyzed in Section 4.2 (Impacts Due to Each Acoustic Substressor and Explosives), although scalloped hammerhead sharks could be exposed to sonar, vessel, aircraft, or weapons noise, impacts would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, these substressors are not analyzed further. Additionally, scalloped hammerhead sharks would not occur in areas where air guns or pile driving are conducted and therefore would not be impacted by these activities.

Scalloped hammerhead sharks could also be exposed to sound and energy from explosives associated with military readiness activities in the offshore portions of the Key West Range Complex. However, the concentration of explosive use in this portion of the Study Area is very low compared to other locations, and explosive activities are generally dispersed in space and time, further limiting the potential for exposures to individual scalloped hammerhead sharks. Most of the explosive munitions used throughout the Study Area would be considered small (E5 (> 5–10 lb. NEW) or below). Although larger detonations could occur, they would be used much less often than smaller detonations.

Based on the estimated ranges in Section 4.4.4 (Range to Effects for Explosives), scalloped hammerhead sharks that are co-located with explosive activities in these described areas may experience TTS, injury or mortality. The potential for masking from single or multiple detonations would be low due to the brief duration of an individual detonation. More likely, exposures could lead to physiological response or behavioral reactions. Due to the short duration of explosives, dispersed and infrequent use throughout the ranges, scalloped hammerhead sharks are not likely to be exposed multiple times within a short period and any physiological response or behavioral reactions that do occur are anticipated to be brief (seconds to minutes) and insignificant. If a school of sharks were present within the vicinity of an explosive, this could result in a larger number of individuals affected depending on their proximity to the source. Although some individuals may be impacted, long-term consequences to ESA-listed scalloped hammerhead shark populations are not expected.

The use of sonars, explosives, and production of vessel, aircraft, and weapons noise during military readiness activities may affect scalloped hammerhead sharks. The use of air guns during testing activities and the use of pile driving under training activities is not applicable to scalloped hammerhead sharks due to lack of geographic overlap with the stressor.

4.4 Range to Effects

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the acoustic and explosive criteria in Section 4.1 (Quantifying Impacts on Fishes from Acoustic and Explosive Stressors), and the acoustic and explosive propagation calculations from the Navy Acoustic Effects Model described in the *Quantitative Analysis TR*. The ranges to effects are shown for representative sonar systems, air guns, and explosive bins from E1 (0.1–0.25 lb. NEW) to E16 (>7,500–14,500 lb. NEW). Ranges are determined by modeling the distance that noise from a source will need to propagate to reach exposure level thresholds specific to a fish hearing group or category that will cause TTS, injury, and mortality. Ranges to effects are utilized to help predict impacts from acoustic and explosive sources.

Tables present median and standard deviation ranges to effects for each fish hearing group or category, source or bin, bathymetric depth intervals of ≤200 m and >200 m to represent areas on an off the continental shelf, exposure duration (sonar), and representative cluster size (air guns and explosives). Ranges to effects consider propagation effects of sources modeled at different locations (i.e., analysis points), seasons, source depths, and radials (i.e., each analysis point considers propagation effects in different x-y directions by modeling 18 radials in azimuthal increments of 20° to obtain 360° coverage around an analysis point). The exception to this is ranges to effects for pile driving, which were calculated outside of the Navy Acoustic Effects Model, do not have variance in ranges, and are not presented as a summary statistic (e.g., median and standard deviation).

Boxplots visually present the distribution, variance, and outlier ranges for a given combination of a source or bin, fish hearing group or category, and effect. On the boxplots, outliers are plotted as dots, the lowest and highest non-outlier ranges are the extent of the left and right horizontal lines respectively that extend from the sides of a colored box, and the 25^{th}, 50^{th} (i.e., median), and 75^{th} percentiles are the left edge, center line, and right edge of a colored box respectively.

4.4.1 Range to Effects for Sonar and Other Transducers

The six representative sonar systems with ranges to effects are not applicable to fishes since they produce sound at frequencies greater than the upper hearing range of most fishes (i.e., > 2 kHz).

4.4.2 Range to Effects for Air Guns

Ranges to effects for air guns were determined by modeling the distance that sound would need to propagate to reach exposure level thresholds specific to a fish hearing group or category that would cause TTS, injury, and mortality as described in Section 4.1 (Quantifying Impacts on Fishes from Acoustic and Explosive Stressors). Air gun ranges for injury and mortality are SPL- and SEL-based.

Table 4.4-1: Fishes Ranges to Effects for Air Guns (SPL-based)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	< 6 m (1 m)	< 6 m (1 m)
	>200 m	1	NA	< 5 m (1 m)	< 5 m (1 m)
Hearing Generalists	≤200 m	1	< 6 m (1 m)	< 13 m (2 m)	< 13 m (2 m)
	>200 m	1	< 5 m (1 m)	< 12 m (2 m)	< 12 m (2 m)
Hearing Specialists with High-Frequency Hearing	≤200 m	1	6 m (1 m)	< 13 m (2 m)	< 13 m (2 m)
	>200 m	1	5 m (1 m)	< 12 m (2 m)	< 12 m (2 m)

-INJ and MORT are SPL-based
-TTS ranges for fishes with a swim bladder only and are SEL-based
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

Table 4.4-2: Fishes Ranges to Effects for Air Guns (SEL-based)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	0 m (0 m)	0 m (0 m)
	>200 m	1	NA	0 m (0 m)	0 m (0 m)
Hearing Generalists	≤200 m	1	< 6 m (1 m)	0 m (0 m)	0 m (0 m)
	>200 m	1	< 5 m (1 m)	0 m (0 m)	0 m (0 m)
Hearing Specialists with High-Frequency Hearing	≤200 m	1	6 m (1 m)	0 m (0 m)	0 m (0 m)
	>200 m	1	5 m (1 m)	0 m (0 m)	0 m (0 m)

-INJ and MORT are SEL-based
-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

4.4.3 Range to Effects for Pile Driving

Ranges to effects for impact pile driving were determined by modeling the distance that sound would need to propagate to reach exposure level thresholds specific to a fish hearing group or category that would cause TTS, injury, and mortality as described in Section 4.1.2 (Quantifying Injury and Hearing Impacts from Air Guns and Pile Driving). Ranges to effects below were estimated using sound levels for timber or plastic round piles up to 16-inches (Caltrans, 2020). Sound exposure criteria are not available for piles driven using the vibratory method, therefore ranges to effects for piles using this method are not available. Modeling for pile driving was done outside of the Navy's Acoustic Affects Model (see the *Quantitative Analysis TR* for details). The pile driving ranges for injury and mortality are SPL- and SEL-based.

Table 4.4-3: Ranges to Effects for Impact Pile Driving for Resident Fishes (1 Day)

Fish Category	Range to Effects (meters)				
	Onset of Mortality		Onset of Injury		TTS
	cSEL	Peak SPL	cSEL	Peak SPL	cSEL
Fishes without a swim bladder	0	0	0	0	0
Fishes with a swim bladder not involved in hearing	1	0	2	0	< 21
Fishes with a swim bladder involved in hearing and high-frequency hearing	1	0	2	0	21

Notes: cSEL = Cumulative sound exposure level, peak SPL = Peak sound pressure level, TTS = Temporary Threshold Shift, NR = no criteria are available and therefore no range to effects are estimated, < indicates that the range to effects would be less than the provided value.

4.4.4 Range to Effects for Explosives

Ranges to effects for explosives were determined by modeling the distance that sound would need to propagate to reach exposure level thresholds specific to a fish hearing group or category that would cause TTS, injury, and mortality as described in Section 4.1 (Quantifying Impacts on Fishes from Acoustic and Explosive Stressors). The explosive ranges for injury and mortality are SPL-based and ranges for TTS are SEL-based.

4.4.4.1 Bin E1 (0.1 - 0.25 lb. NEW)

Table 4.4-4: Fishes Ranges to Effects for E1 (0.1 - 0.25 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	117 m (9 m)	44 m (6 m)
	>200 m	1	NA	116 m (6 m)	44 m (6 m)
Hearing Generalists	≤200 m	1	< 55 m (8 m)	117 m (9 m)	44 m (6 m)

Group	Depth	Cluster Size	TTS	INJ	MORT
		25	< 242 m (20 m)	NA	NA
		100	< 451 m (50 m)	NA	NA
	>200 m	1	< 2 m (23 m)	116 m (6 m)	44 m (6 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

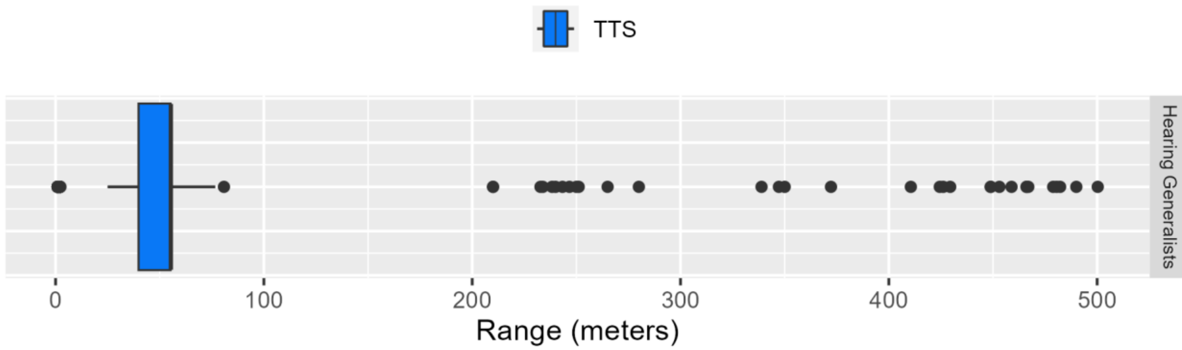

Figure 4.4-1: Fishes Ranges to Temporary Threshold Shift for E1 (0.1 - 0.25 lb.)

