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3 Affected Environment and Environmental Consequences

3.0 Introduction

This chapter describes existing environmental conditions in the HCTT Study Area as well as the analysis of resources potentially impacted by the Proposed Action described in Chapter 2. The Study Area is described in Section 2.1 and depicted in Figure 2-1. The activities analyzed in this EIS/OEIS are largely a continuation of activities that have been ongoing for decades and were analyzed previously in the 2018 HSTT EIS/OEIS and the 2022 PMSR EIS/OEIS. Activities related to modernization and sustainment of ranges activities are also analyzed. Since the completion of the 2018 HSTT EIS/OEIS, new information is available and is used in this updated analysis. That information typically takes the form of new science or research that has been completed since 2018. This new information is identified when it is used throughout the remainder of this updated EIS/OEIS.

This section provides the ecological characterization of the Study Area and describes the resources evaluated in the analysis. The Overall Approach to Analysis section (Section 3.0.3) explains that each proposed military readiness activity was examined to determine which environmental stressors could potentially impact a resource. Additionally, this section describes how the potential adverse effects of activities are used to make significance determinations that inform a comparison of environmental consequences amongst the alternatives.

Resources Analyzed:

Physical Resources:
- Air Quality
- Sediments and Water Quality

Biological Resources:
- Vegetation
- Invertebrates
- Habitats
- Fishes
- Marine Mammals
- Reptiles
- Birds

Human Resources:

- Cultural Resources
- Socioeconomic Resources and Environmental Justice
- Public Health and Safety

3.0.1 Navy Compiled and Generated Data

While preparing this document, the Navy used the best available data, science, and information recognized by the relevant and appropriate regulatory and scientific communities to establish a baseline in the environmental analyses for all resources in accordance with NEPA (Section 102(2)(A)), the Administrative Procedure Act (5 U.S.C. sections 551–596), and EO 12114.

In support of the environmental baseline and environmental consequences sections for this and other environmental documents, the Navy has sponsored and supported both internal and independent research and monitoring efforts. The Navy's research and monitoring programs, as described below, are largely focused on filling data gaps and obtaining the most up-to-date science.

3.0.1.1 Marine Species Monitoring and Research Programs

Through the Commander, U.S. Pacific Fleet Environmental Readiness Program; U.S. Navy Marine Species Monitoring Program; Living Marine Resources Program; ONR; USCG environmental programs; and other programs and offices, the Navy has sponsored research and monitoring for over 30 years. The USCG also spends tens of millions of dollars annually protecting living marine resources through its maritime response, prevention, and law enforcement missions, which have a direct and positive impact on the maritime environment. Additional details are provided in Table 3.0-1.

Table 3.0-1: Marine Species Monitoring and Research Programs

Research Sponsor	Research Focus	Additional Information
U.S. Navy Marine Species Monitoring Program	The U.S. Navy Marine Species Monitoring Program was established to meet regulatory compliance requirements under the MMPA and ESA. This program focuses on improving the broader scientific understanding of protected marine species across Study Areas, including species occurrences, responses to stressor exposure, and consequences of stressor exposure on individuals and populations. The monitoring program coordinates its investments across all regions where the Navy conducts military readiness activities, and it allocates resources based on a set of standardized objectives through what is known as the Integrated Comprehensive Monitoring Program. Program goals and objectives were developed in coordination with NMFS and in consultation with a Science Advisory Group and other regional experts. The monitoring program is designed to be flexible, scalable, and adjustable to periodically assess progress and reevaluate objectives. Detailed and specific studies that support the Action Proponents' and NMFS's top-level monitoring goals will continue to be developed through what is known as the Strategic Planning Process. Monitoring methods include a combination of field techniques, including visual surveys, passive acoustic monitoring, short- and long-term animal tagging, biopsy sampling, and photo-identification. The monitoring program uses a combination of techniques so that detection and observation of marine animals is maximized and meaningful information can be derived to address monitoring objectives.	Monitoring data are available to the public on the webpages of the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations webpage (http://seamap.env.duke.edu/) and Animal Telemetry Network (https://ioos.noaa.gov/project/atn/), and through collaborations such as the National Oceanic and Atmospheric Administration's Passive Acoustic Cetacean Map (https://apps-nefsc.fisheries.noaa.gov/pacm/#/) and WhaleMap (https://whalemap.org/WhaleMap/). Additional information about the monitoring program, including annual reports, technical reports, publications, and project summaries are provided on the U.S. Navy Marine Species Monitoring webpage (http://www.navymarinespeciesmonitoring.us/).

Table 3.0-1: Marine Species Monitoring and Research Programs (continued)

Research Sponsor	Research Focus	Additional Information
Living Marine Resources Program	The Living Marine Resources program's fundamental mission supports the ability for uninterrupted training and testing by broadening the use of or improving the technology and methods available to the U.S. Navy Marine Species Monitoring Program, and improving best available science on potential impacts of military readiness activities on marine species. Sponsored research covers four main investment areas: (1) data to support risk threshold criteria, (2) data analysis and processing tools, (3) technology demonstrations, and (4) standards and metrics. Research on data to support risk threshold criteria is used to support the acoustic effects analyses as discussed in the Marine Mammal Auditory Weighting Functions and Exposure Functions for U.S. Navy Phase IV Acoustic Effects Analyses Technical Report and Sea Turtle Auditory Criteria and Thresholds for U.S. Navy Phase IV Acoustic Effects Analyses Technical Report.	For publications, program reports, and details about current and completed projects, see the Living Marine Resources program webpage (https://exwc.navfac.navy.mil/LMR).
U.S. Navy Office of Naval Research	The ONR's Marine Mammals and Biology program supports basic and applied research and technology development related to understanding the effects of sound on marine mammals. The program focuses on characterizing and understanding behavioral, ecological, physiological, and population-level impacts on marine mammals, primarily from exposure to sonar. Sponsored research across five main concentration areas (monitoring and detection, integrated ecosystem research, sensing and tag development, effects of sound on marine life, and models and databases) focuses on improving marine mammal monitoring capabilities by developing technology such as passive acoustics, infrared, tags and sensors, and detection and signal processing software. An example of a recent success is the adaptation of autonomous ocean gliders for timely, reliable, accurate, and actionable marine mammal monitoring. A key goal is to make technologies available to the broader research and Navy communities.	For additional information, see the program's webpage (https://www.nre.navy.mil/organization/departments/code-32/division-322/marine-mammals-and-biology).

Notes: MMPA = Marine Mammal Protection Act, ESA = Endangered Species Act, NMFS = National Marine Fisheries Service, ONR = Office of Naval Research

3.0.1.2 Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals

When an activity introduces sound or explosive energy into the marine environment, the potential impacts on marine species are analyzed to obtain a quantitative value for the impact. The density of animals of each species and stock, along with criteria and thresholds, which define the levels of sound and energy that may cause certain types of impacts, is used to conduct the analysis. The Navy's acoustic effects model incorporates the density and the criteria and thresholds as inputs and analyzes training and testing activities. A detailed explanation of this analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase IV Training and Testing*.

3.0.1.2.1 Marine Species Density Database

A quantitative analysis of impacts on a species requires data on their abundance and distribution in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. Estimating marine species density requires substantial surveys and effort to collect and analyze data to produce a usable estimate. NMFS is the primary agency responsible for estimating marine mammal and sea turtle density within the U.S. Exclusive Economic Zone (EEZ). Other agencies and independent researchers often publish density data for species in specific areas of interest, including areas outside the U.S. EEZ. In areas where surveys have not produced adequate data to allow robust density estimates, methods such as model extrapolation from surveyed areas, Relative Environmental Suitability (habitat) models, or expert opinion are used to estimate occurrence. These density estimation methods rely on information such as animal sightings from adjacent locations, amount of survey effort, and the associated environmental variables (e.g., depth, sea surface temperature).

There is no single source of density data for every area of the world, species, and season because of the fiscal, resource, and practical limitations, as well as the level of effort required to provide survey coverage to sufficiently estimate density. Therefore, to characterize marine species density for large areas, such as the Study Area, the Navy compiled data from multiple sources and developed a protocol to select the best available density estimates based on species, area, and time (i.e., season).

The resulting Geographic Information System database includes density values, defined seasonally where possible, for every marine mammal and sea turtle species present within the Study Area. This database is described in the technical report *U.S. Navy Marine Species Density Database Phase IV for the Hawaii-California Training and Testing Study Area*. These data are used as an input into the Navy Acoustic Effects Model.

3.0.1.2.2 Developing Acoustic and Explosive Criteria and Thresholds

Information about the numerical sound and energy levels that are likely to elicit certain types of physiological and behavioral reactions is needed to analyze potential impacts to marine species. Phase IV criteria and thresholds for quantitative modeling of impacts use the best available existing data from scientific journals, technical reports, and monitoring reports to develop thresholds and functions for estimating impacts on marine species. A detailed description of the Phase IV acoustic and explosive criteria and threshold development is included in the supporting technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase IV)* (U.S. Department of the Navy, In Progress).

3.0.1.2.3 The Navy's Acoustic Effects Model

The Navy Acoustic Effects Model was developed to conduct a comprehensive acoustic impact analysis for use of sonars, air guns, and explosives[1] in the marine environment. This model considers the physical environment, including bathymetry, seafloor composition/sediment type, wind speed, and sound speed profiles, to estimate propagation loss. The propagation information combined with data on the locations, numbers, and types of military readiness activities and marine resource densities provides estimated numbers of effects to each stock.

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

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

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

- Broadband sonar bins are split into one octave sub-bins, propagation calculations performed, and then the energy in each one-octave bin is summed at the receiver (i.e., animat). Broadband sources were represented and modeled in previous analyses using only the source's center frequency. Using the full frequency spectrum of the source, as opposed to only the center frequency, may lead to higher weighted received levels for some hearing groups, dependent on the overlap of source frequencies with the auditory range of the hearing group. This will increase sound exposure level (SEL)-based impacts (i.e., temporary threshold shift [TTS] and auditory injury [AINJ]) for broadband sources in this analysis versus prior analyses for the same event. Sometimes in prior analyses, broadband sonar sources were not analyzed for some hearing groups if the center frequency was beyond the group's frequency cutoffs. Now considering the full broadband frequency spectra of the signal, some previously discounted hearing groups are now assessed for impacts from those sources.
- The impulsive propagation model was updated to use an equation that was more suitable for use in water. The total peak pressure and overall energy of both equations is the same and not expected to result in significant differences in estimates for the number of non-auditory injury, AINJ, TTS, or behavioral effects. However, because of the slower decay time of the updated equation, there would be a slight increase in modeled non-auditory injury and mortality as compared to prior analyses.
- Animal avoidance of high sources levels was incorporated into the Navy Acoustic Effects Model, with marine mammal avoidance thresholds based on their sensitivity to behavioral response. Some species that are less sensitive to behavioral response (i.e., most odontocetes and

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

mysticetes) had less reduction in AINJ due to avoidance than in the prior analysis, leading to higher AINJ estimates.

3.0.2 Effects Analysis Framework

Consistent with the revised NEPA regulations promulgated by the CEQ on May 1, 2024, the Navy as the lead agency must determine the environmental consequences of the Proposed Action and reasonable alternatives. Per 40 CFR 1502.16(a), a comparison of the proposed action and reasonable alternatives is based on the reasonably foreseeable effects of their activities and the significance of those effects under the criteria presented in 40 CFR section 1501.3.

A significance determination under 1501.3(d) considers the context of the action and the intensity of the effect to determine the significance of reasonably foreseeable adverse effects of activities under the proposed action. A significance determination is only required for activities that have reasonably foreseeable adverse effects on the human environment based on the eight listed factors in 1501.3(d)(2) (Table 3.0-2). To this end, the significance determination analysis reaches a significant/less than significant conclusion only for activities with reasonably foreseeable adverse effects on any of the listed factors. This avoids conflating the degree of adverse effects on a particular resource with the holistic look at activity effects on the human environment, as explained by the CEQ regulations. Ultimately, the significance determinations in subsequent sections are used to compare environmental consequences amongst the alternatives.

