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## 3.4 Invertebrates

**INVERTEBRATES SYNOPSIS**

Stressors to invertebrates that could result from the Proposed Action were considered, and the following conclusions have been reached for the Preferred Alternative (Alternative 1):

- Acoustic: Invertebrates could be exposed to noise from the proposed military readiness activities. However, available information indicates that invertebrate sound detection is primarily limited to low frequency (less than 1 kilohertz) particle motion and water movement that diminishes rapidly with distance from a sound source. The expected effect of noise on invertebrates is correspondingly diminished and mostly limited to offshore surface layers of the water column where only zooplankton, squid, and jellyfish are prevalent mostly at night when military readiness activities occur less frequently. Invertebrate populations are typically lower offshore, where most military readiness activities occur, than nearshore due to the scarcity of habitat structure and comparatively lower nutrient levels. Exceptions occur at nearshore locations where occasional pierside sonar, air gun, or pile driving actions occur near relatively resilient soft bottom or artificial substrate communities. Because the number of individuals affected would be small relative to population numbers, population-level effects are unlikely. As such, effects would be less than significant.

- Explosives: Explosives produce pressure waves that can harm invertebrates in the vicinity of where they typically occur, which is primarily in offshore surface waters. This area is also inhabited by zooplankton, squid, and jellyfish, which are prevalent mostly at night when military readiness activities with explosives do not typically occur. Invertebrate populations are generally lower offshore than nearshore due to the scarcity of habitat structure and comparatively lower nutrient levels. Exceptions occur where explosives are used on the bottom within nearshore waters or near sensitive hard bottom communities. Soft bottom communities are resilient to occasional disturbances. Due to the relatively small number of individuals affected, population-level effects are unlikely. As such, effects would be less than significant.

- Physical Disturbance and Strike: Invertebrates would be unlikely to experience physical disturbance and strike effects from vessels and in-water devices, military expended materials (MEM), seafloor devices, and pile driving. Most risk occurs offshore (where invertebrates are less abundant) and near the surface where relatively few invertebrates occur during the day when actions are typically occurring. Most expended materials are used in locations far from nearshore bottom areas where invertebrates are not the most abundant. Exceptions occur for actions taking place within nearshore waters over primarily soft-bottom communities, such as vessel transits, nearshore vessel training, nearshore explosive ordnance disposal training, operation of bottom-crawling seafloor devices, and pile driving. Invertebrate communities in affected soft bottom areas are naturally resilient to occasional disturbances. Physical disturbance and strike stressors would not have reasonably foreseeable adverse effects on invertebrates.

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- Entanglement: It is unlikely that invertebrates could be entangled by expended materials (e.g., wires, cables, decelerators/parachutes). Most entanglement risk occurs in offshore areas where invertebrates are relatively less abundant. The risk of entangling invertebrates is minimized by the typically linear nature of the expended structures (e.g., wires, cables), although decelerators/parachutes have mesh that could pose a risk to those invertebrates that are large and slow enough to be entangled (e.g., jellyfish). Deep-water coral could also be entangled by drifting decelerators/parachutes, but co-occurrence is highly unlikely given the extremely sparse coverage of corals in the deep ocean. Entanglement stressors would not have reasonably foreseeable adverse effects on invertebrates.
- Ingestion: Expended materials and material fragments pose an unlikely ingestion risk to invertebrates. Most MEM are too large to be ingested, and many invertebrate species are unlikely to consume an item that does not visually or chemically resemble its natural food. Exceptions occur for materials fragmented by explosive charges or weathering, which could be ingested by filter- or deposit-feeding invertebrates. Ingestion of such materials would likely occur infrequently, and only invertebrates located very close to the fragmented materials would potentially be affected. Furthermore, most human-deposited ingestible materials in the ocean originate from non-military sources. Ingestion stressors would not have reasonably foreseeable adverse effects on invertebrates.

### 3.4.1 Introduction

This section provides analysis of potential effects on marine invertebrates found in the HCTT Study Area and an introduction to the species that occur in the Study Area.

### 3.4.2 Affected Environment

The affected environment provides the context for evaluating the effects of the proposed military readiness activities on marine invertebrates. Because invertebrates occur in all habitats, activities that interact with the water column or the bottom could potentially affect many species and individuals, including microscopic zooplankton (e.g., invertebrate larvae, copepods, protozoans) that drift with currents, larger invertebrates living in the water column (e.g., jellyfish, shrimp, squid), and benthic invertebrates that live on or in the seafloor (e.g., clams, corals, crabs, worms). Because many benthic animals have limited mobility compared to pelagic species, activities that contact the bottom generally have a greater potential for effect. Activities that occur in the water column generally have less potential for effect due to dilution and dispersion of some stressors (e.g., chemical contaminants), potential drifting of small invertebrates out of an affected area, and the relatively greater mobility of open water invertebrates large enough to actively leave an affected area.

#### 3.4.2.1 General Background

Invertebrates, which are animals without backbones, are the most abundant life form on Earth, with marine invertebrates representing a large, diverse group with approximately 367,000 species described worldwide to date (World Register of Marine Species Editorial Board, 2015). However, it is estimated that most existing species have not yet been described (Mora et al., 2011). The total number of invertebrate species that occur in the Study Area is unknown but is likely to be many thousands. The results of a research effort to estimate the number of marine invertebrate species in various areas identified nearly 6,000 species in the Hawaii Study Area and over 8,000 species in the California Current large marine ecosystem (Fautin et al., 2010). Invertebrate species vary in their use of abiotic habitats. Some populations, especially endangered species, are threatened by human activities and other natural changes.

Marine invertebrates are important ecologically and economically, providing an important source of food, essential ecosystem services (e.g., coastal protection, nutrient recycling, food for other animals, habitat formation), and income from tourism and commercial fisheries (Spalding et al., 2001). The health and abundance of marine invertebrates are vital to the marine ecosystem and the sustainability of the world's fisheries (Pauly et al., 2002). Economically important invertebrate groups that are fished, commercially and recreationally, for food in the United States include crustaceans (e.g., shrimps, lobsters, and crabs), bivalves (e.g., scallops, clams, and oysters), echinoderms (e.g., sea urchins and sea cucumbers), and cephalopods (e.g., squids and octopuses) (Chuenpagdee et al., 2003; Food and Agriculture Organization of the United Nations, 2005; Pauly et al., 2002). Marine invertebrates or the structures they form (e.g., shells and coral colonies) are harvested for many purposes, including jewelry, curios, and the aquarium trade. In addition, some marine invertebrates are sources of chemical compounds with potential medical applications. Natural products have been isolated from a variety of marine invertebrates and have shown a wide range of therapeutic properties, including anti-microbial, antioxidant, anti-hypertensive, anticoagulant, anticancer, anti-inflammatory, wound healing and immune modulation, and other medicinal effects (De Zoysa, 2012; Romano et al., 2022). Information on invasive species and SOPs used by the Navy related to invasive species is presented in Section 3.0.4.

#### 3.4.2.2 Endangered Species Act-Listed Species

Table 3.4-1 presents ESA-listed marine invertebrates in the Study Area, including two abalone species listed as endangered (black abalone [*Haliotis cracherodii*] and white abalone [*H. sorenseni*]) and one sea star proposed as threatened (sunflower sea star [*Pycnopodia helianthoides*]). Detailed information on each ESA-listed species is presented in Appendix C. In addition, one ESA-listed coral species, the Globiceps coral (*Acropora globiceps*), has been reported at French Frigate Shoals in the Northwestern Hawaiian Islands (National Marine Fisheries Service, 2024). This species does not occur in the Hawaii Range Complex, and no military readiness activities would occur in shallow nearshore areas in the Temporary Operating Area where this species has been reported. Therefore, this species will not be analyzed further in this document.

NMFS has identified the overall primary factors contributing to decline of the abalone species, shown in Table 3.4-1 (National Oceanic and Atmospheric Administration Fisheries, 2015). These factors are overharvesting, low population density, loss of genetic diversity, disease, poaching, and natural predation. Lowry et al. (2022) reported that the sunflower sea star faces ongoing threats from sea star wasting syndrome (SSWS) and direct (i.e., physiological) and indirect (i.e., ecological) consequences of anthropogenic climate change. Military readiness activities are not expected to contribute substantially to any of these factors.

