Acoustic and Explosive Effects Analysis for Marine Mammals, Sea Turtles, and Fishes in the Mariana Islands Training and Testing Study Area (Phase IV)

Technical Report

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Acronyms and Abbreviations

Acronym	Definition
µPa	microPascal
AINJ	Auditory Injury
ASW	Anti-Submarine Warfare
BEH	Behavioral Response
BIA	Biologically Important Area
dB	decibel
DPS	Distinct Population Segment
EEZ	Exclusive economic zone
EIS	Environmental Impact Statement
FDM	Farallon de Medinilla
HF	High Frequency (hearing group)
Hz	hertz
INJ	Non-Auditory Injury
kHz	kilohertz
LF	Low Frequency (hearing group)
LOA	Letter of Authorization
MIRC	Mariana Islands Range Complex
MITT	Mariana Islands Training and Testing
MMPA	Marine Mammal Protection Act
MORT	Mortality
NAEMO	Navy Acoustic Effects Model
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NAVWAR	Naval Information Warfare Systems Command
Navy	U.S. Department of the Navy
NEPA	National Environmental Policy Act
NEPM	Non-Explosive Practice Munitions
NM	Nautical Mile
NM^2	Square Nautical Miles
NMFS	National Marine Fisheries Service
NMSDD	Navy Marine Species Density Database
OCA	Otariids and Other Marine Carnivores In Air (hearing group)
OCW	Otariids and Other Marine Carnivores in Water (hearing group)
OEIS	Overseas Environmental Impact Statement
ONR	Office of Naval Research
OPAREA	Operating Area
PCA	Phocid In Air (hearing group)
PCW	Phocid In Water (hearing group)
PTS	Permanent Threshold Shift
rms	Root-mean-square
SAR	Stock Assessment Report
SEL	Sound Exposure Level
SINKEX	Sinking Exercise
SPL	Sound Pressure Level
TR	Technical Report
TTS	Temporary Threshold Shift
UAV	Unmanned Aerial Vehicle
U.S.	United States
UUV	Unmanned Underwater Vehicle
VHF	Very High Frequency (hearing group)
VLF	Very Low Frequency (hearing group)
W	Warning Area
USCG	U.S. Coast Guard
USAF	U.S. Air Force
USMC	U.S Marine Corps

1 INTRODUCTION

This technical report presents a detailed look at effects on protected marine species (marine mammals, reptiles, and fish) due to acoustic and explosive stressors under the Mariana Islands Training and Testing (MITT) Proposed Action. This technical report supports the analysis and conclusions presented in the MITT Supplemental Environmental Impact Statement (SEIS)/Overseas Environmental Impact Statement (OEIS), provides information to assist the evaluation of the effects of the Proposed Action on listed species and critical habitat and the extent of incidental take to support consultation under Section 7 of the Endangered Species Act (ESA), and provides information on the type and the extent of incidental take of marine mammal species and stocks to support a negligible impact determination under the Marine Mammal Protection Act.

There are two Action Alternatives in the MITT SEIS/OEIS: Alternative 1 and Alternative 2. Alternative 1 is the Preferred Alternative and accounts for the fluctuations of training cycles, testing programs, and deployment schedules. Alternative 2 reflects the maximum number of training and testing activities that could occur within a given year and assumes that the maximum level of activity would occur every year over a seven-year period. A maximum year of training and testing under both action alternatives assumes the same number of activities.

1.1 INFORMATION REFERENCED IN THIS ANALYSIS

This technical report's analysis relies on information presented within the MITT SEIS/OEIS and other relevant technical reports. The following lists contain abbreviated names for each of these supporting sections and briefly describe the content therein.

The below sections of the MITT SEIS/OEIS (available at https://www.nepa.navy.mil/mitteis/) provide details and descriptions of the Proposed Action:

- The *Proposed Activities* section in Section 2.5 (Proposed Training and Testing Activities for Both Alternatives) provides the number of activities and the locations they would occur.
- The *Activity Descriptions* section in Appendix A (Training and Testing Activity Descriptions) 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 the *Explosive Stressors* section in 3.0.3.3.2 (Explosive Stressors) describe the general categories and characteristics of each acoustic substressor and explosives, 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 Section 3.0.3.3.1 (Acoustic Stressors).
- The *Vessel Movements* data in Section 3.0.3.3.4 (Physical Disturbance and Strike Stressors) quantifies the vessel activity in the Study Area. Vessel movements, and therefore vessel noise, are expected to be highest around US Naval Base Guam and in the Transit Corridors to the east (to and from Hawaii) and to the west and northwest (to and from the Philippine Sea).
- The *Munitions* data in Section 3.0.3.3.4 (Physical Disturbance and Strike Stressors) quantifies the number of non-explosive practice munitions and the number of explosives that may result in fragments 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.

The below technical reports and sections of the MITT SEIS/OEIS provide general background information and cite relevant supporting best available science:

- The *Marine Mammal Background*, the *Sea Turtle Background*, and the *Fishes Background* refer to the Affected Environment sections in each resource chapter (Sections 3.4.2, 3.5.2, and 3.9.2, respectively*)* and Appendix C (Biological Resources Supplemental Information) of the SEIS/OEIS, which describe species present in the Study Area and the general status, habitat and geographic range, population trends, and population threats of each species.
- The *Acoustic Primer* section in the technical report titled *Acoustic and Explosive Effects Supporting Information* (Section 1, Acoustic and Explosive Concepts / Primer) 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 (rms) values (see the *Acoustic Primer* section entitled Sound Metrics).
- The *Acoustic Habitat* section in the technical report titled *Acoustic and Explosive Effects Supporting Information* (Section 2, Acoustic Habitat) describes natural and anthropogenic sources that contribute to the ambient noise within the Study Area.
- The *Fishes Acoustic Background*, the *Marine Mammal Acoustic Background*, and the *Sea Turtle Acoustic Background* refer to Sections 3, 4, and 5 respectively in the technical report titled *Acoustic and Explosive Effects Supporting Information*, which summarize the best available science on impacts to marine mammals, sea turtles, and fishes from exposure to acoustic and explosive stressors. These include serious injury/mortality, non-auditory injury (INJ), 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, and behavioral responses.

The following technical reports (TR) and analyses provide details on the quantitative process and show specific data inputs to the models (available for download at https://www.nepa.navy.mil/mitteis/):

- 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 effects on marine mammals and sea turtles from exposure to sonar and explosives.
- 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, 2025) which describes the development of criteria and thresholds used to predict effects 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 Mariana Islands Training and Testing Study Area* (U.S. Department of the Navy, 2024c) which describes the spatial and temporal density distributions for each marine mammal and sea turtle species or stock/ distinct population segment (DPS) in the Study Area. The density models have been updated with new data since the prior analysis.
- 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 Mariana Islands Training and*

Testing Study Areas (Oliveira et al., 2025) which describes the dive profile and group size for each species. There are no substantive changes from the prior analysis.

The *Mitigation* section refers to Sections 4.6.1 (Mitigation Specific to Acoustic Stressors, Explosives, and Non-Explosive Ordnance), Section 4.6.2 (Mitigation Specific to Vessels, Vehicles, and Towed In-Water Devices) and geographic mitigation in Section 4.7 (Geographic Mitigation) of the MITT Draft SEIS/OEIS. This section describes the actions taken to avoid, reduce, or minimize potential effects from acoustic and explosive stressors.

This report refers to relevant background sections and technical reports using the shorthand italicized names noted above.

1.2 Changes from Prior Analyses

Changes in the predicted acoustic effects on protected species since the 2020 MITT SEIS/OEIS (available at https://www.nepa.navy.mil/mitteis/) are primarily due to the following:

- Updates to data on marine mammal and sea turtle presence, including estimated density of each species or stock/DPS (number of animals per unit area), group size, and depth distribution. Any substantial changes that are affecting the quantified effects in this analysis are discussed for each species or stock below. For additional details see the *Density TR* and *Dive Profile 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 effect 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 (NAEMO). An overview of notable changes is provided in relevant sections below. For additional details, see the technical report *Quantitative Analysis TR*.
- Changes in the Proposed Action. This report does not rely on the prior SEIS/OEIS analysis of effects for MITT. Significant changes in the use of acoustic and explosive substressors during training and testing activities that are relevant to understanding the predicted effects on species under this Proposed Action compared to prior actions are noted in the analysis of each substressor.
- Changes in how mitigation is considered in reducing predicted effects. The number of model-predicted auditory injuries from sonar and mortalities from explosive activities are not reduced due to activity-based mitigation, unlike in the prior phase.

1.3 Summary of Acoustic and Explosive Stressors

This section summarizes the stressors that marine mammals, sea turtles, and fishes may be exposed to during the Proposed Action. Brief descriptions of each stressor, locations of use, and types of activities are provided. Additional characteristics of stressors under the Proposed Action are described in the *Acoustic Stressors* and *Activity Descriptions* sections of the SEIS/OEIS.

1.3.1 Sonar and Other Transducers

Sonar 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).

Sonars could be used throughout the Study Area at locations identified for each activity in the *Activity Descriptions* section of the SEIS/OEIS. Activities using sonar range from single source, limited duration events to multi-day events with multiple sound sources on different platforms. As described below, the types of sonars and the way they are used differ between primary mission areas. This in turn influences the potential for marine mammals, sea turtles, and fishes to be exposed to and affected by acoustic stressors.

- Anti-submarine warfare typically relies on relatively high source level, mid-frequency sources including hull-mounted sonar on Navy combatant vessels such as destroyers. Most anti-submarine warfare sonars use mid-frequency ranges (1 - 10 kilohertz [kHz]), and some use low-frequency ranges (< 1 kHz). The duration and duty cycle of different sources can vary greatly, from very low duty cycle submarine sonars that infrequently emit single pings, to rotary-wing aircraft dipping sonars that are active for minutes, to continuously active sources on some vessels (e.g., high duty cycle hull-mounted sonar, MF1C). The MF1 hull-mounted sonar is the predominant vessel-based anti-submarine warfare sonar. It nominally operates at 3 kHz with a source level of 235 decibels (dB) re 1 microPascal (µPa) at 1 meter (m), with a low duty cycle (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. Sonars on torpedoes would be higher frequency and used for shorter periods of time. Compared to the prior analysis, this analysis considers proposed decreased use of MF1 (low duty cycle) and MF1C (continuous duty cycle [previously MF11 in the prior Phase III 2020 MITT SEIS/OEIS]). Under the proposed maximum annual activity, MF1 hours have decreased by 23 percent and MF1C hours have decreased 15 percent compared to the maximum year under the preferred alternative in the 2020 MITT SEIS/OEIS (U.S. Department of the Navy, 2020).

  The largest activities in terms of number of platforms using sonars 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 involves 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.

  Most anti-submarine warfare activities would occur greater than 3 nautical miles (NM) from shore in the Study Area, with some sonar maintenance, sonar systems checks, and pierside sonar testing occurring in Inner Apra Harbor. Individual ships and submarines would use their anti-submarine warfare sonars during maintenance of these systems.

- Mine Warfare activities typically involve a ship, rotary-wing aircraft, 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 occur offshore throughout the Study Area but would also occur closer to shore at designated areas like Inner and Outer Apra Harbor, Piti Floating Mine Neutralization, and Agat Bay Mine Neutralization Sites.

Navigation and object detection activities (under Mine Warfare) 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 sonars at higher frequencies and lower source levels (e.g., bin MF1K) to detect and avoid hazards. The navigation and object detection activities could occur throughout the Study Area and while navigating near ports (i.e., around Apra Harbor).

- 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 to nearby animals. In addition, low-frequency and mid-frequency sonars may be used during some activities. UUV sonar use would occur offshore around the MIRC and within Apra Harbor.

1.3.2 Vessel Noise

Marine mammals, sea turtles, and 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, Vessel Movements,* and *Activity Descriptions* sections of the SEIS/OEIS. Specifically, Navy vessel traffic in the Study Area is heaviest around U.S. Naval Base Guam, with transit routes to the East (i.e., the MITT Transit Corridor, to and from Hawaii) and to the West and Northwest (to and from the Philippine Sea), though activities could occur throughout the Study Area, as described in the *Acoustic Habitat* section. The amphibious approaches around Tinian, Guam, Rota, and within Apra Harbor are sources of nearshore vessel noise as well. 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. Vessel speeds generally range from around 10 to 14 knots (Starcovic & Mintz, 2021); however, vessels will, on occasion, operate within the entire spectrum of their specific operational capabilities. A variety of smaller craft and unmanned vessels 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. 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.

1.3.3 Aircraft Noise

Marine mammals, sea turtles, and 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 of the SEIS/OEIS. 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 and typically fly at lower altitudes than fixed-wing aircraft. Additional characteristics of aircraft noise are described in the *Acoustic Stressors* section of the SEIS/OEIS. 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.* Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Most of these sounds would be concentrated around airbases where aircraft take off and land and are closer to the surface. Aircraft noise could 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 surface.

Animals 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.

1.3.4 Weapons Noise

Marine mammals, sea turtles, and fishes may be exposed to sounds caused by the firing of weapons, objects in flight, impacts of explosive munitions on land, and impact of non-explosive munitions on the water surface during activities conducted at sea. This incidental noise is collectively called weapons noise. Noise produced due to explosions in the water, at the water surface, and just above the water surface is discussed separately from weapons noise in the following section. 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 of the SEIS/OEIS*.* The locations where gunnery and other munitions may be used are shown in the *Munitions* section of the SEIS/OEIS. Most weapons noise is attributable to gunnery activities.

Most activities involving naval gunfire and launching of missiles, bombs, and other munitions are conducted more than 3 NM from shore. Large caliber gunnery would be conducted greater than 12 NM from shore. Bombing Exercises, Sinking Exercises, Surface-to-Surface Missile Exercises, and Air-to-Surface Missile Exercises are conducted greater than 50 NM from shore. The distance from shore for each type of activity is shown in the *Activity Descriptions* section of the SEIS/OEIS. An exception to the above distances is that some Bombing, Gunnery, and Missile Exercises using land-based targets at Farallon de Medinilla (FDM) may be conducted closer to shore. The Action Proponents will implement mitigation to avoid or reduce potential effects from weapon firing noise during Large-Caliber Gunnery activities, as discussed in the *Mitigation* section.

The firing of a weapon may have several components of associated noise. Gunnery noise 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. Underwater sounds would be strongest just below the surface and directly under the firing point. Sound enters the water within a narrow cone below the firing point or path of the projectile and is mostly reflected (not transmitted into the water) outside of this cone. The average peak sound pressure in the water measured directly below the muzzle of a large caliber gun was approximately 200 dB re 1 µPa. 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 and non-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. 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. The impact of munitions on land-based targets at FDM (due to explosive munitions or non-explosive practice munitions [NEPM]) may be audible to some species in the water via the air-water or ground-water sound pathway.

1.3.5 Explosives

Marine mammals, sea turtles, and fishes may be exposed to sound and energy from explosions in the water and just above the water surface associated with the proposed activities. Activities using explosives would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections of the SEIS/OEIS. Most activities involving in-water (including at or just above the surface) explosions associated with naval gunnery are conducted more than 12 NM from shore. Sinking Exercises, Surface-to-Surface Missile Exercises, and Air-to-Surface Bombing Exercises are conducted greater than 50 NM from shore, as shown in the *Proposed Activities* section of the SEIS/OEIS. Certain activities with explosives may be conducted closer to shore at locations identified in the *Activity Descriptions* section of the SEIS/OEIS. This includes certain Mine Warfare activities conducted within Agat Bay Mine Neutralization Site, Outer Apra Harbor, and Piti Floating Mine Neutralization Site. Some Bombing, Gunnery, and Missile Exercises can occur closer to shore at FDM, where misses and ricochets may cause in-water explosions in the nearshore waters surrounding FDM.

Characteristics, quantities, and net explosive weights of in-water explosives used during military readiness activities are provided in the *Explosive Stressors* section of the SEIS/OEIS. Explosives used in the water and at or just above the water surface are binned based on net explosive weights (NEW). The number of explosives proposed in this action is similar to the number under the preferred alternative in the 2020 MITT SEIS/OEIS (U.S. Department of the Navy, 2020), with increases and decreases of specific bins. There are proposed increases in four explosive bins (E1 [0.1 – 0.25 lb. NEW], E3 [>0.5–2.5 lb. NEW], E6 [>10-20 lb. NEW], E9 [>100-250 lb. NEW], and decreases or similar amounts in all other bins. A small number of explosives in bin E7 (>20-60 lb.), not analyzed in the previous 2020 MITT SEIS/OEIS, are also proposed.

The types of activities with detonations below the surface include Mine Warfare, activities using explosive torpedoes, and other specific training and testing activities like Civilian Port Defense. Most explosive munitions used during military readiness activities, however, would occur at or just above the water surface (greater than 90 percent by count). These include explosives used during surface warfare activities, such as explosive gunnery, bombs, and missiles. In the below quantitative analysis, effects on marine mammals, sea turtles, and fishes are over-estimated because explosions at or just above the water surface are modeled as underwater explosions, with all energy assumed to remain in the water. Most sound and energy from in-air detonations at higher altitudes would be reflected at the water surface and would have no effect on marine species.

1.4 The Navy Acoustic Effects Model (NAEMO)

The Navy Acoustics Effects Model (NAEMO) was developed to conduct a comprehensive acoustic effects analysis for use of sonars and explosives[1] in the marine environment. NAEMO processes are

[1] 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 of energy at the surface.

comprehensively described in the *Quantitative Analysis TR.* NAEMO considers the physical environment, including bathymetry, seafloor composition/sediment type, wind speed, and underwater sound speed profiles, to estimate propagation loss. 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. The propagation information is combined with data on the locations, numbers, and types of military readiness activities and marine species densities to provide estimated numbers of effects on each species or stock (marine mammals and sea turtles only) and estimates of ranges-to-effect.

During any individual modeled event, effects on individual animats are considered over 24-hour periods (i.e., an effect is counted under the highest order effect threshold exceeded in periods up to 24 hours for each modeled event). 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 affected over a year. Some individuals could be affected multiple times, while others may not experience any effects.

NAEMO underwent several notable changes from the prior analysis that influence estimates of the number of marine mammals and sea turtles that could be affected in each military readiness 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 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, depending on the overlap of source frequencies with the auditory range of the hearing group. This will increase sound exposure level (SEL)-based effects (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 cut-offs. Now considering the full broadband frequency spectra of the signal, some previously discounted hearing groups are assessed for effects 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 are the same. 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 non-impulsive source levels was incorporated into NAEMO, 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 Section 2.2.1 (*Quantifying Effects on* Hearing).

2 EFFECTS ON MARINE MAMMALS FROM ACOUSTIC AND EXPLOSIVE STRESSORS

This analysis is presented as follows:

- The effects that would be expected due to each type of acoustic stressor and explosives used in the Proposed Action are described in Section 2.1 (Effects due to Each Acoustic Substressor and Explosives).
    - Incidental take as defined under the Marine Mammal Protection Act (MMPA) and incidental take of ESA-listed marine mammals is anticipated due to the following substressors: sonars and other transducers 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 effects for stressors that may cause injury, auditory effects, or significant behavioral responses[2] is summarized in Section 2.2 (Quantifying Effects on 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 Effects on Individuals and Populations).
- Effects on individual species (stocks) in the Study Area, including predicted instances of harm or harassment, are presented in Section 2.4 (Species Assessments). Tables summarizing quantified effects due to each substressor that correspond to the request for a Letter of Authorization under the MMPA are presented at the end of Section 2.4 (Species Assessments).
- Ranges to effects for each modeled sub-stressor are shown in Section 2.5 (Ranges to Effects).

2.1 EFFECTS 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 effects, 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-

[2] For the purposes of this analysis, a 'significant behavioral response' is defined as a behavioral reaction that rises to the level of harassment for military readiness activities under the MMPA, as amended by Section 319 of the National Defense Authorization Act (NDAA) for Fiscal Year 2004 (Public Law 108-136). This statute defines harassment as any act that disturbs or is likely to disturb a marine mammal to a point where such behavioral patterns are abandoned or significantly altered. Throughout this analysis, 'significant behavioral response' refers exclusively to this statutory threshold for harassment and does not indicate significance under NEPA.

enclosed bay vs. open ocean), and proximity of the animal to the source of the sound. The *Marine Mammal Acoustic Background TR* summarizes what is currently known about effects on marine mammals from all acoustic substressors and explosives. That section cites the best available science that is relied on for this assessment.

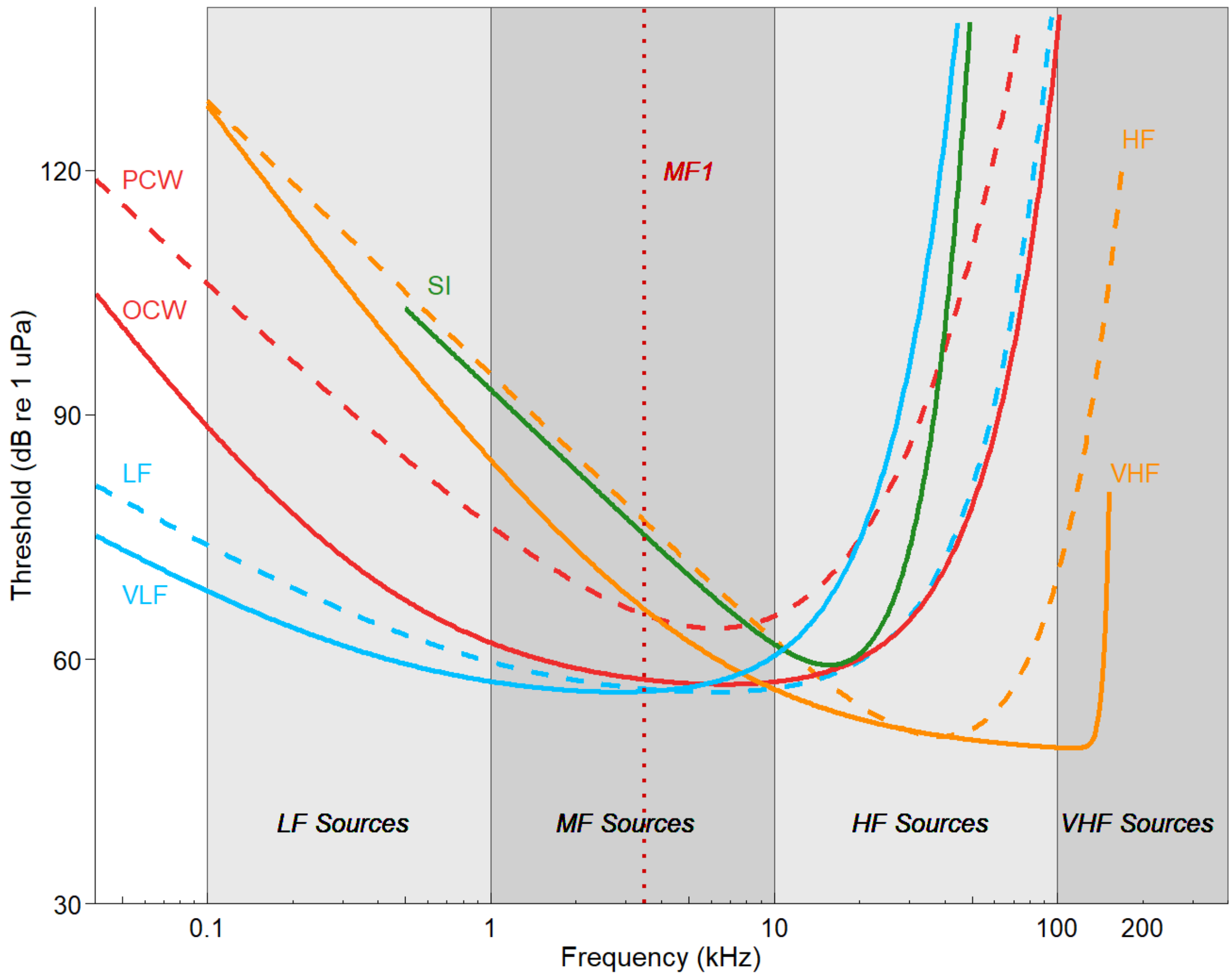
2.1.1 EFFECTS FROM SONARS AND OTHER TRANSDUCERS

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 hear poorly at low frequencies (see Figure 2-1). 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* section of the SEIS/OEIS 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. When the frequency of best hearing is the same as, or within one octave above the dominant frequency of the sound source, there is a greater potential for hearing loss. 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 AINJ (including permanent threshold shift [PTS]). See the section titled *Hearing Loss and Auditory Injury* in the *Marine Mammal Acoustic Background TR* for additional information. TTS and AINJ due to sonars are estimated using criteria developed for marine mammal hearing groups and modeling methods described below in Section 2.2 (Quantifying Effects 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. These sources often have medium to high duty cycles but typically have lower source levels than anti-submarine warfare sonars. 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 less likely because of the small zone of effect.

Masking effects of sonar are typically transient and temporary for most 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, are used intermittently, and have a duration of only a few hours. These sonars typically have lower duty cycles and 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. Some of these activities use mid-frequency hull-mounted high duty cycle sonars (MF1C) that increase the potential for auditory effects and masking. Overall, the proposed use of MF1C is low (256-258 hours) relative to the proposed use of MF1 (1386-1392 hours). In some cases, mammals can compensate for masking by changing their calling behaviors or moving away from the source.



Notes: Composite audiograms for each in-water marine mammal hearing group were re-plotted from U.S. Department of the Navy (2024a). Hearing groups are very low frequency cetaceans (VLF), low frequency cetaceans (LF), high frequency cetaceans (HF), very high frequency cetaceans (VHF), phocid carnivores in water (PCW), otariids and other marine carnivores in water (OCW), and sirenians (SI) (see section 2.2.1 Quantifying Effects on Hearing). PCW, PCA, OCW, OCA, and SI are not in MITT Study Area. Exposure to each of the sonar sources (LF, MF, HF, and VHF) can result in maximum auditory effects above the frequency range of the source.

Figure 2-1: Sonar Source Frequency Overlap with Marine Mammal Hearing

For large mysticetes in the very low frequency (VLF) hearing group, the range of best hearing is estimated between 0.1 and 10 kHz, which overlaps with low- and mid-frequency sonar sources, and their vocalizations are below 1 kHz which overlaps with low-frequency sources. Any auditory effects (TTS, AINJ, or masking) from mid-frequency sonars would be less likely to interfere with communication than effects due to low-frequency sonars. For the other mysticetes in the low frequency (LF) hearing group, 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 mid-frequency sonars.

Odontocetes that use echolocation to hunt may experience masking of the echoes needed to find their prey when foraging near low-frequency 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 opportunities for odontocetes to detect and interpret biologically relevant sounds may be reduced. Odontocetes in the very high frequency (VHF) hearing group 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. See the section titled *Masking* in the *Marine Mammal Acoustic Background TR* for additional information.

Physiological response (stress): Physiological stress is an adaptive process that helps an animal cope with changing conditions. Marine mammals could experience a physiological change in heart rate, stress hormones, or immune system due to sound exposure. Currently, the sound characteristics that correlate with physiological responses in marine mammals are poorly understood, as are the ultimate consequences of these changes. Because there are many unknowns regarding the occurrence of acoustically induced stress responses in marine mammals, any physiological response (e.g., hearing loss or injury) or significant behavioral response is assumed to be associated with a stress response. See the section titled *Physiological Response* in the *Marine Mammal Acoustic Background TR* 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 traveling, breeding, or feeding. Behavioral responses may include alerting, terminating feeding dives and surfacing, diving, or swimming away. Marine mammals' reaction to sonar can vary based on the individual, species, and context. See the section titled *Behavioral Reactions* in the *Marine Mammal Acoustic Background TR* for additional information, including a summary of best available science and supporting citations for responses to sonars by each of the behavioral groups listed below. Behavioral responses to sonars are estimated using criteria developed for marine mammal behavioral groups and modeling methods described below in Section 2.2 (Quantifying Effects 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 maneuver around sound sources placed in their migration path.
- A wide range of odontocete responses to sonar have been observed. Large odontocetes such as sperm whales, killer whales, and pilot whales have been observed to temporarily cease natural behaviors such as feeding and diving and avoid the sonar. These same behavioral responses have been observed in smaller odontocetes like delphinids, both in captivity and in the field; however, delphinids appear to be less sensitive to sound and anthropogenic disturbance than other cetaceans, and in some cases may approach vessels using active sonar to bowride.
- Beaked whales are more sensitive to disturbance than other cetaceans. When exposed to sonar or other active acoustic sources, they are more likely to discontinue feeding dives and avoid the area. Although there is not a permanent instrumented anti-submarine warfare training range in the MITT

Study Area, responses of beaked whales have been carefully studied on other Navy instrumented ranges. 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., 2025; Henderson et al., 2015; Henderson et al., 2016; Jacobson et al., 2022; Manzano-Roth et al., 2016; Tyack et al., 2011). In areas where beaked whales are unlikely to regularly encounter naval sonar activity, beaked whales may be displaced for longer periods of time (e.g., Stanistreet et al., 2022). Significant behavioral reactions to sonar are likely to occur when beaked whales are exposed within a few tens of kilometers, especially for prolonged periods (a few hours or more). Avoidance likely decreases the potential for hearing loss for these species. Population levels of beaked whales and other odontocetes on Navy fixed ranges that have been operating for decades appear to be stable.

Stranding: 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 *Marine Mammal Acoustic Background TR*), and U.S. Navy sonar has not been identified as a causal 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 correlation between sonar use and beaked whale strandings in the MITT Study Area has been investigated (Simonis et al., 2020). Further analysis using more accurate data on sonar use did not find a statistically significant correlation, but this finding was sensitive to uncertainties in assumptions regarding timeframes and distances, as well as the small number of incidents (Filadelfo, 2024). 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, therefore the Navy is not requesting incidental take for this unlikely event. Through adaptive management under the 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.

Activity-based mitigation for acoustic stressors (see *Mitigation*) includes trained Lookouts that observe defined mitigation zones for marine mammals and indicators that marine mammals may be present. The mitigation zones encompass the ranges to AINJ for all marine mammals for all sonars including the ship hull-mounted sonars MF1, MF1C, and MF1K. See Section 2.5.1 (Ranges to Effects for Sonar and Other Transducers) for more information.

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

2.1.2 Effects from Vessel Noise

Proposed military vessel transits would comprise a small portion of overall vessel traffic and 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 effects from vessel noise on marine mammals.

Hearing loss: Noise from vessels generally lacks the amplitude and duration to cause any hearing loss in marine mammals under realistic conditions. Vessel noise 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). Even so, hearing loss under these conditions is not anticipated.

Masking: Broadband vessel noise could lead to short-term masking as the vessel passes by within a few hundred meters if the level of vessel noise is above a sound of interest (e.g., sounds of prey, predators, or conspecifics) and in a similar frequency band (see the section titled *Masking* in the *Marine Mammal Acoustic Background TR*). 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 (see *Acoustic Habitat*). 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; 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 offshore would be short term and intermittent, and therefore unlikely to result in any substantial costs or consequences to individual animals or populations. Because ship noise tends to be low-frequency and broadband, 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. 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 Navy 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.

Areas with increased levels of ambient noise from anthropogenic noise sources such as 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. In noisier inshore areas, vessel noise may be detectable above ambient levels for only several hundred meters. However, Navy vessels make up a very small percentage of the overall vessel traffic, and the rise of ambient noise levels in these areas is attributed to all ocean users, including commercial and recreational vessels, shoreline development, and industrialization.

Behavioral response and physiological response (stress): Vessel noise has the potential to disturb marine mammals and elicit an alerting, avoidance, or other behavioral reaction. Physiological stress responses have 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. 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. Odontocetes could have a variety of reactions to passing vessels, including attraction, bow-riding, increased traveling time, decreased feeding behaviors, diving, or avoidance of the vessel, which may vary depending on their prior experience with vessels. For example, species like the Kogia and beaked whales have been observed avoiding vessels while delphinids approach vessels to bow ride. 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. Best available science on responses to vessel noise, including behavioral responses, stress, and masking, is summarized in the *Marine Mammal Acoustic Background TR*.

2.1.3 Effects from Aircraft Noise

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. Repeated exposure to most individuals over multiple days is unlikely. Animals could be subjected to multiple overflights per day during certain activities; however, fixed-wing aircraft would pass quickly overhead, typically at altitudes above 3,000 ft. (around 914 m). Most fixed-wing aircraft and rotary-wing aircraft activities are transient in nature, although rotary-wing aircraft could also hover over the water at low altitudes for extended periods (5 to 15 minutes). Daytime and nighttime activities involving rotary-wing aircraft may occur for extended periods of time, typically 1 to 3 hours in some areas. Effects from military readiness activities would be highly localized and concentrated in space and duration.

<u>Hearing loss</u>: 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 while rotary-wing aircraft may hover at lower altitudes for longer durations, it would still be for relatively brief periods.

<u>Masking</u>: Potential effects from aircraft noise include masking of other biologically relevant sounds. The duration of masking due to hovering rotary-wing aircraft would be limited to the duration of hovering events (5 to 15 min).

<u>Behavioral and physiological response (stress)</u>: Brief behavioral and physiological response reactions as aircraft pass overhead could occur. 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 also startle marine mammals, but

these events are transient, typically happen at high altitudes, and happen infrequently at any given location within the Study Area. Based on the short duration of potential exposure to aircraft noise, behavioral and physiological stress responses are unlikely to be significant. Longer activity durations and periods of time where rotary-wing aircraft hover may increase the potential for behavioral reactions, startle reactions, and physiological response, although the likelihood that marine mammals would appear or remain at the surface while an aircraft hovers directly overhead would be low. Low-altitude flights of rotary-wing aircraft during some activities, often under 100 ft. (around 30 m), 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 rotary-wing aircraft's rotor. Marine mammals would likely avoid the area under the rotary-wing aircraft. 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. Military 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.

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.

2.1.4 Effects from Weapons Noise

Hearing loss is not expected, and any masking from weapons noise would be infrequent and brief.

Behavioral response: Animals at the surface of the water, in a narrow footprint under a weapons trajectory, could be exposed to naval gunfire, missiles, and targets launched by ships 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. 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.

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.

2.1.5 Effects from Explosives

Explosions produce loud, impulsive, broadband sounds that are within the hearing range of all marine mammals. Potential effects from explosive energy and sound include mortality, non-auditory injury, behavioral reactions, physiological stress response, masking, and hearing loss.

Direct injury and mortality: The rapid, high magnitude pressure changes created by explosives can kill or injure marine mammals. Susceptibility to injury is estimated using data on terrestrial animals exposed to explosives. See the section titled *Direct Injury* in the *Marine Mammal Acoustic Background TR* for additional information. There is only one instance of observed marine mammal mortalities associated with explosives used during a military readiness activity. Information on this incident, which occurred off the coast of California in 2011, is provided in the *Marine Mammal Acoustic Background TR* (see the section "Direct Injury due to Explosives").

Hearing loss: Exposure to an explosion may cause AINJ or TTS due to high intensity, broadband sounds with high peak pressures. There is limited information on hearing loss due to explosives, although there are data from other impulsive sources. See the section titled *Hearing Loss and Auditory Injury* in the *Marine Mammal Acoustic Background TR* for additional information.

Masking: Potential masking from explosive sounds or weapon noise is likely similar to masking studied for other impulsive sounds, such as air guns or pile driving. Because explosive periods are so brief, any effects would be limited. See the section titled *Masking* in the *Marine Mammal Acoustic Background TR* for additional information.

Behavioral response and physiological response (stress): If marine mammals are exposed to impulsive sounds such as those from explosives, potential behavioral reactions could include alerting, startling, breaking off feeding dives and surfacing, diving, swimming away, changing vocalizations, or showing no response at all. 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 responses could occur in conjunction with short-term behavioral responses. See the sections titled *Physiological Response* and *Behavioral Reactions* in the *Marine Mammal Acoustic Background TR* for additional information.

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 effects. 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.

Because in-water explosives may result in the incidental take of marine mammals (mortality[3], non-auditory injury, auditory effects, and significant behavioral responses), explosive effects are modeled per the methods presented in Section 2.2 (Quantifying Effects on Marine Mammals from Acoustic and Explosive Stressors). Effects on each marine mammal stock are quantified below in Section 2.4 (Species Assessments). Effect ranges for marine mammals exposed to explosive sound and energy are shown in Section 2.5.2 (Ranges to Effects for Explosives).

2.2 Quantifying Effects on Marine Mammals from Acoustic and Explosive Stressors

The following section provides an overview of key components of the methods used in this analysis to estimate the number and types of acoustic and explosive effects on marine mammals. The *Quantitative*

[3] No mortalities due to explosives are predicted for any marine mammal species or stock in this Proposed Action.

Analysis TR, Criteria and Thresholds TR, Density TR, and *Dive Profile TR* detail the quantitative process and show specific data inputs to the models. Effects are modeled using NAEMO as previously discussed in Section 1.4 (The Navy Acoustic Effects Model (NAEMO)).

2.2.1 QUANTIFYING EFFECTS ON HEARING

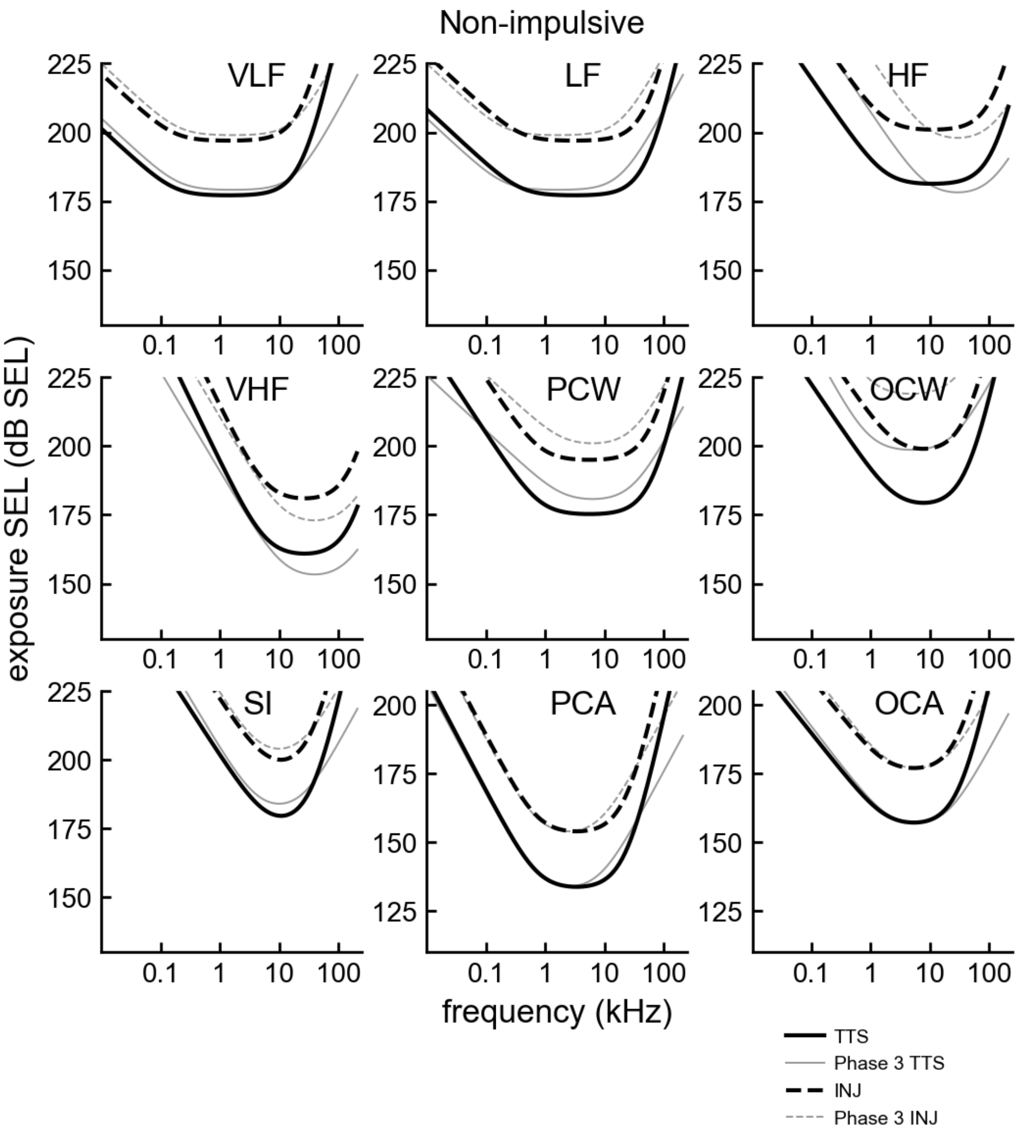
The auditory criteria and thresholds used in this analysis have been updated since the prior assessment of effects due to military readiness activities in the Study Area. They incorporate new best available science since the release of NMFS guidance for assessing the effects of sound on marine mammal 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 hearing group, exposure functions for TTS and AINJ (previously called PTS but now called AINJ to clarify that this is inclusive of neural injury) 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 effects (Phase III) are compared in Figure 2-2 and Figure 2-3. While both figures include exposure functions for phocids, otariids, and sirenians, these species are not present in the MITT Study Area. Exposure functions for non-impulsive sounds are Figure 2-2. Impulsive sounds are analyzed using two criteria: SEL and peak pressure. Figure 2-3 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 affected in each training or testing event.