Table 3.0-2: Factors to Consider for Intensity of Effects

Agencies shall analyze the intensity of effects considering the following factors, as applicable to the proposed action and in relationship to one another:
1) The degree to which the action may adversely affect public health and safety.
2) The degree to which the action may adversely affect unique characteristics of the geographic area such as historic or cultural resources, parks, Tribal sacred sites, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
3) Whether the action may violate relevant Federal, State, Tribal, or local laws or other requirements or be inconsistent with Federal, State, Tribal, or local policies designed for the protection of the environment.
4) The degree to which the potential effects on the human environment are highly uncertain
5) The degree to which the action may adversely affect resources listed or eligible for listing in the National Register of Historic Places.
6) The degree to which the action may adversely affect an endangered or threatened species or its habitat, including habitat that has been determined to be critical under the Endangered Species Act of 1973.
7) The degree to which the action may adversely affect communities with environmental justice concerns.
8) The degree to which the action may adversely affect rights of Tribal Nations that have been reserved through treaties, statutes, or Executive Orders.

3.0.3 Overall Approach to Analysis

The overall approach to analysis in this EIS/OEIS is consistent with the approach used in previous analyses and included the following general steps:

- Determine if information about the affected environment has changed.
- Identify new or changed actions.
- Identify resources (e.g., biological resources, air quality, and cultural resources) and stressors (e.g., physical disturbance and strike, acoustic, and entanglement) for analysis.

- Analyze resource-specific impacts for individual stressors by reviewing and applying new literature, including science, surveys, and information on how resources could be affected by stressors.
- Analyze resource-specific impacts for multiple stressors.
- Review and consider comments received from members of the public and other stakeholders during scoping.
- Identify past, present, and reasonably foreseeable future actions to analyze the cumulative impacts.
- Consider mitigation measures to reduce identified potential impacts.

Stressor: an agent, condition, or other stimulus that causes stress to an organism or alters physical, socioeconomic, or cultural resources.

Military readiness activities that comprise the Proposed Action may produce one or more stimuli that cause stress on a resource. Each proposed activity was examined to determine its potential stressors. The term stressor is broadly used in this document to refer to an agent, condition, or other stimulus that causes stress to an organism or alters physical, socioeconomic, or cultural resources. Not all stressors affect every resource, nor do all proposed activities produce all stressors. See Appendix B to see the relationship of stressors to activities and stressors to resources.

The potential direct, indirect, and cumulative impacts of the Proposed Action were analyzed based on these potential stressors being present within range of the resource. Data sets used for analysis were considered across the full spectrum of military readiness activities for the foreseeable future. For the purposes of analysis and presentation within this EIS/OEIS, data were organized and evaluated in 1-year increments. Direct impacts result when an action and a resource occur at the same time and place. Indirect impacts result when a direct impact on one resource induces an impact on another resource (referred to as a secondary stressor). Indirect impacts would be reasonably foreseeable because of a functional relationship between the directly impacted resource and the secondarily impacted resource. For example, a change in water quality could also result in impacts on those resources that rely on water quality, such as marine animals and public health and safety. Cumulative effects or impacts are the incremental impacts of the action added to other past, present, and reasonably foreseeable future actions.

First, a preliminary analysis was conducted to determine the environmental resources potentially impacted and associated stressors. Second, each resource was analyzed for potential effects of individual stressors if those stressors would have reasonably foreseeable adverse effects. This was followed by an analysis of the combined impacts of all stressors related to the Proposed Action. Last, a cumulative impact analysis was conducted (Chapter 4).

In this sequential approach, the initial analyses were used to develop each subsequent step so the analysis focused on relevant issues (defined during scoping) that warranted the most attention. The systematic nature of this approach allowed the Proposed Action with the associated stressors and potential impacts to be effectively tracked throughout the process. This approach provides a comprehensive analysis of applicable stressors and potential impacts. Each step is described in more detail below.

3.0.3.1 Resources and Issues Evaluated

Categories of resources evaluated include physical (air quality, sediments and water quality); biological resources (including threatened and endangered species), such as habitats, vegetation, invertebrates, fishes, marine mammals, reptiles, and birds; and human resources (e.g., cultural resources, socioeconomic resources and environmental justice, and public health and safety). These resources each have unique stressors described in their respective sections of Chapter 3.

The evaluation concluded that the stressors associated with the Proposed Action would not result in any reasonably foreseeable adverse effects on two resource areas: Sediments and Water Quality, and Public Health and Safety. These resource areas remain included in this Draft EIS/OEIS to document and support the analysis leading to this conclusion.

3.0.3.2 Resources and Issues Eliminated from Further Consideration

This EIS/OEIS analyzes only activities that affect resources that are beneath, on, or over the ocean. Therefore, some resource areas are not analyzed. Resources and issues considered but not carried forward for further consideration include land use, demographics, and children’s health and safety. Land use and demographics were not further considered because the effects associated with the Proposed Action occur at sea away from human populations and would not result in a change in the land use or demographics within the coastal areas that abut the Study Area. To the extent an action originated from land but has impacts at sea (missile and target launches from SNI and PMRF as noted in Chapter 2, Section 2.1 of this EIS/OEIS), the land activities have been evaluated in other environmental analyses that may be re-evaluated periodically. EO 13045 was not considered because all of the proposed activities occur in the ocean, where there are no child populations present. Therefore, the Proposed Action would not lead to disproportionate risks to children that result from environmental health risks or safety risks.

3.0.3.3 Identifying Stressors for Analysis

The proposed military readiness activities were evaluated to identify specific components that could act as stressors by having direct or indirect impacts on the environment. This analysis considers the locations where activities may occur (i.e., spatial variation). Matrices were prepared to identify associations between stressors, resources, and the spatial relationships of those stressors, resources, and activities within the Study Area under the Proposed Action. Each stressor includes a description of activities that may generate the stressor.

A preliminary analysis identified the stressor/resource interactions that warrant further analysis in this EIS/OEIS based on public comments received during scoping, previous NEPA analyses, and professional opinions of subject matter experts. Stressor/resource interactions that were determined to have negligible or no impacts were not carried forward for analysis in this EIS/OEIS.

In subsequent sections, tables are provided in which the annual number of events that could involve a particular stressor are totaled by alternative and by location, within the categories of training and testing. It is important to note that the various tables are not exclusive of each other, and that the stressors from a single named activity from Chapter 2 could show up on several tables. For example, the activity ASW Tracking Exercise – Helicopter could include acoustic stressors (Table 3.0-3), physical disturbance stressors (Table 3.0-23), strike stressors (Table 3.0-21), entanglement stressors (Table 3.0-24), and ingestion stressors (Table 3.0-18, Table 3.0-19, Table 3.0-21, and (Table 3.0-26). Also, activities are not always conducted independently of each other. For example, there are instances where a training activity could occur on a vessel while another training activity or a testing activity is being conducted on the same vessel simultaneously. Finally, note that some of the tables that follow in this section count individual items expended (e.g., Table 3.0-20) while others count the annual number of events in which that stressor could occur at least once during the conduct of that activity (e.g., Table 3.0-22).

3.0.3.3.1 Acoustic Stressors

The categories of acoustic sources identified for analysis in this EIS/OEIS are the same as those in the 2018 HSTT EIS/OEIS (sonar and other transducers, pile driving, vessel noise, aircraft noise, weapons noise, and air guns). Detailed information describing these sources can be found in Appendix D.

In order to better organize and facilitate the analysis of hundreds of individual sources of underwater sound produced by the Action Proponents, including sonars and explosives, a schema of source bins was previously developed and is used in this study. A fuller description of the schema and the benefit of using this method is described in more detail in the Technical Report "*Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase IV Training and Testing*."

In previous phases, non-impulsive, narrow-band sources were grouped into bins that were defined by their acoustic properties and in some cases, their purpose or application. For Phase IV, binning by purpose or application is being revised, and sources are binned based only on their acoustic properties. As in previous phases, each bin was represented by the most impactful characteristics of any source within that bin. Specifically, bin parameters were based on (1) highest source level, (2) lowest geometric mean frequency, (3) highest duty cycle, and (4) largest horizontal and vertical beam patterns.

Breaking the bins up to represent smaller ranges of acoustic properties resulted in bin parameters that more closely match those of the sources contained within. In binning sources for the purpose of modeling, the combination of the four parameters above allowed for over 1,000 potential unique bins. While HCTT military readiness activities only use sources falling into a small number of these potential bins, the binning construct allows for easy addition of bins as required in the future. For this EIS/OEIS, bins will only be described by their frequency (low, medium, high, or very high) and their source level (low, medium, or high), resulting in 12 individual non-impulsive acoustic bins.

In many cases, sources that previously fell into one purpose-based bin now fall into multiple bins. Likewise, sources with similar acoustic parameters that were previously broken into separate bins due to different purposes now share a bin. As a result, the new bins do not represent a one-for-one replacement in comparison to bins used in previous EIS/OEIS phases, and a crosswalk table between the old bins and new bins is not possible. An exception to the new naming convention was retention of "MF1" and "MF1K" to represent the hull-mounted surface ship sonar that was previously in the MF1 and MF1K bins. The retention of these names was to allow for clear comparison to past documents due to the extensive use of these sources in training and testing activities.

Separate from the acoustic bins described above, explosives were divided into bins E0–E16, with HCTT training and testing using explosives falling into only 14 of these explosives bins. Broadband sources were divided into bins BB1–BB27, with HCTT training and testing using only sources falling into 12 of these broadband bins, which were further generalized into 4 bins. As in previous studies, some sources were removed from quantitative analysis because they are not anticipated to result in takes of protected species. These sources are typically referred to as de minimis and include those with low source level, narrow beamwidth, downward-directed transmission, short pulse lengths, frequencies above known hearing ranges of marine mammals and sea turtles, or some combination of these factors, as well as sources used for safety of navigation.

Sonars and other transducers are now grouped into bins based on the frequency or bandwidth, source level, duty-cycle, and three-dimensional beam coverage.

The use of source bins provides the following benefits:

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

Table 3.0-3 shows the broadband and non-impulsive bin use that could occur in any year under each action alternative for military readiness activities. A range of annual bin use indicates that use of that bin is anticipated to vary annually, consistent with the variation in the number of annual activities described in Chapter 2.

Table 3.0-3: Sonar and Transducer Sources Quantitatively Analyzed

Source Class Category	Description	Unit	Annual Training		Annual Testing	
			Alternative 1	Alternative 2	Alternative 1	Alternative 2
Broadband Sources						
LF	<205 dB	H	-	-	430–570	430–570
LF to HF		C	804–818	804–818	686–859	686–859
		H	-	-	1,662–2,077	1,670–2,077
LF to MF		H	-	-	2,801–2,833	2,801–2,833
MF to HF		H	8,082–11,585	10,047–11,585	1,451–1,779	1,451–1,779
Low-Frequency Acoustic Sources						
LFL	160 dB to 185 dB	H	-	-	12	12
LFM	185 dB to 205 dB	C	-	-	1,160–1,384	1,384
		H	468–536	468–536	7,531–8,984	9,031–9,056
LFH	>205 dB	C	1,493–2,120	1,863–2,120	6,046–6,704	6,704
		H	14	14	4,050–6,050	4,230–6,050
Mid-Frequency Acoustic Sources Other Than Hull-Mounted						
MFL	160 dB to 185 dB	H	-	-	12,632–14,982	12,632–14,982
MFM	185 dB to 205 dB	C	4,890–6,552	5,568–6,552	15,080–16,928	16,698–16,928
		H	30	30	14,381–16,081	14,747–16,129
MFH	>205 dB	H	1,942–3,003	2,831–3,003	8,115–10,424	8,389–10,448
Hull-Mounted Surface Ship Sonar						
MF1C	Hull-mounted surface ship sonar (previously MF11) with duty cycle >80%	H	796–1,406	1,315–1,406	45	45
MF1K	Hull-mounted surface ship sonar (previously MF1K) in Kingfisher mode	H	455	455	14	14
MF1	Hull-mounted surface ship sonar (previously MF1)	H	5,084–8,758	8,146–8,758	413–917	413–917
High-Frequency Acoustic Sources						
HFL	160 dB to 185 dB	H	60	60	21,326–22,076	21,326–22,076
HFM	185 dB to 205 dB	C	9	9	1,800–2,346	2,346
		H	3,907–5,290	5,266–5,290	12,409–13,259	12,762–13,307
HFH	>205 dB	C	801–899	804–899	835–1,137	876–1,137
		H	2,419–2,498	2,494–2,498	1,367–1,920	1,409–1,920

Table 3.0-3: Sonar and Transducer Sources Quantitatively Analyzed (continued)

Source Class Category	Description	Unit	Annual Training		Annual Testing	
			Alternative 1	Alternative 2	Alternative 1	Alternative 2
Very High-Frequency Acoustic Sources						
VHFL	160 dB to 185 dB	H	30	30	9,160	9,160
VHFM	185 dB to 205 dB	H	-	-	96	120
VHFH	>205 dB	C	-	-	72–106	72–106
		H	5,458–7,862	6,362–7,862	12,544–16,824	12,544–16,824

Notes: dB = decibel(s), H = hours; C = count; LF = low frequency; MF = mid frequency; HF = high frequency; VHF = very high frequency; the third letter following LF, MF, HF, and VHF corresponds to: L = low power, M = medium power, H = high power; when following “MF1” C = duty cycle > 80%, K = Kingfisher mode.