### Table 3.4-1: Status of Endangered Species Act-Listed Species Within the Study Area

| Species Name and Regulatory Status | | | | Presence in Study Area | | |
|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Endangered Species Act Status** | **Critical Habitat Designated** | **Open Ocean Area/Transit Corridor** | **California Study Area** | **Hawaii Study Area** |
| Black abalone | *Haliotis cracherodii* | Endangered | Yes | None | Yes | None |
| White abalone | *Haliotis sorenseni* | Endangered | No | None | Yes | None |
| Globiceps coral | *Acropora globiceps* | Threatened | Proposed | None | None | Yes |
| Sunflower sea star* | *Pycnopodia helianthoides* | Proposed Threatened | No | None | Yes | None |

* Final Rule listing the sunflower sea star is expected from the National Marine Fisheries service before the end of 2024.

#### 3.4.2.3 Species Not Listed Under the Endangered Species Act

Thousands of invertebrate species occur in the Study Area. The variety of species spans many taxonomic groups (taxonomy is a method of classifying and naming organisms). Many species of marine invertebrates are commercially or recreationally fished, with several species being managed under the Magnuson-Stevens Fishery Conservation and Management Act.

Marine invertebrates are classified within major taxonomic groups, generally referred to as a phyla. Major invertebrate phyla—those with greater than 1,000 species (Roskov et al., 2015; World Register of Marine Species Editorial Board, 2015)—and the general zones they inhabit in the Study Area are listed in Table 3.4-2. Vertical distribution information is generally shown for adults; the larval stages of most of the species occur in the water column. In addition to the discrete phyla listed, there is a substantial variety of single-celled organisms, commonly referred to as protozoan invertebrates, that represent several phyla (Kingdom Protozoa in Table 3.4-2). Throughout the invertebrates section, organisms may be referred to by their phylum name or, more generally, as marine invertebrates.

### Table 3.4-2: Major Taxonomic Groups of Marine Invertebrates in the Study Area

| Major Invertebrate Groups[1] | | Presence in Study Area[2] | |
|---|---|---|---|
| **Common Name (Classification)[3]** | **Description[4]** | **Open Ocean** | **Coastal Waters** |
| Foraminifera, radiolarians, ciliates (Kingdom Protozoa) | Benthic and planktonic single-celled organisms; shells typically made of calcium carbonate or silica. | Water column, bottom | Water column, bottom |
| Sponges (Porifera) | Mostly benthic animals; sessile filter feeders; large species have calcium carbonate or silica structures embedded in cells to provide structural support. | Bottom | Bottom |
| Corals, anemones, hydroids, jellyfish (Cnidaria) | Benthic and pelagic animals with stinging cells; sessile corals are main builders of coral reef frameworks. | Water column, bottom | Water column, bottom |
| Flatworms (Platyhelminthes) | Mostly benthic; simplest form of marine worm with a flattened body. | Water column, bottom | Water column, bottom |
| Ribbon worms (Nemertea) | Benthic marine worms with an extendable, long tubular-shaped extension (proboscis) that helps capture food. | Water column bottom | Bottom |

**Table 3.4-2: Major Taxonomic Groups of Marine Invertebrates in the Study Area (continued)**

| Major Invertebrate Groups[1] | | Presence in Study Area[2] | |
|---|---|---|---|
| **Common Name (Classification)[3]** | **Description[4]** | **Open Ocean** | **Coastal Waters** |
| Round worms (Nematoda) | Small benthic marine worms; free-living or may live in close association with other animals. | Water column, bottom | Water column, bottom |
| Segmented worms (Annelida) | Mostly benthic, sedentary to highly mobile segmented marine worms (polychaetes); free-living and tube-dwelling species; predators, scavengers, herbivores, detritus feeders, deposit feeders, and filter or suspension feeders. | Bottom | Bottom |
| Bryozoans (Bryozoa) | Small, colonial animals with gelatinous or hard exteriors with a diverse array of growth forms; filter feeding; attached to a variety of substrates (e.g., rocks, plants, shells or external skeletons of invertebrates). | Bottom | Bottom |
| Cephalopods, bivalves, sea snails, chitons (Mollusca) | Soft-bodied benthic or pelagic predators, filter feeders, detritus feeders, and herbivore grazers; many species have a shell and muscular foot; in some groups, a ribbon-like band of teeth is used to scrape food off rocks or other hard surfaces. | Water column, bottom | Water column, bottom |
| Shrimp, crabs, lobsters, barnacles, copepods (Arthropoda) | Benthic and pelagic predators, herbivores, scavengers, detritus feeders, and filter feeders; segmented bodies and external skeletons with jointed appendages. | Water column, bottom | Water column, bottom |
| Sea stars, sea urchins, sea cucumbers (Echinodermata) | Benthic animals with endoskeleton made of hard calcareous structures (plates, rods, spicules); five-sided radial symmetry; many species with tube feet; predators, herbivores, detritus feeders, and suspension feeders. | Bottom | Bottom |

[1]Major species groups (those with more than 1,000 species) are based on the World Register of Marine Species (World Register of Marine Species Editorial Board, 2015) and Catalogue of Life (Roskov et al., 2015).
[2]Presence in the Study Area includes open ocean areas (North Pacific Gyre and North Pacific Transition Zone) and coastal waters of two large marine ecosystems (California Current and Insular-Pacific Hawaiian). Occurrence on or within seafloor (bottom or benthic) or water column (pelagic) pertains to juvenile and adult stages; however, many phyla may include pelagic planktonic larval stages.
[3]Classification generally refers to the rank of phylum, although Protozoa is a traditionally recognized group of several phyla of single-celled organisms (e.g., historically referred to as Kingdom Protozoa, which is still retained in some references, such as in the Integrated Taxonomic Information System).
[4]benthic = a bottom-dwelling organism associated with seafloor or substrate; planktonic = an organism (or life stage of an organism) that drifts in pelagic (water) environments

Additional information on the biology, life history, and conservation of marine invertebrates can be found in Appendix C.

### 3.4.3 Environmental Consequences

None of the proposed military readiness activities would be conducted under the No Action Alternative. Therefore, baseline conditions of the existing environment for marine invertebrates would either remain unchanged or would improve slightly after cessation of ongoing military readiness activities. As a result, the No Action Alternative is not analyzed further within this section.

This section describes and evaluates how and to what degree the activities and stressors described in Chapter 2 and Section 3.0.2.3 potentially affects marine invertebrates known to occur within the Study Area. In addition, invasive marine invertebrates, such as octocorals in Pearl Harbor, are an emerging threat to other marine invertebrate communities. Information on SOPs used by the Navy related to invasive species is presented in Section 3.0.4.

The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors analyzed for invertebrates are as follows:

- **acoustics** (sonar and other transducers)
- **explosives** (explosions in water)
- **physical disturbance and strikes** (vessels and in-water devices, MEM, seafloor devices, pile driving, cable installation)
- **entanglement** (wires and cables, decelerators/parachutes, nets)
- **ingestion** (MEM)

The analysis considers SOPs and mitigation measures that would be implemented under Alternatives 1 and 2 of the Proposed Action. The standard operating procedures and mitigation that are specific to invertebrates are listed in Table 3.4-3.

As noted in Section 3.0.2, a significance determination is only required for activities that may have reasonably foreseeable adverse effects on the human environment based on the significance factors in 40 CFR 1501.3(d). Of the stressors analyzed in this section, only acoustic and explosive stressors could have a reasonably foreseeable adverse effect; thus requiring a significance determination. Stressors with no reasonably foreseeable adverse effects remain included in this Draft EIS/OEIS to document and support the analysis leading to this conclusion.

A stressor is considered to have a significant effect on the human environment based on an examination of the context of the action and the intensity of the effect. In the present instance, the effects of acoustics or explosives would be considered significant if the impacts have short- or long-term changes well outside the limits of 1) the natural range of variability of species' populations, 2) their habitats, or 3) the natural processes sustaining them within the Study Area. A significant effect finding would be appropriate if invertebrate habitat would be degraded over the long term or permanently such that it could cause the population of a managed species to become stressed, less productive, or unstable.