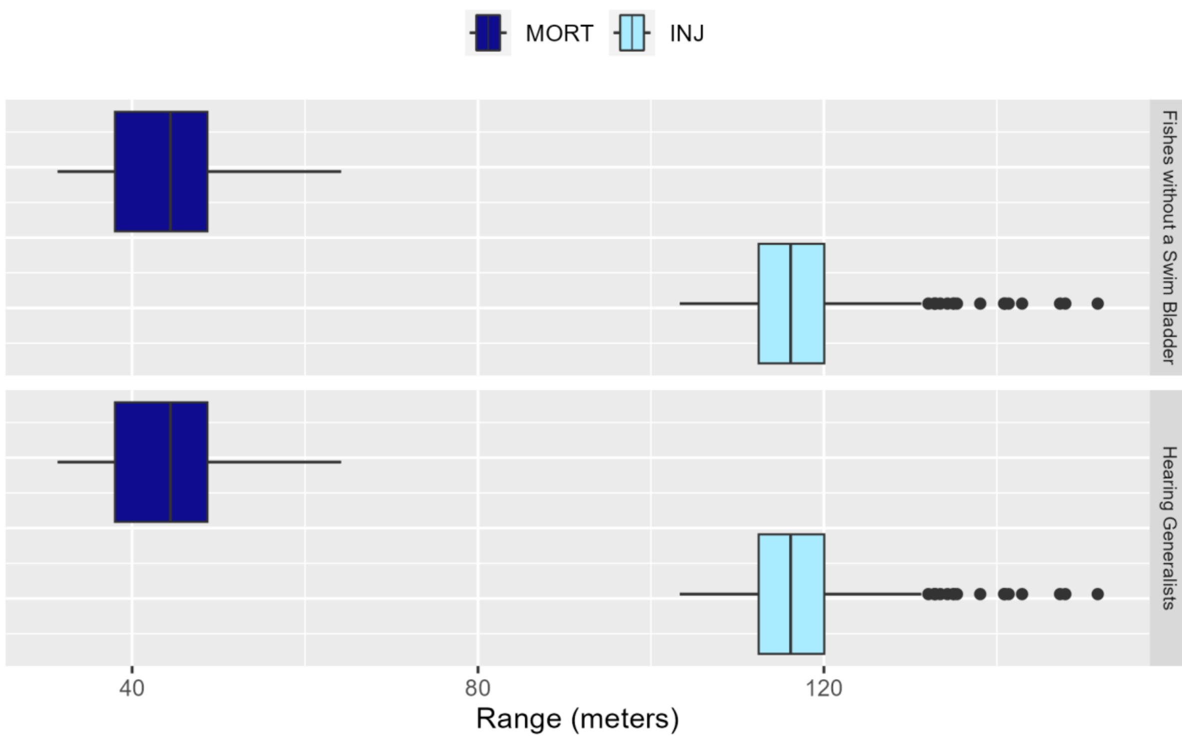

Figure 4.4-2: Fishes Ranges to Mortality and Injury for E1 (0.1 - 0.25 lb.)

4.4.4.2 Bin E2 (>0.25 - 0.5 lb. NEW)

Table 4.4-5: Fishes Ranges to Effects for E2 (>0.25 - 0.5 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	113 m (0 m)	51 m (0 m)
Hearing Generalists		1	< 65 m (0 m)	113 m (0 m)	51 m (0 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

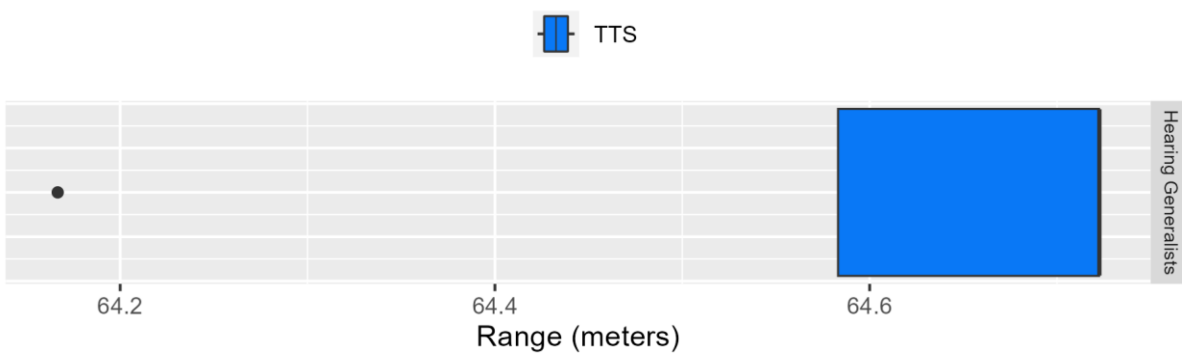

Figure 4.4-3: Fishes Ranges to Temporary Threshold Shift for E2 (>0.25 - 0.5 lb.)

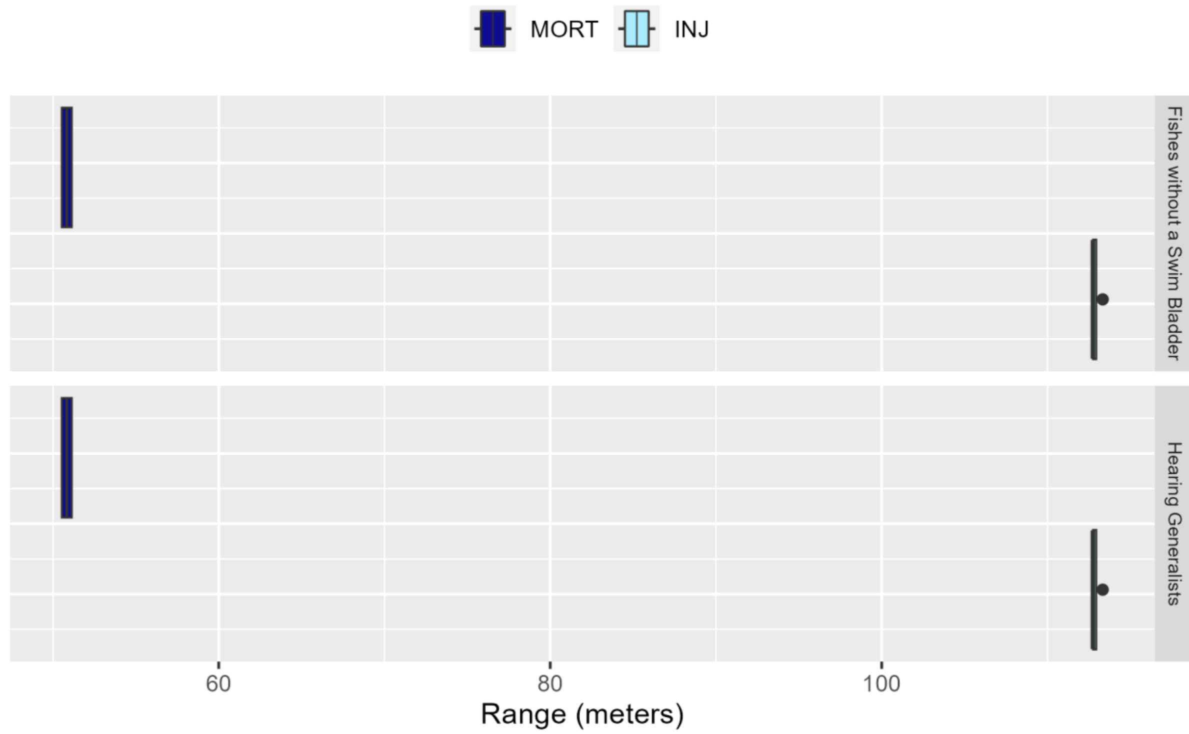

Figure 4.4-4: Fishes Ranges to Mortality and Injury for E2 (>0.25 - 0.5 lb.)