3.0.3.3.1.1 Air Guns

Air guns are essentially stainless-steel tubes charged with high-pressure air via a compressor. An impulsive sound is generated when the air is almost instantaneously released into the surrounding water, providing a consistent sound source used to evaluate performance capabilities of acoustic sensor systems. Small air guns with capacities up to 60 cubic inches would be used during testing activities in the offshore areas of the Study Area. Table 3.0-4 shows the number of air gun shots proposed in the HCTT Study Area.

Table 3.0-4: Air Gun Sources Quantitatively Analyzed

Source Class Category	Bin	Unit	Annual Training	Annual Testing
Air Guns (AG): small underwater air guns	AG	Count	0	30,432–36,780

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

3.0.3.3.1.2 Pile Driving

Impact pile driving and vibratory pile removal would occur during training for Port Damage Repair, an activity that trains forces to repair critical port facilities.

Table 3.0-5 summarizes the number of piles that would be installed (Impact) or removed (Vibratory) during Port Damage Repair activities annually and over a 7-year period.

Table 3.0-5: Summary of Pile Driving and Removal Activities During Port Damage Repair

Method	Alternative 1		Alternative 2	
	Annual	7-Year	Annual	7-Year
Impact	864	6,048	864	6,048
Vibratory	4,248	29,736	4,248	29,736

Pile driving for the Port Damage Repair would occur in shallower water at Port Hueneme, California. Sound from in-water pile driving could be transmitted on direct paths through the water, be reflected at the water surface or bottom, or travel through bottom substrate. Soft substrates such as sand bottom would absorb or attenuate the sound more readily than hard substrates (rock), which may reflect the acoustic wave.

Impact pile driving would involve the use of an impact hammer with both it and the pile held in place by a crane. When the pile driving starts, the hammer part of the mechanism is raised up and allowed to fall, transferring energy to the top of the pile. The pile is thereby driven into the sediment by a repeated series of these hammer blows. Each blow results in an impulsive sound emanating from the length of the pile into the water column as well as from the bottom of the pile through the sediment. Broadband impulsive signals are produced by impact pile driving methods, with most of the acoustic energy concentrated below 1,000 hertz (Hz) (Hildebrand, 2009b).

Vibratory installation and extraction would involve the use of a vibratory hammer suspended from the crane and attached to the top of a pile. The pile is then vibrated by hydraulic motors rotating eccentric weights in the mechanism, causing a rapid vibration of the pile. The vibration and the weight of the hammer applying downward force drives the pile into the sediment. During removal, the vibration causes the sediment particles in contact with the pile to lose frictional grip on the pile. The crane slowly lifts the vibratory extraction hammer and pile until the pile is free of the sediment. In some cases, the crane may be able to lift the pile without the aid of an extraction hammer (i.e., dead pull), in which case no noise would be introduced into the water. Vibratory driving and removal create broadband, non-impulsive noise at low source levels, for a short duration with most of the energy dominated by lower frequencies (Hildebrand, 2009a).

Table 3.0-6 summarizes the sound levels selected for use in the acoustic analysis for each pile size and type to be used during Port Damage Repair activities.

Table 3.0-6: Summary of Pile Driving and Removal Activities During Port Damage Repair

Pile Descriptions	Unattenuated Single Strike Level (dB)			Unattenuated SPL (dB rms)
	Peak SPL	RMS	SEL	
Impact (install only)				
12 to 20-inch Timber Round Piles[1]	180	170	160	-
12 to 20-inch Steel H-Piles[2]	195	180	170	-
12 to 20-inch Steel, Timber or Composite Round Piles[3]	203	189	178	-
Vibratory (install and/or remove)				
18 or 27.5-inch steel or FRP Z-piles[4]	-	-	-	159
12 to 20-inch Steel, Timber or Composite Round or H-Piles[5]	-	-	-	166

Sources: (1) 14-inch round timber piles (Caltrans, 2020); (2) 14-inch steel H-beam piles (Caltrans, 2020); (3) 24-inch steel pipe piles (Illingworth and Rodkin Inc., 2007); (4) 25-inch steel sheet piles (Naval Facilities Engineering Systems Command Southwest, 2020); (5) 24-inch steel piles (Washington State Department of Transportation, 2010).

In addition to underwater noise, the installation and removal of piles would also result in airborne noise in the environment. Impact pile driving creates in-air impulsive sound up to a maximum of 114 dB re 20 µPa (unweighted) at a range of 15 meters (m) for 24-inch (in.) and 36-in. steel piles (Illingworth and Rodkin, 2015, 2017; Illingworth and Rodkin Inc., 2013). Reported sound levels for vibratory driving or extraction would be lower than that produced during impact driving (e.g., 94 dB re 20 µPa within a range of 10–15 m).

3.0.3.3.1.3 Vessel Noise

See Appendix D, Section D.2.2.1, for a discussion of vessel noise in the HCTT Study Area.

3.0.3.3.1.4 Aircraft Noise

Fixed-wing, tiltrotor, and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area, contributing both airborne and underwater sound to the ocean environment. Sounds in air are often measured using A-weighting, which adjusts received sound levels based on human hearing abilities. Aircraft used in training and testing generally have turboprop, or jet engines. Motors, propellers, and rotors produce the most noise, with some noise contributed by aerodynamic turbulence. Aircraft sounds have more energy at lower frequencies. Aircraft may transit to or from vessels at sea throughout the Study Area from established airfields on land. Takeoffs and landings occur at established airfields as well as on vessels across the Study Area. Takeoffs and landings from Navy vessels produce in-water noise at a given location for a brief period as the aircraft climbs to cruising altitude. Kuehne et al. (2020) observed EA-18G aircraft during takeoff and landing and detected broadband noise (20 Hz – 20 kHz) at received levels as high as 119 dB re 20 µPa at a water depth of 30 m. Military activities involving aircraft generally are dispersed over large expanses of open ocean but can be highly concentrated in time and location. Table 3.0-7 provides source levels for some typical aircraft used during training and testing in the Study Area and depicts comparable airborne source levels for the F-35A, EA-18G, and F/A-18C/D during takeoff.

Table 3.0-7: Representative Aircraft Sound Characteristics

Noise Source	Sound Pressure Level
In-Water Noise Level	
F/A-18 Subsonic at 1,000 ft. (300 m) Altitude	152 dB re 1 µPa at 2 m below water surface[1]
F/A-18 Subsonic at 10,000 ft. (3,000 m) Altitude	128 dB re 1 µPa at 2 m below water surface[1]
H-60 Helicopter Hovering at 82 ft. (25 m) Altitude	Approximately 125 dB re 1 µPa at 1 m below water surface[2*]
Airborne Noise Level	
F/A-18C/D Under Military Power	143 dBA re 20 µPa at 13 m from source[3]
F/A-18C/D Under Afterburner	146 dBA re 20 µPa at 13 m from source[3]
F35-A Under Military Power	145 dBA re 20 µPa at 13 m from source[3]
F-35-A Under Afterburner	148 dBA re 20 µPa at 13 m from source[3]
H-60 Helicopter Hovering at 82 ft. (25 m) Altitude	113 dBA re 20 µPa at 25 m from source[2]
H-60 Helicopter Hovering at 82 ft. (25 m) Altitude	113 dBA re 20 µPa at 25 m from source[2]
F-35A Takeoff Through 1,000 ft. (300 m) Altitude	119 dBA re 20 $\mu Pa^2 s$[4**] (per second of duration)
EA-18G Takeoff Through 1,622 ft. (500 m) Altitude	115 dBA re 20 $\mu Pa^2 s$ [5**] (per second of duration)

Sources: [1]Eller and Cavanagh (2000) [2]Bousman and Kufeld (2005); [3]U.S. Naval Research Advisory Committee (2009), [4]U.S. Department of the Air Force (2016), [5]U.S. Department of the Navy (2012)
* estimate based on in-air level
**average sound exposure level
Notes: dB re 1 µPa = decibel(s) referenced to 1 micropascal, dBA re 20 µPa = A-weighted decibel(s) referenced to 20 micropascals, m = meter(s), ft. = feet

An intense but infrequent type of aircraft noise is the sonic boom, produced when an aircraft exceeds the speed of sound. Supersonic flight over land or within 30 miles offshore would be conducted only in specifically designated areas. As a general policy, sonic booms would not be intentionally generated below 30,000 feet (ft.) of altitude unless over water and more than 30 miles from inhabited land areas or islands. However, deviation from these guidelines may be authorized for tactical missions that require supersonic flight, phases of formal training requiring supersonic speeds, research and test flights that require supersonic speeds, and for flight demonstration purposes when authorized by the Chief of Naval Operations (U.S. Department of the Navy, 2016a).

In air, the energy from a sonic boom is concentrated in the frequency range from 0.1 to 100 Hz. The underwater sound field due to transmitted sonic boom waveforms is primarily composed of low-frequency components (Sparrow, 2002). Frequencies greater than 20 Hz have been found to be difficult to observe at depths greater than 33 ft. (10 m) (Sohn et al., 2000). F/A-18 Hornet supersonic flight was modeled to obtain peak SPLs and energy flux density at the water surface and at depth (U.S. Department of the Air Force, 2000). These results are shown in Table 3.0-8.

Table 3.0-8: Sonic Boom Underwater Sound Levels Modeled for F/A-18 Hornet Supersonic Flight

Mach Number*	Aircraft Altitude (km)	Peak SPL (dB re 1 µPa)			Energy Flux Density (dB re 1 µPa^2-s)[1]		
		At surface	50 m Depth	100 m Depth	At surface	50 m Depth	100 m Depth
1.2	1	176	138	126	160	131	122
	5	164	132	121	150	126	117
	10	158	130	119	144	124	115
2	1	178	146	134	161	137	128
	5	166	139	128	150	131	122
	10	159	135	124	144	127	119

* Mach number equals aircraft speed divided by the speed of sound.

[1] Equivalent to SEL for a plane wave.

Notes: SPL = sound pressure level, dB re 1 µPa = decibel(s) referenced to 1 micropascal, dB re 1 µPa^2-s = decibel(s) referenced to 1 micropascal squared seconds, m = meter(s)

3.0.3.3.1.5 Weapon Noise

The Navy trains and tests using a variety of weapons, as described in Appendix A. Depending on the weapon, incidental (unintentional) noise may be produced at launch or firing, while in flight, or upon impact. Other devices intentionally produce noise to serve as a non-lethal deterrent. Not all weapons utilize explosives, either by design or because they are non-explosive practice munitions. Noise produced by explosives, both in air and water, are discussed in Section 3.0.3.3.2.