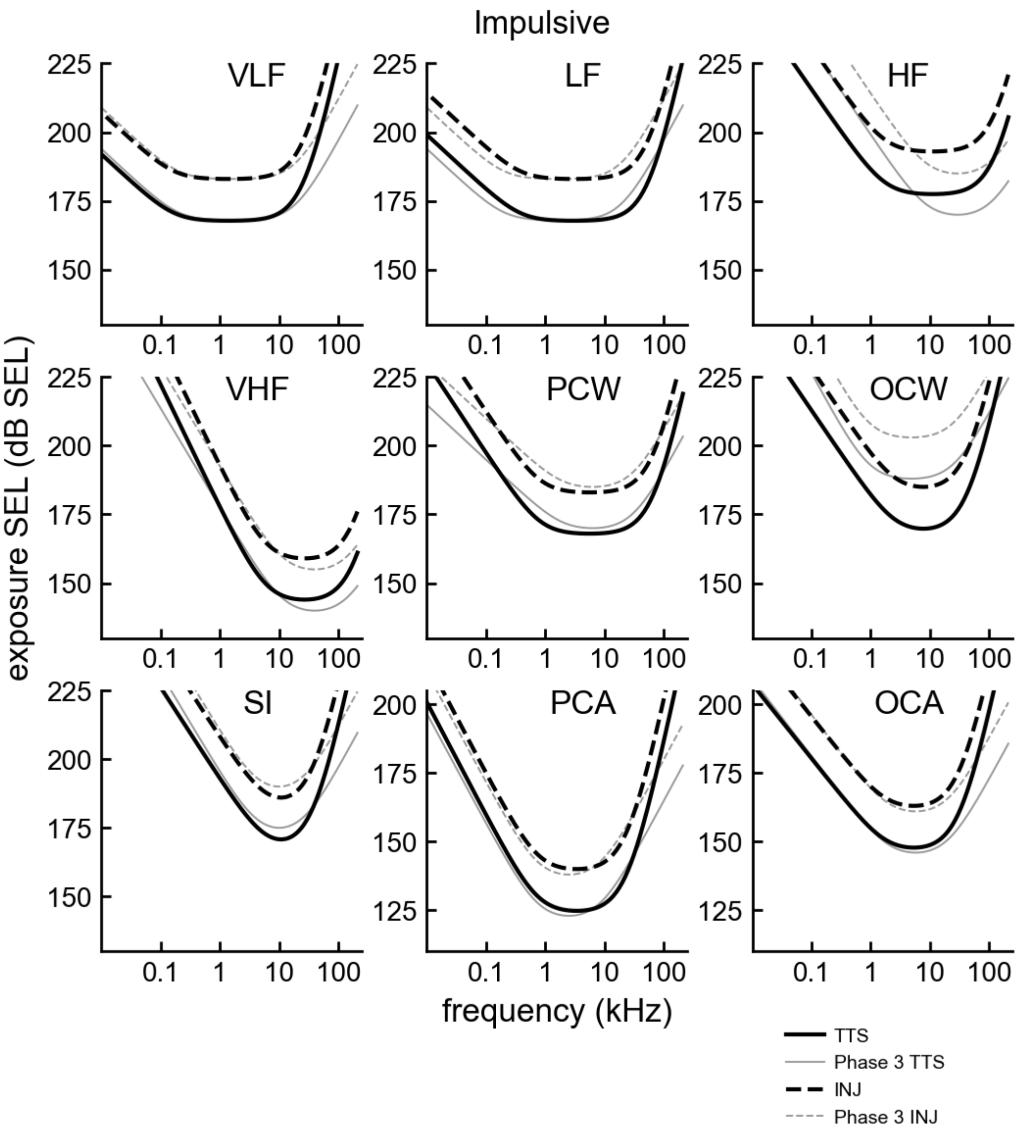
- The mysticetes have been split from one hearing group (the low frequency cetaceans, LF) into two hearing groups: the LF (including minke, humpback, gray, Rice's, Bryde's, Omura's, and sei whales) and the very low frequency cetaceans (VLF; blue, fin, right, and bowhead whales). While the VLF hearing group retains similar susceptibility to auditory effects as the prior analysis, the new LF hearing 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 hearing group previously called the mid-frequency cetaceans (MF) is now called the high frequency cetaceans (HF). All species previously in the MF cetacean hearing group (most odontocetes) are now in the HF cetacean hearing group, and there is no MF cetacean exposure function. In the future, there may be sufficient data to support splitting the current HF cetacean hearing group into MF and HF hearing groups, with certain larger odontocetes (sperm, beaked, and killer whales) in the MF hearing 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 hearing group than in prior analyses of the same activities.
- The hearing group previously called the high frequency cetaceans (HF) is now called the very high frequency cetaceans (VHF). This hearing group, which includes Kogia whales, is predicted to be less

susceptible to auditory effects at high frequencies (above 10 kHz) than previously analyzed. Consequently, estimated effects on this group from high frequency sources are slightly lower than prior analyses of the same activities.



Note: Hearing 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). PCW, PCA, OCW, OCA, and SI are not in MITT Study Area. Heavy solid lines —Phase IV (4) TTS exposure functions. Thin solid lines —Phase III (3) TTS exposure functions. Heavy dashed lines —Phase IV (4) AINJ exposure functions. Thin dashed lines —Phase III (3) AINJ exposure functions. Figure taken from U.S. Department of the Navy (2024a).

Figure 2-2: Marine Mammal TTS and AINJ Exposure Functions for Sonars and Other Non-Impulsive Sources



Note: Hearing 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). PCW, PCA, OCW, OCA, and SI are not in MITT Study Area. Heavy solid lines —Phase IV (4) TTS exposure functions. Thin solid lines —Phase III (3) TTS exposure functions. Heavy dashed lines —Phase IV (4) AINJ exposure functions. Thin dashed lines —Phase III (3) AINJ exposure functions. Figure taken from U.S. Department of the Navy (2024a).

Figure 2-3: Marine Mammal TTS and AINJ Exposure Functions for Impulsive Sources

Table 2.2-1: Peak SPL Thresholds for Auditory Effects on Marine Mammals from Impulsive Sources

Hearing Group	TTS		AINJ		Change
	Phase III	Phase IV	Phase III	Phase IV	
VLF & LF	213	216	219	222	+3
HF	224	224	230	230	0
VHF	196	196	202	202	0

Note: values are unweighted peak pressures in dB re 1 µPa underwater. VLF = very low frequency cetacean, LF = low frequency cetacean, HF = high frequency cetacean, VHF = very high frequency cetacean.

The instances of AINJ predicted by NAEMO are not reduced to account for activity-based mitigation in this analysis, unlike prior analyses. Section 2.3.3 (Potential Opportunities to Mitigate Auditory and Non-Auditory Injury) discusses the potential opportunities to mitigate modeled auditory effects from sonar and explosions.

NAEMO estimates the reduction in cumulative SEL due to marine mammal avoidance of high-receive-level sonar exposures. 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. The estimated cumulative SEL, including any reductions due to avoidance (if initiated), is compared to the thresholds for AINJ and TTS to assess auditory effects. 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. 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 SEL 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 SEL 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 range in percentage reduction of AINJ due to avoidance for each hearing group and behavioral group based upon avoidance results for each species within each group and across all modeled sonar activities in this analysis. For example, in the VLF - Mysticete results shown here, zero percent of predicted AINJ for fin whales and two percent of predicted AINJ for blue whales were reduced due to avoidance on average across the entire action.

The reduction in AINJ due to avoidance differs across activities and between auditory and behavioral groups. It also depends on the geographic overlap of each species with different activities. Most predicted AINJ in MITT are attributable to activities with sonars used in anti-submarine warfare, and uniform densities are assumed for many species. Thus, the variability in the reduction of AINJ across species is more limited in this study area compared to other Phase IV study areas. Groups that are relatively less sensitive to behavioral disturbance compared to susceptibility of auditory effects are less likely to avoid AINJ, particularly the Mysticete behavioral group. Within the Odontocete behavioral group, the VHF cetaceans are more susceptible to auditory effects attributable to mid-frequency anti-submarine warfare sonars than the HF cetaceans and are therefore less likely to avoid AINJ. The Sensitive Species behavioral group is relatively more susceptible to behavioral disturbance compared to auditory effects, so these species would likely avoid AINJ. The reduction in AINJ for most groups is less than assumed in prior analyses[4] for most species except for beaked whales (HF cetacean hearing group and Sensitive Species behavioral group).

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

Hearing Group	Behavioral Group		
	Mysticete	Odontocete	Sensitive
VLF	0 - 2 %	-	-
LF	1 - 4 %	-	-
HF	-	63 - 84 %	100 - 100 %
VHF	-	40 - 42 %	-

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Note: The range of percentages in each hearing - behavioral group combination is the species with the lowest average avoidance reduction to the species with the highest average avoidance reduction across the entire proposed action.

VLF = very low frequency cetacean, LF = low frequency cetacean, HF = high frequency cetacean, VHF = very high frequency cetacean

Recovery from TTS after a sound exposure is not quantified in this analysis (see the *Marine Mammal Acoustic Background TR*). 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 NAEMO, intermittent sound exposures are summed over the length of the event up to 24 hours. In general, cumulative SEL for intermittent sound exposures likely over-estimates auditory effects because recovery from TTS can 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 effects from higher duty cycle sources and certainly overestimate effects 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.

2.2.2 Quantifying Behavioral Responses to Sonars

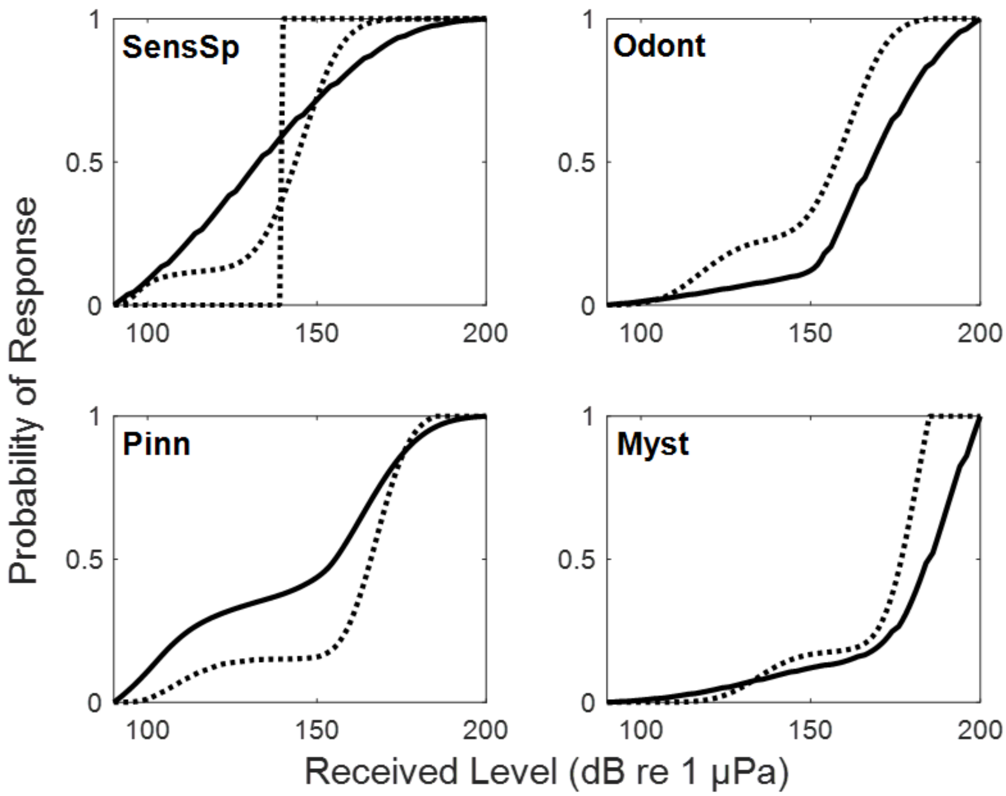
Criteria and thresholds for behavioral responses have been updated since the prior analysis (see *Criteria and Thresholds TR*). Notable differences between the prior and updated criteria and thresholds for behavioral responses to sonars are as follows:

- Beaked whales 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) and Odontocetes (most toothed whales and dolphins).

[4] In prior analyses, the reduction in AINJ due to avoidance was calculated outside of NAEMO 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 (U.S. Department of the Navy, 2019). 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 2-4.



Notes: Revised behavioral response functions (solid lines) and prior behavioral response functions (Phase III, dotted lines). SensSp = Sensitive Species, Odont = Odontocetes, Pinn = Pinnipeds, Myst = Mysticetes. Pinnipeds are not in the MITT Study Area. The Phase III beaked whale behavioral response function is plotted against the new Sensitive Species curve. Figure taken from U.S. Department of the Navy (2024a)

Figure 2-4: 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 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 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., 2012) 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 are 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. The cut-off distance is based on the farthest source-animal distance across all known studies where animals exhibited a significant behavioral response. Animals within a specified distance and exposed to received SPLs associated with the minimum probability (0.50) of response on the behavioral response function are assumed to have a significant behavioral response. Animals beyond the cut-off distance but exposed to received SPLs associated with a probability of response of 0.50 or above 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[1]	Cut-off Range[2]
Sensitive Species[1]	133 dB re 1 µPa	40 km
Odontocetes	168 dB re 1 µPa	15 km
Mysticetes	185 dB re 1 µPa	10 km

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

2.2.3 Quantifying Behavioral Responses to Explosives

Behavioral responses are quantified for explosions, which are impulsive sounds. The thresholds used to quantify behavioral responses to 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 Explosive Sounds

Sound Source	Behavioral Threshold
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 impulse, 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 effects (AINJ and TTS). This reasoning was applied to previous shock trials and is extended to the criteria used in this analysis. Because of this approach, the number of auditory effects is higher than the number of behavioral effects in the quantified results for some stocks. If more than one explosion occurs within any given 24-hour period within a military readiness event, criteria are applied to predict the number of animals that may have a behavioral reaction.

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

2.2.4 Quantifying Mortality and 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 tract injury observed in the same data set. Mortality and slight lung injury effects on marine mammals are estimated using impulse thresholds based on both calf /juvenile and adult body 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 generally results in a small increase in the predicted non-auditory injuries and mortalities for the same event versus prior analyses, although there are no mortalities estimated for this analysis. Thresholds are provided in Table 2.2-5 for use in non-auditory injury assessment for marine mammals exposed to underwater explosives.

Any instances of mortality predicted by NAEMO are not reduced to account for activity-based mitigation in this analysis, unlike prior analyses. Section 2.3.3 (Potential Opportunities to Mitigate Auditory and Non-Auditory Injury) discusses the potential opportunities to mitigate modeled effects from explosions.

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 Effects 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" and "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, 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.

The behavioral responses predicted in this analysis are likely of 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 Behavioral Responses by Distance and Sound Pressure Level

Figure 2-5 and Figure 2-6 provide the total number of predicted behavioral responses under a maximum year of activities for each behavioral response group 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 NAEMO, 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 2.2.2 (Quantifying Behavioral Responses to Sonars) and presented in Table 2.2-3 for each behavioral response group.

Figure 2-5 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 exposures are due to sources with lower source levels while within the cut-off ranges in Table 2.2-3. Overall, there are few exposures to sonar at or above 200 dB SPL.

Figure 2-6 shows the total number of behavioral responses in 5-km bins. For odontocetes and mysticetes, few significant behavioral responses are estimated beyond the cut-off ranges in Table 2.2-3, which are 15 km and 10 km, respectively. 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. For mid-frequency bins in open ocean, there is a strong convergence zone between 50 km – 60 km and a second convergence zone starting beyond 95 km. This explains the spike in predicted behavioral responses at these distances in this Study Area.

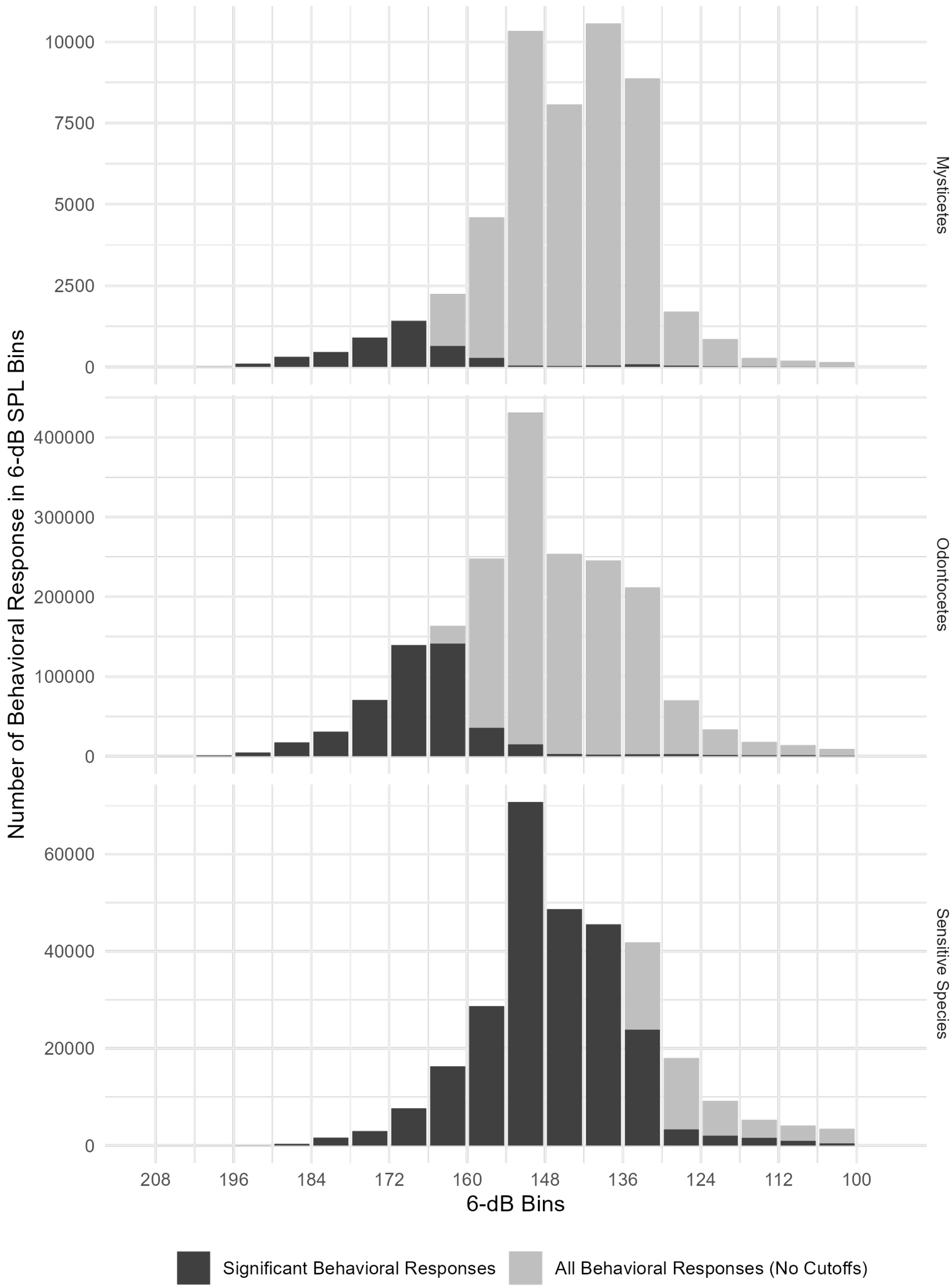


Figure 2-5: Total predicted Instances of Marine Mammal Behavioral Responses in the Study Area by Received Level

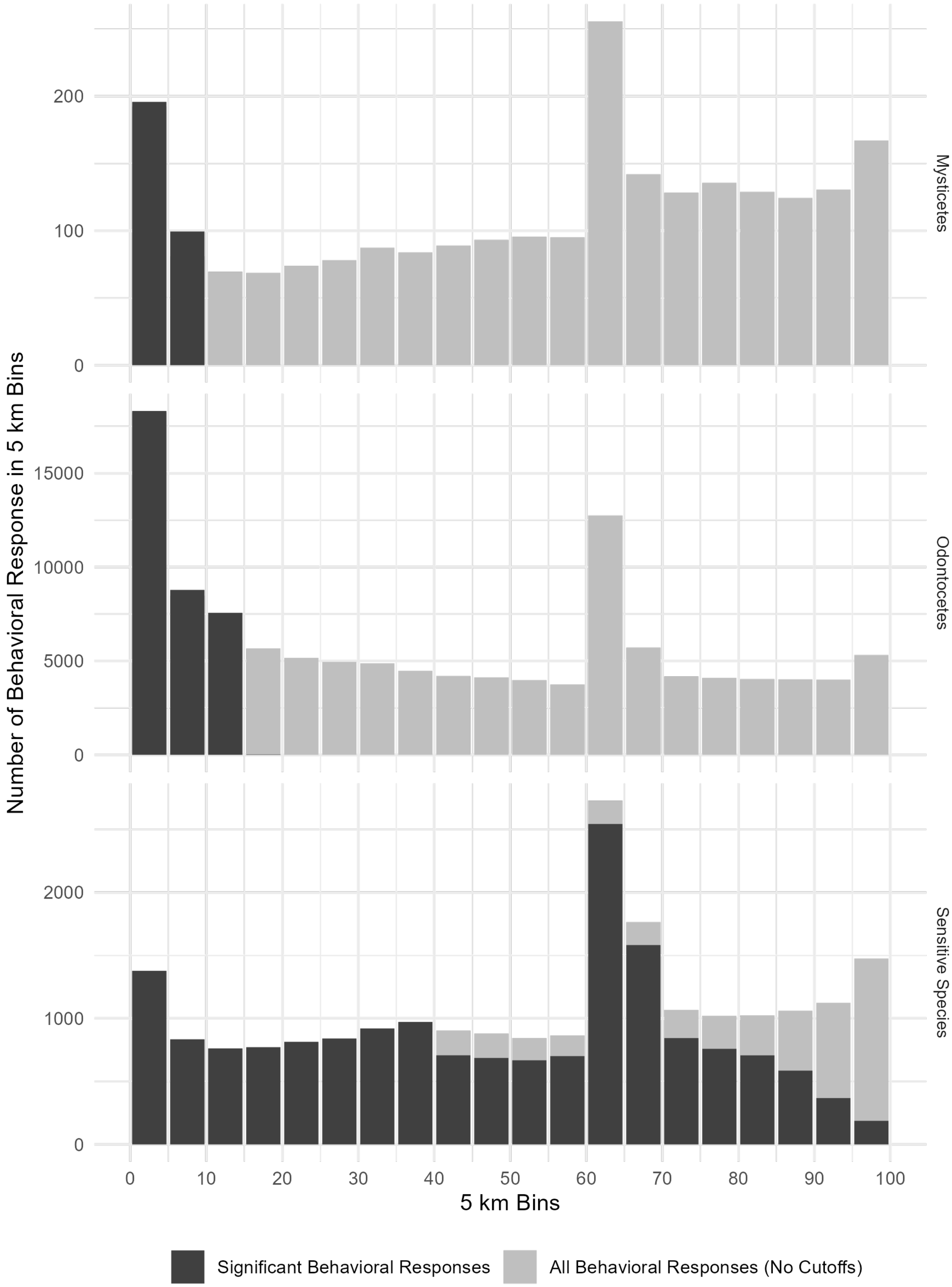


Figure 2-6: Total Predicted Instances of Marine Mammal Behavioral Responses in the Study Area by Distance

2.3.3 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 (Ranges to Effects for Sonar and Other Transducers) for the following sonars: hull-mounted surface ship sonars (bins MF1, MF1C, and MF1K), rotary-wing aircraft 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 mammals exposed to in-water explosions are in Section 2.5.2 (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 effects to account for visual observations, unlike previous analysis. Instead, NAEMO 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 hearing groups are shown in Table 2.3-1. Activities and hearing groups that have no predicted AINJ [following the rounding rules presented below, under Section 2.4 (Species Assessments)] are not shown in Table 2.3-1. For example, no species within the VLF hearing group has a model-predicted AINJ from sonar exposure and is therefore not included 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 a hearing group (e.g., VLF); thus, the ratio is sensitive to the limited number of instances modeled. Most auditory injuries to the HF cetacean hearing groups have an associated closest point of approach in a mitigation zone. Some of these will be observed and the exposure minimized or avoided because of mitigation. A portion (5 percent) of the hearing 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	LF	HF	VHF
Anti-Submarine Warfare Mission Package Testing	-	-	100%
Anti-Submarine Warfare Torpedo Exercise - Ship	-	-	92%
Anti-Submarine Warfare Tracking Exercise - Ship	100%	100%	97%
Civilian Port Defense	-	-	92%
Joint Multi-Strike Group Exercise (CPF)	63%	97%	53%
Medium Coordinated Anti-Submarine Warfare	99%	-	91%
Mine Countermeasure and Neutralization Testing (NAVSEA)	-	-	80%
Sinking Exercise	-	-	23%
Small Integrated ASW	100%	100%	94%
Surface Ship Sonar Maintenance and Systems Checks	-	-	100%
Surface Warfare Advanced Tactical Training	99%	100%	94%
Surface Warfare Torpedo Exercise - Submarine	-	-	25%
Undersea Warfare Testing	-	-	96%

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For this Proposed Action, there are no model-predicted instances of mortality. This analysis did not reduce model-predicted mortality to account for visual observations like in previous analysis, even though the mitigation zones cover the range to mortality. It is likely that animals, especially species that are highly visible such as delphinids in pods, in the mitigation zone will be observed from nearby Lookouts and the exposure avoided, as described in *Mitigation.* Based on the ranges to effect for explosives, most of the predicted non-auditory injuries would also occur within the applicable mitigation zones.

2.3.4 Risks To Marine Mammal Populations

To issue a Letter of Authorization under the MMPA, NMFS must determine that an impact resulting from the specified activity "cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival." 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 (see the section "Population Consequences to Marine Mammals from Acoustic Stressors" in the *Marine Mammal Background*).

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 species that are ESA-listed 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 effect 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 depends 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 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. 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 affect foraging during lactation. Some species exhibit traits of both, such as beaked whales.
- Body size (small/medium/large): For purposes of this assessment, marine mammals were generally categorized as small (less than 3m [10 ft.]), medium (3-9m [10-30 ft.]), or large (more than 9m [30 ft.]) based on length. 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 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, therefore, a temporary feeding disturbance is likely to have inconsequential effects on a mysticete but may be consequential for small cetaceans.
- 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 is 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 effects on breeding adults have a longer-term effect on population growth rates. The discussion of “generation times” in the species effect analyses below are referring to that species’ age of maturity. 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 species that are ESA-listed and in Table 2.3-5 for all other species. 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

	Body Size	Feeding/ Breeding Strategy	Pace of Life	Chronic Anthropogenic Risk Factors	Chronic Biological Risk Factors (Non-Noise)
Categories/ Definitions	[Small, Medium, Large]	[Capital, 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 or equal number of slow, medium and fast attributes	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.
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 (i.e., entanglement in nets, whaling, and bycatch), pollution, 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 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:

- 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 effects.
- 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, if reasonable estimates of abundance are available.
- Activities that occur within homeports and long duration activities, such as major training exercises, require special consideration due to the potential for more frequent repeated effects on 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[2]	Other Risk Factors[3]
Blue whale	Central North Pacific	Migratory	Large	Capital	Slow	Unk, but possibly stable	Vessel strikes, fisheries interactions, ingestion of marine debris, ocean noise	Disease, predation by killer whales, pollution
Fin whale	NSD	Migratory	Large	Capital	Slow	Unk	Vessel strikes, fisheries interactions, ocean noise	Disease, parasites, predation by killer whales
Humpback Whale	Western North Pacific	Migratory	Large	Capital	Slow	Unk, but possibly increasing	Vessel strikes, fisheries interactions, ingestion of marine debris	Disease, parasites, predation by (false) killer whales
Sei whale	NSD	Migratory	Large	Capital	Slow	Unk	Vessel strikes, fisheries interactions, ocean noise	Disease, parasites, predation by killer whales
Sperm whale	NSD	Nomadic	Large	Income	Slow	Unk	Vessel strikes, fisheries interactions, ingestion of marine debris, ocean noise	Disease, parasites, predation by (false) killer whales and pilot whales, pollution

Notes: Unk = unknown; Med = medium; NSD = No Stock Determined
[1] Stock designations are from Pacific Stock Assessment Reports prepared by NMFS (Carretta et al., 2023; Young, 2023).
[2] Fisheries interactions represent entanglement in fishing gear, including derelict fishing gear, whaling, and bycatch.
[3] Climate-related changes have the potential to affect all populations by, for example, shifting prey distributions or physically altering habitats (Gulland et al., 2022).

1 **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[2]	Other Risk Factors[3]
Blainville's beaked whale	NSD	Nomadic	Med	Mixed	Med	Unk	Fisheries interactions, ingestion of marine debris, ocean noise	n/a
Bryde's whale	NSD	Nomadic	Large	Capital	Slow	Unk	Vessel strikes, fisheries interactions, ocean noise	Predation by killer whales
Common bottlenose dolphin	NSD	Resident-nomadic	Small-Med	Income	Med	Unk	Fisheries interactions	Disease, pollution
Deraniyagala's beaked whale	NSD	Unk, likely nomadic	Med	Mixed	Med	Unk	Fisheries interactions, ingestion of marine debris, ocean noise	n/a
False killer whale	NSD	Nomadic	Med	Income	Med	Unk	Fisheries interactions, ingestion of marine debris	Predation by killer whales, prey availability, disease
Fraser's dolphin	NSD	Nomadic	Small	Income	Fast	Unk	Fisheries interactions	n/a
Ginko-toothed beaked whale	NSD	Unk, likely nomadic	Med	Mixed	Med	Unk	Fisheries interactions, ocean noise	n/a
Goose-beaked (Cuvier's) whale	NSD	Unk, likely nomadic	Med	Mixed	Med	Unk	Fisheries interactions, ocean noise	n/a
Killer whale	NSD	Nomadic	Large	Income	Slow	Unk	Fisheries interactions, ocean noise	Disease, pollution
Longman's beaked whale	NSD	Unk, likely nomadic	Med	Mixed	Med	Unk	Fisheries interactions, ocean noise	Predation by killer whales, disease
Melon-headed whale	NSD	Nomadic	Small	Income	Med	Unk	Fisheries interactions, ocean noise	Predation by killer whales, pollution
Minke whale	NSD	Nomadic	Med-Large	Capital	Slow	Unk	Vessel strike, fisheries interactions	Prey availability
Omura's whale	NSD	Unk, likely nomadic	Large	Capital	Slow	Unk	Vessel strike, fisheries interactions	n/a

Species	Stock[1]	Movement Ecology	Body Size	Feeding/ Breeding Strategy	Pace of Life	Population Trend	Chronic Anthropogenic Risk Factors[2]	Other Risk Factors[3]
Pantropical spotted dolphin	NSD	Nomadic	Small	Income	Med	Unk	Fisheries interactions	Predation from (pygmy and false) killer whales, sharks, and short-finned pilot whales
Pygmy and dwarf sperm whales	NSD	Unk, likely nomadic	Small-Med	Income	Fast	Unk	Vessel strike, fisheries interactions, ingestion of marine debris, ocean noise	Disease
Pygmy killer whale	NSD	Nomadic	Small	Income	Med	Unk	Fisheries interactions, ocean noise	Predation by killer whales
Risso's dolphin	NSD	Nomadic	Small-Med	Income	Med	Unk	Fisheries interactions, ocean noise	Predation by killer whales and sharks, pollution
Rough-toothed dolphin	NSD	Resident-nomadic	Small	Income	Med	Unk	Fisheries interactions, ocean noise	Predation by killer whales
Short-finned pilot whale	NSD	Nomadic	Med	Income	Slow	Unk	Vessel strike, fisheries interactions	Predation by killer whales
Spinner dolphin	NSD	Resident-nomadic	Small	Income	Fast	Unk	Fisheries interactions, ingestion of marine debris, ocean noise	Predation by (pygmy) killer whales, sharks, and short-finned pilot whales, disease
Striped dolphin	NSD	Nomadic	Small	Income	Med	Unk	Fisheries interactions	Predation by killer whales and sharks, disease

Notes: Unk = unknown; Med = medium; NSD = No Stock Determined; n/a = none available, no other specific risks were identified in Appendix C of the SEIS/OEIS

[1] Stock designations are from Pacific and Alaska Stock Assessment Reports prepared by NMFS (Carretta et al., 2023; Young, 2023).

[2] Fisheries interactions represents entanglement in fishing gear, including derelict fishing gear, whaling, and bycatch

[3] Climate-related changes have the potential to affect all populations by, for example, shifting prey distributions or physically altering habitats (Gulland et al., 2022).

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, killer whales) may be affected by some short-term and intermittent masking by mid-frequency sonars. 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. 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, or calls from predators, could be more difficult to detect or interpret. For example, killer whales are a primary predator of most other marine mammals, and 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 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 shifts 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 effects on 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 could be a small amount of residual permanent threshold shift and less than initial (i.e., > 40 dB) TTS (Reichmuth et al., 2019) or could cause other physiological changes without permanent threshold shift (see the *Criteria and Thresholds TR*). In cases where AINJ results in permanent hearing loss, this could reduce an animal's ability to detect sounds that are important for survival (including sounds that facilitate breeding, signal feeding opportunities, and allow avoidance of predators, vessels, and other threats), which could have 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 decrease in hearing sensitivity may include some degree of energetic costs, it would be unlikely to affect 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 affected as compared to relatively healthy individuals.

- Exposures that result in non-auditory injuries (INJ) 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 affect 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) effects on marine mammals resulting from training and testing activities based on observations of marine mammals generally in and around range complexes (see the *Marine Mammal Background* section).

2.4 Species Assessments

The following sections analyze effects on each marine mammal stock under the Proposed Action and show detailed model-predicted estimates of take for a maximum year of activity under the Proposed Action. The analyses rely on information on species presence and behavior in the Study Area presented in the *Marine Mammal Background*. That information is briefly summarized in each species effect analysis. The reader is referred to the *Marine Mammal Background* for additional detail and supporting references.

The methods used to quantify effects for each substressor are described above in Section 2.2.1 (Quantifying Effects on Marine Mammals from Acoustic and Explosive Stressors). The methods used to assess significance of individual effects and risks to marine mammal populations are described above in Section 2.3 (Assessing Effects on Individuals and Populations).

For each stock, a multi-sectioned table quantifies effects as follows:

Section 1

The first section shows the number of instances of each effect type that could occur due to each substressor (sonar or explosives) over a maximum year of activity. Effects are shown by type of activity (training or testing).

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 NAEMO and are not further reduced to account for activity-based 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. Effects are assigned to the highest order threshold exceeded at the animat. Non-auditory injuries are assumed to outrank auditory effects, and auditory effects are assumed to outrank significant behavioral responses. 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. In all instances any auditory effect or injury is assumed to represent a concurrent significant behavioral response.

An activity's effects are calculated by multiplying the average expected effects at a location per season by the number of times that activity is expected to occur.

The summation of instances of effect includes all fractional values caused by averaging multiple modeled iterations of individual events. Effects 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 effects is greater than true zero but less than 0.5. These effects are described in the species analysis as "negligible."
- A dash (-) indicates that no effects are predicted (i.e., a "true" zero). This would occur when there is no overlap of an animat in the model with a level of acoustic exposure that would result in any possibility of effects. 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.
- A one in parentheses (1) indicates that predicted effects round to zero in a maximum year of activity, but a single effect is predicted over seven years when summing the fractional risks across years. This is explained further below.
- If there are no modeled effects from a substressor, even though a stressor could occur in a region where a species may be present, this is described as "no effect" in the species analysis and the substressor is not shown on the table.
- If there are comparatively few instances of modeled effects from a substressor, this result will be described in the species analysis as "limited."
- If there is no geographic overlap between the use of a stressor and the potential presence of a species, this is stated in the analysis.

The summation of effects across seven years is shown in Section 2.4.3 (Effect Summary Tables). The seven-year sum for Alternative 1 accounts for any variation in the annual levels of activities. The seven-year sum includes any fractional effect values predicted in any year, which is then rounded following standard rounding rules. That is, the seven-year effects are not the result of summing the rounded annual effects.

If a seven-year sum is larger than the annual modeled effects multiplied by seven, the annual maximum effects shown in the stock impact tables were increased by dividing the seven-year sum of effects by seven then rounding up to the nearest integer. For example, this could happen if maximum annual modeled effects are 1.34 (rounds to 1 annually) and seven-year modeled effects are 8.60 (rounds to 9), where 9 divided by 7 years (9 ÷ 7 = 1.29) is greater than the rounded annual effect of 1. In this instance, the maximum annual effects would be adjusted from 1 to 2 based on rounding up 1.29 to 2. In multiple instances, this approach resulted in increasing the maximum annual effects predicted by NAEMO.

Section Two

The second section estimates the average number of times an individual in a stock or population would be affected in a maximum year of activity. The annual effects per individual is the sum of all instances of effect divided by the population abundance estimate. The annual injurious effects per individual is only the sum of injuries (auditory, non-auditory, and mortality) divided by the population abundance estimate. 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 (auditory or non-auditory) will be stated.

The ratios of effects to abundances are based on the same underlying assumptions about species presence applied in the modeling. Abundances are either literature-based estimates (if available; see the *Marine Mammal Background* section) or the predicted abundance within the Study Area boundary using the Navy Marine Species Density Database (NMSDD) (see the *Density TR*). Where literature-based abundance estimates for species are available, the NMSDD-based abundances applied in NAEMO were normalized to the literature-based values. These are identified in Table 2.4-1. Despite additional surveys in the Study Area since the prior analysis, there is insufficient data to estimate densities and abundances for some species (see the *Density TR*). Consequently, the densities, and therefore the abundances, for all other species are completely or partially based on values extrapolated from other regions, typically Hawaii. The abundances are based on the extent of the density models in the Study Area including the MIRC and the Transit Corridor. For species with seasonal density differences (only a sub-set of the mysticetes), the highest seasonal abundance is shown. Only two populations in the Study Area have stock assessment reports (Central North Pacific blue whales and Western North Pacific humpback whales). The best available abundance estimates in the stock assessment reports (SAR) are not used here because there is insufficient information to estimate the abundances in this Study Area.

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). NAEMO 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 effects that would occur within seasons and general geographic areas. The general geographic areas are the MIRC and the Transit Corridor. Most activities using sonar and explosives would occur in the MIRC.

Section Four

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

Table 2.4-1: Number of Animats Assumed within the Boundary of the MITT Study Area for Modeling Effects

Species	Stock Designation	Number of Animats
ESA-listed		
Mysticetes		
Blue whale	Central North Pacific	232
Fin whale	NSD	309
Humpback whale	Western North Pacific	5,287[1]
Sei whale	NSD	166[2,3]
Odontocetes		
Sperm whale	NSD	1,574[2,4]
Non-ESA-listed		
Mysticetes		
Bryde's whale	NSD	233[2,3]
Minke whale	NSD	91[2,5]
Omura's whale	NSD	154
Odontocetes		
Blainville's beaked whale	NSD	15,705[2,4]
Common Bottlenose dolphin	NSD	1,800[2,6]
Goose-beaked (Cuvier's) whale	NSD	6,007[2,4]
Deraniyagala's beaked whale	NSD	4,592
Dwarf sperm whale	NSD	59,040
False killer whale	NSD	1,059[2,6]
Fraser's dolphin	NSD	62,714
Ginkgo toothed beaked whale	NSD	4,592
Killer whale	NSD	285
Longman's beaked whale	NSD	730[2,6]
Melon-headed whale	NSD	2,455[2,3]
Pantropical spotted dolphin	NSD	33,518[2,7]
Pygmy killer whale	NSD	4,351[2,6]
Pygmy sperm whale	NSD	66,333
Risso's dolphin	NSD	9,554
Rough-toothed dolphin	NSD	9,256[2,6]
Short-finned pilot whale	NSD	1,192[2,6]
Spinner dolphin	NSD	10,202[2,7]
Striped dolphin	NSD	7,676[2,7]

NSD: No stock is designated

[1] Limited data exist to estimate humpback whale abundance in the offshore portion of the Study Area. The minimum population estimate for the Western North Pacific stock (n = 1,007) in the 2022 stock assessment report (Carretta et al., 2023) is noted to be underestimated. The humpback whale density used for modeling effects due to this Proposed Action likely overestimates humpback whale presence in the Study Area (see the *Density TR* and "Section Two" in Section 2.4 above).

[2] The NMSDD-based abundances seeded in the Study Area in NAEMO were normalized to the literature-based values (see "Section Two" in Section 2.4 above).

[3] Fulling et al. (2011)

[4] Badger et al. (2024)

[5] Norris et al. (2017)

[6] Bradford et al. (in prep.)

[7] Becker et al. (in prep.)

The seven-year sum of effects for all acoustic and explosive stressors combined and for each type of stressor are shown for all species and stocks in Section 2.4.3 (Effects Summary Tables).

2.4.1 Effects on Mysticetes

The mysticetes have been split from the previous inclusive LF cetacean hearing group into two hearing groups: the VLF and LF cetaceans. The predicted hearing range of the VLF cetaceans resembles the previous combined hearing group for all mysticetes, whereas the predicted hearing range for the revised LF cetacean group is shifted to slightly higher frequencies.

For sonar exposures, the behavioral response function indicates less sensitivity to behavioral disturbance than predicted in the prior analysis. As described in Section 2.2.1 (Quantifying Effects 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 2.2.2 (Quantifying Behavioral Responses to Sonars). 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 effects than the prior analysis. These factors interact in complex ways that make the results of this analysis challenging to compare to prior analyses. The below species analyses note where differences in estimated effects between this analysis and the prior 2020 MITT SEIS/OEIS analysis are significantly influenced by changes in the estimated densities.

Most estimated auditory effects on mysticetes are from hull-mounted sonar (MF1 and MF1C) utilized during Anti-Submarine Warfare activities. These effects could affect members of the VLF and LF hearing groups differently. Auditory effects from MF1 sonar may disrupt communication in LF cetaceans, however, it is unlikely to affect communication in VLF cetaceans because their calls are typically much lower in frequency. For example, while a VLF mysticete could experience either a temporary or permanent threshold shift at the mid-frequency range (1-10 kHz), their communication calls occur at much lower frequencies (100-400 Hz); therefore, the ability to detect lower frequency calls from conspecifics may not be affected.

Effects due to non-modeled acoustic stressors are discussed above in Section 2.1.2 (Effects from Vessel Noise), Section 2.1.3 (Effects from Aircraft Noise), and Section 2.1.4 (Effects from Weapons Noise).

2.4.1.1 Blue Whale (*Balaenoptera musculus*) - Endangered

Blue whales are in the VLF cetacean hearing group and the Mysticete behavioral group. Blue whales in the Study Area likely belong to the Central North Pacific stock. Blue whales are endangered throughout their range with no designated DPS. The Central North Pacific stock of blue whales migrates from summer feeding grounds south of the Aleutian Islands and in the Gulf of Alaska to lower latitudes in the winter. While acoustic recordings around Tinian and Saipan have identified blue whales in the MITT Study Area, they are not sighted frequently or year-round (see the *Marine Mammal Background* section). Blue whales are not expected to be in the Study Area or associated Transit Corridor during the summer months. Model-predicted effects are presented in the table below.

Most potential effects would occur in the MIRC during the cold season (winter to spring) and would be due to sonar during Anti-Submarine Warfare training activities. Most effects are auditory because mysticetes are relatively less sensitive to behavioral disturbance. Estimated auditory injury effects from sonar are limited. There are no predicted non-auditory injuries from training explosive activity and there are no predicted effects of any type due to explosives during testing activities. In addition to the refinements to the assessment of auditory effects described in Section 2.4.1 (Effects on Mysticetes), slight increases in estimated density also contribute to a minor increase in modeled acoustic effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area could be affected less than once per year. The average individual risk of injury is negligible. Most effects would be temporary auditory and behavioral effects due to hull-mounted sonar. Auditory effects are not likely to result in disruptions to communication behaviors, as the calling frequency of blue whales is between 10 – 100 Hz, well below the nominal frequency of hull-mounted sonar. The risk of auditory injury may be reduced through activity-based mitigation because blue whales are moderately sightable when present in the area.

The risk of repeated effects 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. The Central North Pacific stock of blue whales is known to feed south of the Aleutian Islands and in the Gulf of Alaska during the summer, therefore no disruptions to foraging are expected while the blue whales are present in the MITT Study Area during the cold months. Population trends for this Central North Pacific stock of blue whales are unknown, but populations are possibly stable across the Pacific. This species is endangered, and their slow pace of life means that long-term effects on breeding adults could have a longer-term effect on population growth rates.