4.4.4.3 Bin E3 (>0.5 - 2.5 lb. NEW)

Table 4.4-6: Fishes Ranges to Effects for E3 (>0.5 - 2.5 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	256 m (19 m)	98 m (6 m)
	>200 m	1	NA	253 m (18 m)	98 m (5 m)
Hearing Generalists	≤200 m	1	< 110 m (46 m)	256 m (19 m)	98 m (6 m)
		10	< 300 m (39 m)	NA	NA
	>200 m	1	< 95 m (28 m)	253 m (18 m)	98 m (5 m)
		10	< 260 m (7 m)	NA	NA

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

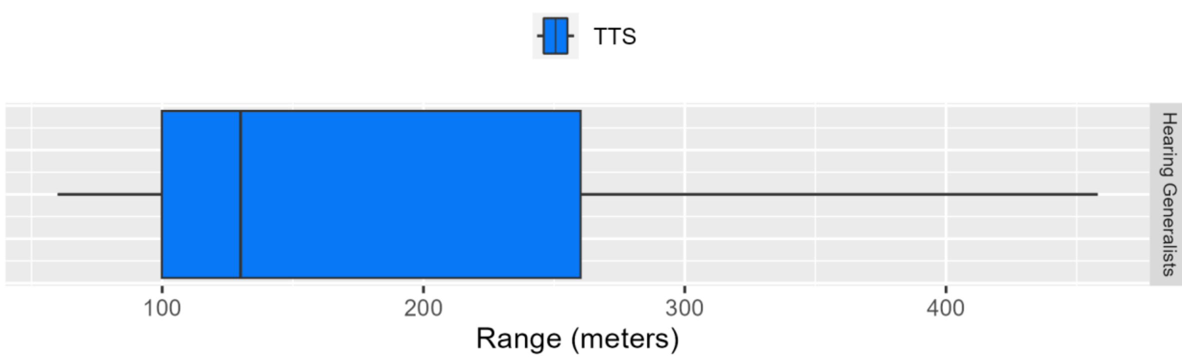

Figure 4.4-5: Fishes Ranges to Temporary Threshold Shift for E3 (>0.5 - 2.5 lb.)

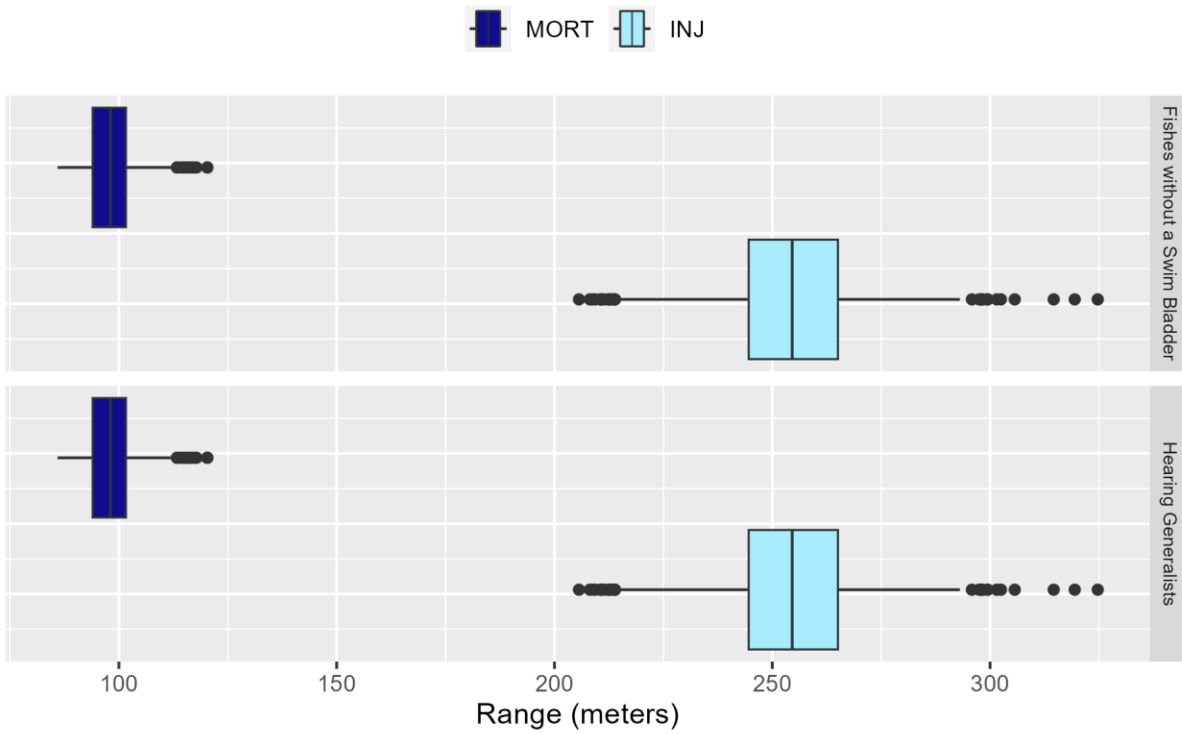

Figure 4.4-6: Fishes Ranges to Mortality and Injury for E3 (>0.5 - 2.5 lb.)

4.4.4.4 Bin E4 (>2.5 - 5 lb. NEW)

Table 4.4-7: Fishes Ranges to Effects for E4 (>2.5 - 5 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	440 m (36 m)	159 m (11 m)
	>200 m	1	NA	434 m (36 m)	157 m (12 m)
Hearing Generalists	≤200 m	1	< 304 m (99 m)	440 m (36 m)	159 m (11 m)
	>200 m	1	< 180 m (18 m)	434 m (36 m)	157 m (12 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

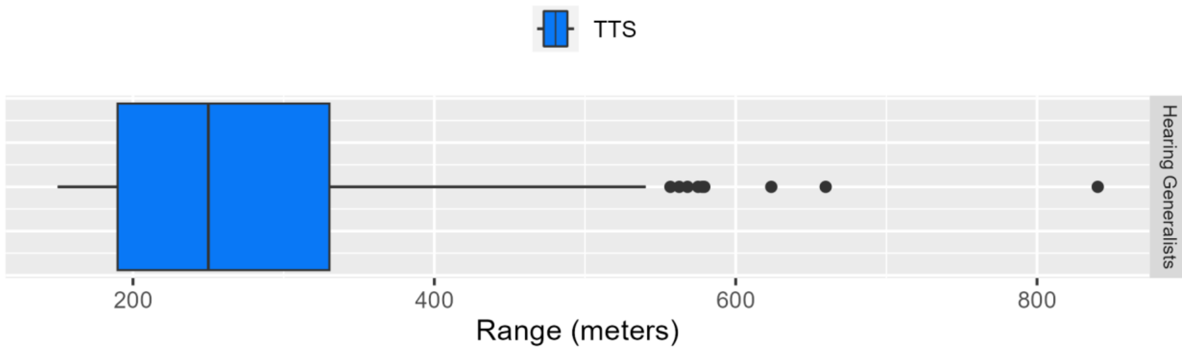

Figure 4.4-7: Fishes Ranges to Temporary Threshold Shift for E4 (>2.5 - 5 lb.)

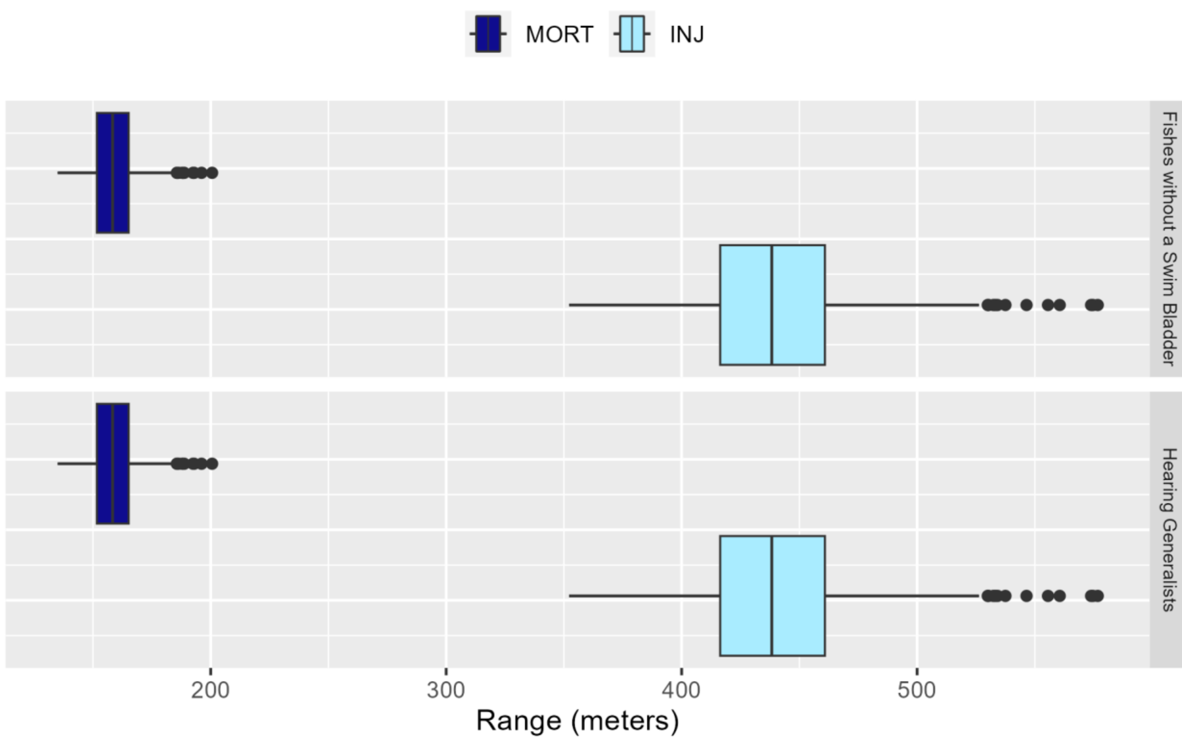

Figure 4.4-8: Fishes Ranges to Mortality and Injury for E4 (>2.5 - 5 lb.)