Noise associated with large-caliber weapons firing, missile firing, target launching, and the impact of non-explosive practice munitions or kinetic weapons would typically occur at locations greater than 12 nautical miles (NM) from shore in warning areas or special use airspace for safety reasons, with the exception of areas near SCI and SNI in the California Study Area and PMRF in the Hawaii Study Area. Small- and medium-caliber weapons firing could occur throughout the Study Area in identified training areas.

Examples of some types of weapons noise are shown in Table 3.0-9. Noise produced by other weapons and devices are described further below.[2]

Table 3.0-9: Example Weapons Noise

Noise Source	Sound Level
In-Water Noise Level	
Naval Gunfire Muzzle Blast (5-inch)	Approximately 200 dB re 1 µPa peak directly under gun muzzle at 1.5 m below the water surface[1]
Airborne Noise Level	
Naval Gunfire Muzzle Blast (5-inch)	178 dB re 20 µPa peak directly below the gun muzzle above the water surface[1]
Hellfire Missile Launch from Aircraft	149 dB re 20 µPa at 4.5 m[2]
RIM 116 Surface-to-Air Missile	122–135 dBA re 20 µPa between 2 and 4 m from the launcher on shore[3]

Sources: [1]Yagla and Stiegler (2003); [2](U.S. Department of the Army, 1999); [3](Investigative Science and Engineering, 1997)
Notes: dB re 1 µPa = decibel(s) referenced to 1 micropascal, dB re 20 µPa = decibel(s) referenced to 20 micropascals, dBA re 20 µPa = A-weighted decibel(s) referenced to 20 micropascals, m = meter(s)

3.0.3.3.2 Explosive Stressors

This section describes the characteristics of explosions during military training and testing and provides the basis for analysis of explosive impacts on resources in the remainder of Chapter 3. The activities analyzed in the EIS/OEIS that use explosives are described in Appendix A. Explanations of the terminology and metrics used when describing explosives in this EIS/OEIS are in Appendix D.

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

In order to better organize and facilitate the analysis of training and testing activities using explosives that could detonate in water or at the water surface, explosive classification bins based on net explosive weight were developed and are shown in Table 3.0-10. The use of explosive classification bins provides the same benefits as described for acoustic source classification bins in Section 3.0.3.3.1.

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[2] While the island of Ka'ula is used for non-explosive practice munitions training, there are not reasonably foreseeable at-sea effects, therefore the training is being evaluated in the ongoing analysis of the PMRF Land Based Training and Testing EA.

Table 3.0-10: Explosive Sources Quantitatively Analyzed that Could be Used Underwater or at the Surface

Bin	Net Explosive Weight	Example Explosive Source	Annual Training	Annual Testing
E1	0.1–0.25	Medium-caliber projectile	1,750–4,303	7,305–7,430
E2	> 0.25–0.5		2,950–3,000	-
E3	> 0.5–2.5	2.75-in. rocket	5,588–5,870	4,744–6,568
E4	> 2.5–5	Mine neutralization charge	179–190	1,324–2,624
E5	> 5–10	5 in. projectile	5,059–5,984	2,024–2,676
E6	> 10–20	Hellfire missile	2,293–2,357	144–148
E7	> 20–60	Demo block/shaped charge	115–190	549–622
E8	> 60–100	Lightweight torpedo	3–5	213–234
E9	> 100–250	500 lb. bomb	386–408	111–115
E10	> 250–500	Harpoon missile	89	13
E11	> 500–675	650 lb. mine	7–11	1–2
E12	> 675–1,000	2,000 lb. bomb	17–19	-
E13	> 1,000–1,740	Underwater demolitions – large area clearance	6	-
E16	10,000	Ship shock detonation	-	0–3

Notes: > = greater than; in. = inch; lb. = pound

3.0.3.3.3 Energy Stressors

This section describes the characteristics of energy introduced through military readiness activities and the relative magnitude and location of these activities to provide the basis for analysis of potential impacts on resources from in-water electromagnetic devices, high-power microwave systems, and high-energy lasers.

3.0.3.3.3.1 In-Water Electromagnetic Devices

In-water electromagnetic energy devices include towed or unmanned mine warfare systems that simply mimic the electromagnetic signature of a vessel passing through the water. None of the devices include any type of electromagnetic “pulse.” A mine neutralization device could be towed through the water by a surface vessel or remotely operated vehicle, emitting an electromagnetic field and mechanically generated underwater sound to simulate the presence of a ship. The sound and electromagnetic signature cause nearby mines to detonate.

Generally, voltage used to power these systems is around 30 volts. Since saltwater is an excellent conductor, just 35 volts (capped at 55 volts) is required to generate the current. These are considered safe levels for marine species due to the low electric charge relative to salt water.

The static magnetic field generated by the mine neutralization devices is of relatively minute strength. Typically, the maximum magnetic field generated would be approximately 2,300 microteslas[3]. This level of electromagnetic density is very low compared to magnetic fields generated by other everyday items. The magnetic field generated is between the levels of a refrigerator magnet (15,000–20,000 microteslas) and a standard household can opener (up to 400 microteslas at 4 in.). The strength of the

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[3] The microtesla is a unit of measurement of magnetic flux density, or “magnetic induction.”

electromagnetic field decreases quickly away from the cable. The magnetic field generated is very weak, comparable to the earth's natural field (U.S. Department of the Navy, 2005).

Cables deployed on the seafloor during SOAR modernization, the installation of two Shallow Water Training Ranges, and the deployment of seafloor cables and instrumentation all generate an electromagnetic force (EMF). The EMF produced by the cable is less than that of the natural background magnetic force of the earth at distances beyond 0.6 centimeters (cm) (0.25 in) from the cable. As electromagnetic energy dissipates exponentially by distance from the energy source, the magnetic field from the cable would be equal to 0.1 percent of the earth's at a distance of 6 m (20 ft.). The cables and nodes would be installed at the bottom of the ocean floor, in most cases at a minimum depth of 37 m (120 ft.).

Electromagnetic energy emitted into the water from magnetic influence mine neutralization systems is considered in this document. Table 3.0-11 shows the number and location of proposed activities, primarily mine sweeping, that include the use of in-water electromagnetic devices.

Table 3.0-11: Events Including In-Water Electromagnetic Devices

Activity Area	Annual Training # of Events		Annual Testing # of Events	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Hawaii Study Area	0	0	8–15	15
California Study Area	30	30	14–33	33
Total	**30**	**30**	**22–48**	**48**

3.0.3.3.3.2 High-Power Microwave Systems

Pulsed-wave high-power microwave systems convert electrical or chemical energy into radiated energy and deliver high-power, short bursts of radiofrequency energy to neutralize a target. High-power microwave systems operate within a wide range of frequencies, from 1 megahertz to 100 gigahertz, and transmit energy to a target to degrade or destroy electrical components in the target. High-power microwave systems would be used only during testing activities off California and can be based on land, ships, or aircraft and directed to engage air, land, or surface targets.

Table 3.0-12 shows the number and location of proposed activities that include the use of high-power microwave systems.

Table 3.0-12: Events Including High-Power Microwave Systems

Activity Area	Annual Training # of Events		Annual Testing # of Events	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
California Study Area	0	0	100	100
Total	**0**	**0**	**100**	**100**

3.0.3.3.3.3 High-Energy Lasers

High-energy laser weapons testing involves the use of up to 30 kilowatts of directed energy as a weapon against small surface vessels and airborne targets. High-energy lasers would be employed from surface ships or aircraft and are designed to create small but critical failures in potential targets. Table 3.0-13 shows the number and location of proposed testing events that include the use of high-energy lasers.

Table 3.0-13: Events Including High-Energy Lasers

Activity Area	Annual Training # of Events		Annual Testing # of Events	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Hawaii Study Area	8	8	55–63	63
California Study Area	8	8	555–565	565
Total	**16**	**16**	**610–628**	**628**

3.0.3.3.4 Physical Disturbance and Strike Stressors

This section describes the characteristics of physical disturbance and strike stressors from military readiness activities. It also describes the magnitude and location of these activities to provide the basis for analyzing the potential physical disturbance and strike impacts on resources in the remainder of Chapter 3.

3.0.3.3.4.1 Vessels and In-Water Devices

Vessels used as part of the Proposed Action include ships (e.g., aircraft carriers, surface combatants), support craft, and submarines ranging in size from 15 ft. to over 1,000 ft. Table 3.0-14 provides examples of the types of vessels, length, and speeds used in both training and testing activities. Vessel speeds during modernization and sustainment of ranges activities are much slower, typically 0-3 knots. The U.S. Navy Fact Files, available on the Internet at https://www.navy.mil/Resources/Fact-Files/, provide the latest information on the quantity and specifications of the vessels operated by the Navy. More information about Coast Guard operational assets, including vessels, can be found at https://www.uscg.mil/About/Assets/.

Table 3.0-14: Representative Vessel Types, Lengths, and Speeds

Type	Example(s)	Length	Typical Operating Speed
U.S. Navy Vessels			
Aircraft Carrier	Aircraft Carrier (CVN)	>1,000 ft.	10–15 knots
Surface Combatant	Cruisers (CG), Destroyers (DDG), Frigates (FFG), Littoral Combat Ships (LCS)	300–700 ft.	10–15 knots
Amphibious Warfare Ship	Amphibious Assault Ship (LHA, LHD), Amphibious Transport Dock (LPD), Dock Landing Ship (LSD), Medium Landing Ship (LSM), Stern Landing Vessel (SLV)	200–900 ft.	10–15 knots
Combat Logistics Force Ships	Fast Combat Support Ship (T-AOE), Dry Cargo/Ammunition Ship (T-AKE), Fleet Replenishment Oilers (T-AO)	600–750 ft.	8–12 knots
Support Craft/Other	Amphibious Assault Vehicle (AAV); Combat Rubber Raiding Craft (CRRC); Landing Craft, Mechanized (LCM); Landing Craft, Utility (LCU); Submarine Tenders (AS); Yard Patrol Craft (YP); Range Support; Torpedo Retrievers	15–140 ft.	0–20 knots
Support Craft/Other – Specialized High Speed	High Speed Ferry/Catamaran; Patrol Combatants (PC); Rigid Hull Inflatable Boat (RHIB); Expeditionary Fast Transport (EPF); Landing Craft, Air Cushion (LCAC)	33–320 ft.	0–50+ knots
Submarines	Fleet Ballistic Missile Submarines (SSBN), Attack Submarines (SSN), Guided Missile Submarines (SSGN)	300–600 ft.	8–13 knots

Table 3.0-14: Representative Vessel Types, Lengths, and Speeds (continued)

Type	Example(s)	Length	Typical Operating Speed
U.S. Coast Guard Vessels			
Large cutters	Legend-Class, Heritage-Class, Famous-Class, Juniper-Class, Reliance-Class	181–418 ft.	0–30 knots
Small cutters	Keeper-Class, Sentinel-Class, Bay-Class, Island-Class, Marine Protector-Class, Small Harbor Tug	66–180 ft.	0–30 knots
Boats	Aid to Navigation Boats, Screening Vessels, Lifeboats, Response Boats, Training Boats, Long Range Interceptors, Law Enforcement Boats, Cutterboat Over the Horizon, Transportable Security Boats	13–65 ft.	0–40 knots

Physical disturbance and strike can occur as vessels move through the water and as some smaller craft and amphibious vessels can come into contact with the seafloor in the nearshore environment.

As described earlier in Section 3.0.3.3, activities are not always conducted independently of each other, as there are instances where a training activity could occur on a vessel while another training activity or a testing activity is being conducted on the same vessel simultaneously. The location and hours of Navy vessel usage for military readiness activities are dependent upon the locations of Navy ports, piers, and established at-sea training and testing areas. Table 3.0-15 shows the historic underway days and distribution of Navy and USCG vessels within the HCTT Study Area from 2016 to 2023. The expansion of the HCTT Study Area would support these proposed activities in areas such as PMSR and the NOCAL Range Complex, where the military has a history of operating.