**Table 3.4-3: List of Standard Operating Procedures and Mitigation for Invertebrates**

| Applicable Stressor | Requirements Summary and Protection Focus | Section Reference |
|---|---|---|
| Explosives | The Action Proponents will not detonate any in-water explosives within 350 yards of shallow-water coral reefs. | Section 5.7.1[1] |
| | The Action Proponents will not detonate any in-water explosives within 350 yards of artificial reefs, biogenic hard bottom, submerged aquatic vegetation, and shipwrecks, except in designated locations where these resources will be avoided to the maximum extent practical. | Section 5.7.2[1] |
| | The Action Proponents will not<br>(1) set vessel anchors within an anchor swing circle radius that overlaps shallow-water coral reefs (except in designated anchorages)<br>(2) place other seafloor devices within 350 yards of shallow-water coral reefs<br>(3) deploy non-explosive ordnance against surface targets within 350 yards of shallow-water coral reefs | Section 5.7.1[1] |
| | The Action Proponents will not<br>(1) set vessel anchors within an anchor swing circle radius that overlaps artificial reefs, biogenic hard bottom, submerged aquatic vegetation, and shipwrecks (except in designated anchorages)<br>(2) place other seafloor devices (that are not precisely placed) within 350 yards of artificial reefs, biogenic hard bottom, submerged aquatic vegetation, and shipwrecks (except for vessel anchors, precisely placed seafloor devices, and as described in Section 5.7.2, Table 5-9)<br>(3) place non-explosive seafloor devices directly on artificial reefs, biogenic hard bottom, submerged aquatic vegetation, or shipwrecks | Section 5.7.2[1] |

[1] The mitigation was developed to protect specific habitats, which also protects invertebrates that are associated with those habitats.

#### 3.4.3.1 Acoustic Stressors

Table 3.4-4 contains brief summaries of information relevant to the analyses of effects for acoustic substressors (e.g., sonar and other transducers) on invertebrates. Details on the updated information in general, as well as effects specific to each substressor, is provided in Appendix D.

**Table 3.4-4: Acoustic Information Summary**

| Substressor | Information Summary |
|---|---|
| All acoustic substressors | Most marine invertebrates do not have the capability to sense sound pressure; however, some are sensitive to nearby low-frequency sounds.<br>• Invertebrates detect sound through particle motion, which diminishes rapidly with distance from the sound source. Therefore, the distance at which they may detect a sound is limited. Studies of continuous noise have found statocyst (small organ used for balance and orientation in some marine invertebrates) damage, stress, changes in larval development, masking of biologically relevant sounds, and behavioral reactions in marine invertebrates under generally extreme experimental conditions.<br>• Noise exposure duration in many of the studies was far greater than that expected to occur during infrequent and localized activities. |

## Table 3.4-4: Acoustic Information Summary (continued)

| Substressor | Information Summary |
|---|---|
| All acoustic substressors (cont.) | • Masking of biologically relevant sounds by sounds generated from human activities could affect behaviors such as larvae settlement, communication, foraging, and predator avoidance. Invertebrates may also grow accustomed (i.e., habituate) to chronically elevated sound from human activities. Some studies indicate the potential for effects on invertebrate larval development and masking resulting from extended exposure.<br>• Recent research regarding the vertical distribution of most pelagic invertebrates suggests they are far below the surface during the daytime and less affected by daytime stressors in surface waters. |
| Sonar and other transducers | Sonar and other transducers produce continuous, non-impulsive sound in the water column at various frequencies.<br>• Sonar and other transducer use in nearshore locations could expose more benthic invertebrates to higher intensity sounds, but the exposures from mobile platforms would be brief and intermittent and affect mostly pelagic invertebrates very close to the particle motion generated by the transducers.<br>• Sessile species or species with limited mobility located near the activity would be exposed for the entire duration of sonar use at pierside locations. Species with greater mobility could potentially be exposed for shorter durations, depending on the time between testing events and the activity of individual animals.<br>• The limited information available suggests that sessile marine invertebrates repeatedly exposed to sound could experience physiological stress or react behaviorally (e.g., shell closing) but there is also evidence to suggest their population is unaffected. |
| Air guns | Air guns produce shock waves when pressurized air is released into the water. The results of studies of the effects of seismic air guns on marine invertebrates suggest differences between taxonomic groups and life stages.<br>• Physical injury has not been reported in relatively large crustaceans exposed to seismic air guns at received levels comparable to the source level of air guns operated at full capacity, but one study reported injury and mortality for zooplankton.<br>• Stress response was not found in crabs exposed to air gun noise but was reported for lobsters located near the source (where particle motion was likely detectable).<br>• While behavioral reaction to air guns has not been documented for crustaceans, squid have exhibited startle and alarm responses at various sound levels.<br>• Developmental effects were found for crab eggs and scallop larvae, but not for crab larvae. Air gun use could also result in substrate vibration, which could cause behavioral effects in nearby benthic invertebrates (e.g., shell closing or changes in foraging activity).<br>• Air gun use in offshore areas would be unlikely to affect individuals of pelagic organisms (e.g., jellyfish, squid, and zooplankton) multiple times due to the relative mobility of invertebrates in the water column (passive/drifting and active movement) and the mobile nature of the sound source.<br>• Exposure to air gun shots has not caused mortality, and invertebrates typically recovered from injuries in controlled laboratory settings.<br>• Effects from air guns are highly unlikely and not considered further in this analysis. |

**Table 3.4-4: Acoustic Information Summary (continued)**

| Substressor | Information Summary |
|---|---|
| Pile driving | Pile driving and removal involves both impact and vibratory methods. Impact pile driving produces repetitive, impulsive, broadband sound with most of the energy in lower frequencies where invertebrate sound sensing capability is greater. Vibratory pile removal produces nearly continuous sound at a lower source level.<br>• Available information indicates that invertebrates may respond to particle motion and substrate vibration produced by pile driving and removal. Investigations have found behavioral effects may vary among taxa or species. Most studies were conducted using small experimental tanks, where effects were observed very close to the sound sources.<br>• Effects from vibratory pile driving are highly unlikely and not considered further in this analysis. |
| Vessel noise | Some invertebrates would likely be able to detect the low-frequency component of vessel noise. Several studies have found physiological responses (e.g., stress and changes in growth and reproduction) and behavioral responses (e.g., changes in feeding activity, shell closing) in some invertebrate species in response to vessel noise playback. Vessel noise may also contribute to acoustic masking.<br>• Exposure to other types of non-impulsive noise has resulted in statocyst damage in squid and octopus, physiological stress, effects on larval development, and behavioral reactions. Noise exposure in several of the studies occurred to captive individuals over time durations greater than that expected to occur during many training and testing activities, and therefore direct applicability of the results to the proposed action is uncertain. However, it is possible that invertebrates in the Study Area that are exposed to episodic vessel noise could exhibit similar reactions.<br>• Marine invertebrates capable of sensing sound may alter their behavior or experience masking of other sounds if exposed to vessel noise. Because the distance over which most marine invertebrates are expected to detect sounds is limited, and because most vessel noise is transient or intermittent (or both), most behavioral reactions and masking effects from training and testing activities would likely be short term, ceasing soon after vessels leave an area. An exception could occur in and around port navigation channels and nearshore waters that receive a high volume of ship or small craft traffic, where sound disturbance would be more frequent.<br>• The relatively high frequency and intensity of vessel traffic in many nearshore training and testing areas may have also given organisms an opportunity to adapt behaviorally to a noisier environment. For example, survey work by the Virginia Institute of Marine Science suggests that large populations of oysters inhabit Navy piers in the Chesapeake Bay that have persisted despite a history of chronic vessel noise. Without prolonged exposure to nearby sounds of relatively high intensity and generally low frequency, measurable effects or behavioral adaptation are not expected.<br>• Effects from vessel noise are highly unlikely and not considered further in this analysis. |
| Aircraft noise | Aircraft and missile overflight noise is not applicable to invertebrates due to the very low transmission of sound pressure across the air/water interface and will not be analyzed further in this section. |

**Table 3.4-4: Acoustic Information Summary (continued)**

| Substressor | Information Summary |
|---|---|
| Weapon noise | Invertebrates could be temporarily affected by noise produced by muzzle blasts and impact of large non-explosive practice munitions.<br>• Effects would likely be limited to pelagic invertebrates (e.g., squid, jellyfish, zooplankton) located near the surface.<br>• Injury and physiological stress would not be likely because most invertebrates are relatively insensitive to underwater sounds. Behavioral reactions have been observed for squid but not for other invertebrates such as crustaceans, jellyfish, or zooplankton.<br>• Overall, effects from weapons noise are highly unlikely and not considered further in this analysis |

Assessing whether sounds may disturb or injure an animal involves understanding the characteristics of the acoustic sources, the animals that may be near the sound, and the effects that sound may have on the physiology and behavior of those animals. Marine invertebrates are likely only sensitive to water particle motion caused by nearby low-frequency sources, and likely do not sense distant or mid- and high-frequency sounds (Appendix D). Compared to some other taxa of marine animals (e.g., fishes, marine mammals), little information is available on the potential effects on marine invertebrates from exposure to sonar and other sound-producing activities (Hawkins et al., 2015). Historically, many studies focused on squid or crustaceans and the consequences of exposures to broadband impulsive air guns typically used for oil and gas exploration (Carroll et al., 2017; Erbe & Thomas, 2022). More recent investigations have included additional taxa (e.g., molluscs) and sources, although extensive information is not available for all potential stressors and effect categories (Carroll et al., 2017; Erbe & Thomas, 2022; Solé et al., 2023). Background information on acoustic effects on marine invertebrates from physical injury to behavioral or stress response is provided in Appendix D. Acoustic stressors such as aircraft noise is not applicable to marine invertebrates due to the very low transmission of sound pressure across the air/water interface and are not analyzed in this section.