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

Table 2.4-2: Estimated Effects on the Central North Pacific Stock of Blue Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Training	(1)	(1)	-	-	-
Sonar	Testing	1	(1)	-	-	-
Sonar	Training	2	36	(1)	-	-
Maximum Annual Total		**4**	**38**	**1**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
232	0.19	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	27%	0%
Cold	72%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	29%
Small Integrated ASW	Training	27%
Surface Warfare Advanced Tactical Training	Training	13%
Medium Coordinated Anti-Submarine Warfare	Training	11%
Joint Multi-Strike Group Exercise (CPF)	Training	9%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.1.2 Bryde's Whale (*Balaenoptera brydei*)

Bryde's whales are in the LF cetacean hearing group and the Mysticete behavioral group. There are two NMFS managed U.S. Pacific stocks in Hawaii and the Eastern Tropical Pacific, however, NMFS has not designated a separate stock off Guam and CNMI. Bryde's whales are expected to be present in the Study Area and associated Transit Corridor year-round and are likely nomadic throughout their range. Seasonal shifts in their distribution are known to occur toward and away from the equator in winter and summer, respectively. Little is known about the movements of Bryde's whales in the Study Area, but most survey efforts have seen Bryde's whales in deep waters (e.g., the West Mariana Ridge and Mariana Trench), and some surveys have identified calves. In general, Bryde's whales occur primarily in offshore oceanic warm waters of the North Pacific (see the *Marine Mammal Background* section). Model-predicted effects are presented in the table below.

Most potential effects would occur in the MIRC during the cold season (winter to spring) and would be due to sonar during Anti-Submarine Warfare activities. Most effects are auditory because mysticetes are relatively less sensitive to behavioral disturbance. Estimated auditory injury effects from sonar activity are limited. Effects from explosive activity are also limited with no predicted non-auditory injuries. The decrease in modeled effects on this population since the 2020 analysis are generally due to normalizing the modeled abundance to the estimated population abundance from literature (please refer to S*ection Two* in Section 2.4 [Species Impact Assessments] for further detail). On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The average individual risk of injury is negligible. The risk of auditory injury may be reduced through activity-based mitigation because Bryde's whales are moderately sightable when present in the area.

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 effects from foraging disruption. Even somewhat migratory movement ecology combined with the overall low number of predicted effects for this stock means the risk of consequences to any individual is low.

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

Table 2.4-3: Estimated Effects on Bryde's Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	-	-
Explosive	Training	(1)	(1)	0	-	-
Sonar	Testing	1	(1)	-	-	-
Sonar	Training	2	62	1	-	-
Maximum Annual Total		**4**	**64**	**1**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
233	0.30	0.00

Season	Percent of Total Effects MIRC
Warm	39%
Cold	60%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	35%
Small Integrated ASW	Training	25%
Surface Warfare Advanced Tactical Training	Training	12%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Fin Whale (*Balaenoptera physalus*) - Endangered

Fin whales are in the VLF cetacean hearing group and Mysticete behavioral group. There are three NMFS recognized stocks in U.S. Pacific waters; however, NMFS has not designated a separate stock off Guam and CNMI. Fin whales are not likely to occur in the MITT Study Area in the summer due to low productivity, nor are they likely to occur near Guam at any time. There have been no recorded visual sightings of fin whales in the Study Area although acoustic recordings of fin whale calls were identified around Tinian, Saipan, and in the Transit Corridor between Guam and Hawaii (see the *Marine Mammal Background* section). Fin whales are endangered throughout their range. Model-predicted effects are presented in the table below.

Most potential effects would occur in the MIRC during the cold season (winter to spring) and would be due to sonar during Anti-Submarine Warfare activities. Most effects are auditory because mysticetes are relatively less sensitive to behavioral disturbance. Estimated auditory injury from sonar are limited. The risk of auditory effects from explosive activities is negligible. There are no predicted non-auditory injuries from explosives. In addition to the refinements to the assessment of auditory effects described in Section 2.4.1 (Effects on Mysticetes), a small increase in estimated density also contributes to slight increases in modeled auditory effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area could be affected less than once per year. The average individual risk of injury is negligible. Most effects would be temporary auditory and behavioral effects due to hull-mounted sonar. Auditory effects are not likely to result in disruptions to communication behaviors, as the calling frequency of fin whales is below 150 Hz; well below the nominal frequency range of hull-mounted sonar. The risk of auditory injury may be reduced through activity-based mitigation because fin whales are moderately sightable when present in the area.

The risk of repeated effects 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. The North Pacific stock of fin whales is known to feed in more temperate and polar waters during the summer, therefore no disruptions to foraging are expected while the fin whales are assumed to be present in the MITT Study Area during the cold months. Population trends for fin whales in this region are unknown; however, fin whales are endangered throughout their range. Their slow pace of life means that long-term effects on breeding adults could have a longer-term effect on population growth rates.

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

Table 2.4-4: Estimated Effects on Fin Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	-	0	-	-	-
Explosive	Training	(1)	0	0	-	-
Sonar	Testing	1	(1)	-	-	-
Sonar	Training	2	30	(1)	-	-
Maximum Annual Total		**4**	**31**	**1**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
309	0.12	0.00

Season	Percent of Total Effects
	MIRC
Warm	26%
Cold	74%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Small Integrated ASW	Training	30%
Anti-Submarine Warfare Tracking Exercise - Ship	Training	24%
Surface Warfare Advanced Tactical Training	Training	14%
Medium Coordinated Anti-Submarine Warfare	Training	11%
Joint Multi-Strike Group Exercise (CPF)	Training	11%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Humpback Whale (*Megaptera novaeangliae*) - Endangered

Humpback whales are in the LF cetacean hearing group and the Mysticete behavioral group. The endangered Western North Pacific stock/DPS is further broken down into two units; the Philippines/Okinawa-Northern Pacific unit and the Mariana Islands/Ogasawara-Northern Pacific unit. Humpback whales in the Mariana Islands/Ogasawara-Northern Pacific unit of the Western North Pacific stock are migratory and expected to be present in the Study Area between December and April during their breeding season, with higher densities around the Northern Mariana Islands (i.e., Saipan, Tinian, and Pagan). This stock will then migrate north to their feeding grounds in Russia and the Aleutian

Islands/Bering Sea in the summer (see the *Marine Mammal Background* section). Model-predicted effects are presented in the table below.

Since humpback whales are seasonally present, most estimated effects would occur within the MIRC during the cold season (winter to spring). Most effects are auditory, including auditory injury, due to sonar during Anti-Submarine Warfare activities. Most effects are auditory because mysticetes are relatively less sensitive to behavioral disturbance. Effects from explosives are relatively limited. There are no predicted non-auditory injuries from explosives. In addition to the refinements to the assessment of auditory impacts described in Section 2.4.10 (Effects on Mysticetes), increases in estimated density also contribute to increases in modeled acoustic effects for this population since the 2020 analysis. Specifically, humpback whale density for Phase IV includes a more detailed and stratified density of whales around the islands of Pagan, Saipan, and Tinian, as well as increased density within the entire Exclusive Economic Zone (EEZ) (for specific density maps around the Study Area see the *Density TR*). It is likely that the densities assumed in the offshore areas for purposes of modeling impacts overestimate humpback presence in those areas.

On average, individuals estimated to occur in the Study Area could be affected less than once per year. The average individual risk of injury is negligible. Most effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The frequency of ASW sonars can overlap humpback whale calls which may result in disruption of communication behaviors. The risk of auditory injury may be reduced through activity-based mitigation, as humpback whales are moderately sightable when present in the area. Although no activities were modeled in the mitigation areas established at Chalan Kanoa Reef and Marpi Reef, a very low number of effects (approximately one TTS) are predicted due to sound propagation from acoustic activities outside of the mitigation zone. Nearly all other effects are predicted for whales outside of these areas.

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. While they are expected to be resilient to short-term foraging disruptions due to their reliance on built-up energy reserves, humpback whales in the Study Area are not feeding but breeding, which is energetically costly. Although some individuals are known to exhibit site fidelity off Saipan, other humpback whales such as juveniles, males, and non-breeding individuals transit within the MITT Study Area, either to other known breeding associated islands in waters off of Japan and the Philippines, or when travelling North in the summer to feeding grounds around Russia (Hill et al., 2020). Transiting whales would be expected to have fewer potential exposures to training and testing activities compared to animals that are seasonally resident. The Western North Pacific stock of humpback whales is endangered throughout its range. Their population trend is likely increasing; however, humpback whales' slow pace of life means that long-term effects on breeding adults could have a longer-term effect on population growth rates.

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

Table 2.4-5: Estimated Effects on the Western North Pacific Stock of Humpback Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	(1)	-	-	-
Explosive	Training	7	4	(1)	-	-
Sonar	Testing	15	10	0	-	-
Sonar	Training	27	1,453	20	-	-
Maximum Annual Total		**49**	**1,468**	**21**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
5,287	0.29	0.00

Season	Percent of Total Effects
	MIRC
Warm	11%
Cold	89%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	38%
Small Integrated ASW	Training	23%
Surface Warfare Advanced Tactical Training	Training	10%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	9%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Minke Whale (*Balaenoptera acutorostrata*)

Minke whales are in the LF cetacean hearing group and the Mysticete behavioral group. There are three NMFS recognized stocks for the U.S. North Pacific; however, NMFS has not designated a separate stock off Guam and CNMI. Minke whales have not been visually observed in the Study Area, but they are one of the most common mysticetes acoustically detected in the area. Minke whales are presumed to be present in the MITT Study Area from the fall through the spring and are not expected to be in the Study Area or associated Transit Corridor during summer months due to low productivity in the region. Model-predicted effects are presented in the table below.

Most potential effects on minke whales would occur in the MIRC during the cold season (winter to spring) and would be due to sonar during Anti-Submarine Warfare activities. Most effects are auditory because mysticetes are relatively less sensitive to behavioral disturbance. Estimated auditory injury effects from sonar are limited and are not expected to occur from explosive activities. There are no predicted non-auditory injuries from explosives. The decrease in modeled effects on this population since the 2020 analysis are generally due to normalizing the modeled abundance to the estimated population abundance from literature (please refer to S*ection Two* in Section 2.4 [Species Impact Assessments] for further detail). On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The frequency of these sources can overlap minke whale calls which may result in disruption of communication behaviors. The average individual risk of injury is low. The risk of auditory injury may be reduced through activity-based mitigation, however, minke whales may not be easy to sight when present in the area.

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. Migratory minke whales are likely to sustain fewer effects during the warm season when their local abundance is lower. If effects were 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, however, their slow pace of life means that long-term effects on breeding adults could have a longer-term effect on population growth rates.

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

Table 2.4-6: Estimated Effects on Minke Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	-	0	-	-	-
Explosive	Training	(1)	0	-	-	-
Sonar	Testing	(1)	(1)	-	-	-
Sonar	Training	(1)	21	(1)	-	-
Maximum Annual Total		**3**	**22**	**1**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
91	0.29	0.01

Season	Percent of Total Effects: MIRC
Warm	24%
Cold	75%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	37%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	11%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Omura's Whale (*Balaenoptera omurai*)

Omura's whales are in the LF cetacean hearing group and Mysticete behavioral group. There is no NMFS recognized stock for Omura's whales off Guam and CNMI, and they are not known to occur in U.S. waters. Omura's whales are nomadic across its range of the tropical and subtropical waters of the western Pacific and eastern Indian oceans where individuals tend to occur in nearshore waters (Jefferson et al., 2015). While there is a lack of confirmed sightings, Omura's whale may be present in the MITT study area year-round. Model-predicted effects are presented in the table below.

Most potential effects would occur in the MIRC during the cold season (winter to spring) and would be due to sonar during Anti-Submarine Warfare activities. Most effects are auditory because mysticetes are relatively less sensitive to behavioral disturbance. Effects from explosives are limited. Estimated auditory injury effects from sonar are limited and are not expected to occur from explosive activities. There are no predicted non-auditory injuries from explosives. On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to sonar. Auditory effects are not likely to result in disruptions to communication behaviors, as the calling frequency of Omura's whales is between 15 – 50 Hz, well below the nominal frequency of hull-mounted sonar. The average individual risk of injury is low. The risk of auditory injury may be reduced through activity-basedmitigation, however, Omura's whales may not be easy to sight if present in the area.

The risk of repeated effects on individuals and consequences to populations from disturbances of individuals can be mediated by certain life history traits of a species. While this species is data deficient, extrapolations can be made from its closest relative, the blue whale (Sasaki et al., 2006; Wada et al., 2003) large capital breeders with a slow pace of life. Unlike other large mysticetes, Omura's whales are noted to be non-migratory with local or restricted ranges across the western Pacific and feed year-round (Cerchio et al., 2019). Therefore, they are likely moderately resilient to missed foraging opportunities due to acoustic disturbance in offshore waters, and the risk of repeated effects on individuals is likely similar within the population as animals move throughout their range.

As Omura's whales were formally recognized as a species in 2003, there is little population information or current trends known. The limited instances of predicted behavioral and non-injurious auditory effects are unlikely to result in any long-term effects on individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted effects are temporary auditory effects that are unlikely to contribute to any long-term effects on individuals. Long-term consequences to the population are unlikely.

Table 2.4-7: Estimated Effects on Omura's Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	-	0	-	-	-
Explosive	Training	(1)	(1)	-	-	-
Sonar	Testing	1	(1)	-	-	-
Sonar	Training	2	46	(1)	-	-
Maximum Annual Total		**4**	**48**	**1**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
154	0.34	0.01

Season	Percent of Total Effects
	MIRC
Warm	39%
Cold	61%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	45%
Small Integrated ASW	Training	22%
Surface Warfare Advanced Tactical Training	Training	10%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Sei Whale (*Balaenoptera borealis*) - Endangered

Sei whales are in the LF cetacean hearing group and the Mysticete behavioral group. There are three NMFS recognized stocks within the U.S. Pacific EEZ; however, NMFS has not designated a separate stock off Guam and CNMI. Sei whales are listed as endangered throughout their range. They are migratory but are typically found in the open ocean, away from the coast. Sei whales generally have higher abundances in the cold temperate to subpolar latitudes and are therefore considered rare in this region, although they have been sighted in the MITT Study Area. Since sei whales migrate between higher latitude summer feeding grounds to lower latitude breeding grounds in the winter, they are more likely to be around the MITT Study Area in the cold season (winter to spring) and are not expected to be in the Study Area or associated Transit Corridor during summer months due to low productivity. Model-predicted effects are presented in the table below.

Most potential effects on Sei whales would occur in the MIRC during the cold season and would be due to sonar during Anti-Submarine Warfare activities. Most effects are auditory because mysticetes are relatively less sensitive to behavioral disturbance. Estimated auditory injury effects from sonar are limited, and negligible amounts are expected to occur from explosive training activities. There are no predicted non-auditory injuries from explosives. The decrease in modeled effects on this population since the 2020 analysis are generally due to normalizing the modeled abundance to the estimated population abundance from literature (please refer to S*ection Two* in Section 2.4 [Species Impact Assessments] for further detail). On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to sonar. Auditory effects are not likely to result in disruptions to communication behaviors, as the calling frequency of sei whales is less than 100 Hz, well below the nominal frequency of hull-mounted sonar. The average individual risk of injury is low. The risk of any injury may be reduced through activity-based mitigation because sei whales are moderately sightable when present in the area.

The risk of repeated effects 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. Migratory sei whales are likely to sustain fewer effects during the warm season when their local abundance is assumed to be low. 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 but they are listed as endangered. Their slow pace of life means that long-term effects on breeding adults could have a longer-term effect on population growth rates.

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

Table 2.4-8: Estimated Effects on Sei Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	-	0	-	-	-
Explosive	Training	(1)	0	0	-	-
Sonar	Testing	(1)	(1)	0	-	-
Sonar	Training	1	33	(1)	-	-
Maximum Annual Total		**3**	**34**	**1**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
166	0.23	0.01

Season	Percent of Total Effects: MIRC
Warm	27%
Cold	73%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	35%
Small Integrated ASW	Training	25%
Surface Warfare Advanced Tactical Training	Training	12%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Effects on Odontocetes

The odontocetes are divided into the HF and VHF cetacean hearing groups. Even though the Action Proponents are proposing fewer hours of hull-mounted sonars in this Proposed Action, most estimated effects on odontocetes are from hull-mounted sonar (MF1 and MF1C) utilized during Anti-Submarine Warfare activities. These effects could influence communication behavior for both HF and VHF hearing groups, as sonar sources can overlap with typical bandwidths of odontocete whistles and social calls, resulting in masking. However, higher-frequency echolocation clicks used for hunting and navigating are unlikely to be masked and an animal's ability to detect clicks would be unaffected.

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 and MF1C hull-mounted sonar and other anti-submarine warfare sonars, are substantially higher for this hearing 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 below species analyses note where differences in estimated effects between this analysis and the prior 2020 MITT SEIS/OEIS analysis are significantly influenced by changes in the estimated densities.

The methods to model sonar avoidance have also been revised to base a species' probability of an avoidance response on the behavioral response functions as described in 2.2.1 (Quantifying Effects on Hearing). The combined behavioral response function for Sensitive Species replaces the two prior distinct behavioral response functions for beaked whales and porpoises. Due to their greater susceptibility to disturbance, beaked whales in the Sensitive Species behavioral group are predicted to avoid many auditory injuries. The revised cut-off conditions for significant behavioral responses in this analysis resulted in predicted effects at farther distances than observed in studies of beaked whale responses to sonar (see Section 2.3.2 [Behavioral Responses by Distance and Sound Pressure Level]).

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 effects and less behavioral effects than the prior analysis for these species. 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 2.2.2 (Quantifying Behavioral Responses to Sonars). Additionally, density values for all populations have increased and/or have become more stratified for island-associated regions around the MITT Study Area. These factors interact in complex ways that make comparing the results of this analysis to prior analyses challenging.

Effects due to non-modeled acoustic stressors are discussed above in Section 2.1.2 (Effects from Vessel Noise), Section 2.1.3 (Effects from Aircraft Noise), and Section 2.1.4 (Effects from Weapons Noise).

2.4.2.1 Sperm Whale (*Physeter macrocephalus*) - Endangered

Sperm whales are in the HF cetacean hearing group and the Odontocete behavioral group. There are three NMFS recognized stocks for the U.S. North Pacific; however, NMFS has not designated a separate stock off Guam and CNMI. Sperm whales are known to prefer deep water and steep topography. They can be somewhat migratory, however, sperm whales within the Study Area are more residential, have been observed with calves, and have been acoustically detected throughout the year in areas around the MITT Study Area, including Guam, Saipan and Tinian (see the *Marine Mammal Background* section). Sperm whales are listed as endangered throughout their range with no designated DPSs. Model-predicted effects are presented in the table below.

Most effects on this stock are due to sonar from Anti-Submarine Warfare activities. A negligible amount of auditory injury is predicted from sonar and explosive activities. Other effects from explosive use are limited, and non-auditory injuries are not anticipated. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Impacts on Odontocetes), increases in estimated density also contribute to a minor increase in modeled auditory effects from sonar for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due hull-mounted sonar. These sources overlap in frequency with sperm whale echolocation clicks, which may result in a disruption of communication and echolocation behaviors. The average individual risk of injury is negligible.

The risk of repeated effects 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 effects due to lost foraging opportunities during reproduction, especially if they occur during lactation. Acoustic recordings show no strong seasonal trend for sperm whale presence, but they are more detectable from January to March. Therefore, it is possible that effects on the stock may be low outside of those months if lack of acoustic presence means sperm whales are not in the area.

Because of their longer generation times, this population would require more time to recover if significantly affected. In addition, this population of sperm whales is endangered and depleted with unknown population trends.

The limited instances of predicted behavioral and non-injurious auditory effects are unlikely to result in any long-term effects on individuals. Long-term consequences to the population are unlikely.

Table 2.4-9: Estimated Effects on Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	-	-
Explosive	Training	(1)	(1)	0	-	-
Sonar	Testing	12	(1)	-	-	-
Sonar	Training	111	99	0	-	-
Maximum Annual Total		**124**	**101**	**0**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
1,574	0.14	0.00

Season	Percent of Total Effects	
	MIRC	Transit Corridor
Warm	45%	1%
Cold	53%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	27%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	12%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%
Surface Ship Sonar Maintenance and Systems Checks	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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, and are frequently classified as Kogia species. Kogia species are in the VHF cetacean hearing group and the Odontocete behavioral group. Kogia whales are assumed to be present year-round in the Study Area. Dwarf sperm whales generally occur offshore and are found in warmer tropical waters more often than pygmy sperm whales. While both Kogia species are assumed to be present in the Study Area, NMFS has not designated a separate stock off Guam and CNMI. Model-predicted effects are presented in the tables below.

Most effects on dwarf and pygmy sperm whales are primarily due to Anti-Submarine Warfare activities. Auditory injuries from sonar are predicted for these populations, primarily due to activities conducted under major training exercises. Effects from explosive sources include behavioral and auditory effects including auditory injuries, primarily from Surface Warfare activities. A negligible number of non-auditory injuries is predicted for explosive activities. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to increases in modeled auditory effects for these populations since the 2020 analysis. On average, individuals estimated to occur in the Study Area could be affected less than once per year.

Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The average individual risk of injury is low which includes auditory injury from hull-mounted sonar. The risk of auditory injury may be reduced through activity-based mitigation, however, Kogia are rarely active at the sea surface and may not be easy to sight when present in the area.

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, other than they are rarely active at the sea-surface and tend to stay away from anthropogenic activity when present. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations would be quick to recover.

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

Table 2.4-10: Estimated Effects on Dwarf Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	7	14	10	0	0
Explosive	Training	302	293	59	0	0
Sonar	Testing	150	686	7	-	-
Sonar	Training	936	16,328	247	-	-
Maximum Annual Total		**1,395**	**17,321**	**323**	**0**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
59,040	0.32	0.01

Season	Percent of Total Effects
	MIRC
Warm	42%
Cold	57%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	34%
Small Integrated ASW	Training	22%
Surface Warfare Advanced Tactical Training	Training	10%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 on Pygmy Sperm Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	7	16	12	-	-
Explosive	Training	343	349	68	0	0
Sonar	Testing	158	728	9	-	-
Sonar	Training	1,064	18,327	285	-	-
Maximum Annual Total		**1,572**	**19,420**	**374**	**0**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
66,333	0.32	0.01

Season	Percent of Total Effects
	MIRC
Warm	42%
Cold	57%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	34%
Small Integrated ASW	Training	22%
Surface Warfare Advanced Tactical Training	Training	10%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	7%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Beaked Whales

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

Blainville's beaked whales are in the HF cetacean hearing group and the Sensitive Species behavioral group. While Blainville's beaked whales are present in the Study Area year-round, NMFS has not designated a separate stock off Guam and CNMI. They are acoustically detected more often to the north of Saipan than to the south. Model-predicted effects are presented in the table below.

Most effects on Blainville's beaked whales are from Anti-Submarine Warfare and Ship Maintenance sonar activities. Relatively fewer TTS effects are predicted than the prior 2020 analysis due to the behavioral sensitivity of beaked whales, and the likelihood that they would leave the area once sonar is detected. Auditory injury from sonar activity is not expected to occur. A limited number of behavioral and auditory effects are expected to occur from explosive activities while injurious effects are negligible. In addition to refinements to the assessment of behavioral effects described in Section 2.4.2 (Impacts on Odontocetes), increases in estimated density also contribute to increases in modeled behavioral effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary behavioral effects from hull-mounted sonar. The average individual risk of injury is negligible.

The risk of repeated effects on 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 movement ecology, the risk of repeated effects on 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 affected.

Several 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. Most predicted effects are behavioral responses in an open ocean basin that are unlikely to contribute to any long-term effects on individuals. Based on the above analysis, long-term consequences for the population of Blainville's beaked whales are unlikely.

Table 2.4-12: Estimated Effects on Blainville's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	-	-
Explosive	Training	(1)	(1)	0	0	-
Sonar	Testing	146	(1)	-	-	-
Sonar	Training	2,948	23	-	-	-
Maximum Annual Total		**3,095**	**25**	**0**	**0**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
15,705	0.20	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	35%	7%
Cold	50%	9%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	30%
Surface Ship Sonar Maintenance and Systems Checks	Training	16%
Small Integrated ASW	Training	12%
Anti-Submarine Warfare Tracking Exercise - Submarine	Training	6%
Surface Warfare Advanced Tactical Training	Training	6%
Medium Coordinated Anti-Submarine Warfare	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.3.2 Deraniyagala's Beaked Whale (*Mesoplodon hotaula*)

Deraniyagala's beaked whales are in the HF cetacean hearing group and the Sensitive Species behavioral group. Deraniyagala's beaked whales were not considered in the 2020 analysis. They were only recently genetically distinguished from gingko-toothed beaked whales (Dalebout et al., 2014), and it is therefore a data-deficient species. They are almost morphologically identical to the ginkgo-toothed and Blainville's beaked whales, making them difficult to identify. Extrapolating from previous knowledge on Mesoplodont species, it is likely that the Deraniyagala's beaked whale have a wide distribution through the tropical Pacific, inhabiting offshore oceanic waters greater than 200 meters deep, and are expected to be nomadic through the MITT Study Area and associated Transit Corridor (see the *Marine Mammal Background* section). Although Deraniyagala's beaked whale is assumed to be present year-round, NMFS has not designated a separate stock off Guam and CNMI. Because it is difficult to distinguish species, the density estimates for gingko-toothed beaked whales were used to model effects on

Deraniyagala's beaked whales. Thus, effects on these two species are likely over-estimated. Model-predicted effects on this stock are presented in the table below.

Most estimated effects are due to sonar used in Anti-Submarine Warfare activities. Fewer TTS effects are predicted due to the behavioral sensitivity of beaked whales, and the likelihood that they would leave the area once sonar is detected. Auditory injury from sonar activities is not expected to occur. The number of effects due to explosives is low, and auditory-injuries are limited. There are no predicted non-auditory injuries from explosives. On average, individuals estimated to occur in the Study Area could be affected approximately once per year. Most of these effects would be temporary behavioral effects due to hull-mounted sonar. The average individual risk of injury is negligible. The risk of auditory injury may be reduced through activity-based mitigation, although no Deraniyagala's beaked whale has been specifically sighted in the Study Area. While the species is less sightable due to their long and deep diving patters, and small pod sizes (1-4 individuals), they have been seen to travel with other Mesoplodont species (Li et al., 2024). Therefore, any sighting of Mesoplodont whales in the Study Area by lookouts during mitigation may benefit the Deraniyagala's beaked whales.

The risk of repeated effects on 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, Deraniyagala'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 Mesoplodont beaked whales have a nomadic movement ecology, the risk of repeated effects on individuals is likely similar within the population as animals move throughout their range.

Several instances of predicted behavioral effects are unlikely to result in any long-term effects on individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted effects are behavioral responses in an open ocean basin that are unlikely to contribute to any long-term effects on individuals. Based on the above analysis, long-term consequences for the population of Deraniyagala's beaked whales are unlikely.

Table 2.4-13: Estimated Effects on Deraniyagala's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	(1)	-	-	-
Explosive	Training	4	3	(1)	-	-
Sonar	Testing	236	(1)	-	-	-
Sonar	Training	4,727	1	-	-	-
Maximum Annual Total		**4,967**	**6**	**1**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
4,592	1.08	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	40%	1%
Cold	57%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	37%
Small Integrated ASW	Training	12%
Surface Ship Sonar Maintenance and Systems Checks	Training	10%
Submarine Navigation	Training	6%
Surface Warfare Advanced Tactical Training	Training	6%
Surface Ship Object Detection	Training	5%
Medium Coordinated Anti-Submarine Warfare	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.3.3 Ginkgo-Toothed Beaked Whales (*Mesoplodon ginkgodens*)

Ginkgo-toothed beaked whales are in the HF cetacean hearing group and the Sensitive Species behavioral group. Like most Mesoplodont beaked whale species, ginkgo-toothed beaked whales are typically found in offshore temperate and tropical waters across the Pacific Ocean. While ginkgo-toothed beaked whales may be present in the Study Area year-round, NMFS has not designated a separate stock off Guam and CNMI. Because it is difficult to distinguish species, the density estimates for gingko-toothed beaked whales were used to model effects on Deraniyagala's beaked whales. Thus, effects on these two species are likely over-estimated. Model-predicted effects on this stock are presented in the table below.

Most effects for this population are due to Anti-Submarine Warfare activities and Ship Sonar Maintenance and Systems Checks. Relatively fewer TTS effects are predicted than the prior 2020 MITT SEIS/OEIS analysis due to the behavioral sensitivity of beaked whales, and the likelihood that they would leave the area once sonar is detected. Auditory injury from sonar activities is not expected to occur. Behavioral and auditory effects from explosive activity are limited, and there are a negligible number of predicted effects for auditory and non-auditory injury estimated. On average, individuals estimated to occur in the Study Area could be affected approximately once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The average individual risk of injury is negligible.

The risk of repeated effects on 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, gingko-toothed 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 Mesoplodont beaked whales have a nomadic movement ecology, the risk of repeated effects on individuals are likely similar within the population as animals move throughout their range.

Several instances of predicted behavioral and non-injurious auditory effects are unlikely to result in any long-term effects on individuals, although individuals who suffer an auditory injury may experience minor energetic costs. Most predicted effects are behavioral responses in an open ocean basin that are unlikely to contribute to any long-term effects on individuals. Based on the above analysis, long-term consequences for the population of gingko-toothed beaked whales are unlikely.

Table 2.4-14: Estimated Effects on Ginkgo-Toothed Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	-	-	-	-
Explosive	Training	(1)	1	0	0	-
Sonar	Testing	297	0	-	-	-
Sonar	Training	5,577	53	-	-	-
Maximum Annual Total		**5,875**	**54**	**0**	**0**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
4,592	1.29	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	42%	1%
Cold	55%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	37%
Small Integrated ASW	Training	11%
Surface Ship Sonar Maintenance and Systems Checks	Training	10%
Submarine Navigation	Training	6%
Surface Ship Object Detection	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.3.4 Goose-beaked Whale (*Ziphius cavirostris*)

Goose-beaked whales (also known as Cuvier's beaked whales) are in the HF cetacean hearing group and the Sensitive Species behavioral group. While Goose-beaked whales (also known as Cuvier's beaked whales) are present in the Study Area year-round, NMFS has not designated a separate stock off Guam and CNMI. They are acoustically detected more often to the north of Saipan than to the south. Model-predicted effects are presented in the table below.

Most potential effects would be from Anti-Submarine Warfare activities and Ship Sonar Maintenance and Systems Checks. Relatively fewer TTS effects are predicted due to the behavioral sensitivity of goose-beaked whales, and the likelihood that they would leave the area once sonar is detected. Auditory and non-auditory injury from sonar activities is not expected to occur. Behavioral and auditory effects from explosive activity is limited, and there are a negligible number of predicted effects for auditory and non-auditory injury estimated. In addition to refinements to the assessment of behavioral and auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to increases in modeled effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary behavioral effects due to hull-mounted sonar. 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 medium-sized odontocetes with a medium pace of life, goose-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 goose-beaked whales have a nomadic-resident movement ecology, the risk of repeated effects on individuals is likely similar within the population as animals move throughout their range. Since this species has longer generation times, this population would require more time to recover if significantly affected.

Several instances of behavioral disturbance over a year are unlikely to have any long-term consequences for most individuals, although individuals who suffer repeated displacement may experience minor energetic costs. Most predicted effects are behavioral responses in an open ocean basin that are unlikely to contribute to any long-term effects on individuals. Long-term consequences to this population are unlikely.

Table 2.4-15: Estimated Effects on Goose-beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	-	-
Explosive	Training	(1)	(1)	0	0	-
Sonar	Testing	142	0	-	-	-
Sonar	Training	2,455	19	-	-	-
Maximum Annual Total		**2,598**	**20**	**0**	**0**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
6,007	0.44	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	40%	2%
Cold	55%	3%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	37%
Small Integrated ASW	Training	12%
Surface Ship Sonar Maintenance and Systems Checks	Training	12%
Surface Warfare Advanced Tactical Training	Training	5%
Medium Coordinated Anti-Submarine Warfare	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
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2.4.2.3.5 Longman's Beaked Whale (*Indopacetus pacificus)*

Longman's beaked whales are in the HF cetacean hearing group and the Sensitive Species behavioral group. While Longman's beaked whales is assumed to be present in the MITT Study Area year-round they have not been visually or acoustically identified in the Study Area, and NMFS has not designated a stock off Guam and CNMI. Longman's beaked whales are known to be present in tropical waters throughout the Pacific and Indian Oceans in waters over deep bathymetric slopes from 200 to 2,000 m and generally congregate in warm deep waters. Survey efforts in Hawaii have identified medium to large group sizes (18-99 individuals) of Longman's beaked whales, and similar grouping behavior is assumed for any Longman's traveling through the Study Area. Model-predicted effects are presented in the table below.

Most potential effects would be from sonar during Anti-Submarine Warfare activities. Auditory injury from sonar activities is not expected to occur. Behavioral and auditory effects from explosive activity are limited, and there are a negligible number of predicted effects for auditory and non-auditory injury estimated. Relatively fewer TTS effects are predicted than the prior analysis due to the behavioral sensitivity of beaked whales, and the likelihood that they would leave the area once sonar is detected. Additionally, the decrease in modeled effects on this population since the 2020 analysis are generally due to normalizing the modeled abundance to the estimated population abundance from literature (please refer to S*ection Two* in Section 2.4 [Species Assessments] for further detail). On average, individuals estimated to occur in the Study Area could be affected approximately once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. 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 medium-sized odontocetes with a medium pace of life, Longman'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 Longman's beaked whales likely have a nomadic movement ecology, the risk of repeated effects on individuals is likely similar within the population as animals move throughout their range.

Several 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. Most predicted effects are behavioral responses in an open ocean basin that are unlikely to contribute to any long-term effects on individuals. Long-term consequences to this population are unlikely.

Table 2.4-16: Estimated Effects on Longman's Beaked Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	-	-
Explosive	Training	(1)	(1)	0	0	-
Sonar	Testing	51	0	-	-	-
Sonar	Training	951	11	-	-	-
Maximum Annual Total		**1,003**	**12**	**0**	**0**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
730	1.39	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	41%	1%
Cold	56%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	37%
Small Integrated ASW	Training	11%
Surface Ship Sonar Maintenance and Systems Checks	Training	10%
Submarine Navigation	Training	6%
Surface Ship Object Detection	Training	5%
Surface Warfare Advanced Tactical Training	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Common Bottlenose Dolphin (*Tursiops truncatus*)

Bottlenose dolphins are in the HF cetacean hearing group and the Odontocete behavioral group. There are two NMFS recognized stocks and one recognized stock complex in U.S. Pacific Hawaii waters; however, NMFS has not designated a separate stock off Guam and CNMI. Bottlenose dolphins occur in coastal waters of tropical and temperate regions of the Pacific Ocean and are one of the most encountered species around the Mariana Islands, and therefore have a relatively high, year-round, density. Survey-based data suggest that there are both pelagic and small island-associated populations around the Mariana Islands. Model-predicted effects are presented in the table below.

Most potential effects would be due to sonar from Anti-Submarine Warfare activities. Auditory injury from sonar activities is limited. Effects from explosive activities are limited, and there is a negligible amount of predicted auditory and non-auditory injuries. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to an increase in modeled auditory effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The average individual risk of injury is negligible. The risk of injury may be reduced through activity-based mitigation, as bottlenose dolphins have relatively high sightability and travel in large, sometimes mixed-species, 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. 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. Because the population found in the pelagic waters is likely nomadic, the risk of repeated exposures to individuals is likely similar within these populations as animals move throughout their range. However, the risk of repeated exposures for the small island-associated population is likely much higher. Risk of effects would also be similar across seasons and critical life functions. Since this species has longer generation times, they would require more time to recover if significantly affected.

Several 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 this population.

Table 2.4-17: Estimated Effects on Bottlenose Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	0	-
Explosive	Training	(1)	(1)	0	0	0
Sonar	Testing	16	1	-	-	-
Sonar	Training	100	237	(1)	-	-
Maximum Annual Total		**117**	**239**	**1**	**0**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
1,800	0.20	0.00

Season	Percent of Total Effects MIRC
Warm	45%
Cold	55%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	29%
Small Integrated ASW	Training	25%
Surface Warfare Advanced Tactical Training	Training	12%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 False Killer Whale (*Pseudorca crassidens*)

False killer whales are in the HF cetacean hearing group and the Odontocete behavioral group. There are three NMFS recognized stocks of false killer whales in Hawaii, one around the Palmyra Atoll, and one in American Samoa, however, NMFS has not designated a separate stock off Guam and CNMI. The year-round density of false killer whales is higher within the associated Transit Corridor than throughout the MITT Study Area. While false killer whales exhibit occasional inshore movements based on prey distribution, most of their time is spent in deep ocean waters and around oceanic islands. Model-predicted effects are presented in the table below.

Most potential effects would be due to sonar from Anti-Submarine Warfare activities. Auditory injury from sonar activities is negligible. All potential effects, including injuries, from explosives would be negligible. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Effects on Odontocetes), slight increases in estimated density also contribute to an increase in modeled auditory effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. 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 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 effects during lactation. In addition, because of their longer generation times, false killer whales would require more time to recover if significantly affected. Since this population of false killer whales are nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range.

Several predicted 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 population of false killer whales are unlikely.

Table 2.4-18: Estimated Effects on the False Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	-	0	0	-	-
Explosive	Training	0	0	0	0	-
Sonar	Testing	10	(1)	-	-	-
Sonar	Training	60	157	0	-	-
Maximum Annual Total		**70**	**158**	**0**	**0**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
1,059	0.22	0.00

Season	Percent of Total Effects MIRC
Warm	42%
Cold	57%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	30%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	11%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%
Surface Ship Sonar Maintenance and Systems Checks	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
version.20250708

2.4.2.6 Fraser's Dolphin (*Lagenodelphis hosei*)

Fraser's dolphins are in the HF cetacean hearing group and the Odontocete behavioral group. While this species may be present in the Study Area year-round, NMFS has not designated a separate stock off Guam and CNMI. Fraser's dolphins are expected to be present year-round as they are a pantropical open ocean deepwater species. Model-predicted effects are presented in the table below.

Most potential effects would be due to sonar from Anti-Submarine Warfare activities. There is a limited number of estimated auditory injuries from activities conducted under major training exercises. Effects from explosive activities would be due to Surface Warfare, and a negligible number of auditory and non-auditory injuries are predicted from both training and testing explosive activities. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to an increase in modeled auditory effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The average individual risk of injury is negligible. A small number of auditory injuries are also predicted from hull-mounted sonar. The risk of these injuries may be reduced through activity-based mitigation, as Fraser's dolphins are known to travel in large, mixed-species groups and have relatively high 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. 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. This nomadic population is believed to move within the range year-round. Therefore, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their Pacific range. Although reproduction in populations with a fast pace of life are more sensitive to foraging disruption, these populations would be quick to recover.

Several predicted instances of behavioral and non-injurious auditory effects are unlikely to result in any long-term consequences for individuals, although individuals who suffer an auditory or non-auditory injury may experience minor energetic costs. Based on the above analysis, long-term consequences for this population of Fraser's dolphins are unlikely.

Table 2.4-19: Estimated Effects on Fraser's Dolphin over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	(1)	(1)	(1)	-	-
Explosive	Training	9	6	(1)	(1)	0
Sonar	Testing	499	12	-	-	-
Sonar	Training	3,728	7,169	3	-	-
Maximum Annual Total		**4,237**	**7,188**	**5**	**1**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
62,714	0.18	0.00

Season	Percent of Total Effects MIRC
Warm	45%
Cold	55%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	28%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	12%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%
Surface Ship Sonar Maintenance and Systems Checks	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Killer Whale (*Orcinus orca*)

Killer whales are in the HF cetacean hearing group and the Odontocete behavioral group. While killer whales are found worldwide, they are most present at higher latitudes around coastal waters, and therefore none of the eight killer whale stocks recognized by NMFS along the Pacific U.S. EEZ is believed to be present in the MITT Study Area. While killer whales are not frequently seen around the Mariana Islands, they are assumed to be present year-round. NMFS has not designated a separate stock off Guam and CNMI. Model-predicted effects are presented below.

Within the Study Area, killer whales are most likely to experience effects from sonar used in Anti-Submarine Warfare activities. The estimated effect of auditory injury from sonar is negligible. There are no predicted effects on killer whales from explosives. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to an increase in modeled auditory effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area would be affected less than once per year. All modeled effects would be temporary auditory and behavioral effects due to hull-mounted sonar exposure. 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. 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. Because killer whales in the Study Area are nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Overall, killer whales would be resilient to missed foraging opportunities but would require more time to recover if significantly affected.

Several predicted 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 this population of killer whales are unlikely.

Table 2.4-20: Estimated Effects on Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Sonar	Testing	3	(1)	-	-	-
Sonar	Training	11	39	0	-	-
Maximum Annual Total		**14**	**40**	**0**	**-**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
285	0.19	0.00

Season	Percent of Total Effects	
	MIRC	Transit Corridor
Warm	51%	0%
Cold	48%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	35%
Small Integrated ASW	Training	21%
Surface Warfare Advanced Tactical Training	Training	10%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	7%
Surface Ship Sonar Maintenance and Systems Checks	Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Melon-Headed Whale (*Peponocephala electra*)

Melon-headed whales are in the HF cetacean hearing group and the Odontocete behavioral group. Two melon-headed whale stocks in Hawaii are recognized by NMFS; however, NMFS has not designated a separate stock off Guam and CNMI. Melon-headed whales congregate in deep tropical waters, although they have been known to rest nearshore of oceanic islands during the day. Melon-headed whales were often seen during Navy surveys within the MIRC in large groups and are therefore assumed to be present in the Study Area year-round. Additionally, density distribution in the off-shore Transit Corridor is estimated to be higher than in the MITT Study Area. Model-predicted effects are presented below.

Most potential effects would be due to Anti-Submarine Warfare activities. A limited number of auditory injuries are predicted from sonar exposure. Behavioral effects from explosive activities would be limited while all auditory effects or injuries would be negligible. The decrease in modeled effects on this population since the 2020 analysis are generally due to normalizing the modeled abundance to the estimated population abundance from literature (please refer to S*ection Two* in Section 2.4 [Species Impact Assessments] for further detail). On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to sonar, specifically hull-mounted sonar. The average individual risk of injury is negligible. The risk of any effect may be reduced through activity-based mitigation – especially since melon-headed whales are highly sightable traveling in large groups of (100 to over 1,000 animals), and sometimes with other delphinid species such as Fraser's dolphins.

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. Because this population is likely nomadic-resident, the risk of repeated exposures to individuals is likely similar within the populations as animals move throughout their range but may be higher in more residential areas. However, because of their longer generation times, these populations would require more time to recover if significantly affected.