Table 3.0-15: Past Average Annual Underway Days of Navy and Coast Guard Vessels

Activity Area	Navy Underway Days	USCG Underway Days	Total Navy/USCG Underway Days	Underway Distribution by Range
Hawaii Range Complex	401	55	456	20%
SOCAL Range Complex	1,342	183	1,525	67%
PMSR	90	12	102	5%
NOCAL Range Complex	50	7	57	2%
Transit Corridor	120	16	136	6%
Total	**2,003**	**273**	**2,276**	**100%**

Source: Mintz (2024)

Notes: USCG = U.S. Coast Guard, SOCAL = Southern California Range Complex, PMSR = Point Mugu Sea Range, NOCAL = Northern California Range Complex

In-water devices as discussed in this analysis include unmanned vehicles, such as remotely operated vehicles, unmanned surface vehicles, unmanned underwater vehicles, motorized autonomous targets, and towed devices. These devices are self-propelled and unmanned or towed through the water from a variety of platforms, including helicopters, unmanned underwater vehicles, and surface ships. In-water devices are generally smaller than most Navy vessels, ranging from several inches to about 50 ft. Table 3.0-16 provides a range of in-water devices used. Table 3.0-17 shows the number and location of proposed events that include the use of vessels or in-water devices. For a list of activities by name that include the use of in-water devices, see Appendix B.

Table 3.0-16: Representative Types, Sizes, and Speeds of In-Water Devices

Type	Example(s)	Length	Typical Operating Speed
Towed Device	Minehunting Sonar Systems; Improved Surface Tow Target; Towed Sonar System; MK-103, MK-104 and MK-105 Minesweeping Systems	< 33 ft.	10–40 knots
Medium USV	Long Range USV, Common USV, MK-33 Seaborne Power Target Drone Boat, QST-35A Seaborne Powered Target, Ship Deployable Seaborne Target, Small Waterplane Area Twin Hull, Unmanned Influence Sweep System	< 190 ft.	Variable, up to 50+ knots
Large USV	Research and Development Surface Vessels, Patrol Boats, Ranger, USV, Nomad USV, Mariner, Vanguard USV	200 - 300 ft.	Typical 1–15 knots, sprint 25–50 knots
Unmanned Underwater Vehicle (UUV)	Acoustic Mine Targeting System, Airborne Mine Neutralization System, Archerfish Common Neutralizer, Crawlers, CURV 21, Deep Drone 8000, Deep Submergence Rescue Vehicle, Gliders, Expendable Mobile Anti-Submarine Warfare Training Targets, Magnum Remotely Operated Vehicle, Manned Portables, MK 30 Anti-Submarine Warfare Targets, Remote Multi-Mission Vehicle, Remote Minehunting System, Large Displacement UUV, Extra-Large UUV	< 100 ft.	1–15 knots
Torpedoes	Light-weight and Heavy-weight Torpedoes	< 33 ft.	20–30 knots

Note: ft. = feet, USV = Unmanned Surface Vehicle

Table 3.0-17: Number and Location of Events Including Vessels or In-Water Devices

Activity Area	Annual Training # of Events		Annual Testing # of Events	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Vessels				
Hawaii Study Area	5,319–5,727	5,727	248–387	388
California Study Area	19,094–21,003	21,003	2,284–2,661	2,671
Transit Corridor	71–109	109	0	0
Total	**24,484–26,839**	**26,839**	**2,532–3,048**	**3,059**
In-Water Devices				
Hawaii Study Area	3,237–3,907	3,907	378–450	452
California Study Area	7,888–9,139	9,139	2,571–2933	2,940
Transit Corridor	30–64	64	4–5	5
Total	**11,155–13,110**	**13,110**	**2,953–3,388**	**3,397**

3.0.3.3.4.2 Military Expended Materials

Military expended materials (MEM) that may cause physical disturbance or strike include (1) all sizes of non-explosive practice munitions (Table 3.0-18); (2) fragments from high-explosive munitions (Table 3.0-19); (3) expendable targets (Table 3.0-20); and (4) expended materials other than munitions, such as sonobuoys or torpedo accessories (Table 3.0-21). See Appendix I for more information on the type and quantities of MEM proposed to be used.

For living marine resources in the water column, the discussion of MEM strikes focuses on the potential of a strike at the surface of the water. The effect of materials settling on the bottom is discussed as an alteration of the bottom substrate and associated organisms (e.g., invertebrates and vegetation) or as an impact to cultural resources.

Table 3.0-18: Number and Location of Non-Explosive Practice Munitions Expended During Training and Testing Activities

Activity Area	Annual Training # of Items		Annual Testing # of Items	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Bombs				
Hawaii Study Area	358	358	41–46	46
California Study Area	1,216	1,216	64–69	69
Total	**1,574**	**1,574**	**105–115**	**115**
Flechettes				
California Study Area	0	0	72	72
Total	**0**	**0**	**72**	**72**
Large Caliber Projectiles				
Hawaii Study Area	1,416–1,625	1,625	1,196–3,408	3,408
California Study Area	1,757–1,789	1,789	3,509–4,628	4,628
Transit Corridor	63	63	0	0
Total	**3,236–3,477**	**3,477**	**4,705–8,036**	**8,036**
Large Caliber – Casings Only				
Hawaii Study Area	163–185	185	85–195	195
California Study Area	304–306	306	464–602	602
Transit Corridor	33	33	0	0
Total	**500–524**	**524**	**549–797**	**797**
Medium Caliber Projectiles				
Hawaii Study Area	334,680–364,800	365,600	30,250–33,750	33,750
California Study Area	624,020–745,450	745,450	93,950–118,050	118,050
Transit Corridor	3,900–24,300	24,300	0	0
Total	**962,600–1,134,550**	**1,135,350**	**124,200–151,800**	**151,800**
Medium Caliber – Casings Only				
Hawaii Study Area	5,219–6,674	6,690	730–905	905
California Study Area	14,975–20,463	20,463	3,549–4,754	4,754
Transit Corridor	190–1,227	1,227	0	0
Total	**20,384–28,364**	**28,380**	**4,279–5,659**	**5,659**
Missiles				
Hawaii Study Area	8–22	22	44–51	51
California Study Area	0	0	343–412	412
Total	**8–22**	**22**	**387–463**	**463**

Table 3.0-18: Number and Location of Non-Explosive Practice Munitions Expended During Training and Testing Activities (continued)

Activity Area	Annual Training # of Items		Annual Testing # of Items	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Rockets				
Hawaii Study Area	791–1,001	1,001	46–61	61
California Study Area	1,785–1,925	1,925	554–735	735
Transit Corridor	28	28	0	0
Total	**2,604–2,954**	**2,954**	**600–796**	**796**
Small-Caliber Projectiles				
Hawaii Study Area	2,175,350–2,736,350	2,736,350	1,250	1,250
California Study Area	7,912,343–7,913,342	7,913,342	12,650–15,050	15,050
Transit Corridor	98,849	98,849	0	0
Total	**10,187,541–10,747,542**	**10,747,542**	**13,900–16,300**	**16,300**
Small Caliber – Casings Only				
Hawaii Study Area	439,770–551,970	551,970	250–1,050	1,050
California Study Area	1,722,409–1,742,209	1,742,209	3,331–4,971	4,971
Transit Corridor	19,770	19,770	0	0
Total	**2,181,949–2,313,949**	**2,313,949**	**3,581–6,021**	**6,021**
Torpedoes[1] (Heavyweight)				
Hawaii Study Area	18	18	53–100	100
California Study Area	9	9	40–77	77
Total	**27**	**27**	**93–177**	**177**
Torpedoes[1] (Lightweight)				
Hawaii Study Area	3–6	6	3	3
California Study Area	10–11	11	7–11	11
Total	**13–17**	**17**	**10–14**	**14**

[1] Non-explosive torpedoes are recovered after use.

Table 3.0-19: Number and Location of Explosives that May Result in Fragments Used During Training and Testing Activities

Activity Area	Annual Training # of Items		Annual Testing # of Items	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Airborne Mine Neutralization System (AMNS) Neutralizers[1]				
Hawaii Study Area	16–20	20	216	216
California Study Area	63–70	70	1,106–2,404	2,404
Total	**79–90**	**90**	**1,322–2,620**	**2,620**
Bombs				
Hawaii Study Area	37–39	39	0	0
California Study Area	122–124	124	54	54
Total	**159–163**	**163**	**54**	**54**

Table 3.0-19: Number and Location of Explosives that May Result in Fragments Used During Training and Testing Activities (continued)

Activity Area	Annual Training # of Items		Annual Testing # of Items	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Large-Caliber Projectiles				
Hawaii Study Area	2,824–3,092	3,092	480	480
California Study Area	8,552–8,580	8,580	6,654–9,184	9,184
Transit Corridor	568	568	0	0
Total	**11,972–12,212**	**12,212**	**7,134–9,664**	**9,664**
Medium-Caliber Projectiles				
Hawaii Study Area	13,142–14,625	14,625	125–250	250
California Study Area	21,748–23,978	23,978	17,700	17,700
Transit Corridor	60–400	400	0	0
Total	**34,950–39,003**	**39,003**	**17,825–17,950**	**17,950**
Missiles				
Hawaii Study Area	446–574	574	128–132	132
California Study Area	504–525	525	1,128–1,235	1,235
Transit Corridor	14	14	0	0
Total	**964–1,113**	**1,113**	**1,256–1,367**	**1,367**
Rockets				
Hawaii Study Area	2,290–2,430	2,430	3	3
California Study Area	2,693–2,833	2,833	76–82	82
Total	**4,983–5,263**	**5,263**	**79–85**	**85**
Torpedoes (Heavyweight)				
Hawaii Study Area	6–8	8	0-1	1
California Study Area	1–3	3	1	1
Total	**7–11**	**11**	**1–2**	**2**

[1] AMNS Neutralizers are used during Remotely Operated Vehicle MIW activities.

Table 3.0-20: Number and Location of Targets Expended During Training and Testing Activities

Activity Area	Annual Training # of Targets		Annual Testing # of Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Air Targets – Flare				
Hawaii Study Area	12–14	14	0	0
California Study Area	62	62	0	0
Total	**74–76**	**76**	**0**	**0**
Air Targets – Decoy				
Hawaii Study Area	11–14	14	0	0
California Study Area	61	61	20	20
Total	**72–75**	**75**	**20**	**20**

Table 3.0-20: Number and Location of Targets Expended During Training and Testing Activities (continued)

Activity Area	Annual Training # of Targets		Annual Testing # of Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Air Targets – Unmanned Aircraft System (UAS)				
Hawaii Study Area	8	8	29–40	40
California Study Area	460–535	535	330–474	474
Transit Corridor	5	5	0	0
Total	**473–548**	**548**	**359–514**	**514**
Air Targets – Other				
Hawaii Study Area	15	15	1–2	2
California Study Area	26	26	1	1
Total	**41**	**41**	**2–3**	**3**
Air Targets – Supersonic UAS				
Hawaii Study Area	4	4	11–21	21
Total	**4**	**4**	**139–188**	**188**
Mine Shapes				
Hawaii Study Area	146–153	153	289–427	427
California Study Area	348–490	490	936–988	988
Total	**494–643**	**643**	**1,225–1,415**	**1,415**
Sub-surface Targets (Maneuvering)				
Hawaii Study Area	290–376	376	212–266	266
California Study Area	485–658	658	417–635	635
Transit Corridor	1	1	0	0
Total	**776–1,035**	**1,035**	**629–901**	**901**
Surface Targets – Floating (Large)				
Hawaii Study Area	33–55	55	13–58	58
California Study Area	97–178	178	67–108	108
Transit Corridor	10–27	27		
Total	**140–260**	**260**	**80–166**	**166**
Surface Targets – Floating (Medium)				
Hawaii Study Area	254–276	276	34–61	61
California Study Area	957–1,002	1,002	77–102	102
Transit Corridor	5	5		
Total	**1,216–1,284**	**1,284**	**111–163**	**163**
Surface Targets – Floating (Small)				
Hawaii Study Area	422–537	537	0	0
California Study Area	966–981	981	0	0
Total	**1,388–1,518**	**1,518**	**0**	**0**
Surface Targets – Maneuvering				
Hawaii Study Area	7	7	1–9	9
California Study Area	13	13	14–26	26
Total	**20**	**20**	**15–35**	**35**