#### 3.4.3.1.1 Sonar and Other Transducers

##### 3.4.3.1.1.1 Effects from Sonar and Other Transducers Under Alternative 1

**Training and Testing**. Marine invertebrates would be exposed to low-, mid-, and high-frequency sonar and sound produced by other transducers during training and testing activities throughout the Study Area. Sounds produced during training and testing are described in Section 3.0.3.3.1.

Invertebrates would likely only sense low-frequency sonar or the low-frequency component of nearby sounds associated with other transducers. Sonar and other transducers are often operated in deep water, where effects would be more likely for pelagic species than for benthic species. Only individuals within a short distance (potentially a few feet) of the most intense sound levels would experience effects on sensory structures such as statocysts. Any marine invertebrate that detects low-frequency sound may alter its behavior (e.g., change swim speed, move away from the sound, or change the type or level of activity). Given the limited distance to which marine invertebrates are sensitive to sound, only a small number of individuals relative to overall population sizes would likely have the potential to be affected. Because the distance over which most marine invertebrates are expected to detect any sounds is limited and because most sound sources are transient or intermittent (or both), any physiological effects, masking, or behavioral responses would be short term and brief. Without prolonged exposures to nearby sound sources, adverse effects on individual invertebrates are not expected, and there would be no effects at the population level. Low frequency sonar and other sounds may result in brief, intermittent effects on individual marine invertebrates and groups of marine invertebrates close to a sound source, but they are unlikely to affect survival, growth, recruitment, or reproduction of marine invertebrate populations or subpopulations.

As summarized in Table 3.4-4, low-frequency sonar and other transducers could expose some benthic invertebrates to higher intensity sounds, but the exposures from mobile platforms would be brief and intermittent and affect mostly pelagic invertebrates very close to the particle motion generated by the transducers. Training and testing activities could occur in designated black abalone critical habitat. However, sound associated with training and testing would not affect essential biological features of critical habitat, which consist of adequate substrate, food availability, and water quality and circulation patterns. Critical habitat is not designated for white abalone or sunflower sea stars under the ESA. Due to the limited range of sound detection and infrequent use of sonar in relatively shallow waters where these species occur, physiological or behavioral reactions due to sonar exposure are unlikely. Although the number of sonar hours used would be greater under Alternative 2 than Alternative 1, the effects on marine invertebrates would be the same, as analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs and for reasons summarized in Table 3.4-4.

**Modernization and Sustainment of Ranges**. There would be no sonar use during modernization and sustainment of ranges activities. All sonar used on the SOAR, SWTR, Mine Warfare, or other training areas is analyzed under Training and Testing above.

**Conclusion**. Activities that include the use of sonar and other transducers under Alternative 1 would result in less than significant effects for reasons presented in Table 3.4-4.

###### 3.4.3.1.1.2 Effects from Sonar and Other Transducers Under Alternative 2

The only difference between Alternatives 1 and 2 in sonar and other transducer use is that the number of sonar hours used would be greater under Alternative 2 (Table 3.0-2). Even though the number of sonar and transducers used in Alternative 2 would be greater than Alternative 1, potential impacts on invertebrates are not expected to be meaningfully different.

Therefore, activities that include the use of sonar and other transducers under Alternative 2 would be similar to Alternative 1 and would result in less than significant effects.

#### 3.4.3.2 Explosive Stressors

##### 3.4.3.2.1 In-Water Explosives

Explosions produce pressure waves with the potential to cause injury or physical disturbance due to rapid pressure changes, as well as loud, impulsive, broadband sounds. Impulsive sounds are characterized by rapid pressure rise times and high peak pressures. When explosive munitions detonate, fragments of the weapon are thrown at high velocity from the detonation point, which can injure or kill invertebrates if they are struck. However, the friction of the water quickly slows these fragments to the point where they no longer pose a threat. The number and location of explosives that may result in fragments are presented in Table 3.0-17. Supporting information on how explosives affect marine invertebrates is presented in Appendix D.

Various types of explosives are used during military readiness activities. The type, number, and location of activities that use explosives are discussed in Chapter 3.0. While explosives would be used throughout the Hawaii Study Area, underwater explosions would primarily occur in the vicinity of Pearl Harbor, and Barbers Point, and Ewa Minefield Training area (areas that have been historically used for these activities), as well as at Pearl City Peninsula and Lima Landing in Pearl Harbor (see Figure H-33). In the SOCAL Range Complex, underwater detonations could occur in San Diego Bay at the Echo location (see Figure H-39) and in nearshore areas within the SSTC training lanes and training areas surrounding SCI over sandy bottom.

Table 3.4-5 contains a summary of information relevant to the analyses of effects from explosive stressors. Detailed background information is provided in Appendix D. Note that underwater explosions from human activities have not been identified among the causes of decline in marine invertebrate populations to date (Appendix C).

**Table 3.4-5: Explosive Stressors Information Summary**

| Information Summary | |
|---|---|
| Explosions in the water | Explosions produce pressure waves with the potential to cause injury or physical disturbance due to rapid pressure changes and other physical effects. Charges detonated in shallow water on or near the bottom could kill and injure marine invertebrates within hundreds of yards of the location. A blast on or near the bottom could also degrade hard substrate suitable for invertebrate colonization or form a crater in soft bottom. A blast in the vicinity of hard corals could cause direct effects on coral polyps, or fragmentation and siltation of the corals.<br>• Invertebrates that detect impulsive or non-impulsive sounds resulting from an explosion may experience stress or exhibit behavioral reactions. Any auditory masking of biologically relevant sounds would be very brief.<br>• The majority of underwater explosions occur on the surface and typically in offshore locations more than 3–9 nautical miles from shore in water depths greater than 100 feet (30 meters), where invertebrate size and abundance is generally low compared to estuarine and nearshore waters. In addition, invertebrate abundances in offshore surface waters tend to be lower during the day, when surface explosions typically occur, than at night.<br>• Charges detonated on or near shallow, soft-bottom habitats affect invertebrate communities that are adapted to frequent disturbance from storms and associated sediment redistribution. Studies of the effects of large-scale sediment disturbance, such as dredging and sediment borrow projects, have found recovery of benthic communities over a period of weeks to years depending on multiple factors (e.g., substrate type, current speeds, and storm intensities).<br>• With the exception of clay bottom, craters resulting from detonations in the soft bottom would be filled and smoothed by waves and long-shore currents over time, resulting in no long-term change to bottom profiles that could affect invertebrate species assemblages. Craters in clay bottom could persist for years. |

#### 3.4.3.2.1.1 Effects from Explosives Under Alternative 1

**Training and Testing**. Mine warfare activities are typical examples of activities involving detonations on or near the bottom in nearshore waters. Invertebrates in these areas such as exposed coastlines, are adapted to frequent disturbance from storms and associated sediment redistribution. Studies of the effects of large-scale sediment disturbance, such as dredging and sediment borrow projects, have found recovery of benthic communities over a period of weeks to years (Posey & Alphin, 2002; U.S. Army Corps of Engineers, 2012). Recovery time is variable and may be influenced by multiple factors but is generally faster in areas dominated by sand and moderate to strong water movement. The area of bottom habitat disturbed by explosions would be less than that associated with dredging or other large projects and would occur mostly in soft-bottom areas that are regularly disturbed by natural processes such as water currents and waves. It is therefore expected that areas affected by detonations would rapidly be recolonized (potentially within weeks) by recruitment from the surrounding invertebrate community. Craters resulting from detonations in the soft bottom would be filled and smoothed by waves and long-shore currents over time, resulting in no permanent change to bottom profiles that could affect invertebrate species assemblages. The time required to fill craters would depend on the size and depth, with deeper craters likely requiring more time to fill (U.S. Army Corps of Engineers, 2001). The amount of bottom habitat affected by explosions would be a very small percentage of the habitat available in the Study Area. Information on the total area of bottom habitat potentially disturbed by explosions is presented in Appendix I. In addition, the locations, number of events, area affected, and potential effects associated with explosives would be the same under Alternative 1 and Alternative 2.