Several potential instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience auditory injury may incur energetic costs. Based on the above analysis, long-term consequences for the population of melon-headed whales are unlikely

Table 2.4-21: Estimated Effects on Melon-Headed Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	-	-	-
Explosive	Training	(1)	0	0	0	-
Sonar	Testing	21	1	-	-	-
Sonar	Training	150	302	(1)	-	-
Maximum Annual Total		**172**	**303**	**1**	**0**	**-**
Population Abundance Estimate		**Annual Effects per Individual**		**Annual Injurious Effects per Individual**		
2,455		0.19		0.00		
	Percent of Total Effects					
Season	**MIRC**			**Transit Corridor**		
Warm	46%			2%		
Cold	51%			2%		
Activities Causing 5 Percent or More of Total Effects				**Category**	**Percent of Total Effects**	
Small Integrated ASW				Training	26%	
Anti-Submarine Warfare Tracking Exercise - Ship				Training	24%	
Surface Warfare Advanced Tactical Training				Training	12%	
Medium Coordinated Anti-Submarine Warfare				Training	10%	
Joint Multi-Strike Group Exercise (CPF)				Training	8%	
Surface Ship Sonar Maintenance and Systems Checks				Training	7%	

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Pantropical Spotted Dolphin (*Stenella attenuata*)

Pantropical spotted dolphins are in the HF cetacean hearing group and the Odontocete behavioral group. Four pantropical spotted dolphin stocks are recognized by NMFS in Hawaiian waters. Although they are one of the most frequently encountered species in the MITT Study Area, NMFS has not designated a separate stock off Guam and CNMI. Pantropical spotted dolphins can be found mostly in deep offshore tropical and subtropical waters of the Pacific, but they do approach the coast in some areas. Based on survey efforts, they have year-round higher densities in nearshore waters around Palau and the southern boundaries of the MITT Study Area. Model-predicted effects are presented in the table below.

Most potential effects would be due to Anti-Submarine Warfare activities. Auditory injury from sonar activities is limited but possible due to activities conducted under major training exercises. Effects from explosive activities are limited, and there is a negligible amount of predicted non-auditory injury. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to increases in modeled effects for this population since the 2020 analysis. Specifically, density estimates for Phase IV include a more detailed and stratified density of dolphins around Guam and the southern range of the MITT Study Area. On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to sonar, specifically from hull-mounted sonar. Estimated auditory injury is also likely due to hull-mounted sonar. The average individual risk of injury is negligible. The risk of injury may be reduced through activity-based mitigation, especially since pantropical spotted dolphins are highly sightable and 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 odontocete income breeders with a medium pace of life, pantropical spotted dolphins are likely somewhat resilient to missed foraging opportunities due to acoustic disturbance. Because nomadic and offshore populations of pantropical spotted dolphins have a larger range farther from shore, they have a lower risk of repeated exposure.

Several predicted instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience auditory or non-auditory injury may incur energetic costs. The risk of mortality is extremely unlikely. Based on the above analysis, long-term consequences for the population of pantropical spotted dolphins are unlikely.

Table 2.4-22: Estimated Effects on Pantropical Spotted Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	0	-
Explosive	Training	2	1	(1)	0	0
Sonar	Testing	190	11	0	-	-
Sonar	Training	1,181	3,170	2	-	-
Maximum Annual Total		**1,373**	**3,182**	**3**	**0**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
33,518	0.14	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	45%	1%
Cold	54%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	28%
Small Integrated ASW	Training	23%
Surface Warfare Advanced Tactical Training	Training	11%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Pygmy Killer Whale (*Feresa attenuata*)

Pygmy killer whales are in the HF cetacean hearing group and the Odontocete behavioral group. NMFS recognizes a single Pacific stock that reside in Hawaii and in adjacent high seas however, NMFS has not designated a separate stock off Guam and CNMI. Pygmy killer whales are generally an open ocean deepwater species found in tropical and subtropical waters. Repeated encounters of the same pod of pygmy killer whales around Guam may indicate an area of site fidelity for a small group of individuals; however, they are a highly mobile species and there are no known concentration areas within the .MITT Study Area.Model-predicted effects are presented in the table below.

Most potential effects would be due to sonar used in Anti-Submarine Warfare activities. Auditory injury from sonar activities is limited. Effects from explosive activity are limited, and there is a negligible number of predicted auditory and non-auditory injury effects. In addition to the refinements to the assessment of behavioral and auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to an increase in modeled effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most of these effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The average individual risk of injury is negligible. The risk of injury may be reduced through activity-based mitigation because pygmy killer whales have a relatively high sightability when in the area, traveling in groups of 15 - 20 individuals.

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. Since they have a nomadic movement ecology, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range.

Several predicted 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 population of pygmy killer whales are unlikely.

Table 2.4-23: Estimated Effects on Pygmy Killer Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	0	0
Explosive	Training	(1)	(1)	0	0	0
Sonar	Testing	39	2	0	-	-
Sonar	Training	230	612	(1)	-	-
Maximum Annual Total		**270**	**615**	**1**	**0**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
4,351	0.20	0.00

Season	Percent of Total Effects: MIRC	Percent of Total Effects: Transit Corridor
Warm	43%	1%
Cold	56%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	30%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	11%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%
Surface Ship Sonar Maintenance and Systems Checks	Training	5%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Risso's Dolphin (*Grampus griseus*)

Risso's dolphins are in the HF cetacean hearing group and the Odontocete behavioral group. Two Risso's dolphin stocks are recognized by NMFS in U.S. Pacific waters, however, NMFS has not designated a separate stock off Guam and CNMI. Risso's dolphins have been observed within the Study Area and are likely present year-round. Density data for the associated Transit Corridor shows a higher density of Risso's dolphins just north of the transit line, around Wake Island, than south of the transit line (Kanaji et al., 2017). Model-predicted effects are presented in the table below.

Most potential effects would be due to Anti-Submarine Warfare activities. Auditory injury from sonar activities is limited. Effects from explosive activity are limited, and while there is a negligible amount of predicted auditory injury, there is a limited amount of predicted non-auditory injury. The changes in modeled effects on this population since the 2020 analysis are generally due to the refinements to the assessment of behavioral and auditory effects described in Section 2.4.2 (Impacts on Odontocetes). On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most effects would be temporary auditory and behavioral effects due to hull-mounted sonar. The average individual risk of injury is negligible. The risk of injury may be reduced through activity-based mitigation, as Risso's dolphins are highly sightable, and sometimes travel with other species such as Fraser's dolphins.

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. Because this population is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of effects would also be similar across seasons and critical life functions. Due to this species' longer generation times, this population would require more time to recover if significantly affected.

Several predicted 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 population of Risso's dolphins are unlikely.

Table 2.4-24: Estimated Effects on Risso's Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	-	0	-	-
Explosive	Training	1	0	0	(1)	-
Sonar	Testing	77	3	-	-	-
Sonar	Training	477	1,223	(1)	-	-
Maximum Annual Total		**555**	**1,226**	**1**	**1**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
9,554	0.19	0.00

Season	Percent of Total Effects: MIRC
Warm	45%
Cold	54%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	29%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	11%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Rough-Toothed Dolphin (*Steno bredanensis*)

Rough-toothed dolphins are in the HF cetacean hearing group and the Odontocete behavioral group. While NMFS recognizes two stocks in U.S. Pacific waters, NMFS has not designated a separate stock off Guam and CNMI. The population of rough-toothed dolphins has been observed often within the Study Area in mixed-species groups, including calves, and are likely present year-round. Model-predicted effects are presented in the table below.

Most potential effects would be due to Anti-Submarine Warfare activities. Auditory injury from sonar activities is limited. Effects from explosive activity are limited, while injurious effects are negligible. In addition to the refinements to the assessment of effects described in Section 2.4.2 (Impacts on Odontocetes), increases in estimated density also contribute to an increase in modeled behavioral and auditory effects for this population since the 2020 analysis. On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most effects would be temporary auditory and behavioral effects due to hull-mounted sonar. Auditory effects may result in disruptions to communication behavior but are unlikely to affect higher frequencies used for echolocation. The average individual risk of injury is negligible. The risk of injury may be reduced through activity-based mitigation, as rough-toothed dolphins are relatively sightable when present.

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 during lactation. Because this population is nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range. Risk of effects would also be similar across seasons and critical life functions. Due to their longer generation times, this population would require more time to recover if it was further significantly affected.

Several predicted 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. The risk of mortality is extremely unlikely. Based on the above analysis, long-term consequences for the population of rough-toothed dolphins are unlikely.

Table 2.4-25: Estimated Effects on Rough-Toothed Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	0	0
Explosive	Training	1	(1)	0	0	0
Sonar	Testing	83	4	0	-	-
Sonar	Training	422	1,473	1	-	-
Maximum Annual Total		**506**	**1,478**	**1**	**0**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
9,256	0.21	0.00

Season	Percent of Total Effects
	MIRC
Warm	45%
Cold	55%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	31%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	11%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
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 Short-Finned Pilot Whale (*Globicephala macrorhynchus*)

Short-finned pilot whales are in the HF cetacean hearing group and the Odontocete behavioral group. While short-finned pilot whales are likely found in the Study Area year-round, NMFS has not designated a separate stock off Guam and CNMI. Short-finned pilot whales are found at varying distances to shore but prefer deeper waters where their prey aggregates. Model-predicted effects are presented in the table below.

Most potential effects would be due to sonar from Anti-Submarine Warfare activities. A negligible number of auditory injuries is predicted from sonar activities. Behavioral effects from explosive activities would be limited while all auditory effects or injuries would be negligible. The decrease in modeled effects on this population since the 2020 analysis are generally due to normalizing the modeled abundance to the estimated population abundance from literature (please refer to S*ection Two* in Section 2.4 [Species Impact Assessments] for further detail). On average, individuals estimated to occur in the Study Area could be affected less than once per year. The average individual risk of injury is negligible. All effects would be temporary auditory and behavioral effects due to sonar, specifically hull-mounted sonar. Auditory effects may result in disruption of communication behaviors but are unlikely to affect higher frequencies used for echolocation.

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. This population is nomadic and move within their range year-round. Therefore, the risk of repeated exposures to individuals is likely similar within the population. Satellite tag data show that short-finned pilot whales may aggregate more often on the northwest side of Guam between May – August (Hill et al., 2018), and suggest frequent use of waters around the Mariana Islands by pilot whales (Hill et al., 2019). Animals who congregate in certain areas more frequently during specific months may have higher risks of exposure for activities concentrated in those regions, although higher concentrations of animals would make them more sightable to Lookouts. However, because of their longer generation times, this population would require more time to recover if significantly affected.

Several potential instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience auditory or non-auditory injury would incur energetic costs. Based on the above analysis, long-term consequences for this population of short-finned pilot whales are unlikely.

Table 2.4-26: Estimated Effects on Short-Finned Pilot Whales over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	-	-	-
Explosive	Training	(1)	0	0	0	0
Sonar	Testing	11	(1)	-	-	-
Sonar	Training	69	146	0	-	-
Maximum Annual Total		**81**	**147**	**0**	**0**	**0**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
1,192	0.19	0.00

Season	Percent of Total Effects
	MIRC
Warm	45%
Cold	55%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	28%
Small Integrated ASW	Training	24%
Surface Warfare Advanced Tactical Training	Training	12%
Medium Coordinated Anti-Submarine Warfare	Training	10%
Joint Multi-Strike Group Exercise (CPF)	Training	8%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
version.20250708

2.4.2.14 Spinner Dolphin (*Stenella longirostris*)

Spinner dolphins are in the HF cetacean hearing group and the Odontocete behavioral group. There are six NMFS recognized stocks of spinner dolphins within the Hawaii EEZ, however, NMFS has not designated a separate stock off Guam and CNMI. There is evidence to suggest that there may be two separate island-associated populations of spinner dolphins in the MITT Study Area: one in the 3-islands area (Saipan, Tinian, and Aguijan) and Rota, and another around Guam. The Agat Bay Nearshore Mitigation area was established to avoid or reduce exposure of spinner dolphins specifically, as this area is an important resting habitat. Sightings of spinner dolphins offshore may suggest a pelagic population as well. Model-predicted effects are presented in the table below.

Most potential effects would be due to Submarine Navigation and Anti-Submarine Warfare activities in the MIRC, including in nearshore portions of the Study Area. Auditory injury from sonar activities is limited. Predicted non-auditory injury due to explosives is negligible. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Effects on Odontocetes), increases in estimated density also contribute to increases in modeled effects for this population since the 2020 analysis, especially for nearshore activities. Specifically, spinner dolphin density estimates for Phase IV include a more detailed and stratified density of dolphins around all islands between Guam and CNMI, as well as increased density offshore to the West of the Mariana Island chain. On average, individuals estimated to occur in the Study Area would be affected less than once per year. Most effects would be temporary auditory and behavioral effects due to sonar use nearshore. Auditory effects and injury would be from the use of hull-mounted sonar. The average individual risk of injury is negligible. The risk of injury may be reduced through activity-based mitigation, as spinner dolphins have relatively high sightability and travel in large, sometimes mixed species, 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 a fast pace of life, spinner dolphins are less resilient to missed foraging opportunities due to acoustic disturbance, especially during lactation. Because this population is resident-nomadic, the risk of repeated exposures to individuals is likely similar within the population as animals move throughout their range but may be higher for populations that associate with certain islands. Risk of effects would also be similar across seasons and critical life functions. Although reproduction in populations with a fast pace of life is more sensitive to foraging disruption, these populations are quick to recover.

Several predicted instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience auditory injury may incur energetic costs. Based on the above analysis, long-term consequences for this population of spinner dolphins are unlikely.

Table 2.4-27: Estimated Effects on Spinner Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	(1)	(1)	0	-	-
Explosive	Training	1	3	1	0	-
Sonar	Testing	113	41	0	-	-
Sonar	Training	2,133	1,798	1	-	-
Maximum Annual Total		**2,248**	**1,843**	**2**	**0**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
10,202	0.40	0.00

Season	Percent of Total Effects
	MIRC
Warm	46%
Cold	54%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Submarine Navigation	Training	23%
Surface Ship Object Detection	Training	18%
Small Integrated ASW	Training	16%
Anti-Submarine Warfare Tracking Exercise - Ship	Training	9%
Surface Warfare Advanced Tactical Training	Training	7%
Joint Multi-Strike Group Exercise (CPF)	Training	6%
Medium Coordinated Anti-Submarine Warfare	Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
version.20250708

2.4.2.15 Striped Dolphin (*Stenella coeruleoalba*)

Striped dolphins are in the HF cetacean hearing group and the Odontocete behavioral group. NMFS recognizes two stocks within the U.S. Pacific; however, NMFS has not designated a separate stock off Guam and CNMI. This population of striped dolphins is present throughout the entire MITT Study Area, with higher densities along the center of the MIRC and associated Transit Corridor. Model-predicted effects are presented in the table below.

Most potential effects would be due to Anti-Submarine Warfare activities. Effects from explosive activities would be limited, and injurious effects are negligible. In addition to the refinements to the assessment of auditory effects described in Section 2.4.2 (Impacts on Odontocetes), increases in estimated density also contribute to increases in modeled effects for this population since the 2020 analysis. Specifically, density estimates for Phase IV include a more detailed and stratified density of dolphins within the entire MITT Study Area. On average, individuals estimated to occur in the Study Area could be affected less than once per year. Most effects would be temporary auditory and behavioral effects due to hull-mounted sonar. Limited auditory injury is also expected from the use of hull-mounted sonar. The average individual risk of injury is negligible. The risk of injury may be reduced through activity-based mitigation, especially since striped dolphins have a high sightability and 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. 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 population of striped dolphins in the MITT Study Area has an unknown population trend, although calves have been seen in the area. Because of their longer generation times, this population would require more time to recover if significantly affected.

Several predicted instances of disturbance over a year are unlikely to have any long-term consequences for individuals, although individuals who experience an auditory injury may incur energetic costs. Based on the above analysis, long-term consequences for the population of striped dolphins are unlikely.

Table 2.4-28: Estimated Effects on Striped Dolphins over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	0	0	0	0	-
Explosive	Training	(1)	(1)	0	0	-
Sonar	Testing	63	3	-	-	-
Sonar	Training	370	1,125	(1)	-	-
Maximum Annual Total		**434**	**1,129**	**1**	**0**	**-**

Population Abundance Estimate	Annual Effects per Individual	Annual Injurious Effects per Individual
7,676	0.20	0.00

Season	Percent of Total Effects	
	MIRC	Transit Corridor
Warm	40%	1%
Cold	57%	1%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Anti-Submarine Warfare Tracking Exercise - Ship	Training	33%
Small Integrated ASW	Training	22%
Surface Warfare Advanced Tactical Training	Training	11%
Medium Coordinated Anti-Submarine Warfare	Training	9%
Joint Multi-Strike Group Exercise (CPF)	Training	7%
Surface Ship Sonar Maintenance and Systems Checks	Training	6%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Asterisk (*) indicates no reliable abundance estimate is available.
See beginning of Section 2.4 for full explanation of table sections.
version.20250708

2.4.3 Effects Summary Tables

The tables in this section show effects on all stocks under the preferred alternative for the following:

- Maximum annual and seven-year total effects due to all acoustic and explosive stressors (i.e., the combined total effects). See Table 2.4-29 and Table 2.4-30.
- Maximum annual and seven-year total effects due to sonar use during training and testing activities. The maximum annual effects per stock are the same values presented in each species effect assessment above. See Table 2.4-32 through Table 2.4-36.
- Maximum annual and seven-year total effects due to explosives during training and testing activities. See Table 2.4-38 through Table 2.4-42.

2.4.3.1 Total Effects Summary Tables

Table 2.4-29: Estimated Effects on Marine Mammal Stocks from All Acoustic and Explosive Activities over One Year of Maximum Training and Testing

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Blue whale	Central North Pacific	4	38	1	-	-
Fin whale	(NSD)	4	31	1	-	-
Humpback whale	Western North Pacific stock and DPS	49	1,468	21	-	-
Sei whale	(NSD)	3	34	1	-	-
Sperm whale	(NSD)	124	101	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	4	64	1	-	-
Minke whale	(NSD)	3	22	1	-	-
Omura's whale	(NSD)	4	48	1	-	-
Bottlenose dolphin	(NSD)	117	239	1	0	0
Dwarf sperm whale	(NSD)	1,395	17,321	323	0	0
False killer whale	(NSD)	70	158	0	0	-
Fraser's dolphin	(NSD)	4,237	7,188	5	1	0
Killer whale	(NSD)	14	40	0	-	-
Melon-headed whale	(NSD)	172	303	1	0	-
Pantropical spotted dolphin	(NSD)	1,373	3,182	3	0	0
Pygmy killer whale	(NSD)	270	615	1	0	0
Pygmy sperm whale	(NSD)	1,572	19,420	374	0	0
Risso's dolphin	(NSD)	555	1,226	1	1	-
Rough-toothed dolphin	(NSD)	506	1,478	1	0	0
Short-finned pilot whale	(NSD)	81	147	0	0	0
Spinner dolphin	(NSD)	2,248	1,843	2	0	-
Striped dolphin	(NSD)	434	1,129	1	0	-
Blainville's beaked whale	(NSD)	3,095	25	0	0	-
Deraniyagala beaked whale	(NSD)	4,967	6	1	-	-
Ginkgo-toothed beaked whale	(NSD)	5,875	54	0	0	-
Goose-beaked whale	(NSD)	2,598	20	0	0	-
Longman's beaked whale	(NSD)	1,003	12	0	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-30: Estimated Effects on Marine Mammal Stocks from All Acoustic and Explosive Activities over Seven Years of Training and Testing under Alternative 1

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Blue whale	Central North Pacific	15	254	3	-	-
Fin whale	(NSD)	18	211	1	-	-
Humpback whale	Western North Pacific stock and DPS	319	10,215	136	-	-
Sei whale	(NSD)	10	231	2	-	-
Sperm whale	(NSD)	850	691	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	17	432	5	-	-
Minke whale	(NSD)	6	148	2	-	-
Omura's whale	(NSD)	15	321	2	-	-
Bottlenose dolphin	(NSD)	795	1,659	1	0	0
Dwarf sperm whale	(NSD)	9,212	120,366	2,156	0	0
False killer whale	(NSD)	482	1,094	0	0	-
Fraser's dolphin	(NSD)	29,067	50,112	22	1	0
Killer whale	(NSD)	92	274	0	-	-
Melon-headed whale	(NSD)	1,177	2,113	1	0	-
Pantropical spotted dolphin	(NSD)	9,337	22,156	11	0	0
Pygmy killer whale	(NSD)	1,849	4,283	1	0	0
Pygmy sperm whale	(NSD)	10,390	134,939	2,486	0	0
Risso's dolphin	(NSD)	3,799	8,555	3	1	-
Rough-toothed dolphin	(NSD)	3,466	10,297	6	0	0
Short-finned pilot whale	(NSD)	549	1,018	0	0	0
Spinner dolphin	(NSD)	14,664	12,711	9	0	-
Striped dolphin	(NSD)	2,977	7,865	3	0	-
Blainville's beaked whale	(NSD)	21,373	162	0	0	-
Deraniyagala beaked whale	(NSD)	34,165	26	3	-	-
Ginkgo-toothed beaked whale	(NSD)	40,346	374	0	0	-
Goose-beaked whale	(NSD)	17,905	130	0	0	-
Longman's beaked whale	(NSD)	6,885	72	0	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-31: Estimated Effects on Marine Mammal Stocks from All Acoustic and Explosive Activities over Seven Years of Training and Testing under Alternative 2

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Blue whale	Central North Pacific	16	255	3	-	-
Fin whale	(NSD)	19	212	1	-	-
Humpback whale	Western North Pacific	343	10,266	137	-	-
Sei whale	(NSD)	10	233	2	-	-
Sperm whale	(NSD)	860	693	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	19	434	5	-	-
Minke whale	(NSD)	6	149	2	-	-
Omura's whale	(NSD)	16	323	2	-	-
Bottlenose dolphin	(NSD)	809	1,664	1	0	0
Dwarf sperm whale	(NSD)	9,751	121,207	2,214	0	0
False killer whale	(NSD)	490	1,098	0	0	-
Fraser's dolphin	(NSD)	29,644	50,301	22	1	0
Killer whale	(NSD)	94	275	0	-	-
Melon-headed whale	(NSD)	1,191	2,122	1	0	-
Pantropical spotted dolphin	(NSD)	9,605	22,268	12	0	0
Pygmy killer whale	(NSD)	1,881	4,296	1	0	0
Pygmy sperm whale	(NSD)	10,998	135,908	2,554	0	0
Risso's dolphin	(NSD)	3,879	8,585	3	1	-
Rough-toothed dolphin	(NSD)	3,534	10,332	7	0	0
Short-finned pilot whale	(NSD)	558	1,023	0	0	0
Spinner dolphin	(NSD)	15,723	12,889	9	0	-
Striped dolphin	(NSD)	3,028	7,892	3	0	-
Blainville's beaked whale	(NSD)	21,657	162	0	0	-
Deraniyagala beaked whale	(NSD)	34,764	30	3	-	-
Ginkgo-toothed beaked whale	(NSD)	41,119	375	0	0	-
Goose-beaked whale	(NSD)	18,181	131	0	0	-
Longman's beaked whale	(NSD)	7,016	72	0	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation.
version.20260128

2.4.3.2 Sonar Effects Summary Tables

2.4.3.2.1 Training Sonar Effects Summary Tables

Table 2.4-32: Estimated Effects on Marine Mammal Stocks from Sonar and Other Active Transducers over One Year of Maximum Training

Species	Stock or Population	BEH	TTS	AINJ
ESA-Listed				
Blue whale	Central North Pacific	2	36	(1)
Fin whale	(NSD)	2	30	(1)
Humpback whale	Western North Pacific stock and DPS	27	1,453	20
Sei whale	(NSD)	1	33	(1)
Sperm whale	(NSD)	111	99	0
Non ESA-Listed				
Bryde's whale	(NSD)	2	62	1
Minke whale	(NSD)	(1)	21	(1)
Omura's whale	(NSD)	2	46	(1)
Bottlenose dolphin	(NSD)	100	237	(1)
Dwarf sperm whale	(NSD)	936	16,328	247
False killer whale	(NSD)	60	157	0
Fraser's dolphin	(NSD)	3,728	7,169	3
Killer whale	(NSD)	11	39	0
Melon-headed whale	(NSD)	150	302	(1)
Pantropical spotted dolphin	(NSD)	1,181	3,170	2
Pygmy killer whale	(NSD)	230	612	(1)
Pygmy sperm whale	(NSD)	1,064	18,327	285
Risso's dolphin	(NSD)	477	1,223	(1)
Rough-toothed dolphin	(NSD)	422	1,473	1
Short-finned pilot whale	(NSD)	69	146	0
Spinner dolphin	(NSD)	2,133	1,798	1
Striped dolphin	(NSD)	370	1,125	(1)
Blainville's beaked whale	(NSD)	2,948	23	-
Deraniyagala beaked whale	(NSD)	4,727	1	-
Ginkgo-toothed beaked whale	(NSD)	5,577	53	-
Goose-beaked whale	(NSD)	2,455	19	-
Longman's beaked whale	(NSD)	951	11	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-33: Estimated Effects on Marine Mammal Stocks from Sonar and Other Active Transducers Over Seven Years of Training under Alternative 1

Species	Stock or Population	BEH	TTS	AINJ
ESA-Listed				
Blue whale	Central North Pacific	10	252	3
Fin whale	(NSD)	12	210	1
Humpback whale	Western North Pacific stock and DPS	178	10,128	135
Sei whale	(NSD)	6	229	2
Sperm whale	(NSD)	769	689	0
Non ESA-Listed				
Bryde's whale	(NSD)	11	428	5
Minke whale	(NSD)	3	147	2
Omura's whale	(NSD)	10	318	2
Bottlenose dolphin	(NSD)	683	1,654	1
Dwarf sperm whale	(NSD)	6,269	113,665	1,720
False killer whale	(NSD)	414	1,092	0
Fraser's dolphin	(NSD)	25,525	49,998	18
Killer whale	(NSD)	76	273	0
Melon-headed whale	(NSD)	1,034	2,107	1
Pantropical spotted dolphin	(NSD)	7,998	22,078	9
Pygmy killer whale	(NSD)	1,578	4,272	1
Pygmy sperm whale	(NSD)	7,128	127,574	1,980
Risso's dolphin	(NSD)	3,260	8,535	3
Rough-toothed dolphin	(NSD)	2,886	10,273	6
Short-finned pilot whale	(NSD)	476	1,016	0
Spinner dolphin	(NSD)	13,873	12,408	4
Striped dolphin	(NSD)	2,540	7,847	3
Blainville's beaked whale	(NSD)	20,354	160	-
Deraniyagala beaked whale	(NSD)	32,496	5	-
Ginkgo-toothed beaked whale	(NSD)	38,266	371	-
Goose-beaked whale	(NSD)	16,911	129	-
Longman's beaked whale	(NSD)	6,527	71	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-34: Estimated Effects on Marine Mammal Stocks from Sonar and Other Active Transducers Over Seven Years of Training under Alternative 2

Species	Stock or Population	BEH	TTS	AINJ
ESA-Listed				
Blue whale	Central North Pacific	10	253	3
Fin whale	(NSD)	12	211	1
Humpback whale	Western North Pacific	190	10,174	136
Sei whale	(NSD)	6	230	2
Sperm whale	(NSD)	779	691	0
Non ESA-Listed				
Bryde's whale	(NSD)	12	430	5
Minke whale	(NSD)	3	148	2
Omura's whale	(NSD)	10	319	2
Bottlenose dolphin	(NSD)	697	1,659	1
Dwarf sperm whale	(NSD)	6,550	114,297	1,731
False killer whale	(NSD)	422	1,096	0
Fraser's dolphin	(NSD)	26,095	50,181	18
Killer whale	(NSD)	78	274	0
Melon-headed whale	(NSD)	1,048	2,116	1
Pantropical spotted dolphin	(NSD)	8,264	22,189	9
Pygmy killer whale	(NSD)	1,609	4,285	1
Pygmy sperm whale	(NSD)	7,450	128,291	1,993
Risso's dolphin	(NSD)	3,339	8,564	3
Rough-toothed dolphin	(NSD)	2,953	10,308	6
Short-finned pilot whale	(NSD)	485	1,020	0
Spinner dolphin	(NSD)	14,931	12,586	4
Striped dolphin	(NSD)	2,591	7,874	3
Blainville's beaked whale	(NSD)	20,638	160	-
Deraniyagala beaked whale	(NSD)	33,090	5	-
Ginkgo-toothed beaked whale	(NSD)	39,039	371	-
Goose-beaked whale	(NSD)	17,186	129	-
Longman's beaked whale	(NSD)	6,658	71	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation.
version.20260128

2.4.3.2.2 Testing Sonar Effects Summary Tables

Table 2.4-35: Estimated Effects on Marine Mammal Stocks from Sonar and Other Active Transducers Over a Maximum Year of Testing

Species	Stock or Population	BEH	TTS	AINJ
ESA-Listed				
Blue whale	Central North Pacific	1	(1)	-
Fin whale	(NSD)	1	(1)	-
Humpback whale	Western North Pacific stock and DPS	15	10	0
Sei whale	(NSD)	(1)	(1)	0
Sperm whale	(NSD)	12	(1)	-
Non ESA-Listed				
Bryde's whale	(NSD)	1	(1)	-
Minke whale	(NSD)	(1)	(1)	-
Omura's whale	(NSD)	1	(1)	-
Bottlenose dolphin	(NSD)	16	1	-
Dwarf sperm whale	(NSD)	150	686	7
False killer whale	(NSD)	10	(1)	-
Fraser's dolphin	(NSD)	499	12	-
Killer whale	(NSD)	3	(1)	-
Melon-headed whale	(NSD)	21	1	-
Pantropical spotted dolphin	(NSD)	190	11	0
Pygmy killer whale	(NSD)	39	2	0
Pygmy sperm whale	(NSD)	158	728	9
Risso's dolphin	(NSD)	77	3	-
Rough-toothed dolphin	(NSD)	83	4	0
Short-finned pilot whale	(NSD)	11	(1)	-
Spinner dolphin	(NSD)	113	41	0
Striped dolphin	(NSD)	63	3	-
Blainville's beaked whale	(NSD)	146	(1)	-
Deraniyagala beaked whale	(NSD)	236	(1)	-
Ginkgo-toothed beaked whale	(NSD)	297	0	-
Goose-beaked whale	(NSD)	142	0	-
Longman's beaked whale	(NSD)	51	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-36: Estimated Effects on Marine Mammal Stocks from Sonar and Other Active Transducers Over Seven Years of Testing under Alternative 1

Species	Stock or Population	BEH	TTS	AINJ
ESA-Listed				
Blue whale	Central North Pacific	4	1	-
Fin whale	(NSD)	5	1	-
Humpback whale	Western North Pacific stock and DPS	104	65	0
Sei whale	(NSD)	3	2	0
Sperm whale	(NSD)	79	1	-
Non ESA-Listed				
Bryde's whale	(NSD)	5	3	-
Minke whale	(NSD)	2	1	-
Omura's whale	(NSD)	4	1	-
Bottlenose dolphin	(NSD)	111	4	-
Dwarf sperm whale	(NSD)	1,044	4,796	48
False killer whale	(NSD)	68	2	-
Fraser's dolphin	(NSD)	3,487	78	-
Killer whale	(NSD)	16	1	-
Melon-headed whale	(NSD)	142	6	-
Pantropical spotted dolphin	(NSD)	1,328	71	0
Pygmy killer whale	(NSD)	270	10	0
Pygmy sperm whale	(NSD)	1,102	5,096	59
Risso's dolphin	(NSD)	535	20	-
Rough-toothed dolphin	(NSD)	577	22	0
Short-finned pilot whale	(NSD)	72	2	-
Spinner dolphin	(NSD)	785	281	0
Striped dolphin	(NSD)	435	16	-
Blainville's beaked whale	(NSD)	1,017	1	-
Deraniyagala beaked whale	(NSD)	1,646	1	-
Ginkgo-toothed beaked whale	(NSD)	2,078	0	-
Goose-beaked whale	(NSD)	993	0	-
Longman's beaked whale	(NSD)	357	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-37: Estimated Effects on Marine Mammal Stocks from Sonar and Other Active Transducers Over Seven Years of Testing under Alternative 2

Species	Stock or Population	BEH	TTS	AINJ
ESA-Listed				
Blue whale	Central North Pacific	4	1	-
Fin whale	(NSD)	5	1	-
Humpback whale	Western North Pacific	104	65	0
Sei whale	(NSD)	3	2	0
Sperm whale	(NSD)	79	1	-
Non ESA-Listed				
Bryde's whale	(NSD)	5	3	-
Minke whale	(NSD)	2	1	-
Omura's whale	(NSD)	4	1	-
Bottlenose dolphin	(NSD)	111	4	-
Dwarf sperm whale	(NSD)	1,044	4,795	48
False killer whale	(NSD)	68	2	-
Fraser's dolphin	(NSD)	3,487	78	-
Killer whale	(NSD)	16	1	-
Melon-headed whale	(NSD)	142	6	-
Pantropical spotted dolphin	(NSD)	1,328	71	0
Pygmy killer whale	(NSD)	270	10	0
Pygmy sperm whale	(NSD)	1,102	5,096	59
Risso's dolphin	(NSD)	535	20	-
Rough-toothed dolphin	(NSD)	577	22	0
Short-finned pilot whale	(NSD)	72	2	-
Spinner dolphin	(NSD)	785	281	0
Striped dolphin	(NSD)	435	16	-
Blainville's beaked whale	(NSD)	1,017	1	-
Deraniyagala beaked whale	(NSD)	1,646	1	-
Ginkgo-toothed beaked whale	(NSD)	2,078	0	-
Goose-beaked whale	(NSD)	993	0	-
Longman's beaked whale	(NSD)	357	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation.
version.20260128

2.4.3.3 Explosives Effects Summary Tables

2.4.3.3.1 Training Explosives Effects Summary Tables

Table 2.4-38: Estimated Effects on Marine Mammal Stocks from Explosives over a Maximum Year of Training

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Blue whale	Central North Pacific	(1)	(1)	-	-	-
Fin whale	(NSD)	(1)	0	0	-	-
Humpback whale	Western North Pacific stock and DPS	7	4	(1)	-	-
Sei whale	(NSD)	(1)	0	0	-	-
Sperm whale	(NSD)	(1)	(1)	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	(1)	(1)	0	-	-
Minke whale	(NSD)	(1)	0	-	-	-
Omura's whale	(NSD)	(1)	(1)	-	-	-
Bottlenose dolphin	(NSD)	(1)	(1)	0	0	0
Dwarf sperm whale	(NSD)	302	293	59	0	0
False killer whale	(NSD)	0	0	0	0	-
Fraser's dolphin	(NSD)	9	6	(1)	1	0
Melon-headed whale	(NSD)	(1)	0	0	0	-
Pantropical spotted dolphin	(NSD)	2	1	(1)	0	0
Pygmy killer whale	(NSD)	(1)	(1)	0	0	0
Pygmy sperm whale	(NSD)	343	349	68	0	0
Risso's dolphin	(NSD)	1	0	0	1	-
Rough-toothed dolphin	(NSD)	1	(1)	0	0	0
Short-finned pilot whale	(NSD)	(1)	0	0	0	0
Spinner dolphin	(NSD)	1	3	1	0	-
Striped dolphin	(NSD)	(1)	(1)	0	0	-
Blainville's beaked whale	(NSD)	(1)	(1)	0	0	-
Deraniyagala beaked whale	(NSD)	4	3	(1)	-	-
Ginkgo-toothed beaked whale	(NSD)	(1)	1	0	0	-
Goose-beaked whale	(NSD)	(1)	(1)	0	0	-
Longman's beaked whale	(NSD)	(1)	(1)	0	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-39: Estimated Effects on Marine Mammal Stocks from Explosives over Seven Years of Training under Alternative 1

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Blue whale	Central North Pacific	1	1	-	-	-
Fin whale	(NSD)	1	0	0	-	-
Humpback whale	Western North Pacific stock and DPS	37	21	1	-	-
Sei whale	(NSD)	1	0	0	-	-
Sperm whale	(NSD)	2	1	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	1	1	0	-	-
Minke whale	(NSD)	1	0	-	-	-
Omura's whale	(NSD)	1	2	-	-	-
Bottlenose dolphin	(NSD)	1	1	0	0	0
Dwarf sperm whale	(NSD)	1,855	1,843	369	0	0
False killer whale	(NSD)	0	0	0	0	-
Fraser's dolphin	(NSD)	54	35	3	1	0
Melon-headed whale	(NSD)	1	0	0	0	-
Pantropical spotted dolphin	(NSD)	11	7	2	0	0
Pygmy killer whale	(NSD)	1	1	0	0	0
Pygmy sperm whale	(NSD)	2,115	2,190	424	0	0
Risso's dolphin	(NSD)	4	0	0	1	-
Rough-toothed dolphin	(NSD)	3	2	0	0	0
Short-finned pilot whale	(NSD)	1	0	0	0	0
Spinner dolphin	(NSD)	5	21	5	0	-
Striped dolphin	(NSD)	2	2	0	0	-
Blainville's beaked whale	(NSD)	2	1	0	0	-
Deraniyagala beaked whale	(NSD)	23	19	3	-	-
Ginkgo-toothed beaked whale	(NSD)	2	3	0	0	-
Goose-beaked whale	(NSD)	1	1	0	0	-
Longman's beaked whale	(NSD)	1	1	0	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-40: Estimated Effects on Marine Mammal Stocks from Explosives over Seven Years of Training under Alternative 2

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Blue whale	Central North Pacific	2	1	-	-	-
Fin whale	(NSD)	2	0	0	-	-
Humpback whale	Western North Pacific	49	26	1	-	-
Sei whale	(NSD)	1	1	0	-	-
Sperm whale	(NSD)	2	1	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	2	1	0	-	-
Minke whale	(NSD)	1	0	-	-	-
Omura's whale	(NSD)	2	3	-	-	-
Bottlenose dolphin	(NSD)	1	1	0	0	0
Dwarf sperm whale	(NSD)	2,113	2,053	415	0	0
False killer whale	(NSD)	0	0	0	0	-
Fraser's dolphin	(NSD)	61	41	3	1	0
Melon-headed whale	(NSD)	1	0	0	0	-
Pantropical spotted dolphin	(NSD)	13	8	3	0	0
Pygmy killer whale	(NSD)	2	1	0	0	0
Pygmy sperm whale	(NSD)	2,401	2,442	479	0	0
Risso's dolphin	(NSD)	5	1	0	1	-
Rough-toothed dolphin	(NSD)	4	2	1	0	0
Short-finned pilot whale	(NSD)	1	1	0	0	0
Spinner dolphin	(NSD)	6	21	5	0	-
Striped dolphin	(NSD)	2	2	0	0	-
Blainville's beaked whale	(NSD)	2	1	0	0	-
Deraniyagala beaked whale	(NSD)	28	23	3	-	-
Ginkgo-toothed beaked whale	(NSD)	2	4	0	0	-
Goose-beaked whale	(NSD)	2	2	0	0	-
Longman's beaked whale	(NSD)	1	1	0	0	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation.
version.20260128

2.4.3.3.2 Testing Explosives Effects Summary Tables

Table 2.4-41: Estimated Effects on Marine Mammal Stocks from Explosives over a Maximum Year of Testing

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Fin whale	(NSD)	-	0	-	-	-
Humpback whale	Western North Pacific stock and DPS	0	(1)	-	-	-
Sei whale	(NSD)	-	0	-	-	-
Sperm whale	(NSD)	0	0	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	0	0	0	-	-
Minke whale	(NSD)	-	0	-	-	-
Omura's whale	(NSD)	-	0	-	-	-
Bottlenose dolphin	(NSD)	0	0	0	0	-
Dwarf sperm whale	(NSD)	7	14	10	0	0
False killer whale	(NSD)	-	0	0	-	-
Fraser's dolphin	(NSD)	(1)	(1)	(1)	-	-
Melon-headed whale	(NSD)	0	0	-	-	-
Pantropical spotted dolphin	(NSD)	0	0	0	0	-
Pygmy killer whale	(NSD)	0	0	0	0	0
Pygmy sperm whale	(NSD)	7	16	12	-	-
Risso's dolphin	(NSD)	0	-	0	-	-
Rough-toothed dolphin	(NSD)	0	0	0	0	0
Short-finned pilot whale	(NSD)	0	0	-	-	-
Spinner dolphin	(NSD)	(1)	(1)	0	-	-
Striped dolphin	(NSD)	0	0	0	0	-
Blainville's beaked whale	(NSD)	0	0	0	-	-
Deraniyagala beaked whale	(NSD)	0	(1)	-	-	-
Ginkgo-toothed beaked whale	(NSD)	0	-	-	-	-
Goose-beaked whale	(NSD)	0	0	0	-	-
Longman's beaked whale	(NSD)	0	0	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 2.4.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-42: Estimated Effects on Marine Mammal Stocks from Explosives over Seven Years of Testing under Alternative 1

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Fin whale	(NSD)	-	0	-	-	-
Humpback whale	Western North Pacific stock and DPS	0	1	-	-	-
Sei whale	(NSD)	-	0	-	-	-
Sperm whale	(NSD)	0	0	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	0	0	0	-	-
Minke whale	(NSD)	-	0	-	-	-
Omura's whale	(NSD)	-	0	-	-	-
Bottlenose dolphin	(NSD)	0	0	0	0	-
Dwarf sperm whale	(NSD)	44	62	19	0	0
False killer whale	(NSD)	-	0	0	-	-
Fraser's dolphin	(NSD)	1	1	1	-	-
Melon-headed whale	(NSD)	0	0	-	-	-
Pantropical spotted dolphin	(NSD)	0	0	0	0	-
Pygmy killer whale	(NSD)	0	0	0	0	0
Pygmy sperm whale	(NSD)	45	79	23	-	-
Risso's dolphin	(NSD)	0	-	0	-	-
Rough-toothed dolphin	(NSD)	0	0	0	0	0
Short-finned pilot whale	(NSD)	0	0	-	-	-
Spinner dolphin	(NSD)	1	1	0	-	-
Striped dolphin	(NSD)	0	0	0	0	-
Blainville's beaked whale	(NSD)	0	0	0	-	-
Deraniyagala beaked whale	(NSD)	0	1	-	-	-
Ginkgo-toothed beaked whale	(NSD)	0	-	-	-	-
Goose-beaked whale	(NSD)	0	0	0	-	-
Longman's beaked whale	(NSD)	0	0	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation under MMPA.
version.20250703

Table 2.4-43: Estimated Effects on Marine Mammal Stocks from Explosives over Seven Years of Testing under Alternative 2

Species	Stock or Population	BEH	TTS	AINJ	INJ	MORT
ESA-Listed						
Fin whale	(NSD)	-	0	-	-	-
Humpback whale	Western North Pacific	0	1	-	-	-
Sei whale	(NSD)	-	0	-	-	-
Sperm whale	(NSD)	0	0	0	-	-
Non ESA-Listed						
Bryde's whale	(NSD)	0	0	0	-	-
Minke whale	(NSD)	-	0	-	-	-
Omura's whale	(NSD)	-	0	-	-	-
Bottlenose dolphin	(NSD)	0	0	0	0	-
Dwarf sperm whale	(NSD)	44	62	20	0	0
False killer whale	(NSD)	-	0	0	-	-
Fraser's dolphin	(NSD)	1	1	1	-	-
Melon-headed whale	(NSD)	0	0	-	-	-
Pantropical spotted dolphin	(NSD)	0	0	0	0	-
Pygmy killer whale	(NSD)	0	0	0	0	0
Pygmy sperm whale	(NSD)	45	79	23	-	-
Risso's dolphin	(NSD)	0	-	0	-	-
Rough-toothed dolphin	(NSD)	0	0	0	0	0
Short-finned pilot whale	(NSD)	0	0	-	-	-
Spinner dolphin	(NSD)	1	1	0	-	-
Striped dolphin	(NSD)	0	0	0	0	-
Blainville's beaked whale	(NSD)	0	0	0	-	-
Deraniyagala beaked whale	(NSD)	0	1	-	-	-
Ginkgo-toothed beaked whale	(NSD)	0	-	-	-	-
Goose-beaked whale	(NSD)	0	0	0	-	-
Longman's beaked whale	(NSD)	0	0	0	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Stocks are not shown if no effects are estimated.
NSD = No stock designation.
version.20260128

2.5 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 NAEMO described in the *Quantitative Analysis TR*. The ranges to effects are shown for representative sonar systems and explosive bins from E1 (0.1–0.25 lb.) to E12 (>675–1,000 lb.). 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 effects 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 (sonar), exposure duration (sonar), source depth (explosives), and representative cluster size (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).