Table 3.0-21: Number and Location of Other Military Materials Expended During Training and Testing Activities

Activity Area	Annual Training # of Materials		Annual Testing # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Acoustic Countermeasures				
Hawaii Study Area	486–495	495	440–533	533
California Study Area	314–318	318	529–609	609
Transit Corridor	6	6	0	0
Total	**806–819**	**819**	**969–1,142**	**1,142**
AMNS Neutralizers (Non-Explosive)[1]				
Hawaii Study Area	1	1	3–4	4
California Study Area	2–3	3	8	8
Total	**3–4**	**4**	**11–12**	**12**
Anchors – Mine				
Hawaii Study Area	308–383	383	10	10
California Study Area	2,228–3,661	3,661	160	160
Transit Corridor	2	2	0	0
Total	**2,538–4,046**	**4,046**	**170**	**170**
Anchors – Other				
Hawaii Study Area	0	0	367–634	634
California Study Area	0	0	461–761	761
Total	**0**	**0**	**837–1,395**	**1,395**
Anti-Torpedo Torpedo Accessories				
Hawaii Study Area	0	0	72–107	107
California Study Area	0	0	75–107	107
Total	**0**	**0**	**147–214**	**214**
Bottom-Placed Instruments				
Hawaii Study Area	0	0	1	1
California Study Area	0	0	30–44	44
Total	**0**	**0**	**31–45**	**45**
Buoys (Non-Explosive)				
Hawaii Study Area	5	5	19–37	37
California Study Area	2	2	10–28	28
Total	**7**	**7**	**29–65**	**65**
Canisters – Miscellaneous				
Hawaii Study Area	40	40	0	0
California Study Area	40	40	0	0
Total	**80**	**80**	**0**	**0**
Chaff – Air Cartridges				
Hawaii Study Area	780–930	930	1,300–1,464	1,464
California Study Area	4,440–4,590	4,590	3,696–4,055	4,055
Total	**5,220–5,520**	**5,520**	**4,996–5,519**	**5,519**

Table 3.0-21: Number and Location of Other Military Materials Expended During Training and Testing Activities (continued)

Activity Area	Annual Training # of Materials		Annual Testing # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Chaff – Ship Cartridges				
Hawaii Study Area	790	790	96–144	144
California Study Area	2,700	2,700	144–192	192
Total	**3,490**	**3,490**	**240–336**	**336**
Chemical/Biological Simulants				
Hawaii Study Area	0	0	0	0
California Study Area	0	0	0–60	60
Total	**0**	**0**	**0–60**	**60**
Decelerators/Parachutes – Extra Large				
Hawaii Study Area	0	0	5–20	20
California Study Area	0	0	106–133	133
Total	**0**	**0**	**111–153**	**153**
Decelerators/Parachutes – Large				
Hawaii Study Area	45–83	83	103–137	137
California Study Area	63	63	779–1,053	1,053
Transit Corridor	17	17	0	0
Total	**125–163**	**163**	**882–1,190**	**1,190**
Decelerators/Parachutes – Medium				
Hawaii Study Area	12–14	14	0	0
California Study Area	62	62	0	0
Total	**74–76**	**76**	**0**	**0**
Decelerators/Parachutes – Small				
Hawaii Study Area	5,621–10,298	10,298	16,927–18,922	18,922
California Study Area	11,494–16,341	16,341	30,152–33,962	33,962
Transit Corridor	184	184	0	0
Total	**17,299–26,823**	**26,823**	**47,079–52,884**	**52,884**
Endcaps – Chaff and Flares				
Hawaii Study Area	6,852–7,424	7,424	2,600–2,854	2,854
California Study Area	11,402–12,032	12,032		
Total	**18,254–19,456**	**19,456**	**12,752–13,798**	**13,798**
Expendable Bathythermographs				
Hawaii Study Area	1,743–2,419	2,419	144–210	210
California Study Area	1,834–3,301	3,301	422–872	872
Transit Corridor	186	186	0	0
Total	**3,763–5,906**	**5,906**	**566–1,082**	**1,082**
Fiber Optic Canister				
Hawaii Study Area	30–36	36	360–372	372
California Study Area	113–126	126	564–576	576
Total	**143–162**	**162**	**924–948**	**948**

Table 3.0-21: Number and Location of Other Military Materials Expended During Training and Testing Activities (continued)

Activity Area	Annual Training # of Materials		Annual Testing # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Flares				
Hawaii Study Area	12–14	14	1,300–1,390	1,390
California Study Area	62	62	6,456–6,889	6,889
Total	**74–76**	**76**	**7,756–8,279**	**8,279**
Heavyweight Torpedo Accessories				
Hawaii Study Area	354	354	224–349	349
California Study Area	183–187	187	266–434	434
Total	**537–541**	**541**	**490–783**	**783**
Jet Assist Take Off Bottles				
Hawaii Study Area	2–7	7	63–112	112
California Study Area	26	26	652–718	718
Transit Corridor	6	6	0	0
Total	**34–39**	**39**	**715–830**	**830**
Landers				
Hawaii Study Area	0	0	180–225	225
California Study Area	0	0	180–226	226
Total	**0**	**0**	**360–450**	**450**
Lightweight Torpedo Accessories				
Hawaii Study Area	61–130	130	52–64	64
California Study Area	201–226	226	145–225	225
Transit Corridor	3	3	0	0
Total	**265–359**	**359**	**197–289**	**289**
Marine Markers				
Hawaii Study Area	0-2	2	0	0
California Study Area	5–6	6	0	0
Transit Corridor	3	3	0	0
Total	**9–10**	**10**	**0**	**0**
Sonobuoys (Non-Explosive)				
Hawaii Study Area	5,680–10,289	10,289	17,338–19,380	19,380
California Study Area	11,446–16,267	16,267	30,683–34,673	34,673
Transit Corridor	184	184	0	0
Total	**17,310–26,740**	**26,740**	**48,021–54,053**	**54,053**
Surface Device – Floating (Small)				
Hawaii Study Area	110	110	0	0
California Study Area	580	580	0	0
Total	**690**	**690**	**0**	**0**
Torpedoes				
Hawaii Study Area	0	0	56–105	105
California Study Area	0	0	49–89	89
Total	**0**	**0**	**105–194**	**194**

[1] AMNS Neutralizers are used during Remotely Operated Vehicle MIW activities.

3.0.3.3.4.3 Seafloor Devices

Seafloor devices represent non-explosive items used during military readiness activities that are deployed onto the seafloor and typically recovered. Recovery could be immediate or after a prolonged time, depending on the device's need for maintenance or removal. These items include moored mine shapes, recoverable anchors, bottom-placed instruments, temporary and permanent bottom cable arrays, energy harvesting devices, and robotic vehicles referred to as "crawlers." Bottom-placed instruments usually include an anchor which may be expended while recovering the instrument. Seafloor devices are either stationary or move very slowly along the bottom and do not pose a threat to highly mobile organisms when in place; however, during the deployment process, they may pose a physical disturbance or strike risk. The effect of devices on the bottom is discussed as an alteration of the bottom substrate and associated living resources (e.g., invertebrates and vegetation) and as a strike risk to cultural resources. Permanent bottom cable arrays and mine/temporary instrument anchors associated with modernization and sustainment of ranges are not recovered.

Table 3.0-22 shows the number and location of proposed events that include the use of seafloor devices.

Table 3.0-22: Number and Location of Events Including Seafloor Devices

Activity Area	Annual # of Training Events		Annual # of Testing Events	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Hawaii Study Area	660–729	729	364–446	446
California Study Area	4,618–5,182	5,182	767–966	966
Transit Corridor	1	1	4–5	5
Total	**5,279–5,912**	**5,912**	**1,135–1,417**	**1,417**

3.0.3.3.4.4 Aircraft

Aircraft involved in military training and testing activities are separated into three categories: (1) fixed-wing aircraft, (2) rotary-wing aircraft, and (3) unmanned aircraft systems (UASs). Fixed-wing aircraft include, but are not limited to, planes such as F-35, P-8, F/A-18, and E/A-18G. Rotary-wing aircraft are also referred to as helicopters (e.g., MH-60) and tilt-rotor aircraft. UASs include a variety of platforms, including but not limited to, the Small Tactical UAS – Tier II, Triton UAS, Fire Scout Vertical Take-off and Landing UAS, and the MQ-25 Stingray Carrier Based UAS. The locations of Navy aircraft usage for training and testing activities depend on the locations of military air stations and established training and testing areas. The expansion of the HCTT Study Area would support these proposed activities in areas such as PMSR and the NOCAL Range Complex, where the Navy has a history of operating. These areas have not appreciably changed in decades and are not expected to change in the foreseeable future.

Table 3.0-23 shows the number and location of proposed events that include the use of aircraft.

Table 3.0-23: Number and Location of Events Including Aircraft

Activity Area	Annual # of Training Events		Annual # of Testing Events	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Hawaii Study Area	4,650–5,174	5,174	481–544	544
California Study Area	18,754–20,211	20,211	2,677–2,896	2,896
Transit Corridor	4	4	0	0
Total	**23,408–25,389**	**25,389**	**3,158–3,440**	**3,440**

3.0.3.3.5 Entanglement Stressors

This section describes the entanglement stressors introduced into the water from the Proposed Action, the relative magnitude and location of these activities, and provides the basis for analysis of potential impacts on resources in the remainder of Chapter 3. To assess the entanglement risk of materials expended during military readiness activities, the characteristics of these items (e.g., size and rigidity) was examined for their potential to entangle marine animals. For a constituent of MEM to entangle a marine animal, the item must be flexible enough to wrap around the animal or appendages or be trapped in the jaw or baleen. This analysis includes the potential impacts from three types of entanglement risks: (1) wires and cables, (2) nets, and (3) decelerators/parachutes. Except for nets, which are used rarely during some testing activities, the Action Proponents' equipment is not designed for trapping or entanglement purposes.

3.0.3.3.5.1 Wires, Cables, and Nets

The varieties of expended wires, cables, and nets includes fiber optic cables, guidance wires, and sonobuoy wires (including bathythermograph wires). During some proposed military readiness activities, the Navy may temporarily install and remove or expend different types of wires and cables. Temporary installations could include arrays or mooring lines attached to the seafloor or to surface buoys or vessels. Because these wires and cables are generally taut while in use, and then are later recovered, they are not considered an entanglement risk to marine species. During modernization and sustainment of ranges activities cables and sensors are installed on the seafloor and are therefore not considered an entanglement risk, but could be a risk of disturbing cultural resources.

As part of Extra Large Unmanned Underwater Vehicle (XLUUV) testing, scenarios would be developed to create subsurface obstacle avoidance interactions and would be recovered at the end of the test. Nets are anticipated to be a maximum size of 300-ft. wide and 100-ft. deep, with a 1-in. mesh. Net deployment and retrieval are estimated to take approximately 30 minutes. Nets would only be used during daylight hours and individual net deployment scenarios would occur over the course of a 48-hour window. Nets would be connected to and constantly monitored by the support vessels, which would hold static nets in place and move nets depending on the testing activity.

Table 3.0-24 shows the number and location of wires, cables, and nets expended during proposed training and testing activities.