4.4.4.5 Bin E5 (>5 - 10 lb. NEW)

Table 4.4-8: Fishes Ranges to Effects for E5 (>5 - 10 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	362 m (28 m)	154 m (8 m)
	>200 m	1	NA	366 m (35 m)	154 m (10 m)
Hearing Generalists	≤200 m	1	< 174 m (171 m)	362 m (28 m)	154 m (8 m)
		8	< 430 m (64 m)	NA	NA
	>200 m	1	< 140 m (7 m)	366 m (35 m)	154 m (10 m)
		8	< 375 m (6 m)	NA	NA

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

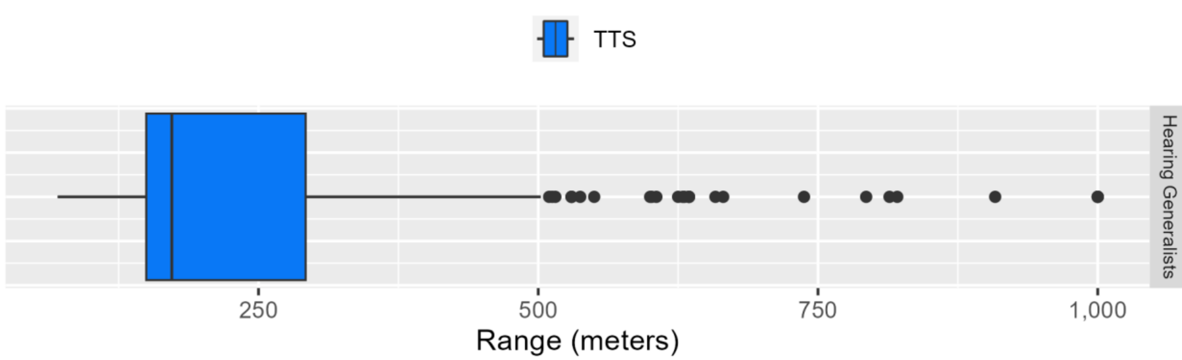

Figure 4.4-9: Fishes Ranges to Temporary Threshold Shift for E5 (>5 - 10 lb.)

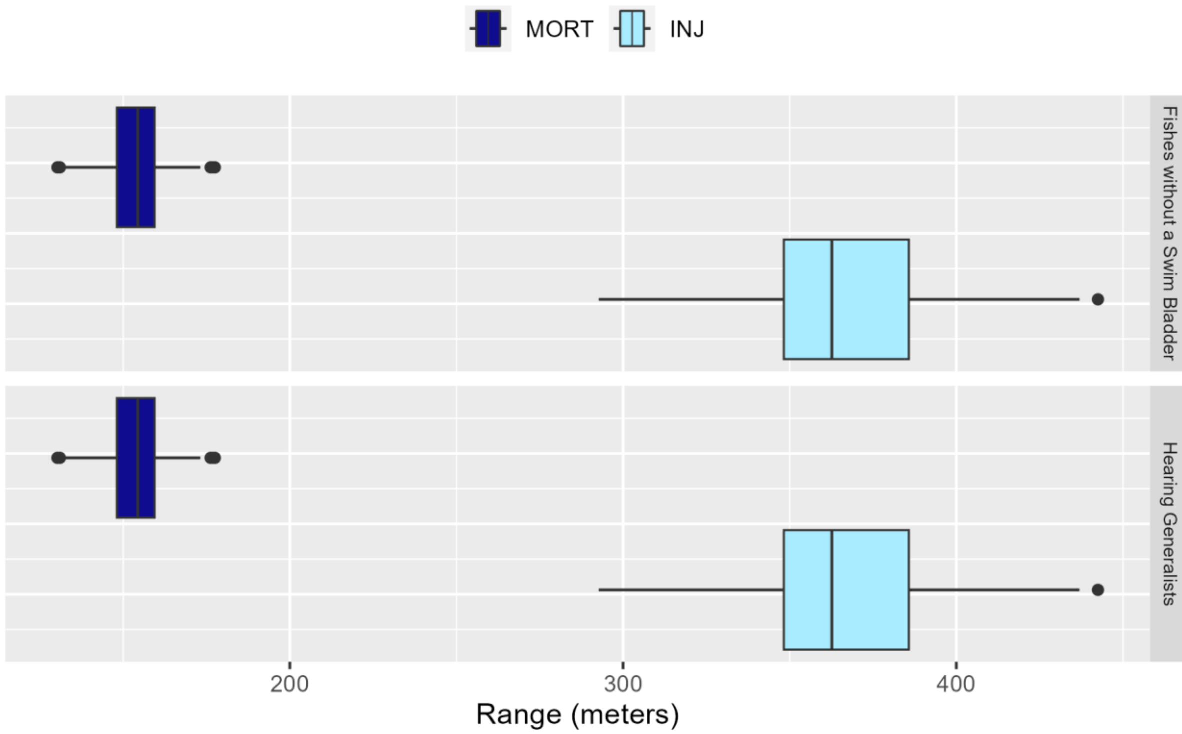

Figure 4.4-10: Fishes Ranges to Mortality and Injury for E5 (>5 - 10 lb.)

4.4.4.6 Bin E6 (>10 - 20 lb. NEW)

Table 4.4-9: Fishes Ranges to Effects for E6 (>10 - 20 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	535 m (60 m)	212 m (19 m)
	>200 m	1	NA	551 m (43 m)	213 m (13 m)
Hearing Generalists	≤200 m	1	< 258 m (284 m)	535 m (60 m)	212 m (19 m)
		4	< 449 m (53 m)	NA	NA
	>200 m	1	< 180 m (78 m)	551 m (43 m)	213 m (13 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

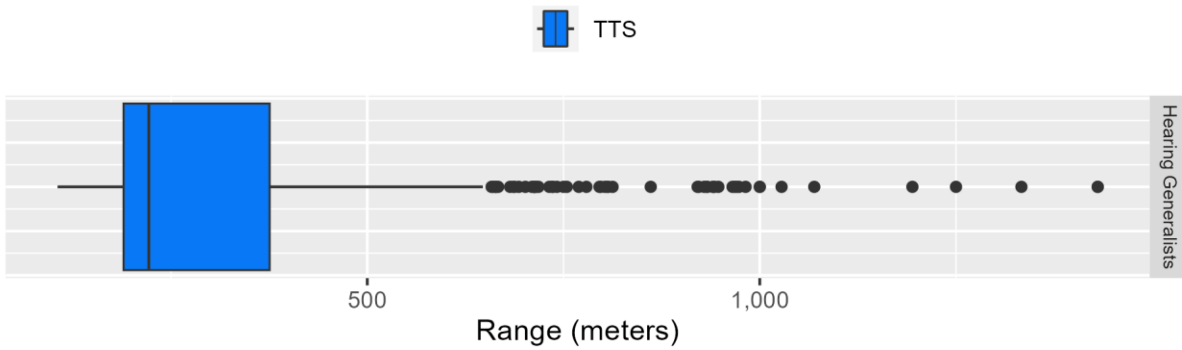

Figure 4.4-11: Fishes Ranges to Temporary Threshold Shift for E6 (>10 - 20 lb.)

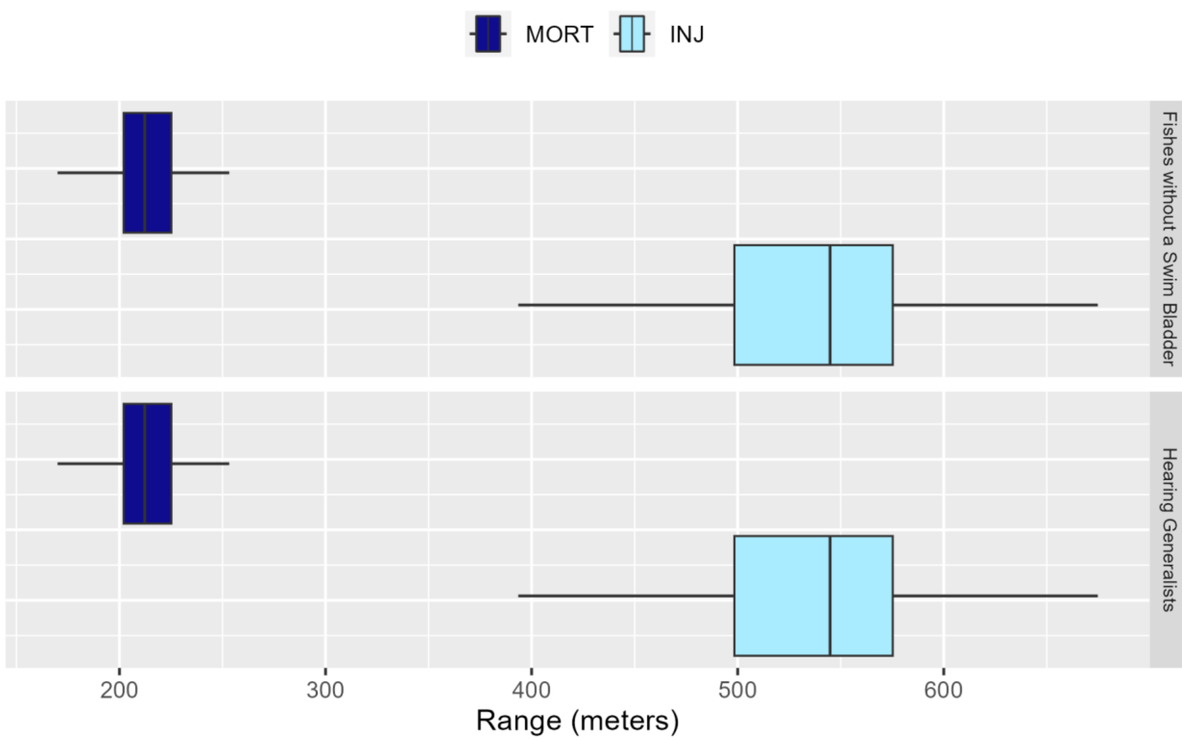

Figure 4.4-12: Fishes Ranges to Mortality and Injury for E6 (>10 - 20 lb.)