Many corals and hard bottom invertebrates are sessile, fragile, and particularly vulnerable to shock wave effects. Many of these organisms are slow growing and could require decades to recover (Precht et al., 2001). However, most other military readiness activities that use explosions would occur at or near the water surface and offshore, reducing the likelihood of effects on shallow-water corals.

As discussed in Section 5.7, mitigation to avoid effects from explosives on seafloor resources in mitigation areas would be implemented throughout the Study Area. For example, except for mine warfare ranges and locations previously used for underwater detonations, explosive mine countermeasure and neutralization activities would not be conducted within 350 yards of shallow-water coral reefs, precious coral beds, artificial reefs, and shipwrecks. The mitigation would consequently also help avoid potential effects on invertebrates that inhabit these areas. The Navy does not conduct underwater detonations near black and white abalone habitat based on established protocol which authorizes on select areas of a given range complex for explosive events. Underwater explosions would also not overlap with designated black abalone critical habitat.

**Modernization and Sustainment of Ranges**. Explosives would not be used during modernization and sustainment of ranges; therefore, there would be no explosives effects.

**Conclusion**. Activities that include the use of explosives under Alternative 1 would result in less than significant effects because of: (1) an unlikely spatial coincidence between explosive effects and the distribution of sensitive invertebrates (e.g., shallow-water coral reefs); (2) a quick recovery of soft bottom communities that are more likely impacted (e.g., worms, clams); and (3) only short-term impacts from most local disturbances of the surface water or seafloor, with some temporary increases in suspended sediment in mostly shallow, soft bottom habitats.

#### 3.4.3.2.1.2 Effects from Explosives Under Alternative 2

The locations, number of events, area affected, and potential effects associated with explosives would be the same or similar to those described under Alternative 1 and potential impacts on invertebrates are not expected to be meaningfully different.

Mitigation to avoid impacts effects from explosives on seafloor resources would be implemented in mitigation areas throughout the Study Area, as described under Alternative 1 and in Section 5.7.

Therefore, activities that include the use of explosives under Alternative 2 would be similar to Alternative 1 and would result in less than significant effects.

### 3.4.3.3 Physical Disturbance and Strike Stressors

Table 3.4-6 contains brief summaries of information relevant to analyses of effects for each physical disturbance and strike substressor. Supporting information on marine invertebrate effects from physical disturbance and strike stressors are provided in Appendix F.

**Table 3.4-6: Physical Disturbance and Strike Stressors Information Summary**

| Substressor | Information Summary |
|---|---|
| Vessels and in-water devices | • In general, there would be a higher likelihood of vessel and in-water device disturbance or strike in the nearshore areas than in the open ocean portions of the Study Area because of the concentration of activities and comparatively higher abundances of invertebrates in areas closer to shore.<br>• In most cases, vessels and in-water devices would avoid contact with bottom (and associated invertebrates) per standard operating procedures unless the vessel/vehicle is designed to touch the bottom (e.g., amphibious vehicles).<br>• Most invertebrates in the water column around a passing vessel would be disturbed, rather than struck, as water flows around a vessel or device due to the hydrodynamic shape.<br>• Propeller wash and turbulent water flow could damage or kill zooplankton and invertebrate gametes, eggs, embryonic stages, or larvae. Even if some tiny invertebrates were affected, their populations are vast, with short life cycles and naturally high mortality rates. Many squid and zooplankton species also migrate far from the surface during the day, reducing the overall potential for strikes or even disturbance.<br>• The potential for vessels to disturb invertebrates on or near the bottom and along the shoreline would occur mostly during nearshore military readiness activities, and along navigation channels. Invertebrates in such areas (e.g., shrimp, crab, oysters, clams, worms) could be affected by sediment disturbance or direct strike during vessel movement in shallow water (e.g., waterborne training, amphibious landings). Touching the bottom in shallow, soft bottom is a common practice among boaters that does not necessarily damage the vessel.<br>• Although amphibious vehicles are designed to touch the bottom during amphibious landings, they are generally used along ocean beaches and similar high-energy shorelines where the numbers of invertebrates present are small and resilient to frequent disturbance.<br>• Invertebrates inhabiting shallow bottoms and shoreline may be subject to recurring wake-induced turbidity and erosion (Zabawa & Ostrom, 1980). For context, Navy vessels represent a small fraction of total maritime traffic (Mintz, 2016) and the wakes generated by small Navy vessels which, for safety reasons are not generally operated at excessive speeds close to shore, are similar to wind waves that naturally occur. |
| Military expended materials | • Military expended material (MEM) deployed over water include a wide range of items that may affect invertebrates upon initial impact or may occur when items reach the seafloor to settle or be moved along the bottom by water currents or gravity.<br>• The effects of expended materials at the surface would be minimal because many invertebrates are absent from surface waters during the day, which is when most military readiness activities occur. Compared to surface waters and offshore areas, a greater number of macroinvertebrates typically occurs on the bottom and closer to shore, where relatively few materials are expended.<br>• After striking the surface or being launched underwater, MEM passing nearby may disturb individuals and cause a stress response or behavioral reaction. Expended items may bury or smother organisms when they reach the seafloor. Expended items could also increase turbidity that could temporarily affect filter-feeding species nearby. |

**Table 3.4-6: Physical Disturbance and Strike Stressors Information Summary (continued)**

| Substressor | Information Summary |
|---|---|
| Military expended materials (continued) | • Whereas some benthic invertebrates have hard, resilient shells (e.g., clams, snails), other species (e.g., sponges and soft corals) have fragile structures and sensitive body parts that could be damaged or covered by MEM. Heavy expended materials such as a ship hulk could also break hard structures such as coral skeletons and mussel beds. Shallow- and deep-water corals that build complex or fragile structures could be particularly susceptible to breakage or abrasion. Expended items may also provide new colonization sites for benthic invertebrates, although species composition on artificial substrates often differs from that of the surrounding natural community.<br>• MEM that are less dense than the underlying substrate (e.g., decelerators/ parachutes) will likely remain on the substrate surface for some time after sinking. The effect of lighter materials on benthic invertebrates would also be temporary and minor due to the mobility of such materials. The rare exception would be for light materials that snag on structure bottom features (e.g., decelerator/parachute or wire/cable on reef-building corals). The potential for lighter materials to drift into shallow, nearshore habitats from at-sea training and testing areas would be low based on the prevailing ocean currents.<br>• Potential effects on deep-water corals and sponges present the greatest risk of long-term damage compared with resilient soft bottom communities. The probability of striking deep-water corals or other sensitive invertebrates located in deep-water habitat is extremely low due to their relatively patchy coverage on suitable habitat. |
| Seafloor devices | • Seafloor devices are either stationary (e.g., mine shapes, anchors, bottom-placed instruments, fiber optic cables) or move very slowly along the bottom (e.g., bottom-crawling unmanned underwater vehicles) where they may temporarily disturb the bottom before being recovered.<br>• Seafloor devices pose little threat to highly mobile organisms (e.g., squid, shrimp) in the water column. Effects on pelagic invertebrates resulting from movement of a device through the water column before it reaches the seafloor would likely consist of only temporary displacement as the object passes by.<br>• Effects on sessile or less mobile benthic organisms (e.g., corals, sponges, snails) may include injury or mortality due to direct strike, disturbance, smothering, and temporary impairment of respiration or filter-feeding due to increased sedimentation and turbidity. The severity of the effect would be greater for relatively fragile invertebrate parts (e.g., coral polyps).<br>• Although intentional placement of seafloor devices on bottom structure is avoided to ensure recovery, seafloor devices placed in depths less than about 2,500 meters may inadvertently affect deep-water corals and other invertebrates associated with live hard bottom (e.g., sponges, anemones). The probability of striking deep-water corals or other sensitive invertebrates located on hard substrate is also relatively low given their typically low percent coverage on suitable habitat. |
| Pile driving | • Pile driving and removal activities at Port Hueneme involves both impact and vibratory methods in soft substrate. Pile driving may have the potential to affect soft bottom communities temporarily during driving, removal, and in the short term thereafter. The effect on benthic invertebrates include displacement within the footprint of the pilings, sediment disturbances during driving and extraction, and loss of sessile invertebrates that colonize the pilings prior to removal. |