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, mean +1 standard deviation, and mean -1 standard deviation behavioral response curves below, provide the probability of behavioral response as a function of range for the sensitive species (beaked whales), mysticete (all baleen whales), and odontocete (most toothed whales and dolphins) behavioral response groups.

Table 2.5-1: Very Low Frequency Cetacean Ranges to Effects for Sonar

Sonar Type	Water Depth	Duration	TTS	AINJ
Dipping Sonar	>200 m	1 s	120 m (19 m)	0 m (0 m)
		30 s	260 m (37 m)	6 m (8 m)
		60 s	360 m (52 m)	23 m (9 m)
		120 s	525 m (74 m)	35 m (14 m)
MF1 Ship Sonar	≤200 m	1 s	749 m (120 m)	90 m (1 m)
		30 s	749 m (120 m)	90 m (1 m)
		60 s	849 m (122 m)	140 m (2 m)
		120 s	881 m (145 m)	176 m (5 m)
	>200 m	1 s	1,000 m (42 m)	85 m (2 m)
		30 s	1,000 m (42 m)	85 m (2 m)
		60 s	1,750 m (162 m)	140 m (5 m)
		120 s	2,264 m (675 m)	170 m (5 m)
MF1C Ship Sonar	>200 m	1 s	1,000 m (44 m)	85 m (2 m)
		30 s	2,271 m (684 m)	170 m (5 m)
		60 s	5,250 m (800 m)	250 m (6 m)
		120 s	7,486 m (1,231 m)	370 m (6 m)
MF1K Ship Sonar	≤200 m	1 s	190 m (3 m)	13 m (0 m)
		30 s	341 m (30 m)	24 m (0 m)
		60 s	422 m (51 m)	30 m (0 m)
		120 s	529 m (89 m)	45 m (0 m)
	>200 m	1 s	190 m (5 m)	6 m (6 m)
		30 s	330 m (7 m)	12 m (12 m)
		60 s	430 m (7 m)	28 m (3 m)
		120 s	625 m (15 m)	40 m (2 m)
Mine-Hunting Sonar	≤200 m	1 s	2 m (2 m)	0 m (0 m)
		30 s	6 m (1 m)	0 m (0 m)
		60 s	9 m (1 m)	0 m (0 m)
		120 s	14 m (2 m)	0 m (1 m)
	>200 m	1 s	0 m (0 m)	0 m (0 m)
		30 s	2 m (3 m)	0 m (0 m)
		60 s	4 m (4 m)	0 m (0 m)
		120 s	12 m (1 m)	0 m (0 m)
Sonobuoy Sonar	>200 m	1 s	0 m (7 m)	0 m (0 m)
		30 s	23 m (11 m)	0 m (0 m)
		60 s	35 m (12 m)	0 m (0 m)
		120 s	50 m (6 m)	0 m (0 m)

Median ranges with standard deviation ranges in parentheses
TTS = Temporary Threshold Shift, AINJ = Auditory Injury
MF1 = hull-mounted surface ship sonar, MF1C = >80% duty cycle, MF1K = kingfisher mode
version.20250520

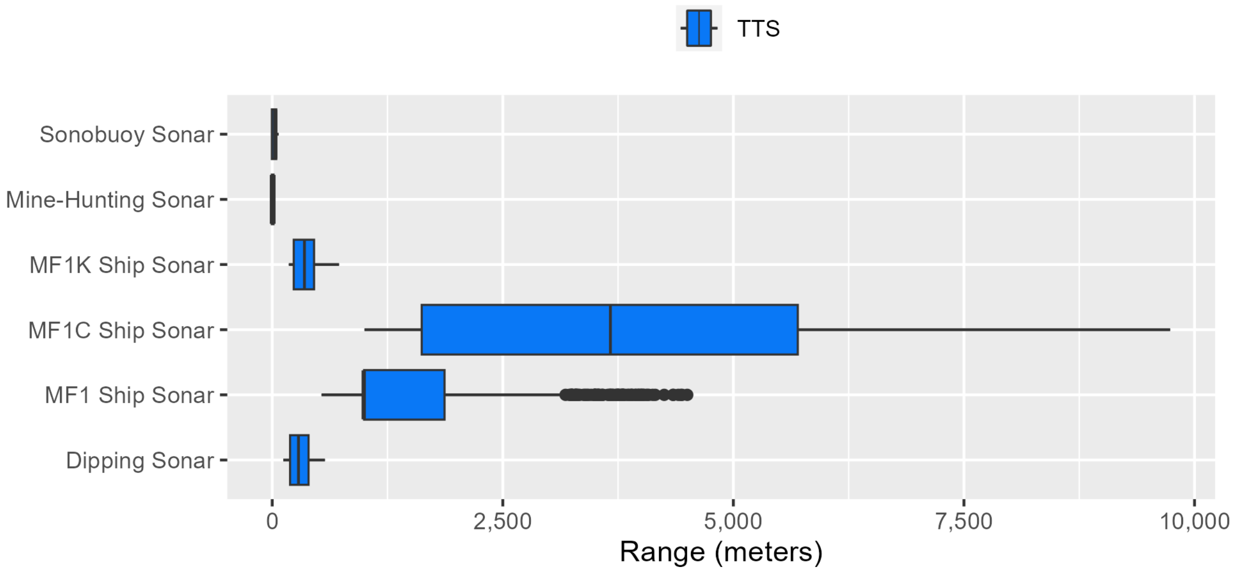

Figure 2-7: Very Low Frequency Cetacean Ranges to Temporary Threshold Shift for Sonar

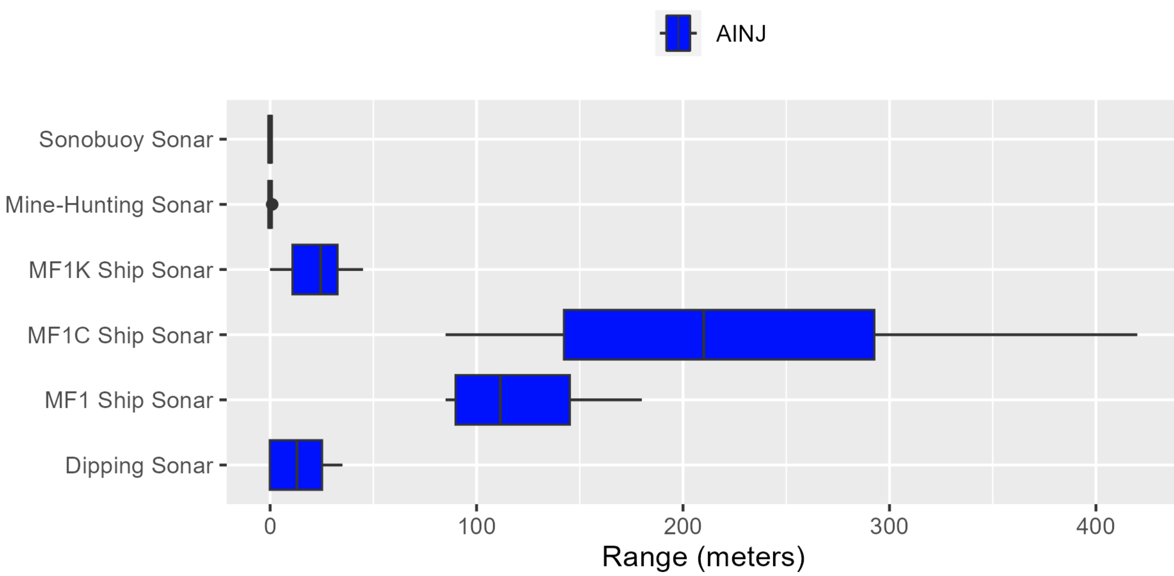

Figure 2-8: Very Low Frequency Cetacean Ranges to Auditory Injury for Sonar

Table 2.5-2: Low Frequency Cetacean Ranges to Effects for Sonar

Sonar Type	Water Depth	Duration	TTS	AINJ
Dipping Sonar	>200 m	1 s	120 m (73 m)	0 m (6 m)
		30 s	270 m (82 m)	0 m (10 m)
		60 s	360 m (107 m)	23 m (12 m)
		120 s	525 m (84 m)	35 m (17 m)
MF1 Ship Sonar	≤200 m	1 s	749 m (117 m)	92 m (3 m)
		30 s	749 m (117 m)	92 m (3 m)
		60 s	858 m (127 m)	140 m (5 m)
		120 s	881 m (173 m)	180 m (2 m)
	>200 m	1 s	1,000 m (98 m)	90 m (3 m)
		30 s	1,000 m (98 m)	90 m (3 m)
		60 s	1,944 m (267 m)	140 m (1 m)
		120 s	3,083 m (849 m)	180 m (1 m)
MF1C Ship Sonar	>200 m	1 s	1,000 m (102 m)	90 m (3 m)
		30 s	3,083 m (863 m)	180 m (1 m)
		60 s	5,694 m (881 m)	260 m (4 m)
		120 s	8,167 m (1,369 m)	380 m (7 m)
MF1K Ship Sonar	≤200 m	1 s	200 m (6 m)	14 m (0 m)
		30 s	350 m (32 m)	25 m (0 m)
		60 s	432 m (53 m)	30 m (0 m)
		120 s	538 m (92 m)	45 m (0 m)
	>200 m	1 s	190 m (5 m)	12 m (1 m)
		30 s	350 m (6 m)	24 m (0 m)
		60 s	450 m (10 m)	30 m (0 m)
		120 s	625 m (21 m)	45 m (0 m)
Mine-Hunting Sonar	≤200 m	1 s	0 m (4 m)	0 m (0 m)
		30 s	0 m (7 m)	0 m (0 m)
		60 s	19 m (3 m)	0 m (0 m)
		120 s	33 m (3 m)	0 m (0 m)
	>200 m	1 s	0 m (3 m)	0 m (0 m)
		30 s	0 m (8 m)	0 m (0 m)
		60 s	0 m (12 m)	0 m (0 m)
		120 s	23 m (5 m)	0 m (0 m)
Sonobuoy Sonar	>200 m	1 s	0 m (8 m)	0 m (0 m)
		30 s	25 m (13 m)	0 m (1 m)
		60 s	35 m (20 m)	0 m (1 m)
		120 s	55 m (28 m)	0 m (2 m)

Median ranges with standard deviation ranges in parentheses
TTS = Temporary Threshold Shift, AINJ = Auditory Injury
MF1 = hull-mounted surface ship sonar, MF1C = >80% duty cycle, MF1K = kingfisher mode
version.20250520

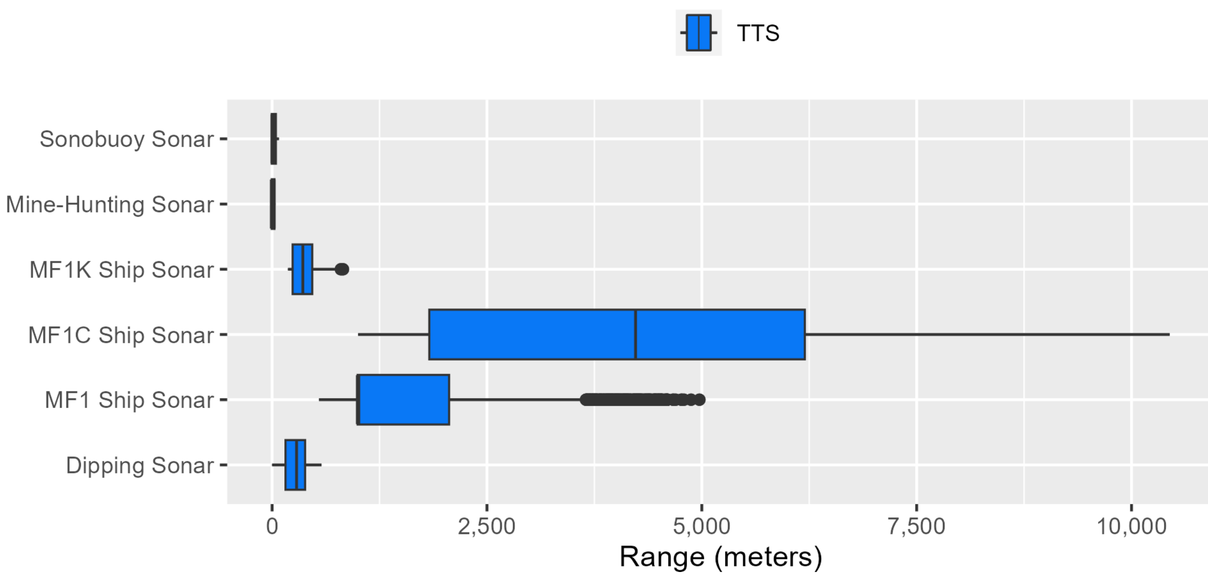

Figure 2-9: Low Frequency Cetacean Ranges to Temporary Threshold Shift for Sonar

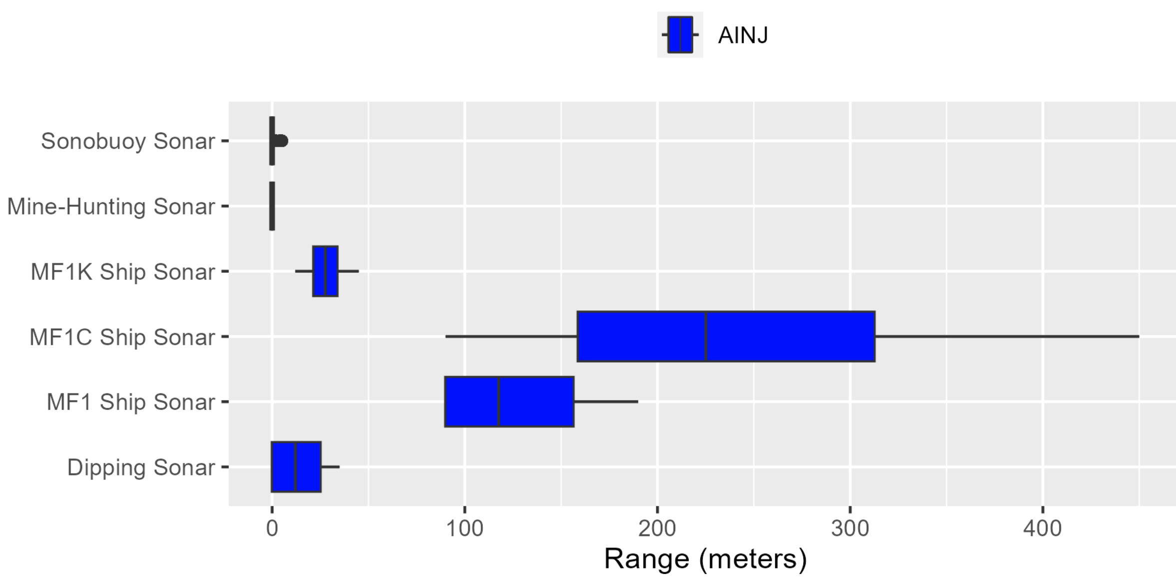

Figure 2-10: Low Frequency Cetacean Ranges to Auditory Injury for Sonar

Table 2.5-3: High Frequency Cetacean Ranges to Effects for Sonar

Sonar Type	Water Depth	Duration	TTS	AINJ
Dipping Sonar	>200 m	1 s	50 m (27 m)	0 m (2 m)
		30 s	95 m (51 m)	0 m (4 m)
		60 s	120 m (70 m)	0 m (5 m)
		120 s	200 m (100 m)	0 m (8 m)
MF1 Ship Sonar	≤200 m	1 s	525 m (107 m)	45 m (8 m)
		30 s	525 m (107 m)	45 m (8 m)
		60 s	661 m (143 m)	65 m (12 m)
		120 s	714 m (151 m)	85 m (16 m)
	>200 m	1 s	600 m (93 m)	42 m (14 m)
		30 s	600 m (93 m)	42 m (14 m)
		60 s	875 m (138 m)	65 m (20 m)
		120 s	1,000 m (152 m)	85 m (20 m)
MF1C Ship Sonar	>200 m	1 s	600 m (93 m)	42 m (14 m)
		30 s	1,000 m (153 m)	85 m (20 m)
		60 s	1,500 m (329 m)	130 m (24 m)
		120 s	3,250 m (1,160 m)	200 m (34 m)
MF1K Ship Sonar	≤200 m	1 s	100 m (17 m)	7 m (3 m)
		30 s	182 m (31 m)	13 m (2 m)
		60 s	241 m (38 m)	17 m (3 m)
		120 s	349 m (58 m)	25 m (4 m)
	>200 m	1 s	100 m (30 m)	0 m (3 m)
		30 s	180 m (32 m)	10 m (6 m)
		60 s	240 m (40 m)	16 m (8 m)
		120 s	350 m (56 m)	24 m (11 m)
Mine-Hunting Sonar	≤200 m	1 s	9 m (5 m)	0 m (0 m)
		30 s	18 m (9 m)	1 m (0 m)
		60 s	25 m (13 m)	1 m (1 m)
		120 s	35 m (17 m)	2 m (1 m)
	>200 m	1 s	7 m (4 m)	0 m (0 m)
		30 s	15 m (7 m)	0 m (0 m)
		60 s	21 m (10 m)	0 m (0 m)
		120 s	25 m (9 m)	0 m (1 m)
Sonobuoy Sonar	>200 m	1 s	0 m (4 m)	0 m (0 m)
		30 s	0 m (9 m)	0 m (0 m)
		60 s	0 m (13 m)	0 m (0 m)
		120 s	30 m (17 m)	0 m (1 m)

Median ranges with standard deviation ranges in parentheses
TTS = Temporary Threshold Shift, AINJ = Auditory Injury
MF1 = hull-mounted surface ship sonar, MF1C = >80% duty cycle, MF1K = kingfisher mode
version.20250520

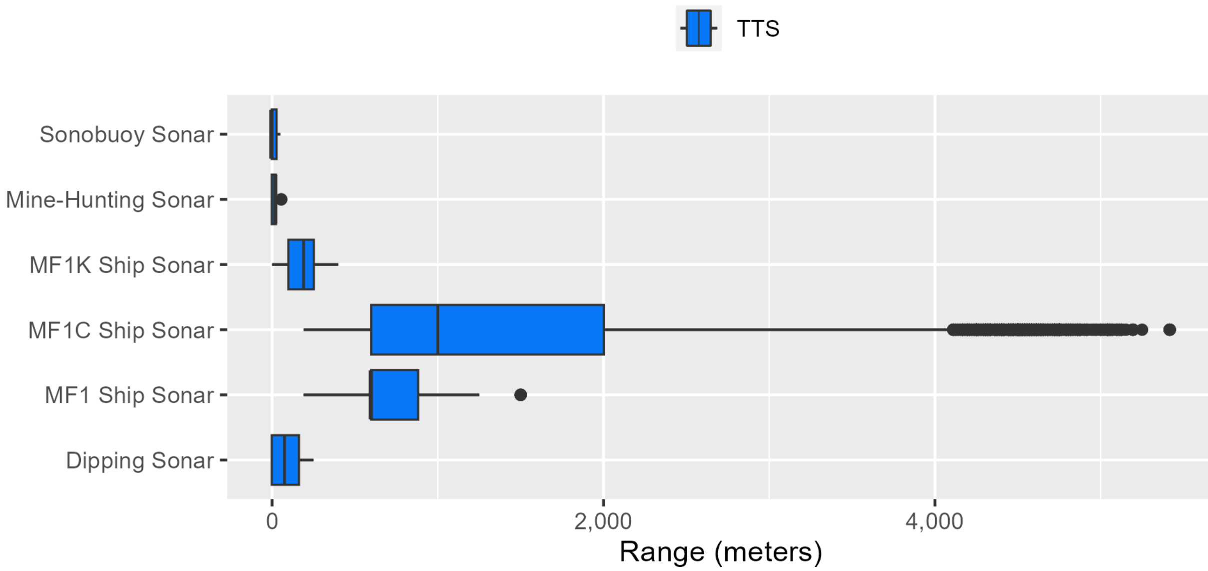

Figure 2-11: High Frequency Cetacean Ranges to Temporary Threshold Shift for Sonar

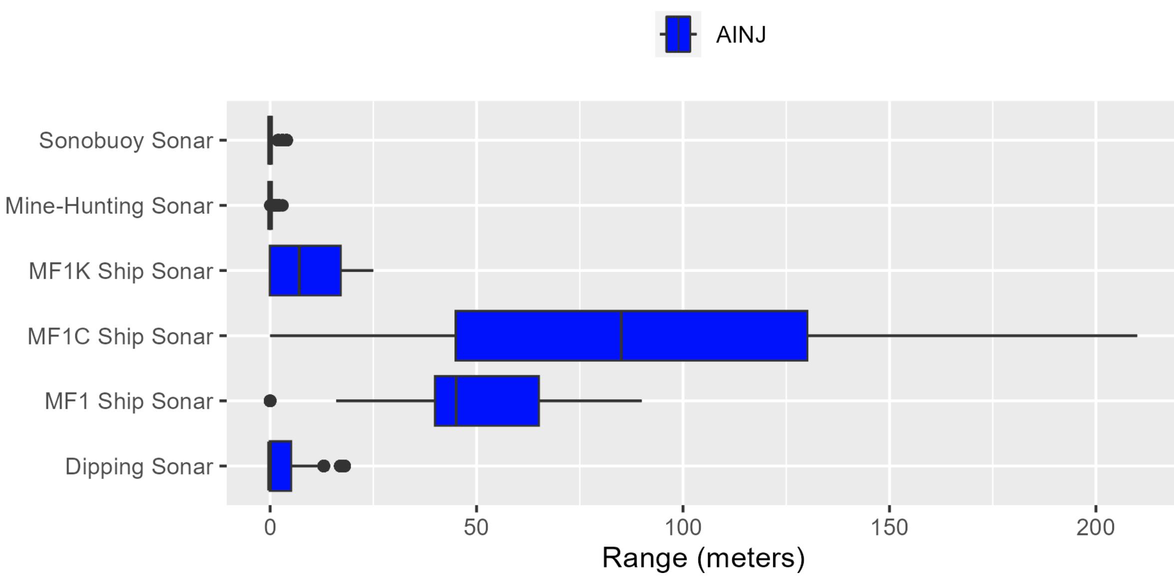

Figure 2-12: High Frequency Cetacean Ranges to Auditory Injury for Sonar

Table 2.5-4: Very High Frequency Cetacean Ranges to Effects for Sonar

Sonar Type	Water Depth	Duration	TTS	AINJ
Dipping Sonar	>200 m	1 s	85 m (47 m)	0 m (0 m)
		30 s	150 m (90 m)	0 m (1 m)
		60 s	230 m (122 m)	14 m (7 m)
		120 s	350 m (65 m)	24 m (12 m)
MF1 Ship Sonar	≤200 m	1 s	863 m (136 m)	150 m (3 m)
		30 s	863 m (136 m)	150 m (3 m)
		60 s	885 m (238 m)	220 m (8 m)
		120 s	894 m (254 m)	271 m (18 m)
	>200 m	1 s	1,785 m (400 m)	150 m (5 m)
		30 s	1,785 m (400 m)	150 m (5 m)
		60 s	4,451 m (830 m)	220 m (2 m)
		120 s	5,500 m (831 m)	270 m (2 m)
MF1C Ship Sonar	>200 m	1 s	1,778 m (407 m)	145 m (5 m)
		30 s	5,569 m (823 m)	270 m (2 m)
		60 s	8,028 m (1,355 m)	390 m (4 m)
		120 s	11,660 m (2,028 m)	550 m (7 m)
MF1K Ship Sonar	≤200 m	1 s	301 m (23 m)	20 m (0 m)
		30 s	478 m (68 m)	35 m (0 m)
		60 s	557 m (99 m)	50 m (1 m)
		120 s	673 m (140 m)	85 m (0 m)
	>200 m	1 s	300 m (2 m)	16 m (0 m)
		30 s	525 m (6 m)	35 m (0 m)
		60 s	675 m (14 m)	50 m (3 m)
		120 s	975 m (19 m)	85 m (2 m)
Mine-Hunting Sonar	≤200 m	1 s	115 m (2 m)	10 m (0 m)
		30 s	281 m (4 m)	19 m (0 m)
		60 s	450 m (3 m)	25 m (0 m)
		120 s	606 m (3 m)	40 m (0 m)
	>200 m	1 s	80 m (0 m)	7 m (0 m)
		30 s	140 m (0 m)	15 m (0 m)
		60 s	210 m (1 m)	22 m (0 m)
		120 s	300 m (5 m)	30 m (0 m)
Sonobuoy Sonar	>200 m	1 s	65 m (33 m)	0 m (2 m)
		30 s	110 m (61 m)	0 m (5 m)
		60 s	170 m (83 m)	10 m (7 m)
		120 s	280 m (50 m)	21 m (11 m)

Median ranges with standard deviation ranges in parentheses
TTS = Temporary Threshold Shift, AINJ = Auditory Injury
MF1 = hull-mounted surface ship sonar, MF1C = >80% duty cycle, MF1K = kingfisher mode
version.20250520

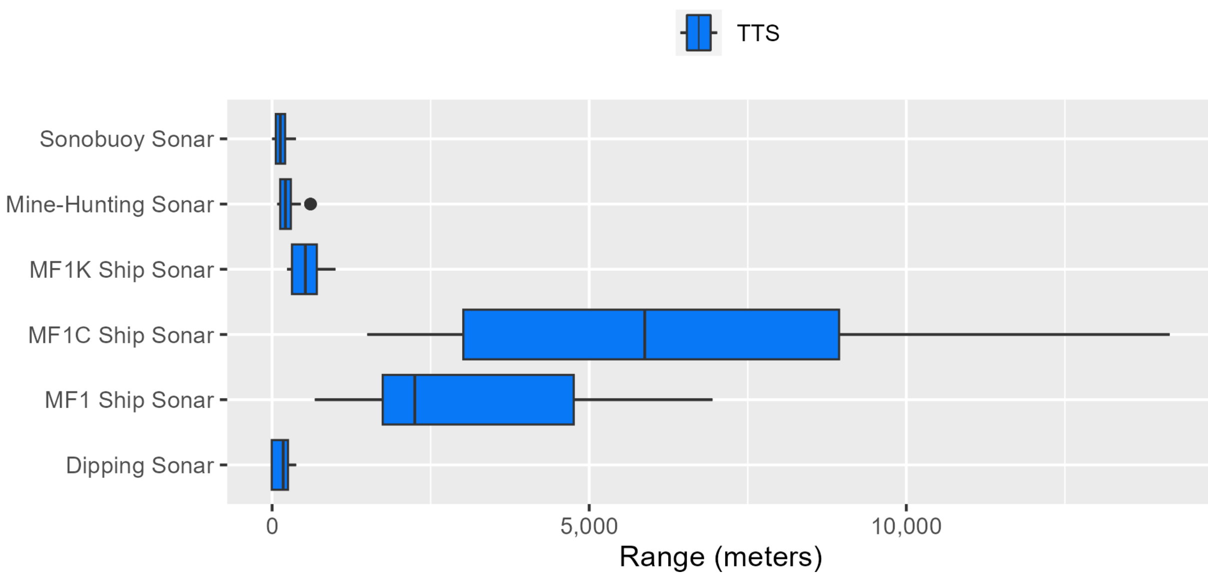

Figure 2-13: Very High Frequency Cetacean Ranges to Temporary Threshold Shift for Sonar

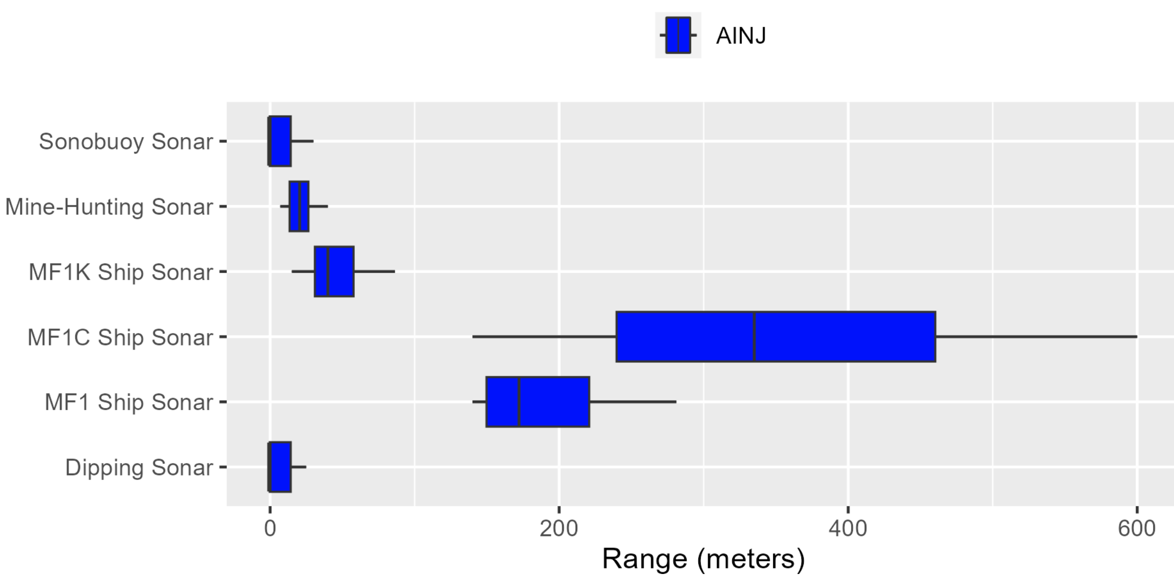

Figure 2-14: Very High Frequency Cetacean Ranges to Auditory Injury for Sonar

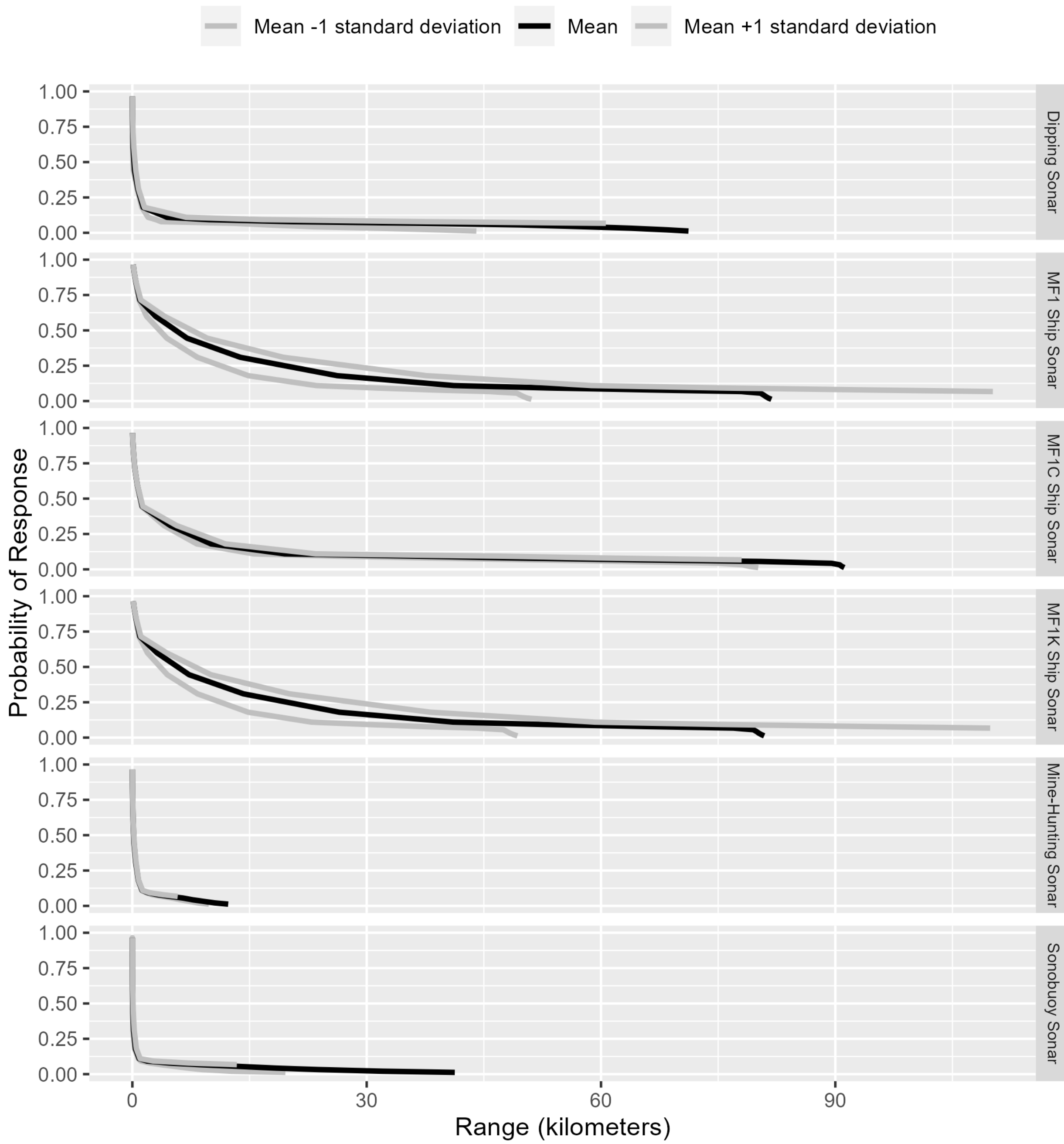

Figure 2-15: Probability of Behavioral Response to Sonar as a Function of Range for Odontocetes

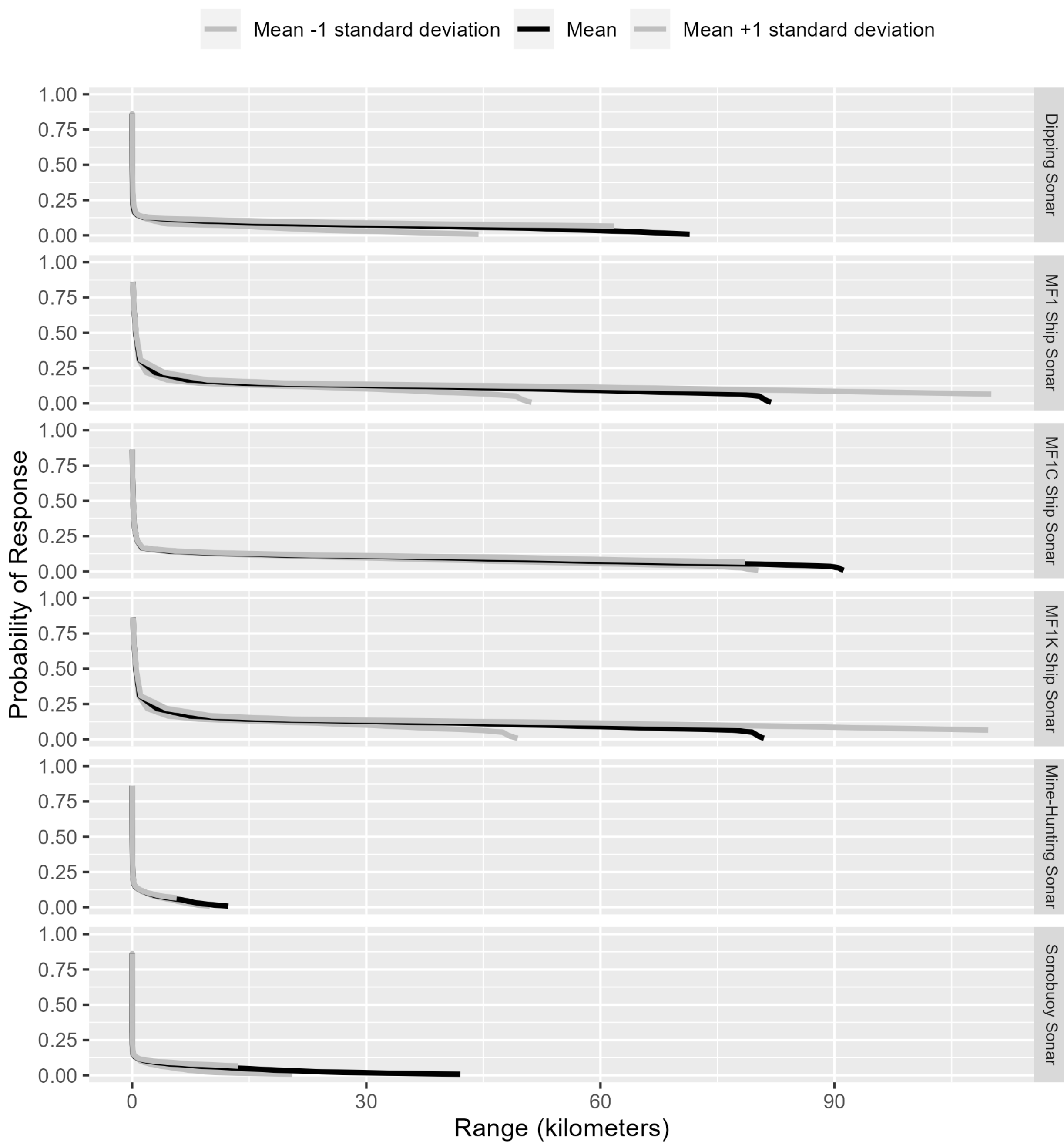

Figure 2-16: Probability of Behavioral Response to Sonar as a Function of Range for Mysticetes

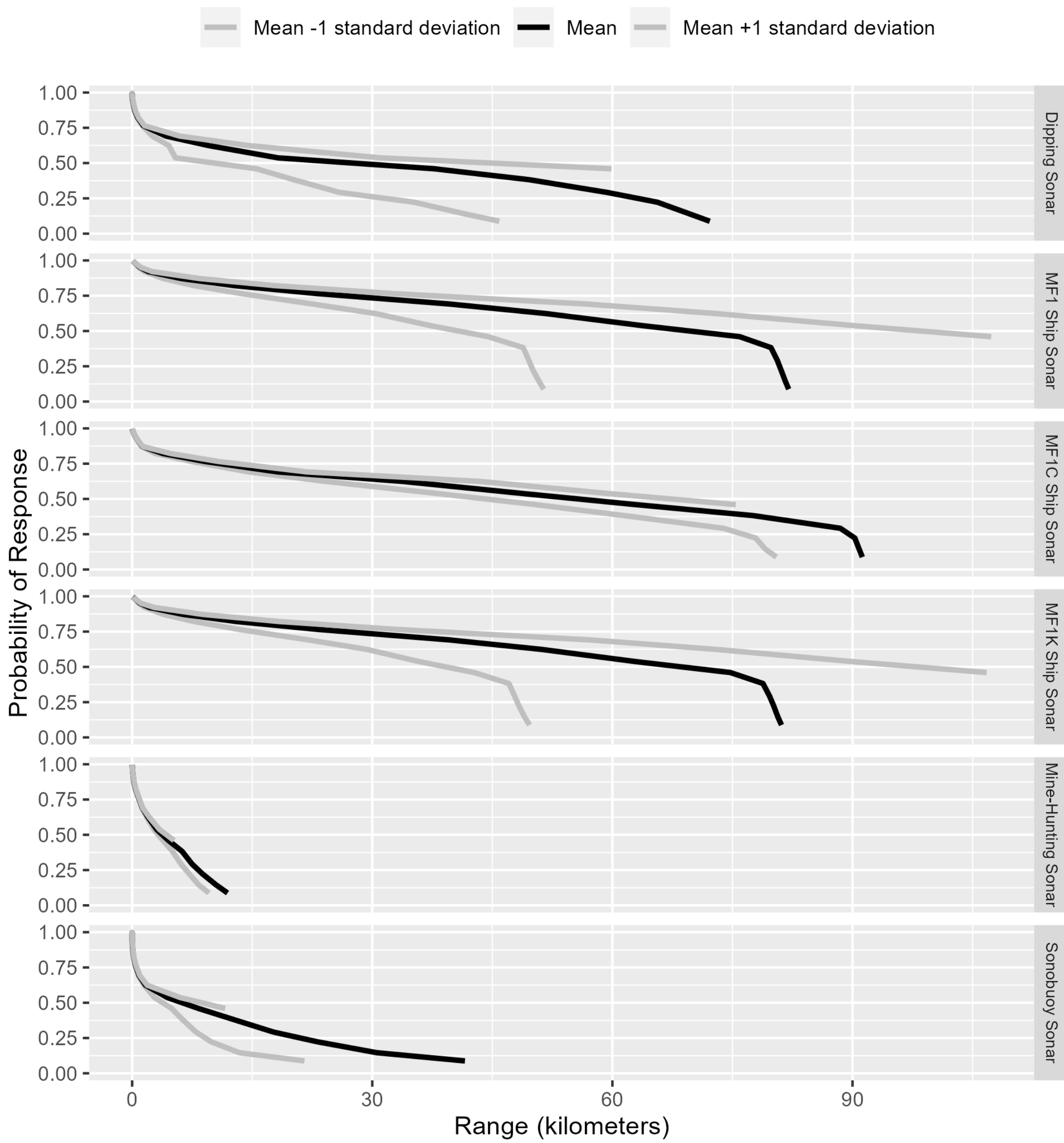

Figure 2-17: Probability of Behavioral Response to Sonar as a Function of Range for Sensitive Species

2.5.2 Range 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*.

Ranges to effect for the same size of explosive differ based on whether it is detonated at or just above the surface or at depth. NAEMO cannot account for the highly non-linear effects of cavitation and surface blow off for shallow underwater explosions, nor can it estimate the explosive energy entering the water from a low-altitude detonation. Thus, for this analysis, in-air sources detonating at or just above (within 10 m of) the surface are modeled as if detonating completely underwater at a source depth of 0.1 m, with all energy reflected into the water rather than released into the air. Therefore, the amount of explosive and acoustic energy entering the water, and consequently the estimated ranges to effects, are likely to be overestimated.