4.4.4.7 Bin E7 (>20 - 60 lb. NEW)

Table 4.4-10: Fishes Ranges to Effects for E7 (>20 - 60 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	639 m (59 m)	276 m (14 m)
	>200 m	1	NA	642 m (58 m)	266 m (16 m)
Hearing Generalists	≤200 m	1	< 411 m (58 m)	639 m (59 m)	276 m (14 m)
	>200 m	1	< 406 m (64 m)	642 m (58 m)	266 m (16 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

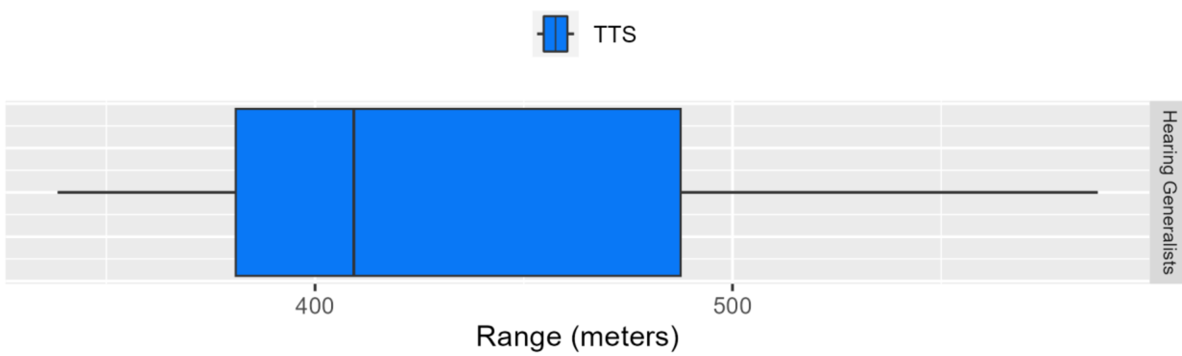

Figure 4.4-13: Fishes Ranges to Temporary Threshold Shift for E7 (>20 - 60 lb.)

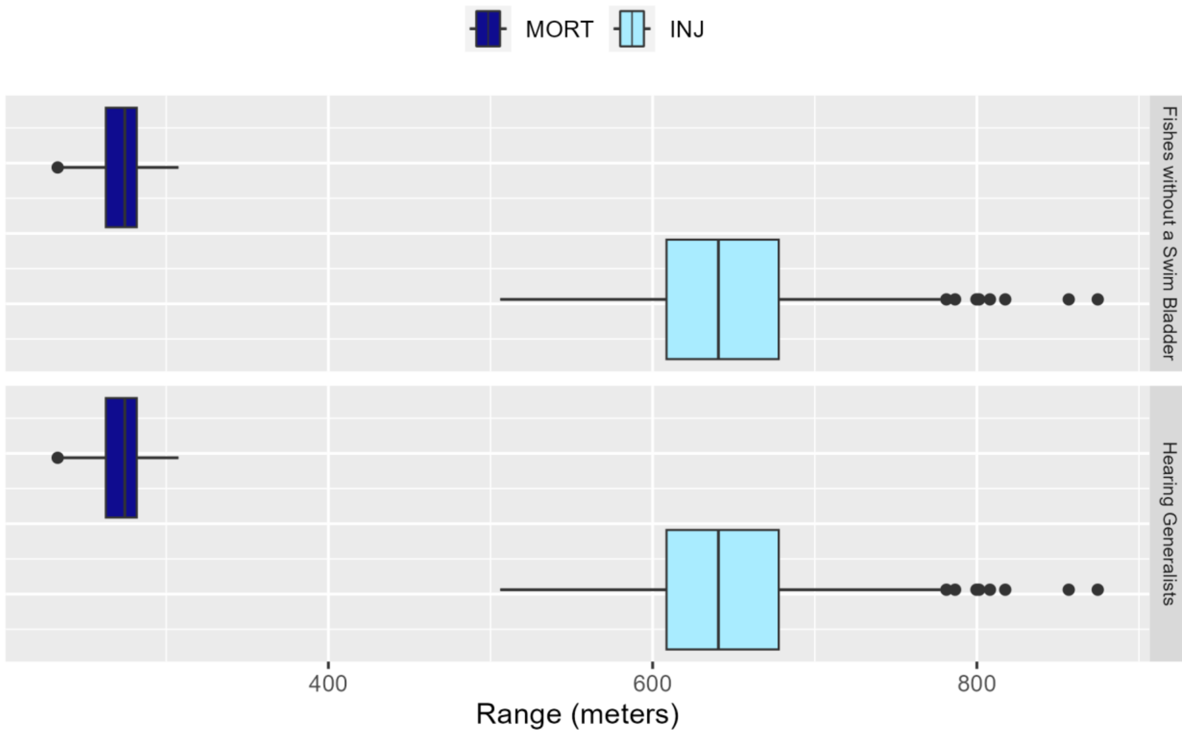

Figure 4.4-14: Fishes Ranges to Mortality and Injury for E7 (>20 - 60 lb.)

4.4.4.8 Bin E8 (>60 - 100 lb. NEW)

Table 4.4-11: Fishes Ranges to Effects for E8 (>60 - 100 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	1,014 m (118 m)	387 m (40 m)
	>200 m	1	NA	964 m (111 m)	373 m (41 m)
Hearing Generalists	≤200 m	1	< 712 m (125 m)	1,014 m (118 m)	387 m (40 m)
	>200 m	1	< 683 m (87 m)	964 m (111 m)	373 m (41 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

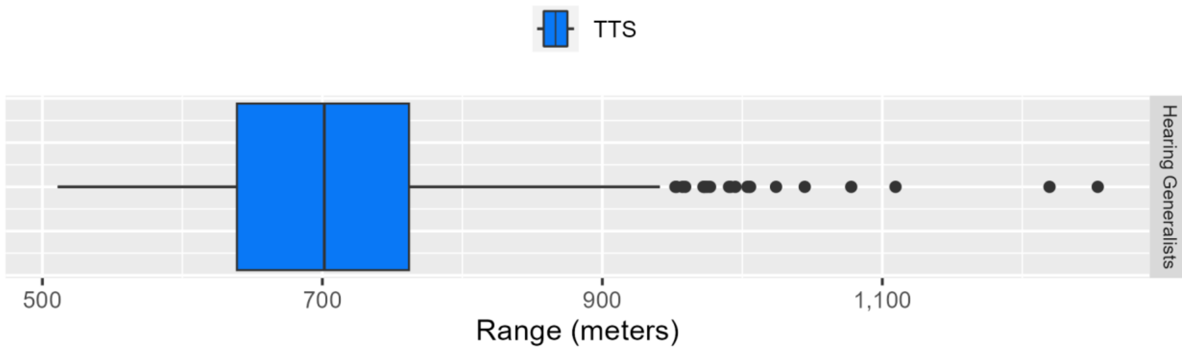

Figure 4.4-15: Fishes Ranges to Temporary Threshold Shift for E8 (>60 - 100 lb.)