#### 3.4.3.3.1 Vessels and In-Water Devices

##### 3.4.3.3.1.1 Impacts from Vessels and In-Water Devices

**Training and Testing**. The number and location of activities that include vessels is shown in Table 3.0-15, and the number and location of activities that include in-water devices is shown in Table 3.0-16. Most training and testing activities include vessels, while a lower number of activities include in-water devices. As indicated in Section 3.0.3.3.4.1, vessel operation would be widely dispersed throughout the Study Area but would be more concentrated near ports, naval installations, and range complexes. Most vessel use would occur in the California Study Area. Amphibious landings could occur at designated beaches adjacent to the Study Area, including beaches adjacent to proposed Amphibious Corridors. Hydrographic surveys have been used to map precise transit routes through sandy bottom areas to avoid potential vessel strikes of corals in the Hawaii Study Areas.

Similar to vessel operation, activities involving in-water devices could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers, and ranges.

Invertebrates located at or near the surface could be struck or disturbed by vessels, and invertebrates throughout the water column could be similarly affected by in-water devices. There would be a higher likelihood of vessel and in-water device strikes over the continental shelf than in the open ocean portions of the Study Area because of the concentration of activities and comparatively higher abundances of invertebrates in areas closer to shore. However, direct strikes would generally be unlikely for most species. Exceptions would include amphibious landings, where vessels contact the bottom and may directly affect invertebrates. Organisms inhabiting these areas are expected to rapidly re-colonize disturbed areas. Other than during amphibious landings, purposeful contact with the bottom by vessels and in-water devices would be avoided. The potential to disturb invertebrates on or near the bottom would occur mostly during vessel nearshore and onshore training activities, and along dredged navigation channels. Invertebrates that typically occur in areas associated with nearshore or onshore activities, such as shorelines, are highly resilient to vessel disturbance. Propeller wash and turbulent water flow could damage or kill zooplankton and invertebrate gametes, eggs, embryonic stages, or larvae. Overall, the area exposed to vessel and in-water device disturbance would be a very small portion of the surface and water column in the Study Area, and only a small number of individuals would be affected compared to overall abundance. Therefore, the effect of vessels and in-water devices on marine invertebrates would be inconsequential. Activities are not expected to yield any lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. In addition, even though there would be a very small increase in vessel and in-water device use in the Study Area in Alternative 2 compared with Alternative 1, the difference would not result in substantive changes to the potential for or types of effects on invertebrates.

Species that do not occur near the surface within the Study Area, including ESA-listed black abalone and white abalone, as well as ESA-proposed sunflower sea stars, would not be exposed to vessel strikes. In addition, these species would not be affected by amphibious landings (amphibious assault, insertion, and extraction) since abalone inhabit rocky shores and hard bottom, which are not used for amphibious landings. In addition, these activities would not occur within black abalone critical habitat.

**Modernization and Sustainment of Ranges**. No vessels or in-water devices are involved in the proposed Special Use Airspace Modernization. Vessels and in-water devices associated with SOAR Modernization; SWTR Installation; Sustainment of Undersea Ranges; Hawaii and California undersea cable projects; and Installation and Maintenance of Underwater Platforms, Mine Warfare, and Other Training Areas would move very slowly during installation activities (0–3 knots) and would not pose a collision threat to invertebrates. Although invertebrates located at or near the surface could be struck or disturbed by vessels, in-water devices would be placed primarily in soft bottom areas and would have less than significant effects on benthic invertebrate species.

**Conclusion**. Activities that include the use of vessels and in-water devices would not have reasonably foreseeable adverse effects on invertebrates for reasons previously analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs and presented in Table 3.4-6. Some of these reasons include the following: (1) invertebrate populations are vast with short life cycles and naturally high mortality rates, so even if some tiny invertebrates are affected, populations would not be affected; and (2) many invertebrates inhabiting nearshore areas are adapted to recurring waves and storm surge, which can generate increased turbidity and suspended sediments.

#### 3.4.3.3.2 Military Expended Materials

##### 3.4.3.3.2.1 Effects from Military Expended Materials

**Training and Testing**. A potential strike to marine invertebrates comes from the following categories of MEM: (1) all sizes of non-explosive practice munitions (Table 3.0-16); (2) fragments from high-explosive munitions (Table 3.0-17); (3) expendable targets (Table 3.0-18); and (4) expended materials other than munitions, such as sonobuoys or torpedo accessories (Table 3.0-19). A discussion of the types of activities that use MEM is presented in Appendix B, and supporting information on potential MEM effects on marine invertebrates is presented in Appendix I.

MEM would occur throughout the Study Area, although relatively few items would be expended in the HCTT Transit Corridor. Most MEM would occur within the California and Hawaii Study Areas. Potential effects on marine invertebrates from MEM may include injury or mortality due to direct strike or burial, disturbance, and indirect effects such as increased turbidity. The potential for direct strikes of pelagic zooplankton and squid at the surface would be minimized by their decreased occurrence in surface waters during the day when training activities typically occur.

The effect of MEM on marine invertebrates is likely to cause injury or mortality to individuals of soft-bodied species that are smaller than the MEM. Zooplankton could therefore be affected by most MEM. Effects on populations would likely be inconsequential because the number of individuals affected would be small relative to known population sizes, the area exposed to the stressor is extremely small relative to the area of both suitable and occupied habitats, the activities are dispersed such that few individuals would likely be exposed to more than one event, and exposures would be localized and would cease when the MEM becomes part of the bottom (e.g., buried or encrusted with sessile organisms). Activities involving MEM are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

As discussed in Section 5.7, mitigation to avoid effects from MEM on seafloor resources would be implemented in mitigation areas throughout the Study Area. For example, gunnery activities within a specified distance of shallow-water coral reefs and precious coral beds would not be conducted. The mitigation would consequently also help avoid potential effects on sensitive invertebrates that inhabit these areas, such as corals. Even though the total area affected for military readiness activities would increase slightly under Alternative 2 compared to Alternative 1, the potential effects on marine invertebrates would be similar between the two alternatives.

In general, the Navy does not conduct training activities that result in MEM in shallow, rocky areas where ESA-listed black abalones occur. In addition, significant amounts of MEM are not used at depths where white abalone are found, such as Tanner Bank. Some MEM may be expended in the nearshore waters off the southern part of SCI, the future Shallow Water Test Range, and explosive ordnance disposal areas near SSTC and southern SCI. Although most MEM typically sinks after use, it is conceivable a MEM item deployed offshore could drift into shallow water, including black abalone critical habitat, although this would be infrequent and insignificant. Similarly, infrequent drifting MEM could be deposited near shallow white abalone habitat such as Tanner Bank. Given the low population of both abalone species, spatial distances between individuals, and very infrequent co-occurrence with MEM, while there could be potential effects, any likely effect would be transitory and minimal. Overall, MEM effects on ESA-listed abalone species and ESA-proposed sunflower sea stars would be minimal due to relatively little overlap with MEM deployment.

**Modernization and Sustainment of Ranges**. No MEM are expected during modernization and sustainment of ranges activities. However, some anchors may not be recovered and would become MEM. Those effects are covered in the analysis of seafloor devices.

**Conclusion**. Activities that include the use of MEM would not have reasonably foreseeable adverse effects on invertebrates for reasons previously analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs and presented in Table 3.4-6. Some of these reasons include the following: (1) the effects of expended materials would be minimal at the surface because many invertebrates are absent from surface waters during the day, when most military readiness activities occur; and (2) a greater number of macroinvertebrates typically occur on the bottom and closer to shore, where relatively few materials are expended.