Table 3.0-24: Number and Location of Wires, Cables, and Nets Expended During Training and Testing Activities

Activity Area	Annual # of Training Materials		Annual # of Testing Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Expendable Bathythermograph Wires				
Hawaii Study Area	1,743–2,419	2,419	144–210	210
California Study Area	1,834–3,301	3,301	422–872	872
Transit Corridor	186	186	0	0
Total	**3,763–5,906**	**5,906**	**566–1,082**	**1,082**
Fiber Optic Cables				
Hawaii Study Area	30–36	36	360–372	372
California Study Area	113–126	126	564–576	576
Total	**143–162**	**162**	**924–948**	**948**

Table 3.0-24: Number and Location of Wires, Cables, and Nets Expended During Training and Testing Activities (continued)

Activity Area	Annual # of Training Materials		Annual # of Testing Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Guidance Wires				
Hawaii Study Area	354	354	224–349	349
California Study Area	183–187	187	266–434	434
Total	**537–541**	**541**	**490–783**	**783**
Sonobuoy Wires				
Hawaii Study Area	5,674–10,282	10,282	17,279–19,297	19,297
California Study Area	11,437–16,259	16,259	30,602–34,456	34,456
Total	**17,292–26,722**	**26,722**	**47,881–53,753**	**53,753**
Nets				
California Study Area	0	0	40	40
Total	**0**	**0**	**40**	**40**

3.0.3.3.5.2 Decelerators/Parachutes

Decelerators/parachutes used during training and testing activities are classified into four different categories based on size: small, medium, large, and extra-large (Table 3.0-25). Both small- and medium-sized decelerators/parachutes are made of cloth and nylon, many with weights attached to their short attachment lines to speed their sinking. At water impact, the decelerator/parachute assembly is expended and sinks away from the unit. The decelerator/parachute assembly may remain at the surface for 5–15 seconds before the decelerator/parachute and its housing sink to the seafloor, where it becomes flattened (Environmental Sciences Group, 2005). Once settled on the bottom the canopy may temporarily billow if bottom currents are present.

Table 3.0-25: Size Categories for Decelerators/Parachutes Expended During Training and Testing Events

Size Category	Diameter (feet)	Associated Activity
Small	1.5–6	Air-launched sonobuoys, lightweight torpedoes, and unmanned aircraft systems (UASs) (drag decelerator/parachute)
Medium	19	Illumination flares
Large	30–50	UASs (main decelerator/parachute)
Extra-large	82	UASs (main decelerator/parachute)

Large and extra-large decelerators/parachutes are also made of cloth and nylon, with suspension lines of varying lengths (large: 40–70 ft. in length [with up to 28 lines per decelerator/parachute]; extra-large: 82 ft. in length [with up to 64 lines per decelerator/parachute]). Some aerial targets also use a small drag parachute (6 ft. in diameter) to slow their forward momentum prior to deploying the larger primary decelerator/parachute. Unlike the small- and medium-sized decelerators/parachutes, UAS decelerators/parachutes do not have weights attached and may remain at the surface or suspended in the water column for some time prior to eventual settlement on the seafloor.

Table 3.0-21 shows the number and location of decelerator/parachutes expended during proposed training and testing activities.

3.0.3.3.6 Ingestion Stressors

This section describes the ingestion stressors introduced into the water through military training and testing and the relative magnitude and location of these activities in order to provide the basis for analysis of potential impacts on resources in the remainder of Chapter 3. To assess the ingestion risk of materials expended during training and testing, the Navy examined the characteristics of these items (such as buoyancy and size) for their potential to be ingested by marine animals in the Study Area. The Navy expends the following types of materials that could become ingestion stressors during training and testing in the Study Area: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosive munitions, and MEM other than munitions (fragments from targets, chaff, flare casings, plastic end caps, pistons, and some decelerators/parachutes. Other MEM such as targets, large-caliber projectiles, intact training and testing bombs, guidance wires, empty 55-gallon drums (used as targets), sonobuoy tubes, and marine markers are too large for marine organisms to consume and are eliminated from further discussion regarding ingestion.

Solid metal materials, such as small-caliber projectiles or fragments from high-explosive munitions, sink rapidly to the seafloor. Lighter plastic items may be caught in currents and gyres or entangled in floating kelp and could remain in the water column for hours to weeks or indefinitely before sinking (e.g., plastic end caps [from chaff cartridges] or plastic pistons [from flare cartridges]).

3.0.3.3.6.1 Non-Explosive Practice Munitions

Small- and medium-caliber projectiles include all sizes up to and including those that are 2.25 in. in diameter. Flechettes from some non-explosive rockets are approximately 2 in. in length. Each non-explosive flechette rocket contains approximately 1,180 individual flechettes that are released. These solid metal materials would quickly move through the water column and settle to the seafloor. Table 3.0-18 shows the number and location of non-explosive practice munitions used during proposed training and testing activities.

3.0.3.3.6.2 Fragments from High-Explosive Munitions

Many different types of high-explosive munitions can result in fragments that are expended at sea during training and testing activities.

Types of high-explosive munitions that can result in fragments include torpedoes, neutralizers, grenades, projectiles, missiles, rockets, buoys, sonobuoys, anti-torpedo countermeasures, mines, and bombs. Fragments would result from fractures in the munitions casing and would vary in size depending on the size of the net explosive weight and munition type; typical sizes of fragments are unknown.

Table 3.0-19 shows the number and location of explosives used during training and testing activities that may result in fragments.

3.0.3.3.6.3 Military Expended Materials

Several different types of other materials are expended at sea during training and testing activities.

Table 3.0-26 shows the number and location of targets used during proposed training and testing activities that may result in fragments. Table 3.0-21 shows the number and location of chaff, flares, chaff/flare components, and small-size decelerators/parachutes expended during proposed training and testing activities.

Table 3.0-26: Number and Location of Targets Expended During Training and Testing Activities That May Result in Fragments

Activity Area	Annual # of Training Targets		Annual # of Testing Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Air Targets				
Hawaii Study Area	203–229	229	28	28
California Study Area	392–417	417	354–498	498
Transit Corridor	5	5	0	0
Total	**600–651**	**651**	**382–526**	**526**
Mine Shapes				
Hawaii Study Area	6	6	173	173
California Study Area	20–22	22	270–302	302
Transit Corridor	1	1	0	0
Total	**27–29**	**29**	**443–475**	**475**
Surface Targets				
Hawaii Study Area	190–228	228	22–23	23
California Study Area	449–545	545	94–125	125
Transit Corridor	7–24	24	0	0
Total	**646–797**	**797**	**116–148**	**148**

3.0.4 Standard Operating Procedures

For military readiness activities to be effective, personnel must be able to safely use their sensors, platforms, weapons, and other devices to their optimum capabilities and as intended for use in missions and combat operations. The Action Proponents have developed standard operating procedures through decades of experience to provide for safety and mission success. Because they are essential to safety and mission success, standard operating procedures are part of the Proposed Action and are considered in the Chapter 3 environmental analysis for applicable resources. Standard operating procedures recognized as providing a benefit to public safety or environmental resources are described in Table 3.0-27.

Table 3.0-27: Standard Operating Procedures

Procedure Focus	Procedure Description	Benefit
Airspace and sea space deconfliction	• Temporary Notices to Airmen or Local Notices to Mariners to alert the public to stay clear of the area based on event locations and the activities involved. • Some locations, such as those where explosive bombing activities routinely occur, have a standing Local Notice to Mariners.	Deconfliction also allows for safe separation from non-participants within established commercial air traffic routes, commercial shipping lanes, and areas used for recreational activities.
Safety distances applied to all hazardous activities	• Safe distances from divers during active sonar and in-water explosives based on U.S. Navy Dive Manual (U.S. Department of the Navy, 2016b). • Safety distances for the use of electromagnetic energy are specified in Department of Defense Instruction 6055.11 (U.S. Department of Defense, 2021) and Military Standard 464D (U.S. Department of Defense, 2020) as the standard safety buffers for in-water energy to protect military divers.	Ensures that explosives and sonar activities are conducted well clear of divers.
Laser safety	• Laser systems are approved for fielding by the Action Proponents' Laser Safety Review Board or equivalent. • The approval process includes adding procedural requirements to ensure public safety. • Only properly trained and authorized personnel operate high-energy lasers within designated areas.	Reduces the risk of inadvertently exposing people or marine resources to high-energy lasers.
In-water explosive safety	• In-water explosive activities are scheduled to occur in areas located away from popular recreational dive sites, primarily for human safety. • Most explosive events are conducted during daylight hours. • Weapon firing activities that involve small boats deploying or retrieving targets are typically conducted in Beaufort Sea state number 4 conditions or better to ensure safe operating conditions for the small boat operators.	Greater visibility around the detonation site reduces the risk of endangering people or marine species during in-water explosives detonations.

Table 3.0-27: Standard Operating Procedures (continued)

Procedure Focus	Procedure Description	Benefit
Cable installation	• Prior to in-water construction, the Navy would issue a Notice to Mariners alerting boaters to avoid areas of installation activity. • Vessels engaged in installation would contain sorbent booms and pads for use in the unlikely event of a fuel spill, and would adhere to all Navy and Coast Guard requirements regarding the containment, cleanup, and reporting of spills. • To prevent any potential impacts to abalone during cable anchoring activities in the Southern California Range Complex, divers would not place an anchor or the cable between the anchors within 3 ft. of any abalone species. • Any lighting associated with the Proposed Action would be directed downward to minimize the illumination of surrounding areas.	Helps deconflict inadvertent vessel interactions to enhance safety and minimize work stoppage. Reduces harm to the marine environment in the unlikely event of a fuel spill by cable-laying vessels. Reduces potential for harm to abalone species. Downward facing lighting reduces effects to marine birds that could be in the vicinity.
Invasive species	• All physical contact and disturbance to the benthos and any invasive species present shall be prevented whenever possible. • Any equipment, gear, or material used in water with known invasive species, shall be dried for 48 hours before moving to an uncontaminated area. • No movement/removal of benthos substrate, water, or invasive species itself from a known invasive species infested area to an uncontaminated area shall take place. Any removal of substrate or invasive species shall be properly disposed of so that it cannot spread to uncontaminated areas. • In-water equipment will be locally sourced thus reducing the risk of introducing non-native species. If any equipment must be brought to the project site from outside the Hawaiian Islands region, then the appropriate prevention measures (e.g., wash-down or	Prevents and/or minimizes the risk of invasive species introductions and spread.

Table 3.0-27: Standard Operating Procedures (continued)

Procedure Focus	Procedure Description	Benefit
	hull cleaning triple flush procedures) will be included in the work plan. • Ballast water exchange during Military Readiness activities will comply with the Navy's Environmental Readiness Program Manual (OPNAV M-5090.1). • Military Readiness activities will be consistent with installation INRMPs designed to ensure, to the maximum extent possible, aquatic invasive species are not introduced into near-shore environments or bodies of water on or adjacent to the installation (OPNAV M-5090.1). • For the California Study Area, the Navy will comply, to the maximum extent possible, with the National Oceanic and Atmospheric Administration Caulerpa Control Protocol (National Marine Fisheries Service, 2021). • All Navy and USCG vessels undergo routine inspections and periodic hull cleanings. • Prior to entering port, Navy and USCG vessels undergo inspections as part of the ships' pest control program.	
Visibility requirements during aircraft activities	• Aircrew are not authorized to deploy ordnance through extensive cloud cover where visual clearance for non-participants is not possible. The two exceptions to this requirement are (1) when operating in the open ocean, clearance for non-participating aircraft and vessels through radar surveillance is acceptable; and (2) when the officer conducting the exercise or civilian equivalent accepts responsibility for the safeguarding of airborne and surface traffic.	Enables aircrews to visually clear the target area of any people or marine species prior to ordnance release.
Bird avoidance	• Aircrew make every attempt to avoid large flocks of birds to reduce the safety risk involved with a potential bird strike. Since 2011, the Navy has required that all Navy flying units report all bird strikes through the	Reduces the risk of aircraft bird strikes.