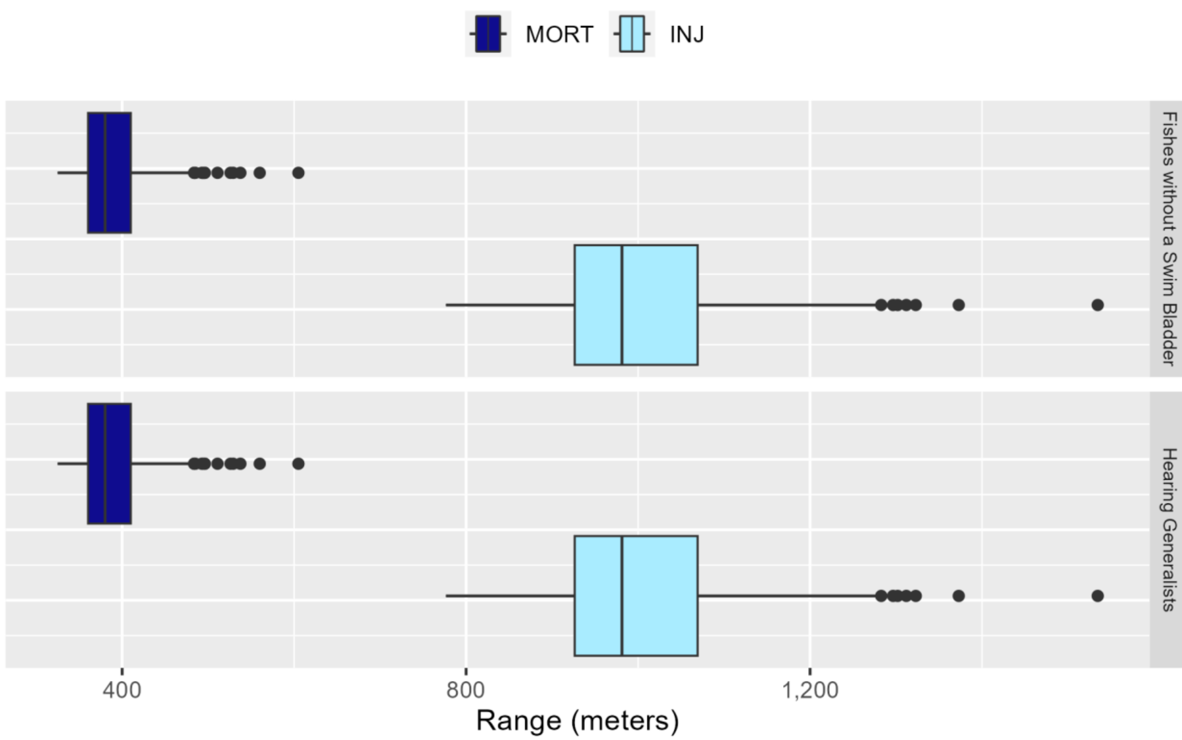

Figure 4.4-16: Fishes Ranges to Mortality and Injury for E8 (>60 - 100 lb.)

4.4.4.9 Bin E9 (>100 - 250 lb. NEW)

Table 4.4-12: Fishes Ranges to Effects for E9 (>100 - 250 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	824 m (78 m)	392 m (26 m)
	>200 m	1	NA	808 m (80 m)	377 m (30 m)
Hearing Generalists	≤200 m	1	< 504 m (63 m)	824 m (78 m)	392 m (26 m)
	>200 m	1	< 488 m (58 m)	808 m (80 m)	377 m (30 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

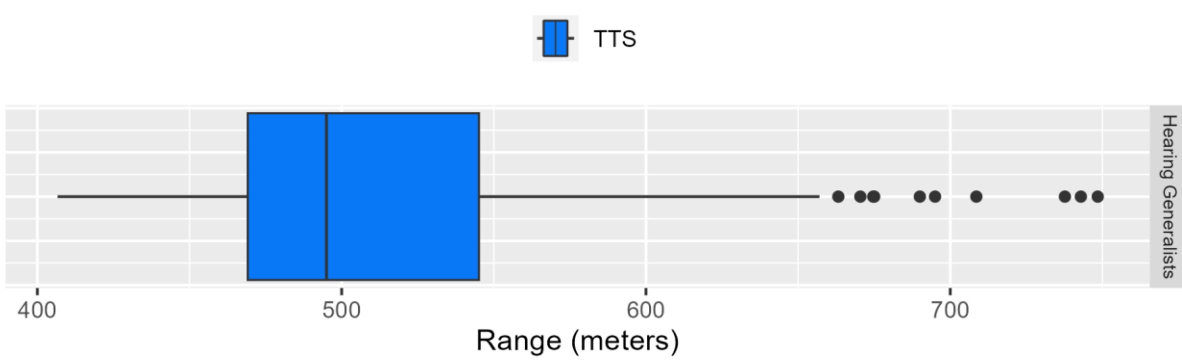

Figure 4.4-17: Fishes Ranges to Temporary Threshold Shift for E9 (>100 - 250 lb.)

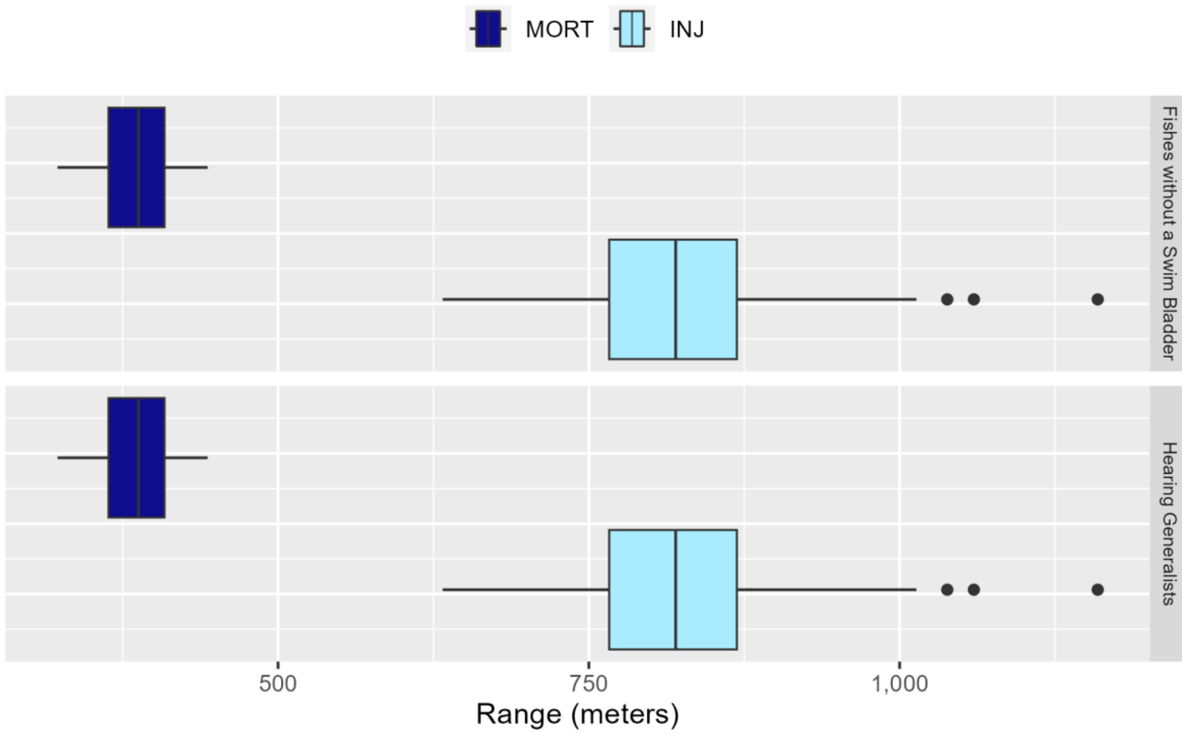

Figure 4.4-18: Fishes Ranges to Mortality and Injury for E9 (>100 - 250 lb.)

4.4.4.10 Bin E10 (>250 - 500 lb. NEW)

Table 4.4-13: Fishes Ranges to Effects for E10 (>250 - 500 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	1,135 m (187 m)	461 m (33 m)
	>200 m	1	NA	1,182 m (152 m)	458 m (31 m)
Hearing Generalists	≤200 m	1	< 704 m (235 m)	1,135 m (187 m)	461 m (33 m)
	>200 m	1	< 695 m (119 m)	1,182 m (152 m)	458 m (31 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

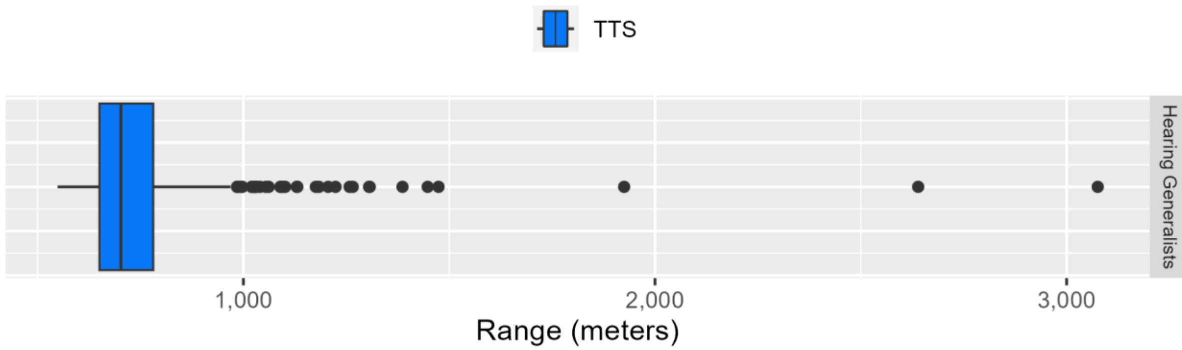

Figure 4.4-19: Fishes Ranges to Temporary Threshold Shift for E10 (>250 - 500 lb.)