#### 3.4.3.3.3 Seafloor Devices

##### 3.4.3.3.3.1 Effects from Seafloor Devices

**Training and Testing**. Seafloor devices represent items used during training or testing activities that are deployed onto the seafloor and recovered. Section 3.0.3.3.4.3 provides the number and location of seafloor devices in the Study Area (see Table 3.0-20). Supporting information on effects of seafloor devices on marine invertebrates is presented in Appendix F.

Effects on marine invertebrates may include injury or mortality due to direct strike, disturbance, smothering, and impairment of respiration or filter-feeding due to increased sedimentation and turbidity. Effects resulting from movement of the devices through the water column before they contact the bottom would likely consist of only temporary displacement as the object passes by.

Although intentional placement of seafloor devices on bottom structure is avoided, activities occurring at depths less than about 3,000 m may inadvertently affect deep-water corals, other invertebrates associated with hard bottom, and other marine invertebrate assemblages. However, most activities involving seafloor devices (e.g., anchors for mine shapes such as concrete blocks) are typically conducted in nearshore areas far from deep-sea corals. Most seafloor devices are operated in the nearshore environment on bottom habitats suitable for deployment and retrieval (e.g., soft or mixed bottom). Hard substrate potentially supporting deep-water corals and other invertebrate communities is present on the continental shelf break and slope. A low percentage of deep substrate on the continental shelf is suitable for hard bottom communities. Based on the results of limited investigation, a low percentage of available hard substrate may be inhabited by deep-water corals or other invertebrate species (Watters et al., 2022), although the percentage of coverage may be higher in some areas, such as undersea banks associated with the Channel Islands. The number of organisms affected is not expected to result in effects on the viability of invertebrate populations.

During precision anchoring, the effect of the anchor on the bottom would likely crush a relatively small number of benthic invertebrates. Effects associated with turbidity and sedimentation would be temporary and localized. Precision anchoring would occur multiple times per year in the same general location. Therefore, although invertebrates in soft bottom areas are generally resilient to disturbance, community composition may be chronically disturbed at anchoring sites that are used repeatedly. However, the effect is likely to be inconsequential and not detectable at the population level for species occurring in the region near the anchoring locations. In addition, even though there would be a small increase in the number of activities involving seafloor devices from Alternative 1 to Alternative 2, this increase would not result in substantive changes to potential effects or the types of effects on marine invertebrates.

Navy practice is to place seafloor devices on soft bottom areas not normally associated with abalone or sunflower sea star habitat. Proposed activities using seafloor devices would not overlap with black abalone critical habitat, and minimally overlap white abalone habitat at Tanner Banks. Therefore, potential effects from seafloor devices on ESA invertebrates would be negligible.

Mitigation that includes not conducting precision anchoring (except in designated anchorages) would be implemented within the anchor swing circle of shallow-water coral reefs, precious coral beds, artificial reefs, and shipwrecks to avoid potential effects from seafloor devices on seafloor resources in mitigation areas throughout the Study Area (see Section 5.7). This mitigation would consequently help avoid potential effects on invertebrates that inhabit these areas.

**Modernization and Sustainment of Ranges**. New range modernization and sustainment activities include installation of undersea cables integrated with hydrophones and underwater telephones to sustain the capabilities of the SOAR. Deployment of fiber optic cables along the seafloor would occur in three locations: south and west of SCI in the California Study Area, and to the northeast of Oahu and west of Kauai in the Hawaii Study Area. In all locations the installations would occur completely within the water; no land interface would be involved. Cable-laying activities in the California Study Area could disturb white abalone and sunflower sea star bottom habitat when the cable crosses rocky substrate at depths between 65 to 196 ft. (20 to 60 m) for the SWTR Intallation. However, it is anticipated that rocky substrate would be avoided to the greatest extent possible throughout the cable corridor to minimize these effects.

Installation and maintenance of underwater platforms, mine warfare training areas, and installation of other training areas involve seafloor disturbance where those activities would take place. Each installation would occur on soft, typically sandy bottom, avoiding rocky substrates.

**Conclusion**. Activities that include the use of seafloor devices would not have reasonably foreseeable adverse effects on invertebrates for reasons previously analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs and presented in Table 3.4-6. Some of these reasons include the following: (1) marine invertebrates in the water column (e.g., squid, shrimp) are highly mobile; and (2) although relatively fragile invertebrate parts (e.g., coral polyps) would be affected greater than other invertebrates, seafloor devices are not typically placed in shallow nearshore areas where coral reefs or other sensitive populations occur.

#### 3.4.3.3.4 Pile Driving

##### 3.4.3.3.4.1 Effects from Pile Driving

**Training and Testing**. Effects on invertebrates resulting from pile driving and vibratory pile extraction are considered in the context of injury, mortality, or displacement that may occur due to physical strikes and disturbance. Pile driving produces impulsive sound that may also affect invertebrates. Effects associated with impulsive sound are discussed with other acoustic stressors in Section 3.4.3.1, and supporting information is presented in Appendix D.

Impact pile driving and vibratory pile removal would occur during training for Port Damage Repair. Pile driving for the Port Damage Repair would occur in shallower water over soft substrates at Port Hueneme, California. Some benthic invertebrates could be crushed, injured, displaced, or react behaviorally because of pile installation and removal. In addition, turbidity could affect respiration and feeding in some individuals. In addition, the location and number of events for pile driving associated with Port Damage Repair at Port Hueneme would be the same under both alternatives.

Because pile driving activities would only be conducted in Port Hueneme as part of Port Damage Repair training, and ESA-listed black and white abalone and ESA-proposed sunflower sea stars and black abalone critical habitat do not occur in Port Hueneme, there would be no on these species.

**Modernization and Sustainment of Ranges**. Pile driving would not occur during modernization and sustainment of ranges activities.

**Conclusion**. Activities that include pile driving would not have reasonably foreseeable adverse effects on invertebrates for reasons previously analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs. Some of these reasons are as follows: (1) pile installation and removal would only occur in one location (Port Hueneme) and for a limited number of times; and (2) although some slow-moving benthic invertebrates may be removed or crushed during pile installation and removal activities, the number of invertebrates affected would be extremely low and have no population-level effects.

### 3.4.3.4 Entanglement Stressors

Entanglement stressors that can affect marine invertebrates include wires and cables and decelerators/parachutes. Nets deployed during testing of XLUUV would not entangle marine invertebrates and are not discussed further. The number and locations where wires and cables would be expended are presented in Table 3.0-22. Table 3.4-7 contains brief summaries of background information that is relevant to analyses of effects for each entanglement substressor on invertebrates. Supporting information on marine invertebrate effects from entanglement stressors are provided in Appendix F.

### Table 3.4-7: Entanglement Stressors Information Summary

| Substressor | Information Summary |
| --- | --- |
| Wires and cables | Fiber-optic cables, torpedo guidance wires, sonobuoy wires, and expendable bathythermograph wires would be expended during military readiness activities.<br>• A marine invertebrate with some degree of mobility could become temporarily entangled and escape unharmed, be held tightly enough that it could be injured during its struggle to escape, be preyed upon while entangled, or starve while entangled. However, the effect of wires and cables on marine invertebrates is not likely to cause injury or mortality to individuals because of the linear and somewhat rigid nature of the material.<br>• Once the items reach the bottom, they could be moved into different shapes or could loop around objects due to water currents, but the items are not expected to form tight coils. Fiber-optic cables are also relatively brittle and easily broken.<br>• The wires and cables would eventually become buried in sediment or encrusted by marine growth. Benthic and sessile invertebrates would be physically disturbed rather than entangled by a wire or cable. |
| Decelerators/ parachutes | Following impact at the water's surface, the decelerator/parachute assembly is expended and sinks away from the unit.<br>• Small and medium decelerator/parachute assemblies may remain at the surface for 5–15 seconds before drifting to the bottom, where it becomes flattened and more of a physical disturbance stressor than an entanglement stressor.<br>• Large and extra-large decelerators/parachutes may remain at the surface or suspended in the water column for a longer time due to the lack of weights, but eventually also sink to the bottom and become flattened.<br>• A decelerator/parachute with attached lines sinking through the water column are unlikely to affect pelagic invertebrates; most pelagic invertebrates would be too small to be ensnared, the lines would be relatively straight during descent, and there are large openings between the cords. Small decelerator/parachute lines may also be detached and incapable of entangling an invertebrate. |

#### 3.4.3.4.1 Wires and Cables

##### 3.4.3.4.1.1 Effects from Wires and Cables

**Training and Testing**. Marine invertebrates may be affected by wires and cables such as fiber-optic cables, torpedo guidance wires, sonobuoy wires, and expendable bathythermograph wires expended during training and testing activities. These materials would be expended during sinking exercises, anti-submarine warfare activities, torpedo exercises, and various mine warfare and countermeasures exercises in the Hawaii and California Study Areas and the Transit Corridor. Compared to sonobuoy wires, a low number of fiber-optic cables, guidance wires, and bathythermograph wires are expended in the Study Area. Most expended items would be sonobuoy wires, and most of the sonobuoy wires would be expended in the California Study Area.