Table 3.0-27: Standard Operating Procedures (continued)

Procedure Focus	Procedure Description	Benefit
	Web-Enabled Safety System Aviation Mishap and Hazard Reporting System.	
Aircraft sonic booms	• As a general policy for aircraft, aircrew do not intentionally generate sonic booms below 30,000 ft. of altitude unless over water and more than 30 miles from inhabited land areas or islands.	Reduces noise impacts on civilian personnel and property.
Additional aircraft procedures	• Aircraft will fly in accordance with Federal Aviation Administration Regulations (Part 91, General Operating and Flight Rules, Annex 2 Rules of the Air to the Convention of International Civil Aviation) or with due regard for the safety of all air traffic, which govern such flight components as operating near other aircraft, right-of-way rules, aircraft speed, and minimum safe altitudes. These rules include the use of tactical training and maintenance test-flight areas, arrival and departure routes, and airspace restrictions as appropriate to help control air operations. • Unmanned aircraft systems are operated in accordance with Federal Aviation Administration air traffic organization policy.	Improves safety during all training and testing activities involving aircraft.
Safe vessel operation	• Vessels are required to operate in accordance with applicable navigation rules, including Inland Waters Navigation Rules (33 Code of Federal Regulations section 83.01 et seq.) and International Regulations for Preventing Collisions at Sea (72 COLREGS). These rules and regulations were formalized in the Convention on the International Regulations for Preventing Collisions at Sea (1972) and implemented through the International Navigational Rules Act of 1977 (33 United States Code sections 1601–1608). Applicable navigation requirements specified in the Inland Navigation Rules include, but are not limited to, Rule 5 (Lookouts) and Rule 6 (Safe Speed). These rules require	These procedures ensure that all Navy and Coast Guard vessels operate consistently with civilian and commercial vessels, which reduce potential conflicts between underway vessels. Reduced speeds also allow Navy and Coast Guard vessels to see and avoid marine species more easily.

Table 3.0-27: Standard Operating Procedures (continued)

Procedure Focus	Procedure Description	Benefit
	that vessels, at all times, proceed at a safe speed so proper and effective action can be taken to avoid collision and so vessels can be stopped within a distance appropriate to the prevailing circumstances and conditions. • Surface ships transit at speeds that are optimal for fuel conservation, to maintain ship schedules, and to meet mission requirements. Vessel captains use the totality of the circumstances to ensure the vessel is traveling at appropriate speeds in accordance with navigation rules. Depending on the circumstances, this may involve adjusting speeds during periods of reduced visibility or in certain locations. • The Action Proponents also avoid known navigation hazards that appear on nautical charts, such as submerged wrecks and obstructions. • With limited exceptions (e.g., amphibious vessels operating in designated locations, bottom-crawling vehicles), manned vessels and unmanned vehicles avoid contact with the seafloor as a standard collision avoidance procedure to prevent damage to the platforms.	
Lookouts	• Lookouts may be positioned on surface vessels, aircraft, piers, or the shore. • Lookouts positioned on U.S. Navy surface vessels (including surfaced submarines) will be solely dedicated to visually observing their assigned sectors. Lookouts on vessels with limited crew may fulfill additional duties. For example, a Lookout on a small boat may also be responsible for navigation or personnel supervision. • Underway surface ships operated by or for the Action Proponents have personnel assigned to stand watch at	Lookouts monitor their assigned sectors for any indication of danger to the ship and the personnel on board, such as a floating or partially submerged object or piece of debris, periscope, surfaced submarine, wisp of smoke, flash of light, or surface disturbance. As a standard collision avoidance procedure for surface vessels, Lookouts also monitor for marine mammals that have the potential to be in the direct path of the vessel.

Table 3.0-27: Standard Operating Procedures (continued)

Procedure Focus	Procedure Description	Benefit
	all times (day and night) for safety of navigation, collision avoidance, range clearance, and man-overboard precautions. • Personnel on underway small boats (e.g., crewmembers responsible for navigation) fulfill similar watch standing responsibilities to those positioned on surface ships. Standard watch personnel, also referred to as "Lookouts," include officers, enlisted personnel, and civilians operating in similar capacities. • Following two ship collisions in 2017 that killed 17 Sailors, the Action Proponents undertook a review of surface ship staffing, training, and personnel effectiveness. As a result, the Action Proponents added additional Lookouts to Navy watch teams for certain surface ship classes, increased the amount of time that Lookouts spend in bridge simulators, and developed watch rotations that align with the body's natural circadian rhythms. Personnel are trained in accordance with the U.S. Navy Lookout Training Handbook or equivalent to use correct scanning procedures while monitoring assigned sectors, to estimate the relative bearing, range, position angle, and target angle of sighted objects, and to rapidly communicated accurate sighting reports. The handbook was updated in 2022 to include a more robust chapter on environmental compliance, mitigation, and marine species observation tools and techniques (NAVEDTRA 12968-E). Watch teams may use radios to communicate with other ships operating in the vicinity to coordinate safe maneuvering. After sunset and prior to sunrise, Lookouts employ night visual search techniques, which could include the use of night vision devices. • A Lookout in an aircraft is typically an existing crewmember such as a pilot or Flight Officer whose	

Table 3.0-27: Standard Operating Procedures (continued)

Procedure Focus	Procedure Description	Benefit
	primary duty is navigation or other mission-essential tasks.	
Pile driving	• Due to pile driving system design and operation, the Navy performs soft starts during impact installation of each pile to ensure proper operation of the diesel impact hammer. During a soft start, the Navy performs an initial set of strikes (three, three-blow sets) from the impact hammer at reduced energy before it can be operated at full power and speed. Each three-blow set will be separated by at least 30 seconds. The energy reduction of an individual hammer cannot be quantified because it varies by individual driver.	This standard operating procedure benefits marine mammals, sea turtles, and fish because soft starts may “warn” these resources and cause them to move away from the sound source before impact pile driving increases to full operating capacity.
Unmanned vehicle procedures	• Unmanned surface vehicles or unmanned underwater vehicles that operate autonomously may have embedded sensors designed for avoidance of large objects. For example, select unmanned vehicles have sensors, such as a forward-looking sonar (FLS), to perform obstacle avoidance. The FLS makes detections at a sufficient range for the onboard processor to determine if there is a need for an avoidance maneuver. If there is a need for an avoidance maneuver, the onboard vehicle control system would insert a new maneuver (in place of the currently executing activity) and continue to introduce new maneuvers if detections continue to be made. There are a number of possible maneuvers that could be implemented, from adjusting heading to stopping or hovering the vehicle. • As an additional standard collision avoidance procedure during specific stages of training or testing (e.g., during an initial training and testing phases), manned support vessels may escort unmanned surface vehicles and unmanned underwater vehicles. Lookouts	Reduces the risk of an unmanned vehicle striking a civilian or commercial vessel or a marine species.

Table 3.0-27: Standard Operating Procedures (continued)

Procedure Focus	Procedure Description	Benefit
	on the support vessels may use radios to communicate with other vessels operating in the vicinity to coordinate safe maneuvering (e.g., communicating the positioning and safety distances for avoiding collisions with unmanned vehicles). • As a standard collision avoidance procedure for in-water devices towed by surface vessels (or by unmanned surface vehicles or unmanned underwater vehicles under positive control by manned support vessels), the Navy searches the intended path of the towed in-water device for floating debris, concentrations of floating vegetation, floating objects, or animals with potential to obstruct, tangle, or damage the device.	

REFERENCES

Bousman, W. G. and R. M. Kufeld. (2005). *UH-60A Airloads Catalog*. Moffett Field, CA: National Aeronautics and Space Administration.

Caltrans. (2020). *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*. Sacramento, CA: California Department of Transportation.

Eller, A. I. and R. C. Cavanagh. (2000). *Subsonic Aircraft Noise at and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals*. McLean, VA: United States Air Force Research Laboratory.

Environmental Sciences Group. (2005). *Canadian Forces Maritime Experimental and Test Range Environmental Assessment Update 2005*. Kingston, Canada: Environmental Sciences Group, Royal Military College.

Hildebrand, J. (2009a). Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series 395* 5–20. DOI:10.3354/meps08353.

Hildebrand, J. A. (2009b). Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series 395* 5–20. DOI:10.3354/meps08353.

Illingworth and Rodkin, Inc. (2015). *Underwater and Airborne Acoustic Monitoring for the U.S. Navy Elevated Causeway Removal at the JEB Little Creek Naval Station: 10–11 September 2015* (Naval Facilities Engineering Command Atlantic under HDR Environmental, Operations and Construction, Inc.). Petaluma, CA: Illingworth & Rodkin, Inc.

Illingworth and Rodkin, Inc. (2017). *Pile-Driving Noise Measurements at Atlantic Fleet Naval Installations: 28 May 2013–28 April 2016. Final Report*. Petaluma, CA: HDR.

Illingworth and Rodkin Inc. (2007). *Compendium of Pile Driving Sound Data*. Sacramento, CA: California Department of Transportation.

Illingworth and Rodkin Inc. (2013). *Acoustic Monitoring Report for Naval Base Kitsap at Bangor Trident Support Facilities Explosive Handling Wharf (EHW-2) Project*. Washington,DC: Navy Strategic Systems Programs.

Investigative Science and Engineering, I. (1997). *Noise Measurements of Various Aircraft and Ordance at San Clemente Island*.

Kuehne, L. M., C. Erbe, E. Ashe, L. T. Bogaard, M. S. Collins, and R. Williams. (2020). Above and below: Military aircraft noise in air and under water at Whidbey Island, Washington. *Journal of Marine Science and Engineering 8*. DOI:10.3390/jmse8110923

Mintz, J. D. (2024, May 6, 2024). Steaming Days.

National Marine Fisheries Service. (2021). *Caulerpa Control Protocol*. Long Beach, CA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Regional Office. Retrieved from https://media.fisheries.noaa.gov/2021-12/caulerpa-control-protocol-v5.pdf.

Naval Facilities Engineering Systems Command Southwest. (2020). *Analysis of Noise Data for Pile Driving Training Exercises at Naval Base 1 Ventura County (Port Hueneme) February 19 & 20, 2020.* San Diego, CA: Naval Facilities Engineering Command Southwest.

Sohn, R. A., F. Vernon, J. A. Hildebrand, and S. C. Webb. (2000). Field measurements of sonic boom penetration into the ocean. *The Journal of the Acoustical Society of America 107* (6): 3073–3083.

Sparrow, V. W. (2002). Review and status of sonic boom penetration into the ocean. *The Journal of the Acoustical Society of America 111* (1): 537–543.

U.S. Department of Defense. (2020). *Electromagnetic Environmental Effects Requirements for Systems (MIL-STD-464D)*. Washington, DC: U.S. Department of Defense.

U.S. Department of Defense. (2021). *Protecting Personnel from Electromagnetic Fields*. Washington, DC: Under Secretary of Defense for Acquisition, Technology, and Logistics.

U.S. Department of the Air Force. (2000). *Supersonic Aircraft Noise At and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals* (AFRL-HE-WP-TR-2000-0167). McLean, VA: United States Air Force Research Laboratory.

U.S. Department of the Air Force. (2016). *United States Air Force F-35A Operational Beddown–Pacific Final Environmental Impact Statement*. Eielson Air Force Base, AK: United States Air Force.

U.S. Department of the Army. (1999). *Finding of No Significant Impact for the Life Cycle Environmental Assessment for the HELLFIRE Modular Missile System*. Washington, DC: U.S. Department of Defense.

U.S. Department of the Navy. (2005). *Final Environmental Assessment and Overseas Environmental Assessment for Organic Airborne and Surface Influence Sweep Mission Tests*. Washington, DC: Airborne Mine Defense Program Office, Program Executive Office: Littoral and Mine Warfare.

U.S. Department of the Navy. (2012). *Biological Assessment for the Expeditionary Electronic Attack Squadron Realignment and Transition at Naval Air Station Whidbey Island, Oak Harbor, Washington*. Washington, DC: U.S. Department of the Navy.

U.S. Department of the Navy. (2016a). *NATOPS General Flight and Operating Instructions*. San Diego, CA: U.S. Department of the Navy, Commander Naval Air Force Pacific.

U.S. Department of the Navy. (2016b). *U.S. Navy Dive Manual*. Washington, DC: Commander, Naval Sea Systems Command.

U.S. Naval Research Advisory Committee. (2009). *Report on Jet Engine Noise Reduction*. Patuxent River, MD: U.S. Department of Defense.

Washington State Department of Transportation. (2010). *Manette Bridge Vibratory Pile Driving Noise Measurements - Technical Memorandum*. Olympia, WA: Washington State Department of Transportation.

Yagla, J. and R. Stiegler. (2003). *Gun blast noise transmission across the air-sea interface*. Presented at the 5th European Conference on Noise Control. Naples, Italy.