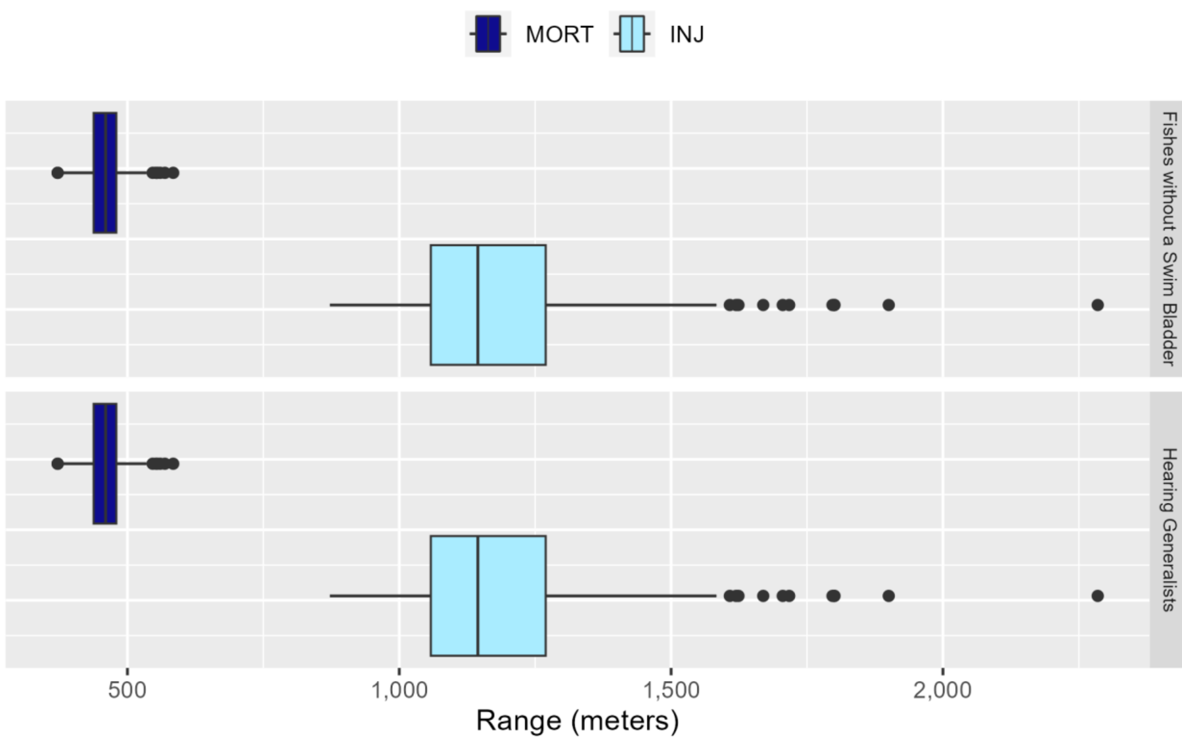

Figure 4.4-20: Fishes Ranges to Mortality and Injury for E10 (>250 - 500 lb.)

4.4.4.11 Bin E11 (>500 - 675 lb. NEW)

Table 4.4-14: Fishes Ranges to Effects for E11 (>500 - 675 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	2,799 m (519 m)	1,031 m (148 m)
	>200 m	1	NA	2,701 m (440 m)	1,007 m (114 m)
Hearing Generalists	≤200 m	1	< 3,361 m (524 m)	2,799 m (519 m)	1,031 m (148 m)
	>200 m	1	< 3,153 m (553 m)	2,701 m (440 m)	1,007 m (114 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

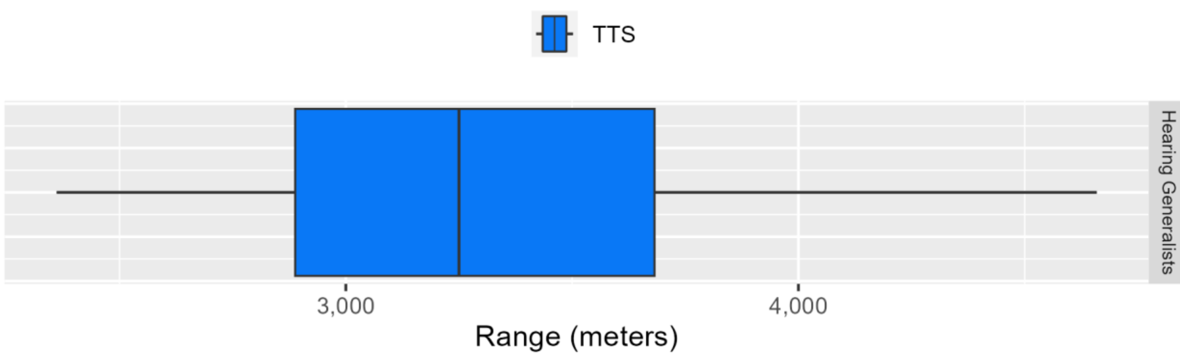

Figure 4.4-21: Fishes Ranges to Temporary Threshold Shift for E11 (>500 - 675 lb.)

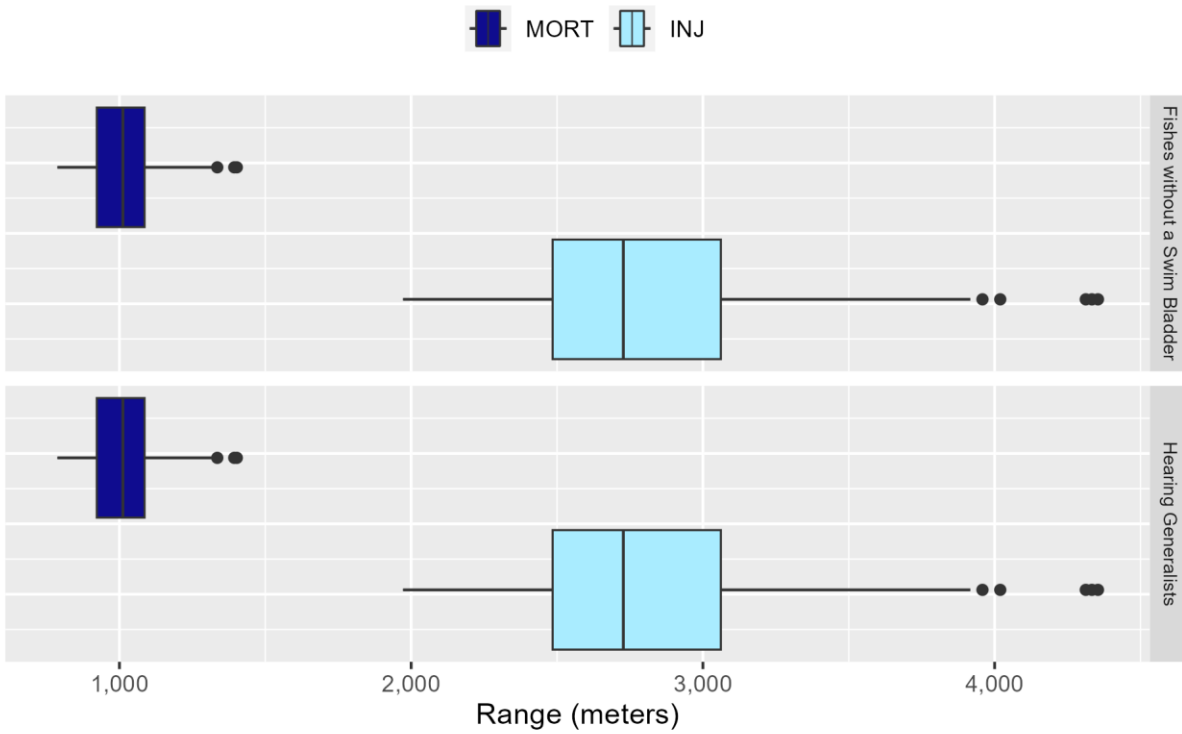

Figure 4.4-22: Fishes Ranges to Mortality and Injury for E11 (>500 - 675 lb.)

4.4.4.12 Bin E12 (>650 - 1,000 lb. NEW)

Table 4.4-15: Fishes Ranges to Effects for E12 (>650 - 1,000 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	≤200 m	1	NA	1,318 m (111 m)	563 m (48 m)
	>200 m	1	NA	1,348 m (159 m)	580 m (47 m)
Hearing Generalists	≤200 m	1	< 1,006 m (344 m)	1,318 m (111 m)	563 m (48 m)
	>200 m	1	< 923 m (165 m)	1,348 m (159 m)	580 m (47 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

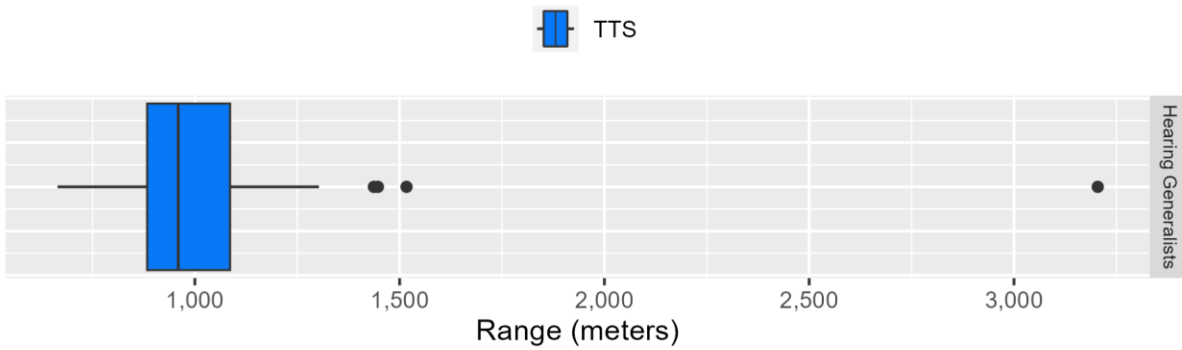

Figure 4.4-23: Fishes Ranges to Temporary Threshold Shift for E12 (>650 - 1,000 lb.)