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 effect 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. 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.

Table 2.5-5: Very Low Frequency Cetacean Ranges to Effects for Explosives

Bin	Source Depth	Cluster Size	BEH	TTS	AINJ
E1	Near surface	1	NA	215 m (0 m)	100 m (0 m)
E2	Below surface	1	NA	420 m (1 m)	132 m (3 m)
E3	Near surface	1	NA	445 m (11 m)	222 m (2 m)
		7	1,000 m (306 m)	775 m (109 m)	250 m (8 m)
		15	1,000 m (251 m)	925 m (97 m)	340 m (11 m)
E4	Near surface	1	NA	526 m (3 m)	282 m (1 m)
	Below surface	1	NA	1,000 m (12 m)	282 m (1 m)
E5	Near surface	1	NA	601 m (24 m)	350 m (1 m)
		5	1,000 m (377 m)	925 m (134 m)	350 m (1 m)
	Below surface	1	NA	1,688 m (108 m)	351 m (1 m)
E6	Near surface	1	NA	740 m (119 m)	436 m (4 m)
	Below surface	1	NA	854 m (162 m)	438 m (6 m)
E7	Near surface	1	NA	2,669 m (233 m)	528 m (14 m)
	Below surface	1	NA	2,844 m (309 m)	523 m (15 m)
E8	Near surface	1	NA	1,098 m (76 m)	649 m (21 m)
E9	Near surface	1	NA	1,271 m (428 m)	763 m (30 m)
E10	Near surface	1	NA	1,125 m (186 m)	847 m (36 m)
E11	Below surface	1	NA	40,882 m (6,708 m)	1,861 m (65 m)
E12	Near surface	1	NA	1,625 m (340 m)	951 m (38 m)

Median ranges with standard deviation ranges in parentheses, TTS and AINJ = the greater of respective SPL and SEL ranges, behavioral response criteria are applied to explosive clusters >1
BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, NA = not applicable, near surface explosives occur at or just above the surface and are modeled at a depth of 0.1 meter
E1 (0.1 - 0.25 lbs), E2 (>0.25 - 0.5 lbs), E3 (>0.5 - 2.5 lbs), E4 (>2.5 - 5 lbs), E5 (>5 - 10 lbs), E6 (>10 - 20 lbs), E7 (>20 - 60 lbs), E8 (>60 - 100 lbs), E9 (>100 - 250 lbs), E10 (>250 - 500 lbs), E11 (>500 - 675 lbs), E12 (>675 - 1,000 lbs)
version.20250714

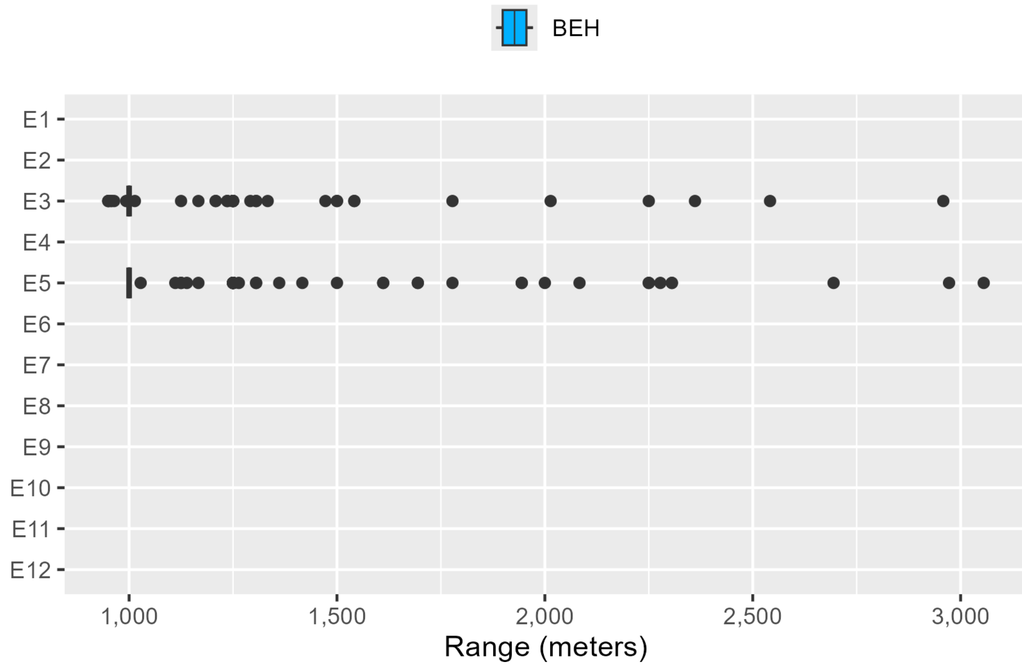

Figure 2-18: Very Low Frequency Cetacean Ranges to Behavioral Response for Explosives

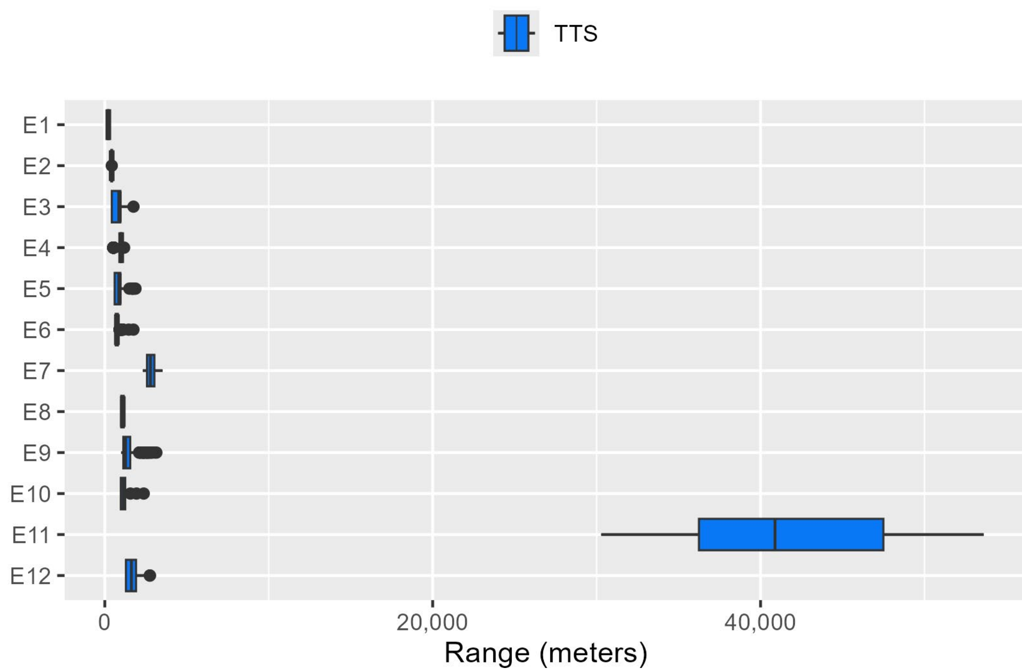

Figure 2-19: Very Low Frequency Cetacean Ranges to Temporary Threshold Shift for Explosives

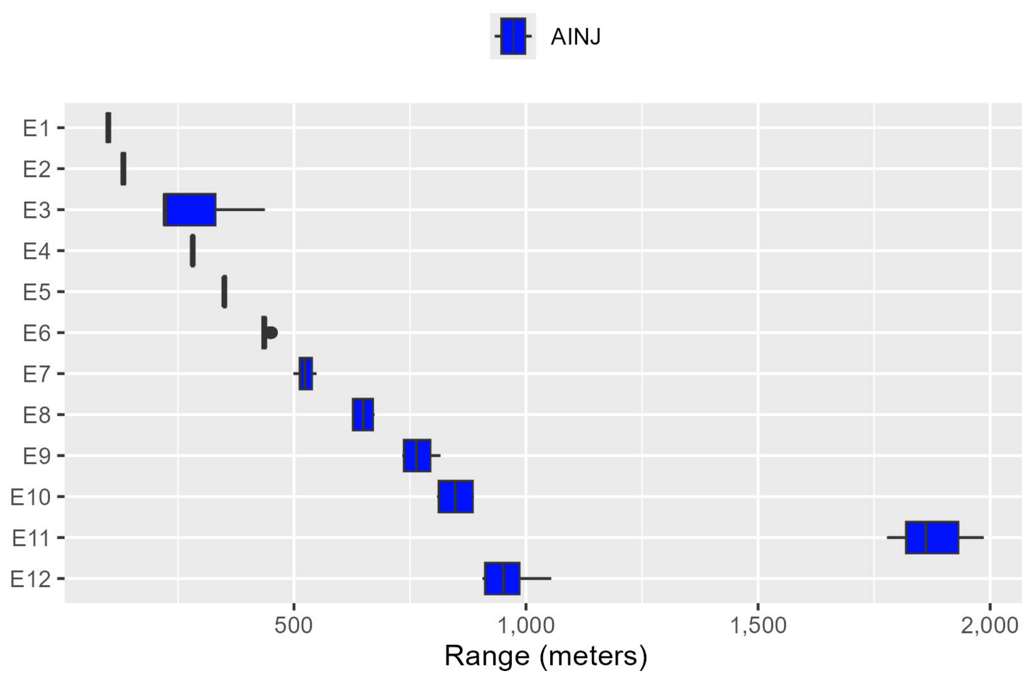

Figure 2-20: Very Low Frequency Cetacean Ranges to Auditory Injury for Explosives

Table 2.5-6: Low Frequency Cetacean Ranges to Effects for Explosives

Bin	Source Depth	Cluster Size	BEH	TTS	AINJ
E1	Near surface	1	NA	246 m (15 m)	100 m (8 m)
E2	Below surface	1	NA	437 m (7 m)	130 m (2 m)
E3	Near surface	1	NA	500 m (74 m)	166 m (17 m)
		7	1,000 m (375 m)	890 m (161 m)	270 m (23 m)
		15	1,250 m (391 m)	1,000 m (172 m)	380 m (47 m)
E4	Near surface	1	NA	509 m (8 m)	274 m (4 m)
	Below surface	1	NA	1,000 m (0 m)	275 m (3 m)
E5	Near surface	1	NA	700 m (114 m)	320 m (35 m)
		5	1,250 m (505 m)	1,000 m (224 m)	370 m (46 m)
	Below surface	1	NA	1,597 m (190 m)	330 m (0 m)
E6	Near surface	1	NA	819 m (195 m)	413 m (56 m)
	Below surface	1	NA	861 m (207 m)	414 m (58 m)
E7	Near surface	1	NA	2,419 m (296 m)	530 m (85 m)
	Below surface	1	NA	2,600 m (354 m)	520 m (83 m)
E8	Near surface	1	NA	1,083 m (117 m)	660 m (115 m)
E9	Near surface	1	NA	1,250 m (231 m)	782 m (143 m)
E10	Near surface	1	NA	1,250 m (162 m)	862 m (170 m)
E11	Below surface	1	NA	16,847 m (3,681 m)	1,660 m (70 m)
E12	Near surface	1	NA	1,708 m (283 m)	962 m (177 m)

Median ranges with standard deviation ranges in parentheses, TTS and AINJ = the greater of respective SPL and SEL ranges, behavioral response criteria are applied to explosive clusters >1
BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, NA = not applicable, near surface explosives occur at or just above the surface and are modeled at a depth of 0.1 meter
E1 (0.1 - 0.25 lbs), E2 (>0.25 - 0.5 lbs), E3 (>0.5 - 2.5 lbs), E4 (>2.5 - 5 lbs), E5 (>5 - 10 lbs), E6 (>10 - 20 lbs), E7 (>20 - 60 lbs), E8 (>60 - 100 lbs), E9 (>100 - 250 lbs), E10 (>250 - 500 lbs), E11 (>500 - 675 lbs), E12 (>675 - 1,000 lbs)
version.20250714

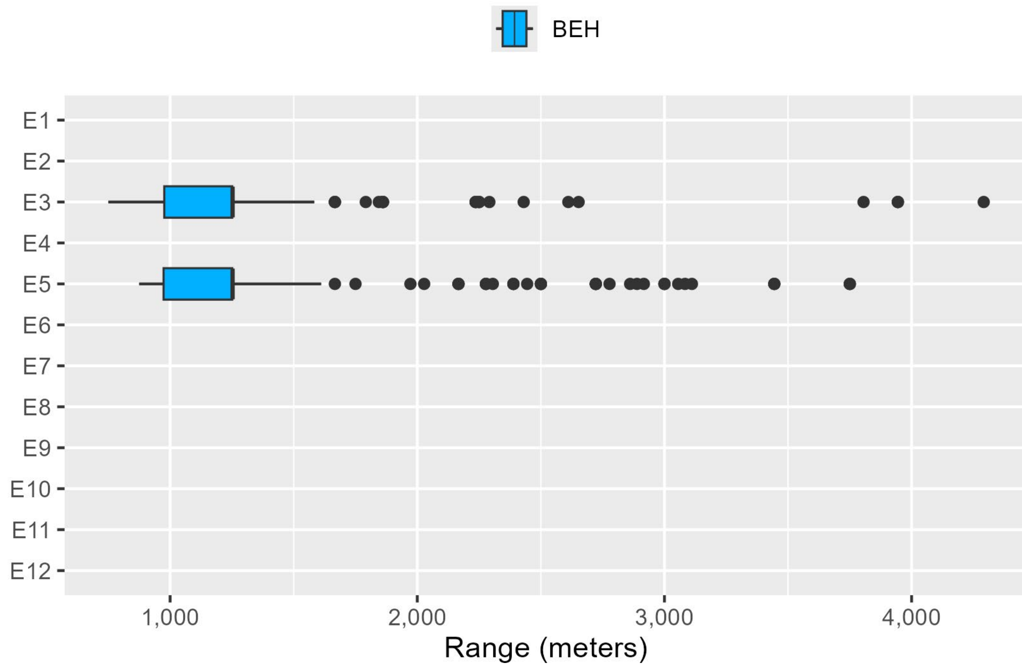

Figure 2-21: Low Frequency Cetacean Ranges to Behavioral Response for Explosives

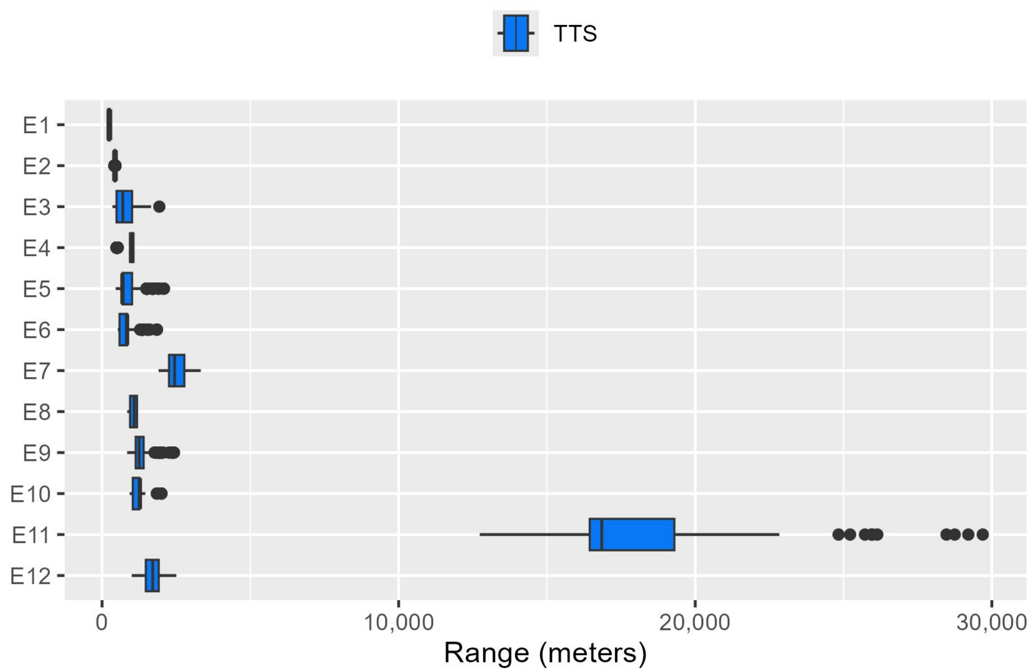

Figure 2-22: Low Frequency Cetacean Ranges to Temporary Threshold Shift for Explosives

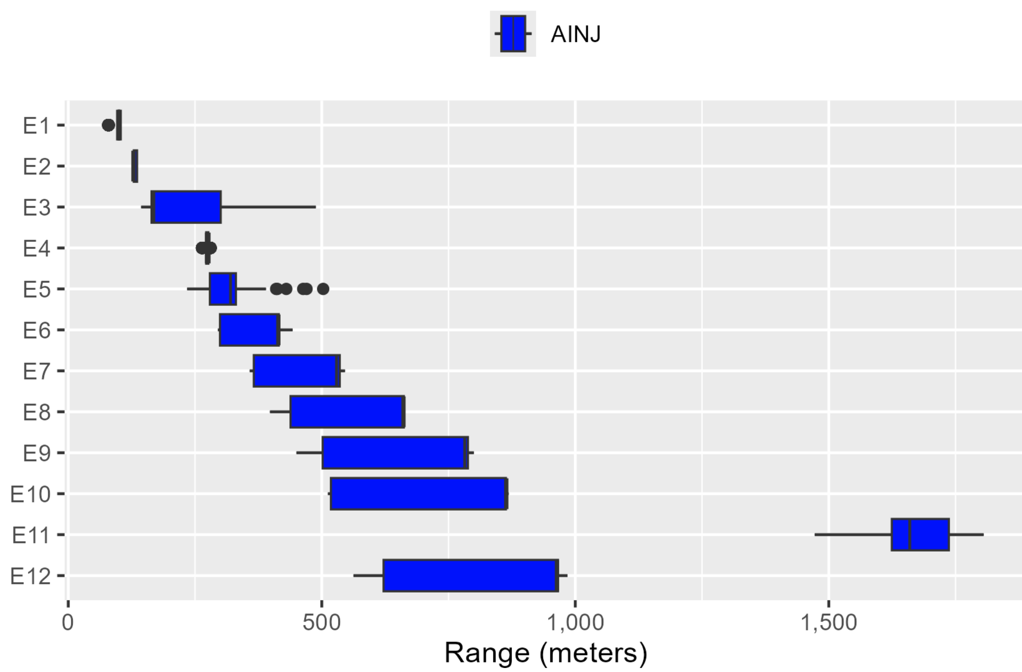

Figure 2-23: Low Frequency Cetacean Ranges to Auditory Injury for Explosives

Table 2.5-7: High Frequency Cetacean Ranges to Effects for Explosives

Bin	Source Depth	Cluster Size	BEH	TTS	AINJ
E1	Near surface	1	NA	92 m (28 m)	44 m (4 m)
E2	Below surface	1	NA	129 m (39 m)	58 m (2 m)
E3	Near surface	1	NA	180 m (56 m)	98 m (5 m)
		7	597 m (253 m)	380 m (145 m)	98 m (5 m)
		15	794 m (368 m)	518 m (203 m)	140 m (40 m)
E4	Near surface	1	NA	228 m (3 m)	120 m (1 m)
	Below surface	1	NA	250 m (72 m)	121 m (1 m)
E5	Near surface	1	NA	270 m (85 m)	150 m (12 m)
		5	824 m (356 m)	515 m (190 m)	150 m (12 m)
	Below surface	1	NA	363 m (100 m)	150 m (13 m)
E6	Near surface	1	NA	348 m (112 m)	176 m (13 m)
	Below surface	1	NA	341 m (114 m)	180 m (13 m)
E7	Near surface	1	NA	304 m (241 m)	157 m (107 m)
	Below surface	1	NA	303 m (228 m)	156 m (115 m)
E8	Near surface	1	NA	499 m (202 m)	279 m (39 m)
E9	Near surface	1	NA	637 m (278 m)	368 m (72 m)
E10	Near surface	1	NA	750 m (367 m)	434 m (109 m)
E11	Below surface	1	NA	1,653 m (871 m)	755 m (42 m)
E12	Near surface	1	NA	827 m (429 m)	537 m (150 m)

Median ranges with standard deviation ranges in parentheses, TTS and AINJ = the greater of respective SPL and SEL ranges, behavioral response criteria are applied to explosive clusters >1
BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, NA = not applicable, near surface explosives occur at or just above the surface and are modeled at a depth of 0.1 meter
E1 (0.1 - 0.25 lbs), E2 (>0.25 - 0.5 lbs), E3 (>0.5 - 2.5 lbs), E4 (>2.5 - 5 lbs), E5 (>5 - 10 lbs), E6 (>10 - 20 lbs), E7 (>20 - 60 lbs), E8 (>60 - 100 lbs), E9 (>100 - 250 lbs), E10 (>250 - 500 lbs), E11 (>500 - 675 lbs), E12 (>675 - 1,000 lbs)
version.20250714

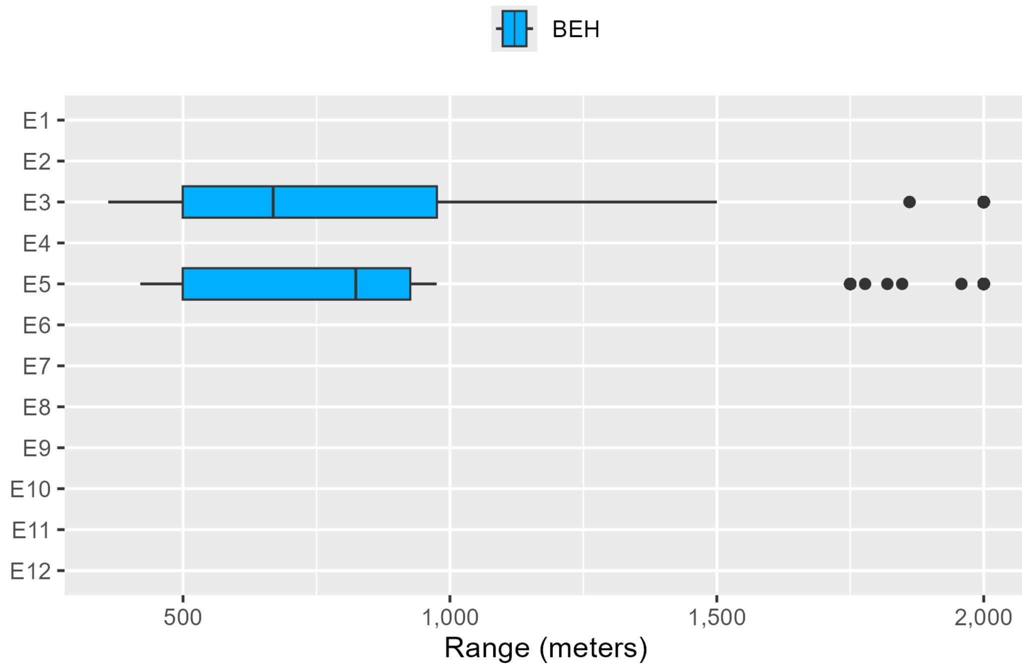

Figure 2-24: High Frequency Cetacean Ranges to Behavioral Response for Explosives

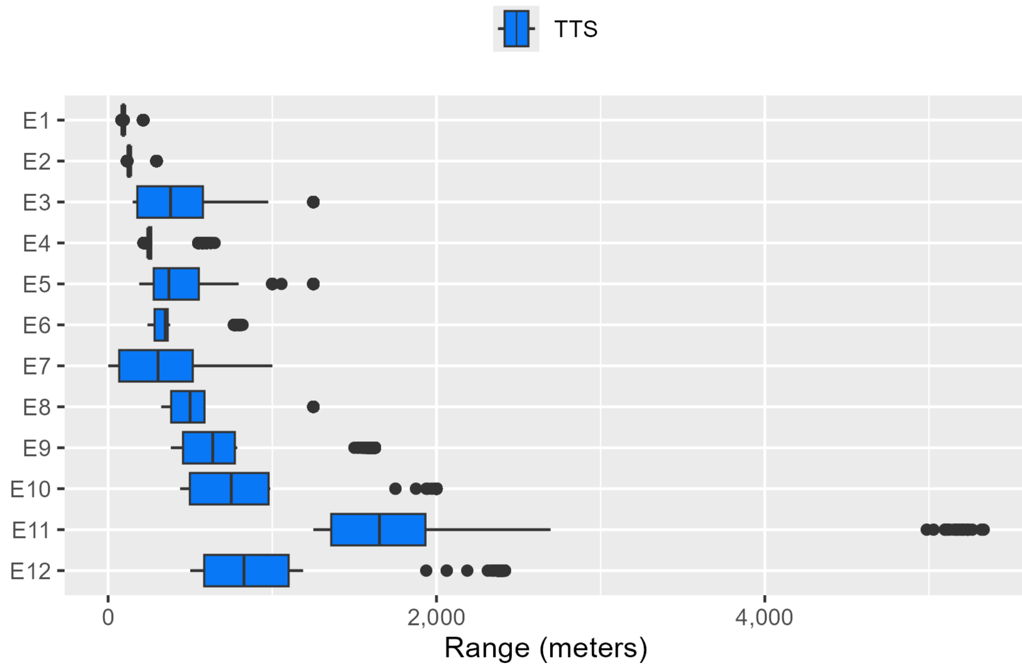

Figure 2-25: High Frequency Cetacean Ranges to Temporary Threshold Shift for Explosives

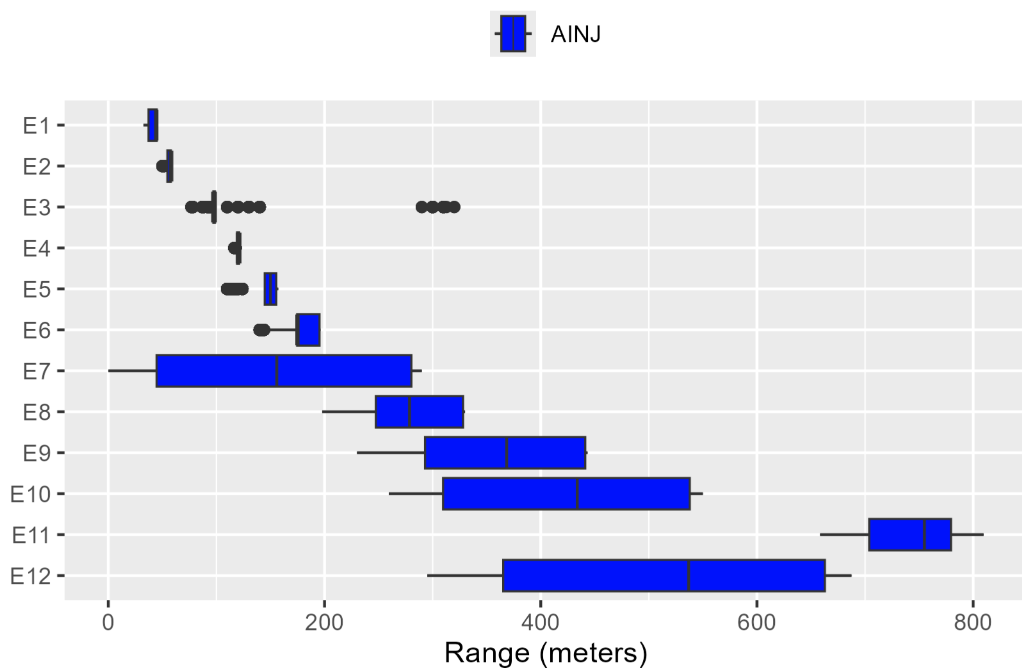

Figure 2-26: High Frequency Cetacean Ranges to Auditory Injury for Explosives

Table 2.5-8: Very High Frequency Cetacean Ranges to Effects for Explosives

Bin	Source Depth	Cluster Size	BEH	TTS	AINJ
E1	Near surface	1	NA	1,375 m (21 m)	697 m (2 m)
E2	Below surface	1	NA	3,076 m (268 m)	1,000 m (0 m)
E3	Near surface	1	NA	2,000 m (57 m)	1,250 m (0 m)
		7	5,764 m (2,284 m)	3,611 m (1,773 m)	1,500 m (123 m)
		15	6,889 m (1,601 m)	3,806 m (1,268 m)	1,750 m (33 m)
E4	Near surface	1	NA	3,714 m (248 m)	1,853 m (30 m)
	Below surface	1	NA	3,757 m (368 m)	1,875 m (20 m)
E5	Near surface	1	NA	2,250 m (241 m)	1,528 m (214 m)
		5	6,382 m (1,710 m)	3,681 m (1,179 m)	1,750 m (95 m)
	Below surface	1	NA	6,604 m (281 m)	1,514 m (16 m)
E6	Near surface	1	NA	2,944 m (396 m)	1,819 m (222 m)
	Below surface	1	NA	3,663 m (509 m)	2,108 m (333 m)
E7	Near surface	1	NA	5,236 m (290 m)	3,888 m (203 m)
	Below surface	1	NA	5,326 m (501 m)	4,056 m (297 m)
E8	Near surface	1	NA	4,264 m (297 m)	2,396 m (94 m)
E9	Near surface	1	NA	5,704 m (574 m)	2,611 m (234 m)
E10	Near surface	1	NA	6,444 m (587 m)	2,583 m (349 m)
E11	Below surface	1	NA	48,069 m (4,745 m)	18,590 m (2,562 m)
E12	Near surface	1	NA	8,035 m (917 m)	3,375 m (573 m)

Median ranges with standard deviation ranges in parentheses, TTS and AINJ = the greater of respective SPL and SEL ranges, behavioral response criteria are applied to explosive clusters >1
BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, NA = not applicable, near surface explosives occur at or just above the surface and are modeled at a depth of 0.1 meter
E1 (0.1 - 0.25 lbs), E2 (>0.25 - 0.5 lbs), E3 (>0.5 - 2.5 lbs), E4 (>2.5 - 5 lbs), E5 (>5 - 10 lbs), E6 (>10 - 20 lbs), E7 (>20 - 60 lbs), E8 (>60 - 100 lbs), E9 (>100 - 250 lbs), E10 (>250 - 500 lbs), E11 (>500 - 675 lbs), E12 (>675 - 1,000 lbs)
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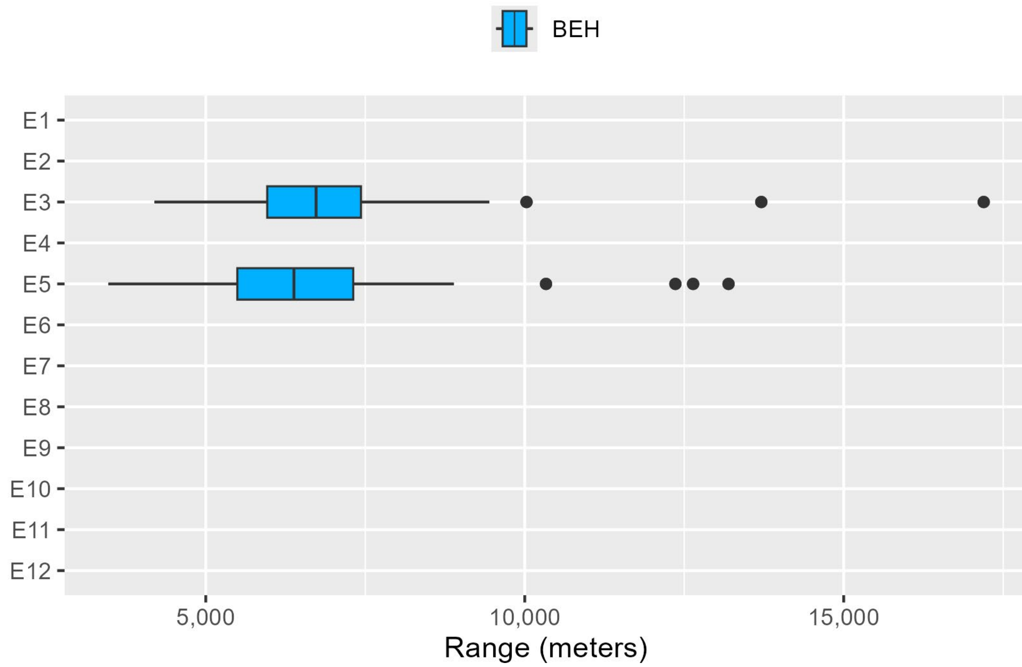

Figure 2-27: Very High Frequency Cetacean Ranges to Behavioral Response for Explosives

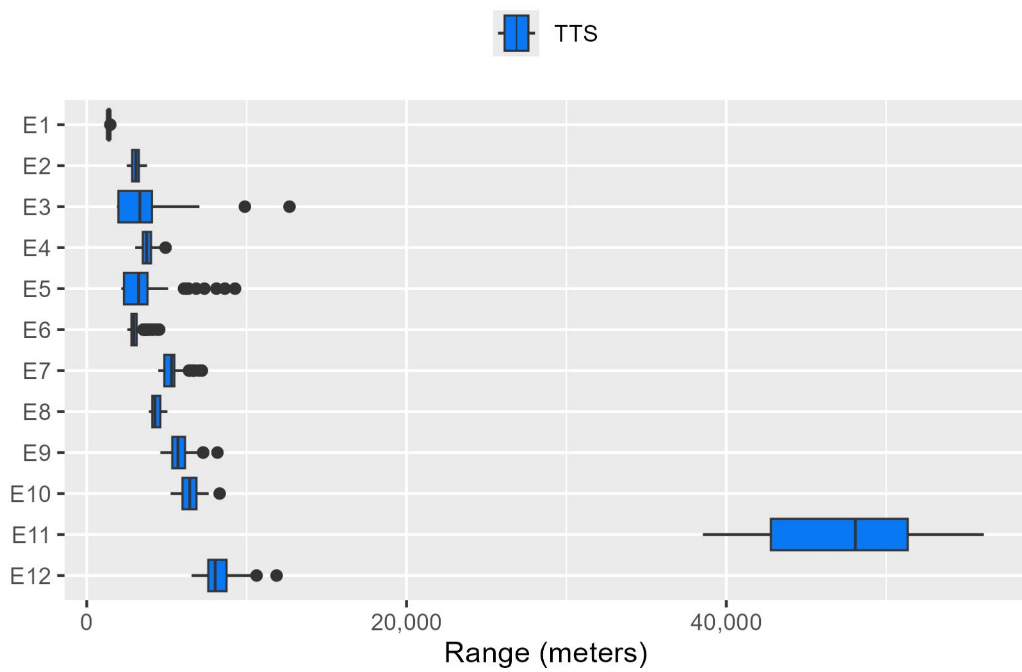

Figure 2-28: Very High Frequency Cetacean Ranges to Temporary Threshold Shift for Explosives

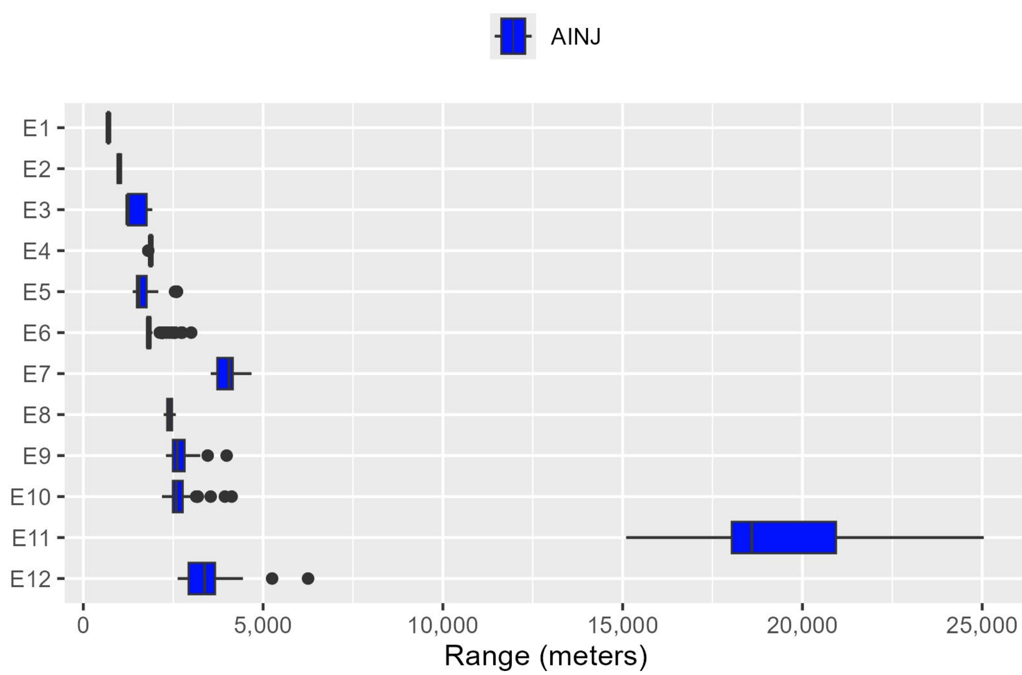

Figure 2-29: Very High Frequency Cetacean Ranges to Auditory Injury for Explosives

Table 2.5-9: Explosive Ranges to Injury and Mortality for All Marine Mammal Hearing Groups as a Function of Animal Mass

Bin	Effect	10 kg	250 kg	1,000 kg	5,000 kg	25,000 kg	72,000 kg
E1	INJ	22 m (0 m)	20 m (3 m)	20 m (3 m)	22 m (4 m)	22 m (2 m)	20 m (2 m)
	MORT	3 m (0 m)	1 m (1 m)	0 m (0 m)	0 m (0 m)	0 m (0 m)	0 m (0 m)
E2	INJ	28 m (0 m)	28 m (1 m)	25 m (1 m)	25 m (1 m)	25 m (1 m)	25 m (0 m)
	MORT	8 m (0 m)	3 m (2 m)	0 m (1 m)	0 m (0 m)	0 m (0 m)	0 m (0 m)
E3	INJ	48 m (0 m)	45 m (3 m)	45 m (2 m)	45 m (4 m)	48 m (2 m)	45 m (0 m)
	MORT	8 m (0 m)	3 m (2 m)	2 m (1 m)	1 m (0 m)	0 m (0 m)	0 m (0 m)
E4	INJ	60 m (2 m)	60 m (2 m)	60 m (1 m)	60 m (0 m)	60 m (2 m)	60 m (0 m)
	MORT	18 m (3 m)	8 m (4 m)	3 m (1 m)	0 m (0 m)	0 m (0 m)	0 m (0 m)
E5	INJ	78 m (1 m)	78 m (4 m)	78 m (3 m)	77 m (3 m)	78 m (4 m)	78 m (0 m)
	MORT	14 m (1 m)	6 m (3 m)	3 m (2 m)	2 m (1 m)	0 m (0 m)	0 m (0 m)
E6	INJ	96 m (4 m)	98 m (5 m)	98 m (6 m)	98 m (2 m)	98 m (8 m)	98 m (0 m)
	MORT	17 m (2 m)	8 m (3 m)	4 m (2 m)	2 m (1 m)	1 m (0 m)	0 m (0 m)
E7	INJ	27 m (14 m)	31 m (41 m)	45 m (51 m)	31 m (43 m)	29 m (47 m)	29 m (15 m)
	MORT	5 m (3 m)	3 m (2 m)	1 m (1 m)	1 m (1 m)	0 m (0 m)	0 m (0 m)
E8	INJ	151 m (14 m)	156 m (11 m)	156 m (15 m)	165 m (4 m)	140 m (12 m)	165 m (1 m)
	MORT	28 m (0 m)	15 m (5 m)	8 m (1 m)	5 m (2 m)	3 m (1 m)	1 m (1 m)
E9	INJ	190 m (15 m)	190 m (16 m)	191 m (25 m)	225 m (10 m)	171 m (13 m)	225 m (0 m)
	MORT	57 m (8 m)	21 m (10 m)	12 m (1 m)	8 m (2 m)	4 m (1 m)	2 m (1 m)
E10	INJ	225 m (21 m)	230 m (25 m)	240 m (29 m)	275 m (21 m)	240 m (25 m)	282 m (3 m)
	MORT	48 m (1 m)	25 m (6 m)	14 m (1 m)	10 m (2 m)	5 m (1 m)	3 m (0 m)
E11	INJ	624 m (19 m)	345 m (17 m)	337 m (16 m)	349 m (20 m)	351 m (15 m)	335 m (16 m)
	MORT	306 m (7 m)	166 m (41 m)	92 m (6 m)	65 m (5 m)	35 m (2 m)	26 m (4 m)
E12	INJ	255 m (21 m)	305 m (41 m)	321 m (37 m)	345 m (39 m)	320 m (33 m)	353 m (1 m)
	MORT	67 m (25 m)	38 m (17 m)	18 m (1 m)	12 m (1 m)	7 m (1 m)	5 m (0 m)

Median ranges with standard deviation ranges in parentheses, INJ = the greater of respective ranges for 1% chance of gastro-intestinal tract injury and 1% chance of injury, MORT = mortality
E1 (0.1 - 0.25 lbs), E2 (>0.25 - 0.5 lbs), E3 (>0.5 - 2.5 lbs), E4 (>2.5 - 5 lbs), E5 (>5 - 10 lbs), E6 (>10 - 20 lbs), E7 (>20 - 60 lbs), E8 (>60 - 100 lbs), E9 (>100 - 250 lbs), E10 (>250 - 500 lbs), E11 (>500 - 675 lbs), E12 (>675 - 1,000 lbs)
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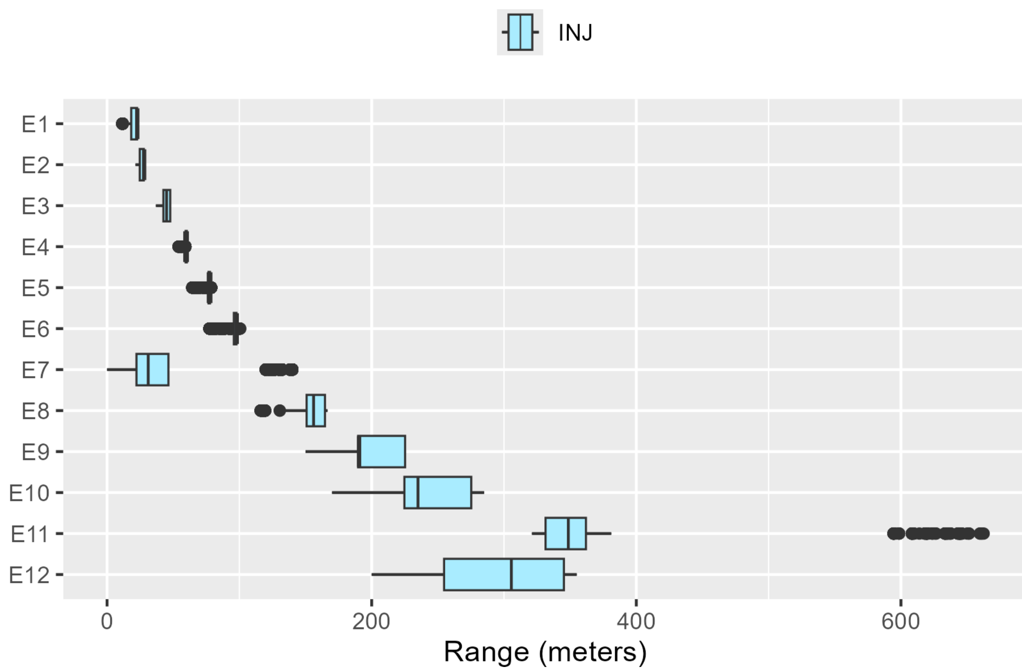


Figure 2-30: Explosive Ranges to Injury for All Marine Mammal Hearing Groups

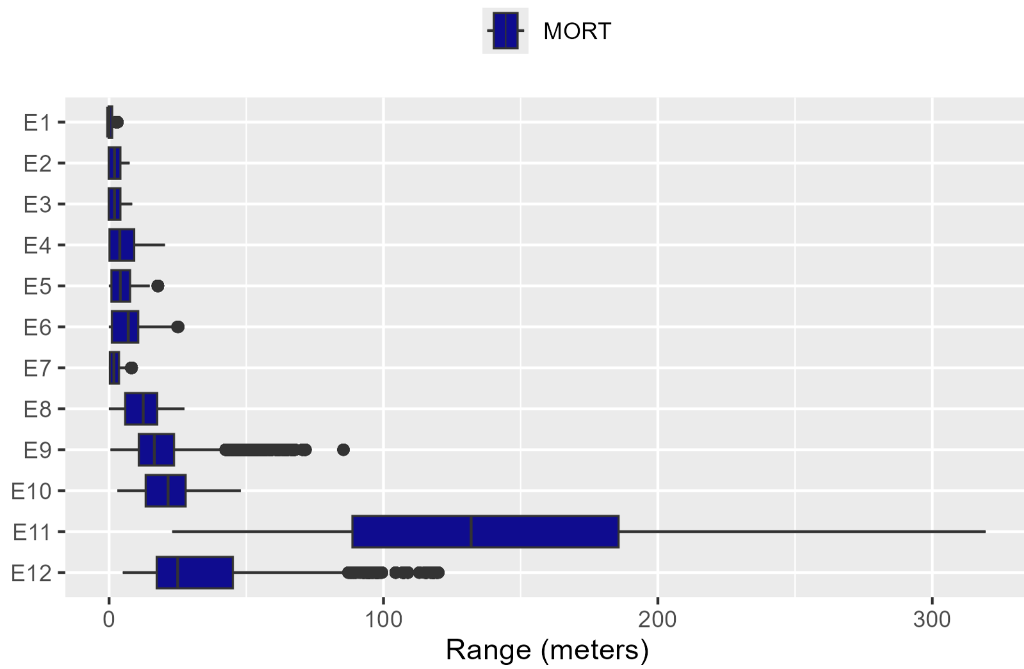


Figure 2-31: Explosive Ranges to Mortality for All Marine Mammal Hearing Groups

3 EFFECTS ON SEA TURTLES FROM ACOUSTIC AND EXPLOSIVE STRESSORS

This analysis is presented as follows:

- The effects that would be expected due to each type of acoustic stressor and explosives used in the Proposed Action are described in Section 3.1 (Effects Due to Each Acoustic Substressor and Explosives)
- The approach to modeling and quantifying effects is summarized in Section 3.2 (Quantifying Effects on Sea Turtles from Acoustic and Explosive Stressors).
- Effects on ESA-listed species in the Study Area, including predicted instances of harm or harassment, are presented in Section 3.3 (ESA-Listed Species Assessments).
- Ranges to effects for each modeled sub-stressor are shown in Section 3.4 (Ranges to Effects).