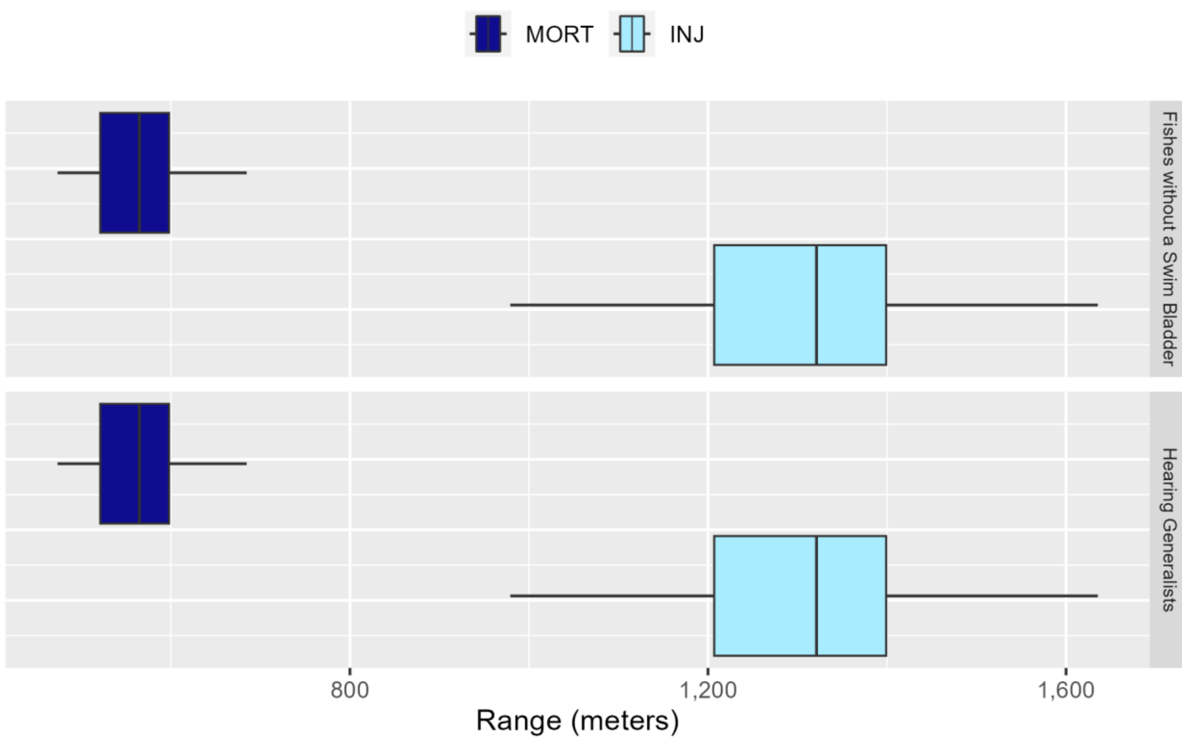

Figure 4.4-24: Fishes Ranges to Mortality and Injury for E12 (>650 - 1,000 lb.)

4.4.4.13 Bin E16 (>7,250 - 14,500 lb. NEW)

Table 4.4-16: Fishes Ranges to Effects for E16 (>7,250 - 14,500 lb.)

Group	Depth	Cluster Size	TTS	INJ	MORT
Fishes without a Swim Bladder	>200 m	1	NA	7,569 m (1,175 m)	2,632 m (320 m)
Hearing Generalists		1	< 16,167 m (1,651 m)	7,569 m (1,175 m)	2,632 m (320 m)

-TTS ranges for fishes with a swim bladder only
-Median ranges with standard deviation ranges in parentheses
-NA = not applicable
-lb. = pounds in net explosive weight (NEW)
-No ranges for depths ≤200 m or >200 m unless shown
-< indicates that the range to effects would be less than the provided value

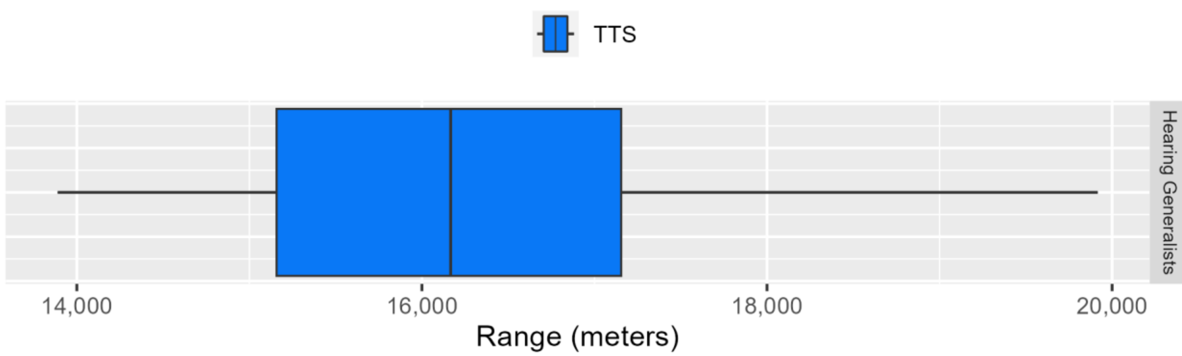

Figure 4.4-25: Fishes Ranges to Temporary Threshold Shift for E16 (>7,250 - 14,500 lb.)

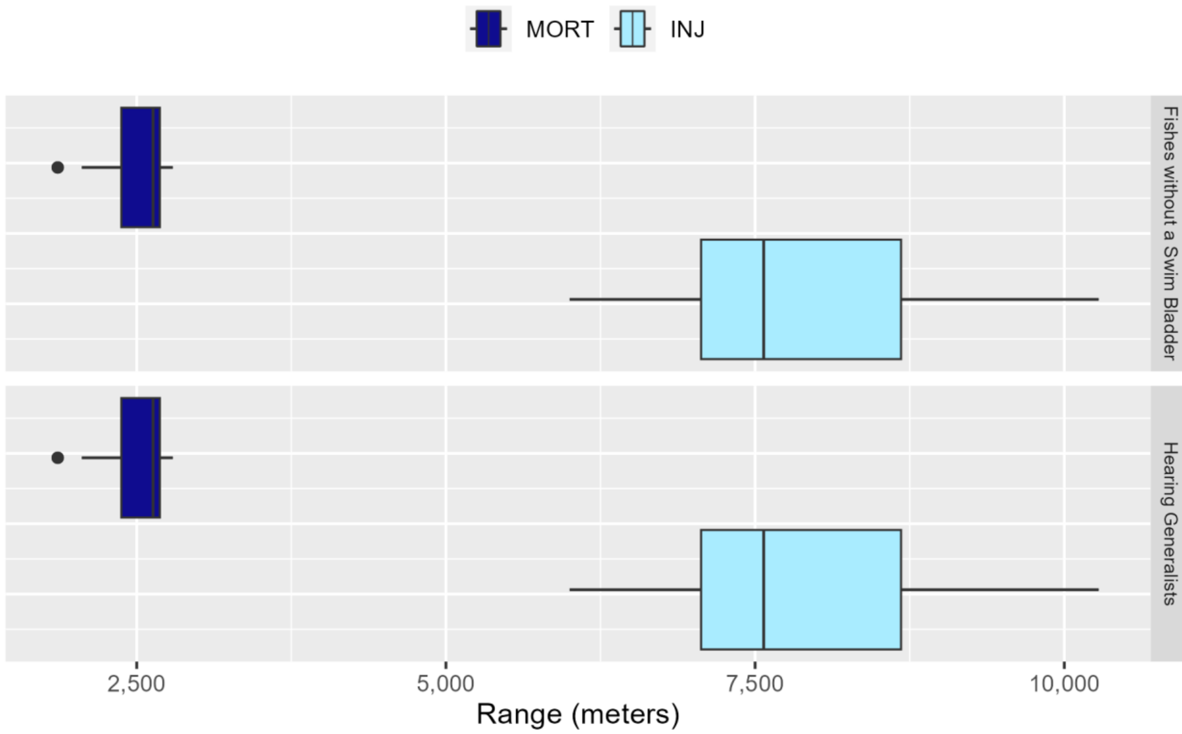

Figure 4.4-26: Fishes Ranges to Mortality and Injury for E16 (>7,250 - 14,500 lb.)

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