3.1 Effects Due to Each Acoustic Substressor and Explosives

Assessing whether a sound may disturb or injure a sea turtle involves understanding the characteristics of the acoustic sources, the sea turtles that may be present in the vicinity of the sources, and the effects that sound may have on the physiology and behavior of sea turtles. 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 *Sea Turtle Acoustic Background TR* summarizes what is currently known about acoustic effects on sea turtles. 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.

3.1.1 Effects from Sonars and Other Transducers

The most probable effects from exposure to sonar are TTS, 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 *Sea Turtle Acoustic Background* section. Non-auditory injury and mortality from sonar are not possible under realistic exposure conditions.

Hearing loss: Sea turtles 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). Any effect on hearing can reduce the distance over which a sea turtle detects environmental cues, such as the sound of waves, or the presence of a vessel or predator. Effects from sonars on sea turtles within the Study Area would be limited to systems operating below 2 kHz, primarily from low-frequency sonars but could also include some broadband and lower mid-frequency sources (less than 2 kHz). These systems could be used throughout the MITT Study Area but are typically operated offshore. Although the use of low-frequency sonars has increased since the prior analysis (U.S. Department of the Navy, 2020), they are still used less than higher-frequency sources across the Study Area, resulting in a low overall risk of exposure.

Masking: Although masking of biologically relevant sounds by the limited number of sonars operated in sea turtle hearing range is possible, this may only occur in certain circumstances. Sea turtles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. Sea turtles 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 sea turtle to detect these sources and the potential for masking of broadband, continuous environmental sounds.

Behavioral and physiological (stress) response: A sea turtle 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.

Because sonars may result in the incidental take of sea turtles (auditory effects and significant behavioral responses), sonar effects are modeled per the methods presented in Section 3.2 (Quantifying Effects on Sea Turtles from Acoustic and Explosive Stressors). Effects on sea turtles are discussed and quantified below in Section 3.3 (ESA-Listed Species Assessments).

3.1.2 Effects from Vessel Noise

Based on best available science summarized in the *Sea Turtle Acoustic Background* section, potential effects on sea turtles include masking, behavioral reactions, and physiological response. Vessel source levels are below the sound levels that would cause hearing loss or AINJ. Furthermore, vessels are transient and would result in brief periods of exposure.

Masking: 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 sea turtle hearing is most sensitive. Smaller vessels emit more energy in higher frequencies, much of which would not be detectable by sea turtles. Existing high ambient noise levels in ports and harbors with non-military vessel traffic, as well as 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.

Behavioral and physiological (stress) response: In response to vessel noise, sea turtles would typically exhibit 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 effects would be insignificant and not rise to the level of measurable effects. 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).

Exposure to vessel noise could result in short-term behavioral reactions, physiological response, masking, or no response (see the *Sea Turtle Acoustic Background* section). Effects from vessel noise would be temporary and localized, and such responses would not be expected to compromise the general health or condition of individual sea turtles. Therefore, long-term consequences for populations are not expected.

3.1.3 Effects from Aircraft Noise

Aircraft noise is within the hearing range of sea turtles, and activities that produce aircraft noise can occur in areas potentially inhabited by sea turtles. In most cases, exposure of a sea turtle to fixed-wing aircraft presence and noise would be brief as the aircraft quickly passes overhead. Animals would have to be at or just above 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.

Masking: Most overflight exposures are short duration which would limit any potential for masking of relevant sounds, and sea turtles may dive or move to a different area to reduce potential masking effects (see the *Sea Turtle Acoustic Background* section).

Behavioral and physiological (stress) response: 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 sea turtle 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, effects from military readiness activities would be highly localized and concentrated in space and duration.

Sea turtles 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 sea turtles were to respond to aircraft noise, only short-term behavioral or physiological response would be expected. Therefore, effects on individuals would be unlikely and long-term consequences for populations are not expected.

3.1.4 Effects from Weapons Noise

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 sea turtles. 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.

Masking: 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 sea turtles in the area over the short duration of the event.

Behavioral and physiological (stress) response: It is expected that weapons noise 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 sea turtle behavioral responses would cease following the exposure event, and the risk of a corresponding sustained stress response would be low. These activities would not typically occur in nearshore habitats where sea turtles may use their limited hearing to sense broadband, coastal sounds. Behavioral reactions, startle reactions, and physiological responses 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 sea turtles.

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 just above the water surface may expose sea turtles 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 sea turtles to these specific stressors have not been recorded; however, sea turtles 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 individuals or species.

3.1.5 Effects from Explosives

Sea turtles 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 activities involving in-water (including at or near the surface) explosions associated with naval gunfire, missiles, bombs, and other munitions are conducted more than 3 NM from shore. Sinking Exercises, Surface-to-Surface Missile Exercises, and Air-to-Surface Bombing 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 the *Activity Descriptions* section of the MITT SEIS/OEIS. This includes certain Mine Warfare activities conducted within Outer Apra Harbor, and at the Piti and Agat Floating Mine Neutralization Sites. Bombing Exercises and some Gunnery and Missile Exercises can occur closer to shore at FDM, and misses and ricochets may cause in-water explosions in nearshore waters surrounding FDM.

Explosions produce loud, impulsive, broadband sounds. Potential effects from exposures to explosives are discussed in the *Sea Turtle Acoustic Background* section and include masking, behavioral reactions, hearing loss, AINJ, non-auditory injury, and mortality. Estimated behavioral reactions, auditory effects, non-auditory effects, and mortality were modeled. Effects 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. Effect ranges for sea turtles exposed to explosive sound and energy are shown in Section 3.4.2 (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 sea turtle is sighted within or entering a mitigation zone to avoid or reduce potential explosive effects. 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.

<u>Direct injury and mortality:</u> Non-auditory injury may result in long-term consequences to some individuals, however, no population-level effect is expected due to the low number of potential injuries and mortalities for any sea turtle species relative to total population size.

<u>Hearing loss:</u> 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 sea turtle's hearing range, reducing the distance over which relevant sounds may be detected for the duration of the threshold shift.

Masking: 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.

Behavioral and physiological (stress) response: A sea turtle'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 *Sea Turtle 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.

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 effect 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).

Because explosives may result in the incidental take of sea turtles (auditory effects and significant behavioral responses), sonar effects are modeled per the methods presented in Section 3.2 (Quantifying Effects on Sea Turtles from Acoustic and Explosive Stressors). Effects on sea turtles are discussed and quantified below in Section 3.3 (ESA-Listed Species Assessments).

3.2 Quantifying Effects on Sea Turtles from Acoustic and Explosive Stressors

The following section provides an overview of key components of the modeling methods used to quantify effects 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.

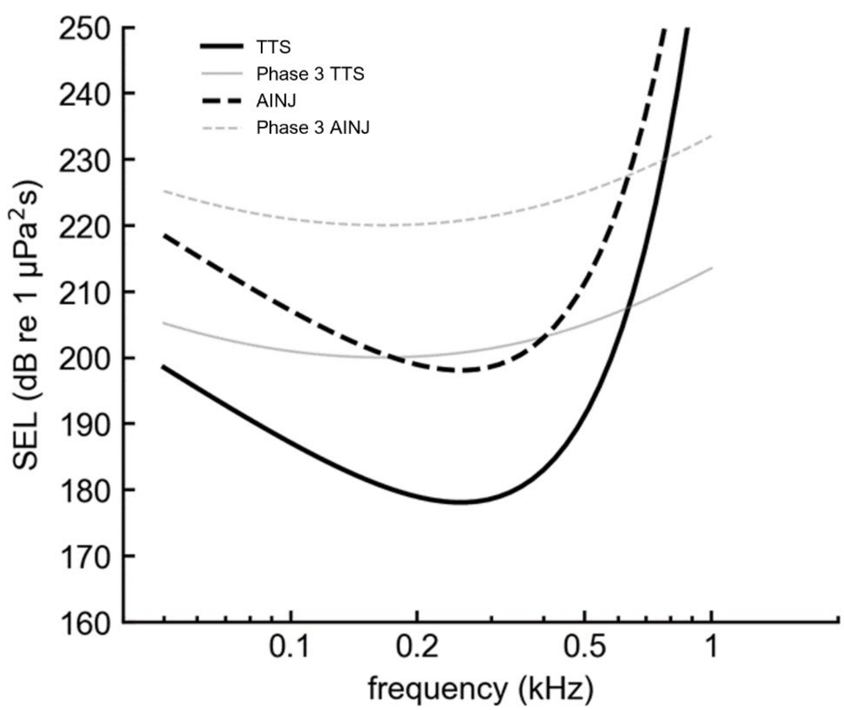
- The modeling methods used to quantify effects are described in detail in the *Quantitative Analysis TR*. Effects due to sonar and explosives were quantified using NAEMO.
- The development of criteria and thresholds used to predict effects is shown in the *Criteria and Thresholds TR.*
- The spatial 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 prior analysis to the updated estimates used for the current 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 TR*. There are no substantive changes from the prior analysis.

3.2.1 Quantifying Effects on Hearing

The auditory criteria and thresholds used in this analysis have been updated since the prior assessment of effects 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 3-1.



Note: TTS = temporary threshold, AINJ = auditory injury.

Figure 3-1: Sea Turtle Exposure Function for Non-Impulsive TTS and AINJ

Estimated auditory effects 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 effect 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 III and Phase IV TTS and AINJ Onset Levels for Sonar (Non-Impulsive) and Explosive (Impulsive) Sound Sources in Sea Turtles

	Phase III		Phase IV	
	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 3-1).

3.2.2 Quantifying Behavioral Effects

The behavioral thresholds for sonars are the same as the prior assessment of effects due to military readiness activities in the Study Area and are 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

3.2.3 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 effects on 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 effects. The onset (i.e., 1%) thresholds will be used to calculate effects 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: M is animal mass (kg), and D is animal depth (m).

3.3 ESA-Listed Species Assessments

The following sections analyze effects on sea turtles under the Proposed Action and show model-predicted estimates of take for sea turtles. The methods used to quantify effects for each substressor are described in this document above in Section 3.1 (Effects Due to Each Acoustic Substressor and Explosives). The methods used to assess significance of individual effects and risks to sea turtles are described above in Section 3.2 (Quantifying Effects on Sea Turtles from Acoustic and Explosive Stressors). For each sea turtle species, a multi-sectioned table quantifies effects as follows:

Section 1

The first section shows the number of instances of each effect type that could occur due to each substressor (sonar or explosives) over a maximum year of activity. Effects are shown by type of activities (training 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 NAEMO and are not further reduced to account for activity-based mitigation that would reduce effects near some sound sources and explosives as described in the *Mitigation* section.

Instances of effect are calculated within 24-hour periods of each individually modeled event. Effects 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 effect or injury is 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 effects are based on multiplying the average expected effects at a location by the number of times that activity is expected to occur. This is a reasonable method to estimate effects for activities that occur every year and multiple times per year.

The summation of instances of effect includes all fractional values caused by averaging multiple modeled iterations of individual events. Effects 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 effects is greater than true zero but less than 0.5. A dash (-) indicates that no effects 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. A one in parentheses (1) indicates that predicted effects round to zero in a maximum year of activity, but a single effect is predicted over seven years when summing the fractional risks across years.

The summation of effects across seven years is shown in Section 3.3.6 (Effects Summary Tables). The seven-year sum for Alternative 1 accounts for any variation in the annual levels of activities. The seven-year sum includes any fractional effect values predicted in any year, which is then rounded following standard rounding rules. That is, the seven-year effects are not the result of summing the rounded annual effects. If a seven-year sum was larger than the annual effects multiplied by seven, the annual maximum effects were increased by dividing the seven-year sum of effects by seven then rounding up to the nearest integer. For example, this could happen if maximum annual effects are 1.34 (rounds to 1 annually) and seven-year effects 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 effects 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 effects predicted by NAEMO.

Section Two

The second section shows the percent of total effects that would occur within seasons (cold and warm) and general geographic areas (MIRC and the Transit Corridor).

Section Three

The third section shows which activities are most impactful, and activities that cause five percent or more of total effects on a species are shown.

3.3.1 Green Sea Turtle (*Chelonia mydas*) - Endangered

Results from NAEMO do not estimate green sea turtle exposures in the Study Area at the DPS level. While most green sea turtles in the Study Area are believed to be from the Central West Pacific DPS (ESA-listed as endangered), the Study Area has minimal overlap with the East Indian-West Pacific DPS (ESA-listed as threatened) and the Central North Pacific DPS (ESA-listed as threatened). There is no critical habitat designated for the green sea turtle in the Study Area, but critical habitat has been proposed by NMFS (88 FR 46376, July 19, 2023). Model-predicted effects are presented in the tables below.

Hatchling and post-hatchling green sea turtles occur in offshore open ocean areas where they forage and develop in floating algal mats. Juvenile green sea turtles leave the open-ocean habitat and retreat to protected lagoons and open coastal areas that are rich in seagrass or marine algae, where they spend most of their lives. Green sea turtles likely to occur in the Study Area come from the Central West Pacific DPS. However, it should be noted that minimal mixing (gene flow) may occur with other distinct population segments, particularly the East Indian – West Pacific DPS and the Central North Pacific DPS (Seminoff et al., 2015). Green sea turtles nest on beaches within the Study Area, and feed throughout the Study Area.

Green sea turtles may be exposed to sonar, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the effects from vessel noise, aircraft noise, and weapons noise on green turtles relies on the information under the respective acoustic substressor in Section 3.1 (Effects Due to Each Acoustic Substressor and Explosives). While the abundance of green turtles is not known, Martin and Jones (2016) calculated a population growth rate of approximately 90 percent from 1962 through 2012. Based on studies of in-water capture rates, Martin and Jones (2016) estimated that 85 percent of the sea turtles in waters off of Guam are green sea turtles.

Results from NAEMO in the table below show that green sea turtles in the Study Area may exhibit behavioral reactions, TTS, AINJ, and non-auditory injury from explosives over the course of a year. No effects on green sea turtles were estimated to occur from sonar and is likely due to the limited usage of low-frequency and broadband sonar sources that are within the hearing range of sea turtles (i.e., < 2 kHz). Compared to the 2020 analysis, estimated green sea turtle behavioral effects decreased due to changes for Maritime Security Operations, and Gunnery Exercise Surface-to-Surface Ship Large Caliber activities. Maritime Security Operations no longer occur in Outer Apra Harbor, where estimated green sea turtle densities are the highest, and now occur in offshore locations where green sea turtle densities are very low. Gunnery Exercise Surface-to-Surface Ship Large Caliber activities still occur in offshore locations; however, usage decreased in the current analysis.

For green sea turtles, the largest contributor of effects from explosives are due to Underwater Demolition Qualification and Certification for training activities and Mine Countermeasure and Neutralization for testing activities, with more effects during the warm season for both activities. No effects on green sea turtles are estimated to occur within proposed critical habitat.

Estimated behavioral and TTS effects from 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 effects. Estimated AINJ from 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 injury may affect populations 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 injury from explosives are not expected to affect the fitness of enough individuals to cause population level effects.

Critical Habitat

Green turtle critical habitat proposed by NMFS includes nearshore reproductive habitat and benthic foraging habitat in waters off Guam, Rota, Aguijan, Tinian, Saipan, Sarigan, Alamagan, Pagan, and Agrihan. Critical habitat proposed by USFWS includes nesting beaches on Guam, Rota, Tinian, Saipan, Pagan, and Agrihan.

The use of sonar and explosives, and activities that produce vessel, aircraft, and weapons noise overlap with and have a pathway to affect the physical and biological features of the reproductive and benthic foraging/resting proposed critical habitat from the mean high-water line to 20 m depth. Any potential effects are likely to be minimized because activities that use acoustic and explosive stressors are typically transient, most sonar sources are outside of sea turtle hearing range which is most sensitive from 100–400 Hz and limited over 1 kHz, and most explosions occur in offshore waters that are beyond the 20 m depth boundary.

The physical and biological features of green sea turtle reproductive areas from the mean high-water line to 20 m depth are sufficiently dark and unobstructed nearshore waters which are adjacent to nesting beaches proposed as critical habitat by USFWS to allow for the transit, mating, and internesting of reproductive individuals and the transit of post-hatchlings. Acoustic and explosive stressors used in reproductive areas may introduce obstructions and disturbances that can potentially interrupt, delay, or prevent mating, the movement of reproductive female green sea turtles on and off nesting beaches, internesting, and the swim frenzy and early dispersal of post-hatchings from nesting beaches. Potential effects from acoustic and explosive stressors are expected to be temporary, localized, and infrequent and are not expected to have meaningful effects on the conservation value of reproductive areas in proposed critical habitat for green sea turtles.

The physical and biological features of benthic foraging/resting areas 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 use of explosives could potentially injure or kill individuals of invertebrate prey species. Potential effects from explosive stressors would be temporary, localized, and infrequent and are not expected to have meaningful effects on the conservation value of benthic foraging/resting areas in proposed critical habitat for green sea turtles. Acoustic stressors are not expected to affect prey condition, distribution, diversity, abundance, or density.

Table 3.3-1: Estimated Effects on Green Sea Turtles Over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Testing	-	0	-	-	-
Explosive	Training	(1)	41	4	(1)	-
Maximum Annual Total		**1**	**41**	**4**	**1**	**-**

Season	Percent of Total Effects MIRC
Warm	79%
Cold	21%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Underwater Demolition Qualification and Certification	Training	73%
Mine Neutralization Explosive Ordnance Disposal	Training	26%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 3.3.
See beginning of Section 3.3 for full explanation of table sections.
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3.3.2 Hawksbill Sea Turtle (*Eretmochelys imbricata*) - Endangered

Hawksbill sea turtles are ESA-listed as endangered throughout their range with no designated DPSs. There is no critical habitat designated for the hawksbill sea turtle in the Study Area. Model-predicted effects are presented in the table below.

The hawksbill sea turtle is the most tropical of the world's sea turtles, rarely occurring above 35° N or below 30° south (Witzell, 1983). After hatching, hawksbill sea turtles migrate to pelagic habitats where they take shelter in floating algal mats. After 1 to 5 years, juveniles migrate to shallower coastal feeding grounds, including their preferred coral reef habitats, where they mature to adulthood and spend the remainder of their lives. Within the Study Area, only five to ten females are estimated to nest annually (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013).

Hawksbill sea turtles may be exposed to sonar, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the effects from vessel noise, aircraft noise, and weapons noise on hawksbill sea turtles relies on the information under the respective acoustic substressor in Section 3.1 (Effects Due to Each Acoustic Substressor and Explosives).

Estimated effects for hawksbill sea turtles in the Study Area include TTS from explosives over the course of a year in the table below. For hawksbill sea turtles, the largest contributor of effects from explosives are due to Underwater Demolition Qualification and Certification for training activities during the warm season, and Mine Neutralization Explosive Ordnance Disposal for training activities during the cold season. In the table below, the risk of any behavioral effect is negligible (zero), and the risk of any temporary auditory effect due to explosives is low (less than one) in any year, but a single effect is shown in the maximum year of effects due to summing risk across seven years and following the rounding approach discussed in Section 3.3 (ESA-Listed Species Assessments). No effects on hawksbill sea turtles were estimated to occur for sonar, likely due to the limited usage of low-frequency and broadband sonar sources that are within the hearing range of sea turtles (i.e., < 2 kHz).

Estimated TTS effects from 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 effects.

Table 3.3-2: Estimated Effects on Hawksbill Sea Turtles Over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Training	0	(1)	-	-	-
Maximum Annual Total		**0**	**1**	**-**	**-**	**-**
Season			**Percent of Total Effects** **MIRC**			
Warm			49%			
Cold			51%			
Activities Causing 5 Percent or More of Total Effects				**Category**	**Percent of Total Effects**	
Underwater Demolition Qualification and Certification				Training	81%	
Mine Neutralization Explosive Ordnance Disposal				Training	17%	

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 3.3.
See beginning of Section 3.3 for full explanation of table sections.
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3.3.3 Olive Ridley Sea Turtle (*Lepidochelys olivacea*) – Endangered

Olive ridley sea turtles that nest along the Pacific coast of Mexico are listed as endangered under the ESA, while all other populations are listed under the ESA as threatened. Most olive ridley sea turtles found within the Study Area are from the Indo-Western Pacific lineage (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014). Olive ridley sea turtles do not have designated DPSs, and do not have designated critical habitat in the Study Area.

The occurrence of the olive ridley sea turtle is rare throughout the year in the Study Area (National Marine Fisheries Service, 2020). Sightings are particularly rare inside the shelf break (e.g., Apra Harbor, Agat Bay, and nearshore waters around Tinian and Saipan) as olive ridley's are primarily an oceanic species (National Marine Fisheries Service, 2020). Nesting beaches with solitary nesters occur in southeast Asia and Australia (Spotila, 2004), suggesting that olive ridley sea turtles have the potential to enter the Study Area. However, due to a lack of available data, density cannot be estimated, and potential effects from sonar and explosives were not modeled.

Olive ridley sea turtles may be exposed to sonar, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the effects from vessel noise, aircraft noise, and weapons noise on olive ridley sea turtles relies on the information under the respective acoustic substressor in Section 3.1 (Effects Due to Each Acoustic Substressor and Explosives).

Due to a lack of olive ridley sea turtle density data, no effects were estimated to occur from sonar or explosives over the course of a year.

3.3.4 Loggerhead Sea Turtle (*Caretta caretta*) - Endangered

Loggerhead sea turtles from the North Pacific Ocean DPS are in the Study Area and are ESA-listed as endangered throughout their range. There is no critical habitat designated for the loggerhead sea turtle in the Study Area.

Loggerhead sea turtles can be found hundreds of kilometers out to sea, as well as in inshore areas, such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. They are considered rare within the Study Area since their preferred habitat is north of the Study Area in temperate waters north of 25°N. As a result, any loggerhead sea turtles in the Study Area are likely to be transiting in offshore waters (National Marine Fisheries Service, 2020). Consistent with the prior analysis (U.S. Department of the Navy, 2020)densities for leatherback sea turtles were used as a surrogate for loggerhead sea turtles and are likely a conservative estimate of their occurrence in the Study Area.

Loggerhead sea turtles may be exposed to sonar, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the effects from vessel noise, aircraft noise, and weapons noise on loggerhead sea turtles relies on the information under the respective acoustic substressor in Section 3.1 (Effects Due to Each Acoustic Substressor and Explosives).

Based on results from NAEMO, no effects on loggerhead sea turtles were estimated to occur from sonar and the risk of explosive effects are negligible over the course of a year.

3.3.5 Leatherback Sea Turtle (*Dermochlys coriacea*) - Endangered

Leatherback sea turtles are ESA-listed as endangered throughout their range with no designated DPSs. There is no designated critical habitat for the leatherback sea turtle in the Study Area. Model-predicted effects are presented in the table below.

The leatherback sea turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. Pacific leatherbacks are split into western and eastern Pacific subpopulations based on their distribution and biological and genetic characteristics. Only western Pacific leatherbacks are expected to be found within the Study Area. There are no known nesting habitats for the leatherback sea turtle in the Study Area. As a result, occurrence of leatherback turtles in nearshore waters would be rare throughout the year (National Marine Fisheries Service & U.S. Fish and Wildlife

Service, 2014), and they are only likely to be occasionally found in pelagic waters of the Marianas archipelago when they transit from regional nesting locations (Benson et al., 2011; Benson et al., 2007).

Leatherback sea turtles may be exposed to sonar, vessel noise, aircraft noise, weapons noise, and explosives associated with military readiness activities throughout the year. Analysis of the effects from vessel noise, aircraft noise, and weapons noise on green turtles relies on the information under the respective acoustic substressor in Section 3.1 (Effects Due to Each Acoustic Substressor and Explosives).

Results from NAEMO in the table below show that leatherback sea turtles in the Study Area may experience TTS from explosives over the course of a year. For leatherback sea turtles, the largest contributor of effects from explosives are due to Bombing Exercise Air-to-Surface training activities during the warm season and Sinking Exercise training activities with equal effects during the cold and warm seasons. In the table below, the risk of any behavioral effect is negligible (zero), and the risk of temporary auditory effect due to explosives is low (less than one) in any year, but a single effect is shown in the maximum year of effects due to summing risk across seven years and following the rounding approach discussed in Section 3.3 (ESA-Listed Species Assessments). No effects on leatherback sea turtles were estimated to occur for sonar and is likely due to the limited usage of low-frequency and broadband sonar sources that are within the hearing range of sea turtles (i.e., < 2 kHz).

Estimated TTS effects from 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 effects.

Table 3.3-3: Estimated Effects on Leatherback Sea Turtles Over a Maximum Year of Proposed Activities

Source	Category	BEH	TTS	AINJ	INJ	MORT
Explosive	Training	0	(1)	-	-	-
Maximum Annual Total		**0**	**1**	**-**	**-**	**-**

Season	Percent of Total Effects MIRC
Warm	83%
Cold	17%

Activities Causing 5 Percent or More of Total Effects	Category	Percent of Total Effects
Bombing Exercise Air-to-Surface	Training	66%
Sinking Exercise	Training	34%

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
For BEH, TTS, AINJ, INJ, MORT annual effects: Dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5 based on the 7-year rounding rules discussed in Section 3.3.
See beginning of Section 3.3 for full explanation of table sections.
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3.3.6 Effects Summary Tables

The tables in this section show effects on all sea turtle species for the maximum annual and seven-year total effects due to explosives. No effects are predicted due to sonars.

3.3.6.1 Training Explosives Effects Summary Tables

Table 3.3-4: Estimated Effects on Sea Turtles from Explosives Over One Year of Maximum Training

Species	BEH	TTS	AINJ	INJ	MORT
ESA-Listed					
Green sea turtle	(1)	41	4	1	-
Hawksbill sea turtle	0	(1)	-	-	-
Leatherback sea turtle	0	(1)	-	-	-
Loggerhead sea turtle	0	-	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5
Species are not shown if no effects are estimated.
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Table 3.3-5: Estimated Effects on Sea Turtles from Explosives Over Seven Years of Training under Alternative 1 and Alternative 2

Species	BEH	TTS	AINJ	INJ	MORT
ESA-Listed					
Green sea turtle	1	286	25	1	-
Hawksbill sea turtle	0	3	-	-	-
Leatherback sea turtle	0	1	-	-	-
Loggerhead sea turtle	0	-	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Species are not shown if no effects are estimated.
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3.3.6.2 Testing Explosives Effects Summary Tables

Table 3.3-6: Estimated Effects on Sea Turtles from Explosives Over One Year of Maximum Testing

Species	BEH	TTS	AINJ	INJ	MORT
ESA-Listed					
Green sea turtle	-	0	-	-	-
Loggerhead sea turtle	-	0	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Values in parentheses are rounded up from less than 0.5
Species are not shown if no effects are estimated.
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Table 3.3-7: Estimated Effects on Sea Turtles from Explosives Over Seven Years of Testing under Alternative 1 and Alternative 2

Species	BEH	TTS	AINJ	INJ	MORT
ESA-Listed					
Green sea turtle	-	0	-	-	-
Loggerhead sea turtle	-	0	-	-	-

BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, INJ = Non-Auditory Injury, MORT = Mortality
A dash (-) indicates a (true zero) and zero (0) indicates a rounded value less than 0.5.
Species are not shown if no effects are estimated.
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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 NAEMO described in the *Quantitative Analysis TR*. The ranges to effects are shown for representative sonar systems and explosive bins from E1 (0.1–0.25 lb.) to E12 (>675–1,000 lb.). 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 effects from acoustic and explosive sources and assess the benefit of mitigation zones.

Tables present median and standard deviation ranges to effects for each bin, source depth (explosives), and representative cluster size (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).

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 sea turtles since they produce sound at frequencies greater than the upper hearing range of sea turtles (i.e., > 2 kHz).

3.4.2 Range 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*.

Ranges to effect for the same size of explosive differ based on whether it is detonated at or just above the surface or at depth. Modeling cannot account for the highly non-linear effects of cavitation and surface blow off for shallow underwater explosions, nor can it estimate the explosive energy entering the water from a low-altitude detonation. Thus, for this analysis, in-air sources detonating at or just above (within 10 m of) the surface are modeled as if detonating completely underwater at a source depth of 0.1 m, with all energy reflected into the water rather than released into the air. Therefore, the amount of explosive and acoustic energy entering the water, and consequently the estimated ranges to effects, are likely to be overestimated.

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 effect 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. 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.

Table 3.4-1: Sea Turtle Ranges to Effects for Explosives

Bin	Source Depth	Cluster Size	BEH	TTS	AINJ
E1	Near surface	1	NA	70 m (7 m)	44 m (5 m)
E2	Below surface	1	NA	110 m (2 m)	58 m (1 m)
E3	Near surface	1	NA	128 m (26 m)	87 m (5 m)
		7	74 m (235 m)	128 m (26 m)	87 m (5 m)
		15	85 m (143 m)	128 m (26 m)	87 m (5 m)
E4	Near surface	1	NA	224 m (7 m)	118 m (1 m)
	Below surface	1	NA	430 m (29 m)	118 m (1 m)
E5	Near surface	1	NA	165 m (56 m)	120 m (18 m)
		5	100 m (302 m)	165 m (56 m)	120 m (18 m)
	Below surface	1	NA	516 m (54 m)	130 m (9 m)
E6	Near surface	1	NA	192 m (73 m)	141 m (27 m)
	Below surface	1	NA	233 m (74 m)	148 m (27 m)
E7	Near surface	1	NA	1,025 m (171 m)	50 m (21 m)
	Below surface	1	NA	1,157 m (207 m)	33 m (25 m)
E8	Near surface	1	NA	356 m (21 m)	189 m (63 m)
E9	Near surface	1	NA	413 m (107 m)	224 m (99 m)
E10	Near surface	1	NA	396 m (56 m)	229 m (136 m)
E11	Below surface	1	NA	2,542 m (158 m)	772 m (32 m)
E12	Near surface	1	NA	647 m (185 m)	292 m (149 m)

Median ranges with standard deviation ranges in parentheses, TTS and AINJ = the greater of respective SPL and SEL ranges, behavioral response criteria are applied to explosive clusters >1
BEH = Significant Behavioral Response, TTS = Temporary Threshold Shift, AINJ = Auditory Injury, NA = not applicable, near surface explosives occur at or just above the surface and are modeled at a depth of 0.1 meter
E1 (0.1 - 0.25 lbs), E2 (>0.25 - 0.5 lbs), E3 (>0.5 - 2.5 lbs), E4 (>2.5 - 5 lbs), E5 (>5 - 10 lbs), E6 (>10 - 20 lbs), E7 (>20 - 60 lbs), E8 (>60 - 100 lbs), E9 (>100 - 250 lbs), E10 (>250 - 500 lbs), E11 (>500 - 675 lbs), E12 (>675 - 1,000 lbs)
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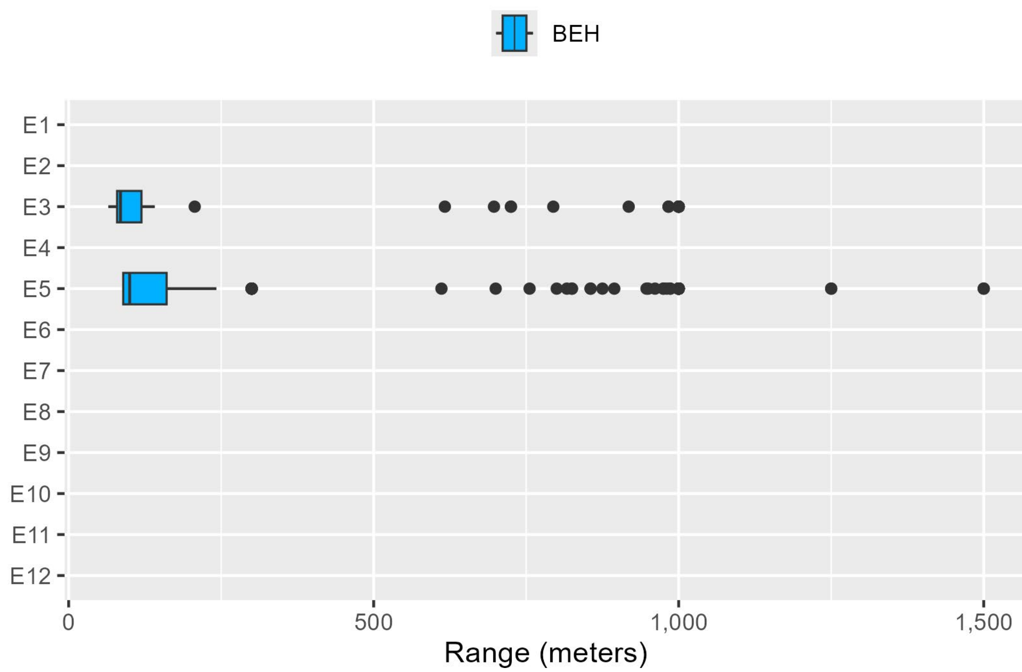

Figure 3-2: Sea Turtle Ranges to Behavioral Response for Explosives

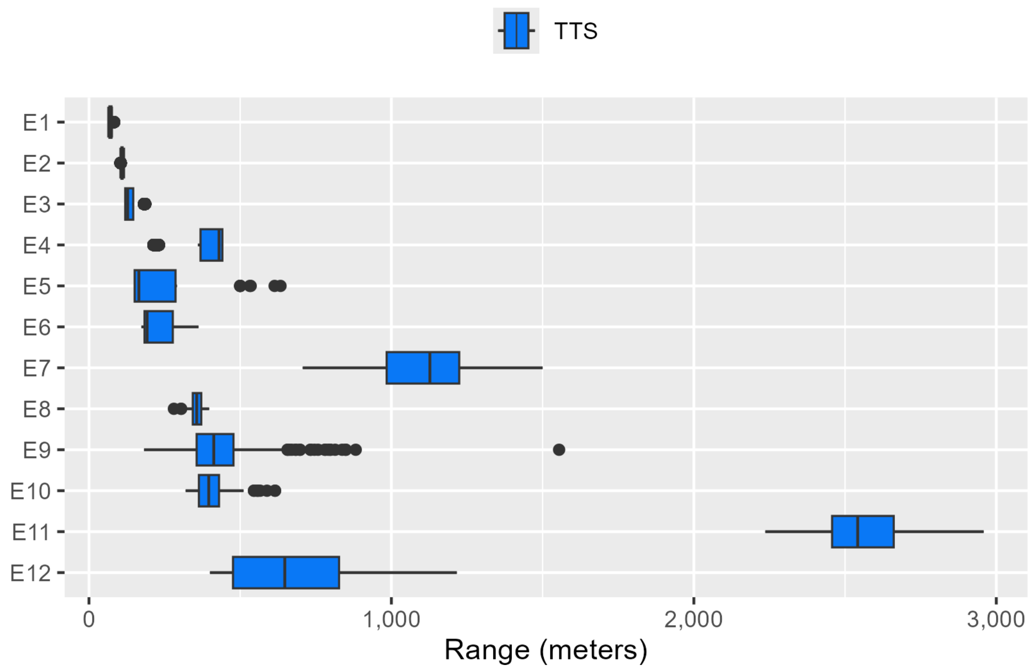

Figure 3-3: Sea Turtle Ranges to Temporary Threshold Shift for Explosives

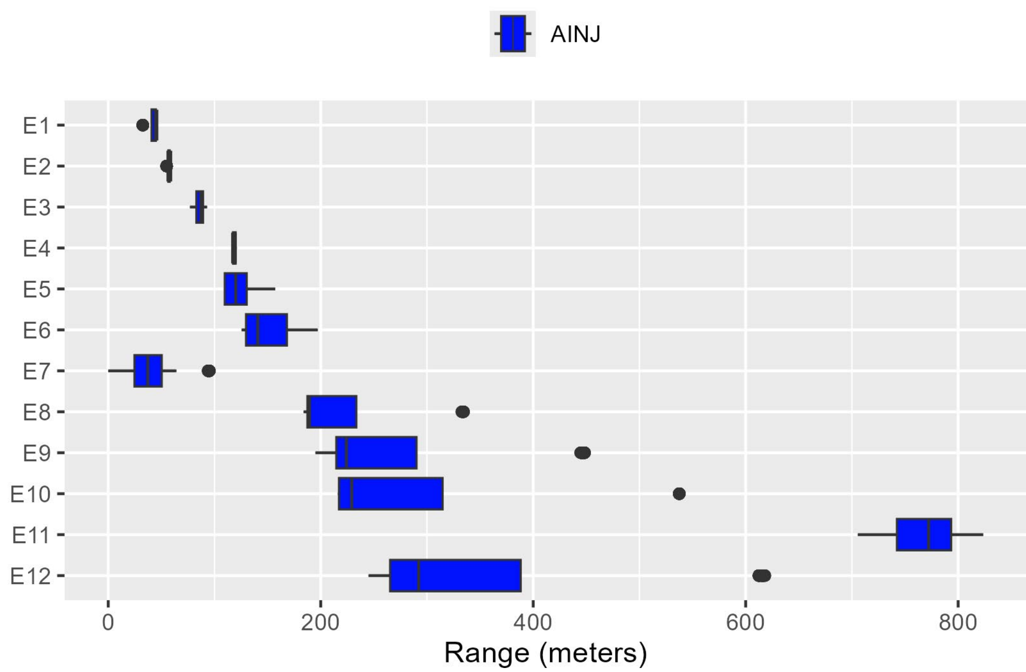

Figure 3-4: Sea Turtle Ranges to Auditory Injury for Explosives

Table 3.4-2: Explosive Ranges to Injury and Mortality for Sea Turtles as a Function of Animal Mass

Bin	Effect	10 kg	250 kg	1,000 kg
E1	INJ	22 m (0 m)	22 m (0 m)	22 m (0 m)
	MORT	3 m (0 m)	1 m (0 m)	0 m (0 m)
E2	INJ	28 m (1 m)	26 m (1 m)	25 m (0 m)
	MORT	7 m (0 m)	3 m (0 m)	0 m (0 m)
E3	INJ	48 m (0 m)	48 m (5 m)	35 m (0 m)
	MORT	8 m (0 m)	4 m (0 m)	2 m (0 m)
E4	INJ	55 m (2 m)	56 m (2 m)	58 m (1 m)
	MORT	7 m (6 m)	1 m (3 m)	0 m (0 m)
E5	INJ	68 m (5 m)	68 m (6 m)	60 m (1 m)
	MORT	13 m (1 m)	8 m (1 m)	4 m (0 m)
E6	INJ	86 m (6 m)	86 m (5 m)	84 m (1 m)
	MORT	16 m (2 m)	10 m (2 m)	6 m (1 m)
E7	INJ	22 m (12 m)	23 m (13 m)	30 m (15 m)
	MORT	5 m (3 m)	3 m (2 m)	2 m (1 m)
E8	INJ	118 m (5 m)	122 m (20 m)	166 m (0 m)
	MORT	25 m (1 m)	16 m (2 m)	10 m (0 m)
E9	INJ	143 m (6 m)	148 m (35 m)	225 m (0 m)
	MORT	48 m (10 m)	22 m (2 m)	13 m (0 m)
E10	INJ	150 m (9 m)	160 m (53 m)	278 m (1 m)
	MORT	42 m (2 m)	26 m (2 m)	16 m (0 m)
E11	INJ	596 m (33 m)	360 m (18 m)	333 m (6 m)
	MORT	293 m (6 m)	174 m (16 m)	109 m (0 m)
E12	INJ	182 m (10 m)	190 m (75 m)	353 m (1 m)
	MORT	61 m (22 m)	35 m (7 m)	20 m (0 m)

Median ranges with standard deviation ranges in parentheses, INJ = the greater of respective ranges for 1% chance of gastro-intestinal tract injury and 1% chance of injury, MORT = mortality
E1 (0.1 - 0.25 lbs), E2 (>0.25 - 0.5 lbs), E3 (>0.5 - 2.5 lbs), E4 (>2.5 - 5 lbs), E5 (>5 - 10 lbs), E6 (>10 - 20 lbs), E7 (>20 - 60 lbs), E8 (>60 - 100 lbs), E9 (>100 - 250 lbs), E10 (>250 - 500 lbs), E11 (>500 - 675 lbs), E12 (>675 - 1,000 lbs)
version.20250714

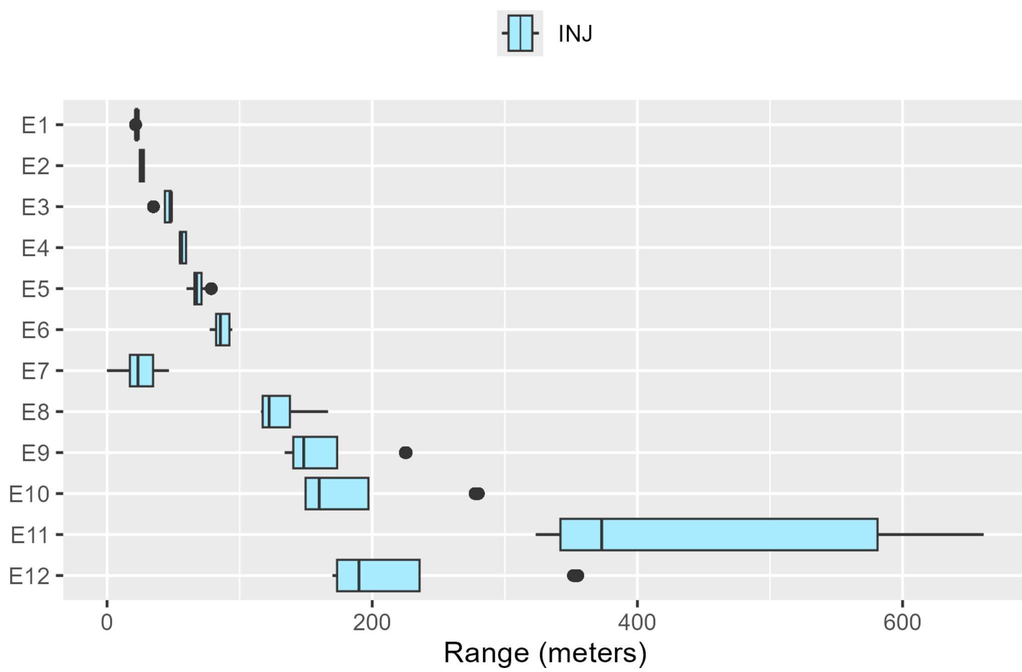

Figure 3-5: Explosive Ranges to Injury for Sea Turtles

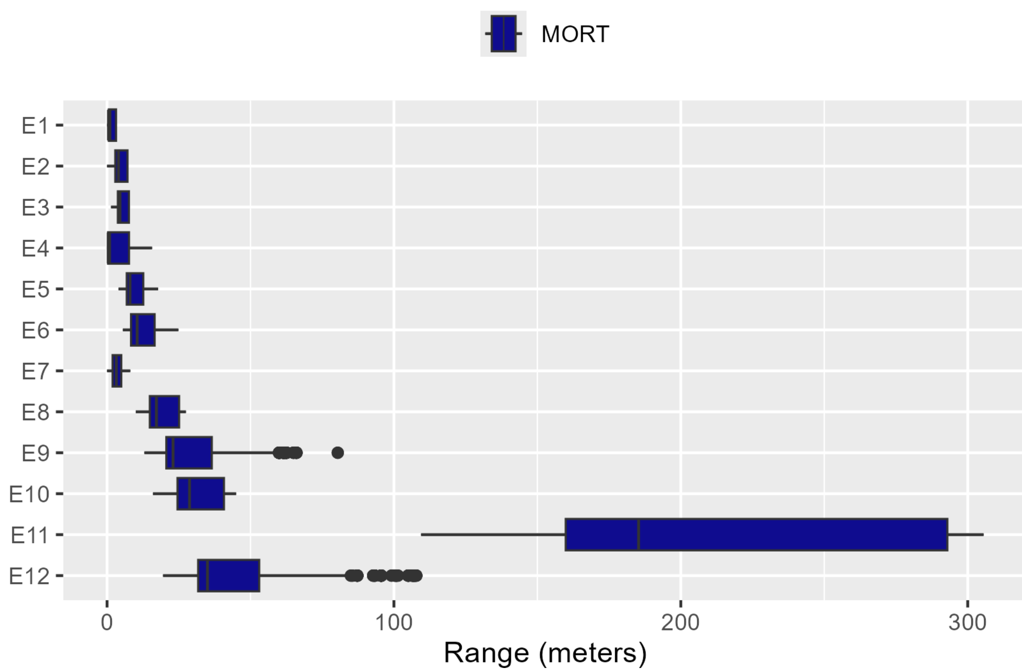

Figure 3-6: Explosive Ranges to Mortality for Sea Turtles

4 EFFECTS ON FISHES FROM ACOUSTIC AND EXPLOSIVE STRESSORS

This analysis is presented as follows:

- The effects on fish populations that would be expected due to each type of acoustic substressor and explosives used in the Proposed Action are described in Section 4.1 (Effects due to each Acoustic Substressor and Explosives).
- The approach to modeling and quantifying effects, as it applies to fishes, is summarized in Section 4.2 (Quantifying Effects on Fishes from Acoustic and Explosive Stressors).
- Effects on ESA-species (Distinct Population Segments [DPS] and Evolutionarily Significant Units [ESU]) in the Study Area, including predicted instances of harm or harassment, are presented in Section 4.3 (ESA-Listed Species Assessments).
- Ranges to effects for each modeled sub-stressor are shown in Section 4.4 (Ranges to Effects).

4.1 Effects Due to Each Acoustic Substressor and Explosives

This section analyzes the potential effects 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. The effects addressed in this section have been categorized based on the factors labeled in section 1.1 of this technical report.

4.1.1 Effects from Sonar and Other Transducers

Effects on fishes from exposure to sonar could include hearing loss, masking, physiological response (including stress), and behavioral reactions. As discussed in the *Fishes Acoustic Background* section, mortality and injury from sonar is highly unlikely and is not considered further in this analysis.

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 effects 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 there is very limited overlap 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.

Effects from sonar to fishes within the Study Area would be limited to systems with energy below 2 kHz, primarily from low-frequency sonars but could also include some broadband and lower mid-frequency sources (less than 2 kHz). Although these systems could be used throughout the MITT Study Area, they are typically operated offshore. Compared to the 2020 MITT SEIS/OEIS, there is an increase in the usage of low-frequency sonars. However, low-frequency sources are operated much less often than higher frequency sources throughout the Study Area resulting in a low risk of exposure overall. General effects from sonar would be similar in severity between training and testing activities, however, there is a higher quantity of sonar usage under training activities and may account for more effects than testing activities.

Hearing loss: Although low-frequency systems generally lack the power necessary to generate TTS in fish, a quantitative analysis was performed using NAEMO 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 (based on criteria discussed in Section 4.2.1, Quantifying Hearing Effects from Sonars) 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 (and AINJ) is not anticipated.

Masking: Although there is the potential for some low-frequency sonars to mask biologically important sounds (i.e., vocalizations), the majority of active sonars 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 over the brief period these systems are used in any given location within the Study Area. 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. Compensation (i.e., the Lombard effect) would only occur if the sound source is louder than the biological signals and lasts long enough to impact transmission and detection of those signals. 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.

Behavioral response and physiological response (stress): 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 and no effect on 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.

Due to the transient nature of most sonar operations, effects, if any, would be localized and infrequent, only lasting a few seconds or minutes. Overall, sonar use is unlikely to affect individuals. If effects do occur, they are expected to be insignificant; therefore, long-term consequences for fish populations would not be expected.

4.1.2 Effects from Vessel Noise

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 to fishes 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 due to 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.

Masking: 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.

Behavioral response and physiological response (stress): 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 indicates 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, effects 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.

4.1.3 Effects 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 (e.g., helicopters) aircraft are used for a variety of military readiness activities throughout the Study Area. Tilt-rotor effects would be like fixed-wing or rotary-wing aircraft effects 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 rotary-wing aircraft that are just above the water 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. 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. 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 rotary-wing aircraft 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.

Masking: 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 short periods of time where a fish is near the surface while directly under a hovering rotary-wing aircraft or aircraft overflight.

Behavioral response and physiological response (stress): Due to their low sound levels in water, fixed-wing aircraft or transiting rotary-wing aircraft 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. Any behavioral response to fixed-wing aircraft would likely be in the form of a temporary startle or avoidance of the immediate area. Daytime and nighttime activities involving rotary-wing aircraft 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, rotary-wing aircraft would typically transit throughout an area and may hover over the water. Longer activity durations and periods of time where rotary-wing aircraft hover may increase the potential for behavioral reactions, startle reactions, and physiological response. Low-altitude flights of rotary-wing aircraft during some activities, which often occur under 100 ft. altitude, may elicit a stronger 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.

Overall, if fish were to respond to aircraft noise, only short-term behavioral or physiological response would be expected. Therefore, effects on individuals would be unlikely and long-term consequences for populations are not expected.

4.1.4 Effects from Weapon Noise

In general, noise from weapons firing is considered impulsive sound and is generated in close vicinity to, or at the water surface, except for weapons 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 considered non-impulsive and 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 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 effects on 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.

Hearing loss: Although hearing loss could potentially occur, the probability is very low of a non-explosive munition landing within a few meters of a fish while it is near the surface.

Masking: 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.

Behavioral response and physiological response (stress): 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 and physiological 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.

4.1.5 Effects from Explosives

Fishes may be exposed to sound and energy from explosions in the water and just above the water surface associated with the proposed activities. Explosions produce loud, impulsive, broadband sounds that are within the hearing range of all fishes. Activities using explosives would be conducted as described in the *Proposed Activities* and *Activity Descriptions* sections. Most activities involving in-water (including at or just above the surface) explosions associated with naval gunfire, missiles, bombs, and other munitions are conducted more than 3 NM from shore. Sinking Exercises, Surface-to-Surface Missile Exercises, and Air-to-Surface Bombing 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 the *Activity Descriptions* section of the MITT SEIS/OEIS. This includes certain Mine Warfare activities conducted within Outer Apra Harbor, and at the Piti and Agat Floating Mine Neutralization Sites. Bombing Exercises and some Gunnery and Missile Exercises can occur closer to shore at FDM, and misses and ricochets may cause in-water explosions in nearshore waters surrounding FDM. Potential effects from explosive energy and sound include mortality, non-auditory injury, behavioral reactions, physiological response, masking, and hearing loss.

The Action Proponents will implement mitigation to avoid effects 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 of the MITT SEIS/OEIS for details), which will help avoid potential effects on fishes that shelter and feed within those habitats.

Direct injury and mortality: Sound and energy from explosions could result in mortality and injury in fish, on average, for hundreds or thousands of meters from some of the largest explosions (see Section 4.4.2, 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. 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 effect on the overall population than potential loss of many larval or juvenile fishes, which tend to occur in high numbers (i.e., due to the nature of spawning) and have naturally high mortality rates. Non-auditory injuries such as barotrauma may lead to impaired swimming ability and could be accompanied by disorientation, reducing the overall fitness of an injured individual and potentially increasing risk of predation.

Hearing Loss: Exposures that result in 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 effect. 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 effects 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).

Masking: Fish could potentially experience masking from explosive sound. Single explosive detonations are less likely to cause masking due to their brief and sudden nature. Multiple detonations that occur within a few seconds could result in a higher risk of masking and would likely happen at farther distances from the source where individual detonations might sound more continuous.

Behavioral response and physiological response (stress): Explosive sound could result in a variety of behavioral and physiological responses in fish, with the likelihood of response lower at farther distances from the source (thousands of meters). These responses could include, alerting, startling, reduced feeding, altered communication, and avoidance. Any stress or behavioral reactions from single explosive detonations 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 behavioral and physiological effects on nearby fishes, though many would likely avoid the source during the first few impulses. 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 effects 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 effects are expected to be short-term, and fish would likely return to their natural behavior shortly after exposure. Although some individuals may be affected, long-term consequences to fish populations would not be expected.

4.2 Quantifying Effects on Fishes from Acoustic and Explosive Stressors

Although the effect 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 sonars and explosives (see Section 4.4 [Range to Effects] for details). Ranges for sonar and explosives were estimated using fish sound exposure criteria and thresholds and sound propagation modeling performed in the NAEMO. 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 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 effects due to military readiness activities in the Study Area. 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.

4.2.1 Quantifying Hearing Effects from Sonars

Although Smith and Popper (2024) suggest that TTS is not a likely occurrence in fishes exposed to anthropogenic sound, the following section explains the derivation of proposed interim sound exposure thresholds provided in the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014).

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 4.2-1.

As shown in Table 4.2-1, 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 SEL, then rounded down for a final proposed threshold of 220 dB re 1 $\mu Pa^2 s$ for all hearing specialists (see Table 4.2-2. 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).

Table 4.2-1: TTS Data for Fishes Exposed to Sonar

Reference	Reported SPL (dB RMS)	Exposure Duration (seconds)	Calculated cSEL [1]	Species	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

A hearing specialist and at least one example of a hearing generalist showed signs of TTS after exposure to low-frequency sonars (see Table 4.2-1). 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 4.2-2). 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 4.2-2: Sonar TTS Thresholds for Fishes

Hearing Group	Fish Category	Mid-Frequency Sonar (cSEL)	Low-Frequency Sonar (cSEL)
Generalists	Fishes without a swim bladder	NC	NC
	Fishes with a swim bladder not involved in hearing	NC	> 210
Specialists	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 cut-off at 2kHz.

4.2.2 Quantifying Mortality, Injury, and Hearing Effects from Explosives

Criteria and thresholds to estimate effects from sound and energy produced by explosive activities are presented below (Table 4.2-3) These thresholds were applied in the Navy’s previous analysis of effects 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 effects 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 4.2-3: Sound Exposure Criteria for Fishes Exposed to Underwater Explosives

Hearing Group	Fish Category	Mortality	Injury	TTS
		peak SPL	peak SPL	cSEL
Generalists	Fishes without a swim bladder	229	220	NC
Generalists and Specialists[1]	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.
[1] Fishes with a swim bladder not involved in hearing are considered generalists, fishes with a swim bladder involved in hearing and with high frequency hearing are considered specialists.

Although NMFS recommended acoustic thresholds for fishes include the use of surrogate pile driving criteria where there is a lack of data on fish injury thresholds for exposure to certain impulsive sounds (i.e., explosives), it is not appropriate to utilize SPL or SEL injury thresholds developed during pile driving studies and therefore pile driving criteria is not utilized in this analysis. The peak sound pressure levels reported in the pile driving literature, upon which interim injury thresholds guidelines were based, were not 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 effects as described herein.

Peak SPL is the most consistently documented metric in the literature when characterizing explosive sources. As a conservative measure, the absolute lowest peak SPL for larval fishes exposed to explosions that resulted in injury (220 dB; 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 starting at peak SPLs of 226 dB (Dahl et al., 2020; Jenkins et al., 2022; Jenkins et al., 2023). Furthermore, when data from multiple years were combined, rates for “any injury” did not approach 50% until around 220 dB [for details, see Figure 4 in Bowman et al. (2024)]. 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 effects for larger or adult fishes. For example, adult 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).

4.3 ESA-Listed Species Assessments

This section relies on the analysis of acoustic and explosive stressors on fish populations described above in Section 4.1 (Effects Due to Each Acoustic Substressor and Explosives). Available research on reactions of fishes to underwater sound largely suggests 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 of the SEIS/OEIS for details*)*, several acoustic substressors (sonars, 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 assumed that non-impulsive acoustic stressors would not result in injurious effects on ESA-listed species.

Although ESA-fishes may be exposed to various acoustic substressors throughout the Study Area, the magnitude and duration of exposures are expected to be brief and episodic. Potential effects would be minor and unlikely to lead to a significant disruption of normal behavioral patterns such as breeding, feeding, or sheltering, and are not expected to result in any harm or harassment. Effects would be short-term for individuals and long-term consequences for populations would not be expected. Therefore, sonars and vessel, aircraft, and weapons noise are not analyzed further for the ESA-listed species below but rather rely on the analysis provided above in Section 4.1 (Effects Due to Each Acoustic Substressor and Explosives).

The overlap analysis below on the effects of explosives on ESA-listed species relies on information presented in the *Fishes Background* section of the SEIS/OEIS.

4.3.1 Oceanic Whitetip Shark (*Carcharhinus longimanus*) – Threatened

Oceanic whitetip sharks could be exposed to sound and energy from explosives associated with training and testing activities throughout the MITT Study Area in a given year. Specifically, oceanic whitetip sharks are highly migratory, dispersed throughout the open ocean portions of the Study Area, and are not anticipated to occur within the nearshore, coastal locations (e.g., Apra Harbor). 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, they could be exposed to underwater detonations throughout the water column as they also frequent deep ocean waters. Risk of exposure in the open water portion of the Study Area is less likely compared to nearshore areas considering the proposed number of offshore detonations, the large area over which such detonations would occur, and the dispersed nature of oceanic whitetip shark populations in offshore areas.

Most of the explosive munitions used throughout the Study Area would be considered small (E5 [>5 to 10 lb.] or below). Although larger detonations would typically occur farther from shore (beyond 3 NM) where oceanic whitetip sharks are present, large explosions would be used less often than smaller detonations, reducing the risk of exposure. Overall, the likelihood of exposure would be low as detonations are generally dispersed in space and time and individual sharks would need to be co-located with explosive activities for potential effects to occur. Generally, smaller explosive bins produce smaller ranges to higher order effects such as injury and mortality compared to larger bins (see Section 4.4.2 [Range to Effects for Explosives] for details). Based on the estimated ranges, oceanic whitetip sharks that are co-located with explosive activities may experience injury or mortality (TTS is not anticipated as sharks do not have a swim bladder and are not susceptible to hearing loss). Additionally, 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, but due to the short duration of explosives as well as the dispersed and infrequent use throughout the range, 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.

Despite lacking precise abundance data within the Study Area, the effect of explosives on the population of oceanic whitetip sharks is expected to be minimal due to the species' wide distribution in tropical and subtropical waters, the infrequent and brief nature of explosive use, and the anticipated low density of sharks in the affected areas. While some individual sharks may experience short-term physiological stress or behavioral reactions, only a very small number are likely to be exposed to explosives at levels that may cause injury or mortality and affect overall fitness.

While this species population is likely declining and facing numerous anthropogenic challenges (e.g., bycatch, targeted for shark fin trade, and destruction or modification of habitat), the number of individuals that may be affected during training and testing activities involving the use of explosives are not anticipated to result in appreciable reductions in overall reproduction, abundance, or distribution of this species. Therefore, long-term consequences to ESA-listed oceanic whitetip sharks are not expected.

4.3.2 Scalloped Hammerhead Shark (*Sphyrna lewini*) – Endangered

Scalloped hammerhead sharks could be exposed to sound and energy from explosives associated with training and testing activities throughout the MITT Study Area in a given year. Scalloped hammerhead sharks are primarily a shallow water, coastal species, although they have been documented making deep open ocean dives with males more likely to occur in open ocean environments. Females and juveniles mostly occur in nearshore areas, with juveniles predominantly in nursery habitats as these areas provide valuable refuge from predation. Given their preference for shallow, coastal environments and variable distribution, scalloped hammerhead sharks (especially females) are most likely to occur in nearshore portions of the Study Area (e.g. Apra Harbor). Scalloped hammerhead sharks are known to school and are largely surface oriented but may occur at deeper depths at night. Scalloped hammerhead sharks in deeper, offshore waters could also be exposed to surface detonations, however, risk of exposure in this portion of the Study Area is less likely compared to nearshore areas considering the proposed number of offshore detonations, the large area over which such detonations would occur, and the anticipated low density of scalloped hammerheads in offshore areas.

Most of the explosive munitions used throughout the Study Area would be considered small (E5 [>5 to 10 lb.] or below). Although scalloped hammerhead sharks could be exposed to larger detonations conducted farther from shore (beyond 3 NM), direct exposure to large explosions would be rare due to their preference for nearshore habitats. Explosive activities are also dispersed in space and time, further reducing the likelihood that transiting individual sharks would be co-located with large detonations. Generally, smaller explosive bins produce smaller ranges to higher order effects such as injury and mortality compared to larger bins (see Section 4.4.2 [Range to Effects for Explosives] for details). Based on the estimated ranges, scalloped hammerhead sharks that are co-located with explosive activities may experience injury or mortality (TTS is not anticipated as sharks do not have a swim bladder and are not susceptible to hearing loss). Additionally, 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 as well as the 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 schools of hammerhead sharks are within the vicinity of an explosive, a larger number of individuals may be affected from a single event depending on their proximity to the source.

The gestation period of female scalloped hammerhead sharks ranges from 9 to 12 months, which is often followed by a one-year resting period. Given that most explosive training and testing activities occur beyond 3 NM from shore, where pregnant females and juveniles are less common, injury and mortality to sharks within these age classes is unlikely, and a decrease in reproductive potential of the population would not be expected. Explosives that scalloped hammerheads are most likely to be exposed to in nearshore areas (E5 [>5 to 10 lb.] or below) produce small ranges to higher order effects such as mortality or injury compared to explosives in larger bin sizes, thus further reducing the potential that scalloped hammerhead sharks would incur effects that could lead to long-term individual fitness consequences. The most probable effects are short-term physiological and behavioral responses.

As described in the *Mitigation* section, the Navy will implement measures during explosive mine neutralization activities involving Navy divers, and during the use of explosives on seafloor resources, which may help avoid potential effects on species (i.e., hammerheads) and life stages associated with shallow-water reef environments. Specific hold fire mitigation will also be implemented if a hammerhead shark is observed immediately prior to the initial start of detonations or fuse initiations.

While this species population likely has undergone substantial decline within the Study Area and faces numerous anthropogenic challenges (e.g., bycatch and illegal fishing), the number of individuals that may be affected during training and testing activities involving the use of explosives are not anticipated to result in appreciable reductions in overall reproduction, abundance, or distribution of this species. Therefore, long-term consequences to ESA-listed scalloped hammerhead sharks are not expected.

4.3.3 Giant Manta Ray (*Manta birostris*) – Threatened

Giant manta rays are migratory and typically occur in areas of upwelling along the coast, near islands, or offshore pinnacles and seamounts. Despite limited data, giant manta rays are expected to occur periodically throughout the MITT Study Area in a given year and could be exposed to sound and energy from explosives associated with training and testing activities. They could be dispersed throughout open ocean habitats and are anticipated to occur within the nearshore portions of the Study Area. Giant manta rays in deeper, offshore waters spend much of their time at the surface, potentially increasing the risk of exposure to surface detonations. However, they also frequent deep ocean waters and could be exposed to detonations throughout the water column or on the seafloor, especially in nearshore areas or near reefs. Giant manta rays have been observed in aggregations of 100 to 1,000 individuals at particular sites believed to be associated with feeding and breeding.

Most of the explosive munitions used throughout the Study Area would be considered small (E5 [>5–10 lb.] or below). Larger detonations would typically occur farther from shore (beyond 3 NM) where manta rays are present. However, large explosions would be used less often than smaller detonations, reducing the risk of exposure. Overall, the likelihood of exposure would be low as detonations are generally dispersed in space and time and individual manta rays would need to be co-located with explosive activities for potential effects to occur. If seasonal aggregations of manta rays occur in other portions of the Study Area and are within the vicinity of an explosive, a larger number of individuals may be affected from a single event depending on their proximity to the source. Generally, smaller explosive bins produce smaller ranges to higher order effects such as mortality, injury and hearing loss compared to larger bin sizes (see Section 4.4.2 [Range to Effects for Explosives] for details). Based on the estimated ranges, giant manta rays that are co-located with explosive activities in these described areas may experience injury or mortality (TTS is not anticipated as rays do not have a swim bladder and are not susceptible to hearing loss). 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 range, 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.

Female giant manta rays are long living, late to reach sexual maturity, and have low birth numbers with long gestation periods. Due to these factors, the loss of a mature adult female could cause reductions in the reproductive potential of the population as a whole; however, the rate of these incidents is expected to be extremely small due to the infrequent and short-duration nature of explosive use in the offshore oceanic waters where the giant manta rays often occur. Removal of individuals from the population in nearshore areas is also unlikely due to the small detonation sizes and resulting ranges to effect in this portion of the Study Area. The most probable effects are short-term physiological and behavioral responses.

As described in the *Mitigation* section, the Navy will implement measures during explosive mine neutralization activities involving Navy divers, and during the use of explosives on seafloor resources, which may help avoid potential effects on species (i.e., manta rays) and life stages associated with shallow-water reef environments. Specific hold fire mitigation will also be implemented if a manta ray is observed immediately prior to the initial start of detonations or fuse initiations.

While this population is likely declining within the Study Area and faces numerous anthropogenic challenges (e.g., commercial fishing and bycatch), the number of individuals that may be affected during training and testing activities involving the use of explosives are not anticipated to result in appreciable reductions in overall reproduction, abundance, or distribution of this species. Therefore, long-term consequences to ESA-listed giant manta rays are not expected.

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 4.2 (Quantifying Effects on Fishes from Acoustic and Explosive Stressors), and the acoustic and explosive propagation calculations from NAEMO described in the *Quantitative Analysis TR*. The ranges to effects are shown for representative sonar systems and explosive bins from E1 (0.1–0.25 lb.) to E12 (>675–1,000 lb.) 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 effects from acoustic and explosive sources.

Tables present median and standard deviation ranges to effects for each fish hearing group or category, bin, source depth (explosives), and representative cluster size (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).

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 25th, 50th (i.e., median), and 75th 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 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, non-auditory injury, and mortality as described in Section 4.2 (Quantifying Effects on Fishes from Acoustic and Explosive Stressors). The explosive ranges for injury and mortality are SPL-based and are only estimated for an explosive cluster size of 1. Ranges for TTS are SEL-based and are estimated for fishes with a swim bladder only. Results may not be intuitive (e.g., shorter ranges for larger explosive bins and longer ranges for lower-level effects) since ranges are modeled in areas specific for the action and can therefore differ based on the environment and not simply the net-explosive weight. In addition, for fishes with a swim bladder, ranges to injury and mortality may exceed ranges to TTS since the criteria for injury and mortality are conservative, and fishes can be more resistant to auditory effects (i.e., TTS).

Ranges to effect for the same size of explosive differ based on whether it is detonated at or just above the surface or at depth. NAEMO cannot account for the highly non-linear effects of cavitation and surface blow off for shallow underwater explosions, nor can it estimate the explosive energy entering the water from a low-altitude detonation. Thus, for this analysis, in-air sources detonating at or just above (within 10 m of) the surface are modeled as if detonating completely underwater at a source depth of 0.1 m, with all energy reflected into the water rather than released into the air. Therefore, the amount of explosive and acoustic energy entering the water, and consequently the estimated ranges to effects, is often overestimated.

Table 4.4-1: Explosive Ranges to Effects for Fishes without a Swim Bladder

Bin	Source Depth	Cluster Size	TTS	INJ	MORT
E1	Near Surface	1	NA	66 m (2 m)	1 m (0 m)
E2	Below Surface	1	NA	127 m (5 m)	9 m (3 m)
E3	Near Surface	1	NA	205 m (4 m)	25 m (8 m)
E4	Near Surface	1	NA	333 m (3 m)	121 m (3 m)
	Below Surface	1	NA	335 m (2 m)	121 m (1 m)
E5	Near Surface	1	NA	389 m (5 m)	112 m (4 m)
	Below Surface	1	NA	398 m (11 m)	115 m (7 m)
E6	Near Surface	1	NA	497 m (2 m)	147 m (4 m)
	Below Surface	1	NA	498 m (2 m)	152 m (8 m)
E7	Near Surface	1	NA	765 m (4 m)	305 m (6 m)
	Below Surface	1	NA	767 m (5 m)	307 m (7 m)
E8	Near Surface	1	NA	874 m (3 m)	323 m (1 m)
E9	Near Surface	1	NA	1,000 m (2 m)	466 m (2 m)
E10	Near Surface	1	NA	1,375 m (17 m)	588 m (4 m)
E11	Below Surface	1	NA	1,500 m (0 m)	685 m (1 m)
E12	Near Surface	1	NA	1,750 m (20 m)	742 m (4 m)

Median ranges with standard deviation ranges in parentheses

TTS = Temporary Threshold Shift, INJ = Injury, MORT = Mortality, NA = not applicable, near surface explosives occur at or just above the surface and are modeled at a depth of 0.1 meter
TTS ranges are SEL-based and for fishes with a swim bladder only
INJ and MORT are SPL-based and for an explosive cluster size of 1 only
version.20250714

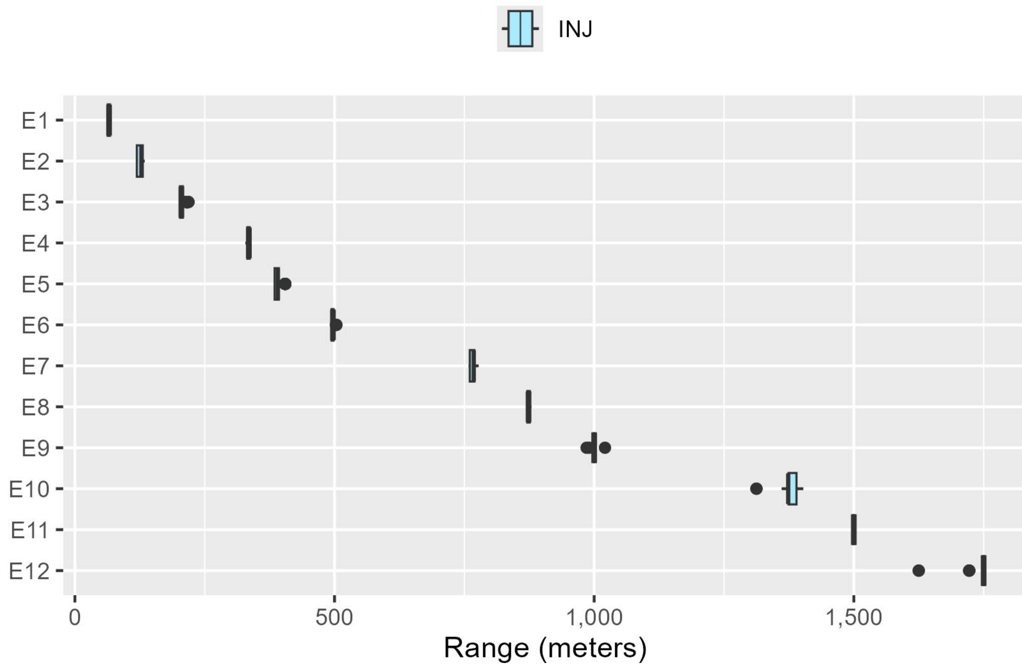

Figure 4-1: Explosive Ranges to Injury for Fishes without a Swim Bladder

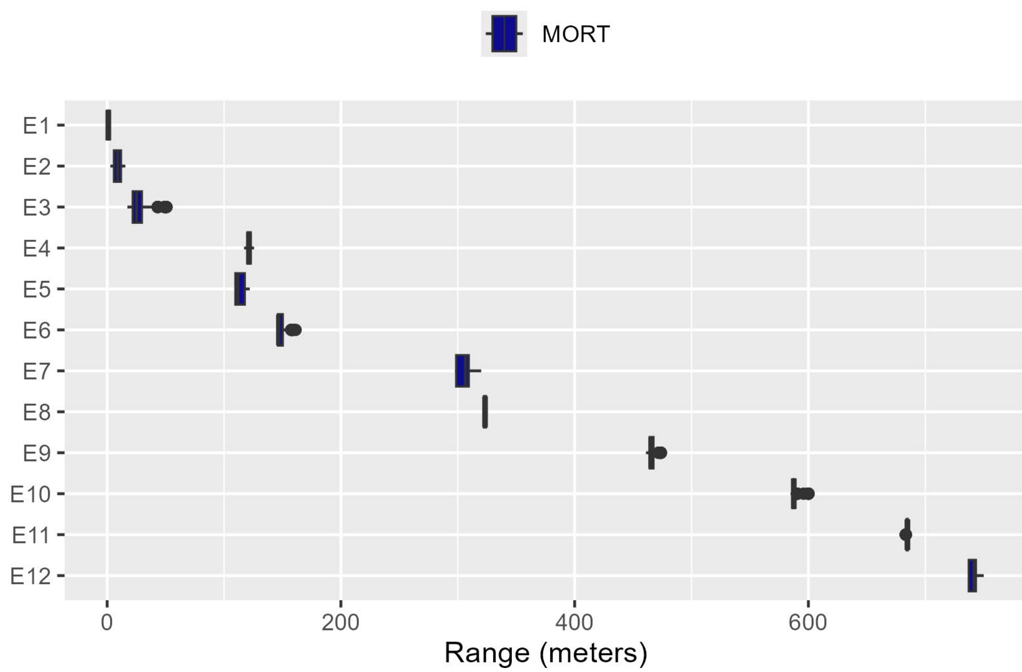

Figure 4-2: Explosive Ranges to Mortality for Fishes without a Swim Bladder

Table 4.4-2: Explosive Ranges to Effects for Fishes with a Swim Bladder

Bin	Source Depth	Cluster Size	TTS	INJ	MORT
E1	Near Surface	1	1 m (0 m)	66 m (2 m)	1 m (0 m)
E2	Below Surface	1	17 m (6 m)	127 m (5 m)	9 m (3 m)
E3	Near Surface	1	60 m (4 m)	205 m (4 m)	25 m (8 m)
		7	60 m (8 m)	NA	NA
		15	60 m (5 m)	NA	NA
E4	Near Surface	1	NA	333 m (3 m)	121 m (3 m)
	Below Surface	1	170 m (8 m)	335 m (2 m)	121 m (1 m)
E5	Near Surface	1	140 m (5 m)	389 m (5 m)	112 m (4 m)
		5	135 m (5 m)	NA	NA
	Below Surface	1	261 m (1 m)	398 m (11 m)	115 m (7 m)
E6	Near Surface	1	175 m (9 m)	497 m (2 m)	147 m (4 m)
	Below Surface	1	189 m (19 m)	498 m (2 m)	152 m (8 m)
E7	Near Surface	1	399 m (15 m)	765 m (4 m)	305 m (6 m)
	Below Surface	1	410 m (22 m)	767 m (5 m)	307 m (7 m)
E8	Near Surface	1	315 m (0 m)	874 m (3 m)	323 m (1 m)
E9	Near Surface	1	425 m (5 m)	1,000 m (2 m)	466 m (2 m)
E10	Near Surface	1	538 m (23 m)	1,375 m (17 m)	588 m (4 m)
E11	Below Surface	1	1,500 m (0 m)	1,500 m (0 m)	685 m (1 m)
E12	Near Surface	1	664 m (17 m)	1,750 m (20 m)	742 m (4 m)

Median ranges with standard deviation ranges in parentheses

TTS = Temporary Threshold Shift, INJ = Injury, MORT = Mortality, NA = not applicable, near surface explosives occur at or just above the surface and are modeled at a depth of 0.1 meter
TTS ranges are SEL-based and for fishes with a swim bladder only
INJ and MORT are SPL-based and for an explosive cluster size of 1 only
version.20250714

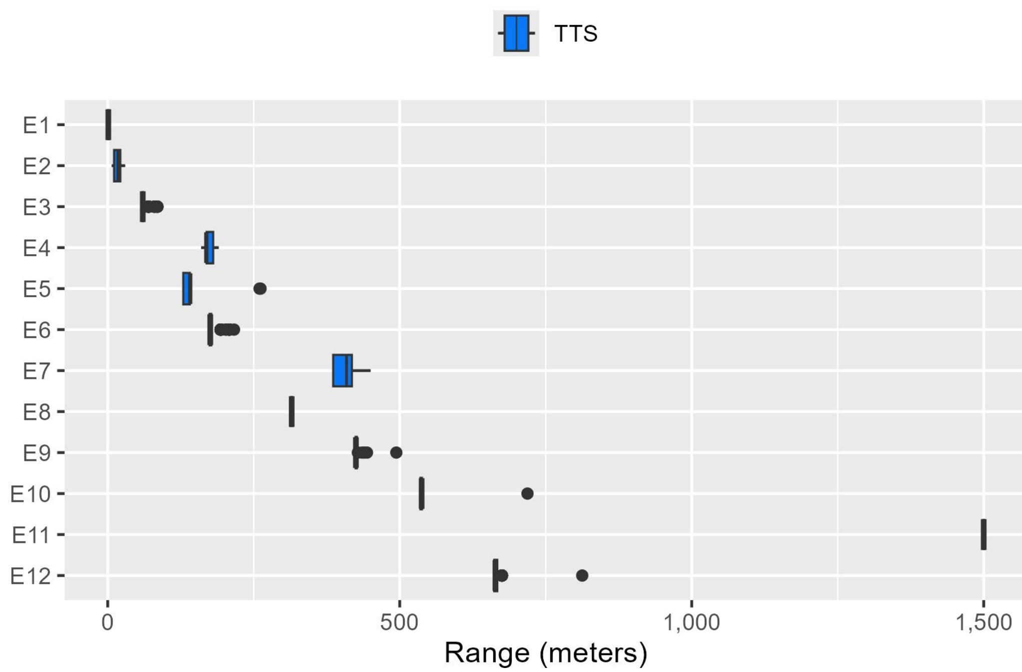

Figure 4-3: Explosive Ranges to Temporary Threshold Shift for Fishes with a Swim Bladder

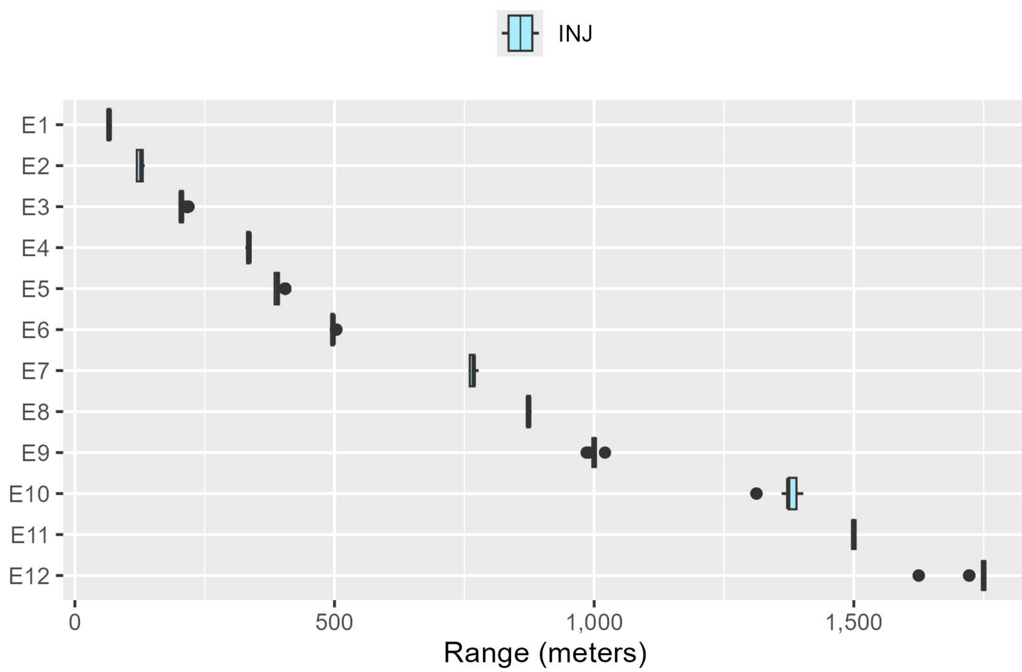

Figure 4-4: Explosive Ranges to Injury for Fishes with a Swim Bladder

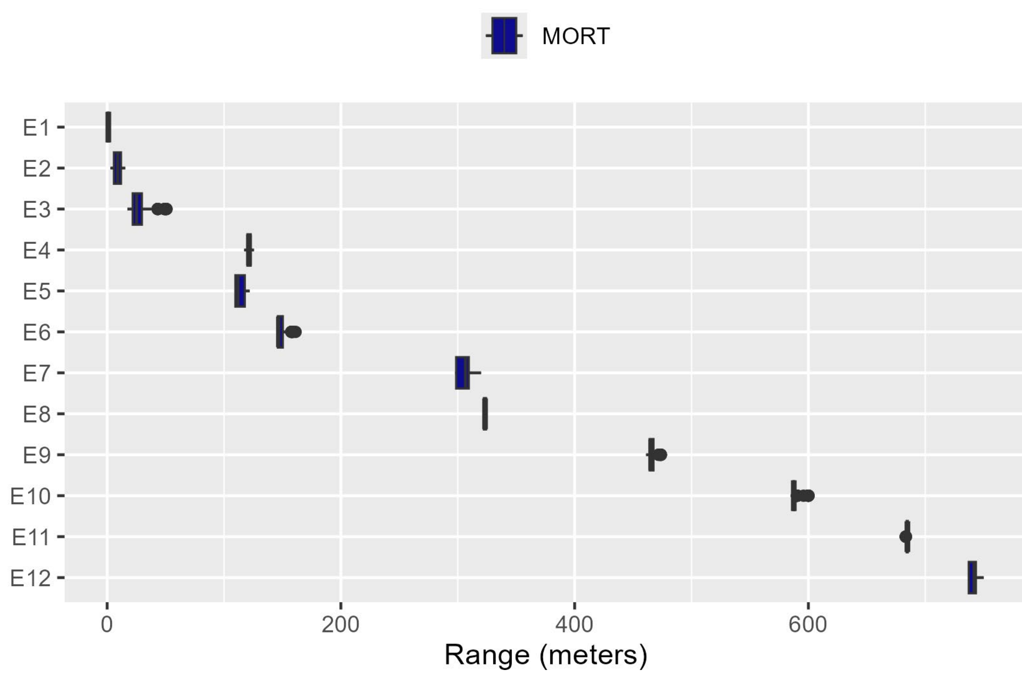

Figure 4-5: Explosive Ranges to Mortality for Fishes with a Swim Bladder

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