The effect of wires and cables on marine invertebrates is not likely to cause injury or mortality to individuals because of the linear and somewhat rigid nature of the material. Effects on individuals and populations would be inconsequential because the area exposed to the stressor is extremely small relative to the distribution ranges of most marine invertebrates, the activities are dispersed such that few individuals would likely be exposed to more than one event, and exposures would be localized. In addition, marine invertebrates are not particularly susceptible to entanglement stressors, as most would avoid entanglement and simply be temporarily disturbed. Activities involving wires and cables are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels. All locations of wire and cable use potentially coincide with deep-water corals and other invertebrates associated with hard bottom areas in water depths less than 3,000 m. The portion of suitable substrate occupied by corals is generally low, and coincidence with such low densities of linear materials is unlikely. However, in some areas, deep-water corals may cover a greater portion of available hard substrate (Watters et al., 2022). Even though there would be a small increase in the number of sonobuoy wires expended in the California Study Area from Alternative 1 to Alternative 2, this increase is not expected to result in substantive changes to the potential for or types of effects on marine invertebrates.

ESA-listed abalone species and ESA-proposed sunflower sea stars do not occur in offshore areas where torpedo launches, or other entanglement stressors would occur, and these species would not be entangled by fiber-optic cables or sonobuoy wires because they are sedentary invertebrates. There is no probable scenario in which an abalone or sunflower sea star would be ensnared by a fiber-optic cable on the bottom and suffer adverse effects.

**Modernization and Sustainment of Ranges**. Fiber optic cables are deployed on the seafloor during SOAR Modernization, and the installation of two SWTRs. The Navy also proposes to deploy undersea fiber optic cables and connected instrumentation to existing undersea infrastructure along the seafloor in the California Study area (south and west of SCI), and the Hawaii Study Area (northeast of Oahu and west of Kauai). Entanglement of invertebrates is not likely because of the rigidity of the cable that is designed to lie extended on the sea floor vice coil easily. Once installed on the seabed, the new cable and communications instruments would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on invertebrates.

**Conclusion**. Activities that include the use of wires and cables would not have reasonably foreseeable adverse effects on invertebrates for reasons previously analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs and presented in Table 3.4-7. Some of these reasons include the following: (1) marine invertebrates do not typically get entangled in wires and cables due to their linear and somewhat rigid nature of the material; and (2) wires and cables would eventually become buried in sediment or encrusted by marine growth, and benthic and sessile invertebrates would be physically disturbed rather than entangled.

#### 3.4.3.4.2 Decelerators/Parachutes

##### 3.4.3.4.2.1 Effects from Decelerators/Parachutes Under Alternative 1

**Training and Testing**. The number and location of decelerators/parachutes expended during proposed training and testing activities are presented in Table 3.0-19, and the size categories of decelerators/parachutes are presented in Table 3.0-23. Supporting information on marine invertebrate effects from entanglement stressors are provided in Appendix F.

Decelerator/parachute lines could temporarily displace invertebrates in the water column but would be unlikely to ensnare individuals. Decelerator/parachute mesh could envelop invertebrates as the item sinks through the water column. Envelopment would primarily be associated with zooplankton, although other relatively slow-moving invertebrates such as jellyfish and swimming crabs could be caught in a billowed decelerator/parachute. Ensnared individuals may be injured or killed or may eventually escape. Decelerators/parachutes on the bottom could cover benthic invertebrates, but some would likely be able to move away from the item. It is highly unlikely that an individual invertebrate would be ensnared by a decelerator/parachute on the bottom and suffer adverse effects. It is possible that decelerators/parachutes could break or abrade deep-water corals.

Most marine invertebrates would not encounter a decelerator/parachute. The effect of decelerators/parachutes on marine invertebrates is not likely to cause injury or mortality to individuals, and effects would be inconsequential because the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, the activities are dispersed such that few individuals would likely be exposed to more than one event, and exposures would be localized. The surface area of decelerators/parachutes expended across the Study Area is extremely small compared to the relatively low percentage of suitable substrate inhabited by deep-sea coral species, resulting in a low risk of coincidence. In addition, marine invertebrates are not particularly susceptible to entanglement stressors, as most mobile invertebrates would be able to avoid entanglement and simply be temporarily disturbed. The number of individuals affected would be inconsequential compared to overall invertebrate population numbers. Activities involving decelerators/parachutes are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels. In addition, even though there would be a small increase in the number of small decelerators/parachutes used in Alternative 2 compared to Alternative 1, this increase would not be expected to result in substantive changes to the potential for or types of effects on invertebrates discussed earlier.

Decelerators/parachutes are unlikely to drift into most areas where ESA-listed black abalone and white abalone or ESA-proposed sunflower sea stars are present due to the typical offshore locations of use (water depths of 600 ft. or more). Potential exceptions include offshore areas known to support these species (e.g., Tanner and Cortes Banks). It is not likely that a sedentary abalone could be ensnared by a decelerator/parachute cord. Effects would more likely be associated with covering or abrasion. An abalone that becomes covered by a decelerator/parachute could have reduced access to food items such as drifting or attached macroalgae until the animal moves away from the item. Respiration could also be affected if an abalone becomes covered by a decelerator/parachute to the extent that water flow is restricted. There is a remote possibility that abalone larvae could be caught in a decelerator/parachute as it sinks, although microscopic organisms may be able to pass through the mesh.

**Modernization and Sustainment of Ranges**. No decelerators/parachutes would be expended during modernization and sustainment of ranges activities.

**Conclusion**. Activities that include the use of decelerators/parachutes would not have reasonably foreseeable adverse effects on invertebrates for reasons previously analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs and presented in Table 3.4-7. Some of these reasons include the following: (1) marine invertebrates do not typically get entangled in declarators/parachute lines but could be temporarily displaced in the water column; (2) most pelagic invertebrates would be too small to be ensnared; and (3) the decelerator/parachute lines would be relatively straight during descent, and the openings between the cords would be large enough for an invertebrates to escape if ensnared.

#### 3.4.3.5 Ingestion Stressors

The various types of MEM used by the Navy during military readiness activities within the Study Area may be broadly categorized as munitions and materials other than munitions. Aspects of ingestion stressors applicable to marine organisms in general are presented in Section 3.0.3.3.6. The number and location of targets expended in the Study Area that may result in fragments is presented in Table 3.0-24.

Table 3.4-8 contains brief summaries of background information that is relevant to analyses of effects for each ingestion substressor. Supporting information on ingestion stressors for marine invertebrates is provided in Appendix F.

**Table 3.4-8: Ingestion Stressors Information Summary**

| Substressor | Information Summary |
|---|---|
| Military expended materials | Ingestion of intact military expended materials is not likely for most types of expended items because they are too large to be ingested by most marine invertebrates. Though ingestion of intact munitions or large fragments is conceivable in some circumstances, such a scenario is unlikely due to the animal's ability to discriminate between food and non-food items.<br><br>Indiscriminate deposit- and detritus-feeding invertebrates could potentially ingest munitions fragments that have degraded to sediment size. Metal particles in the water column may be taken up by suspension feeders, although metal concentrations in the water are typically much lower than concentrations in sediments.<br><br>Most military expended materials would sink to the bottom, while some could persist at the surface or in the water column for some time.<br>• Ingestion is not likely for most military expended materials because they are too large to be consumed by most marine invertebrates. Though ingestion of intact items on the bottom is conceivable in some circumstances, such a scenario is unlikely due to the animal's ability to discriminate between food and non-food items. Similarly, it is unlikely that an invertebrate at the surface or in the water column would ingest a relatively large, expended item as it floats or sinks through the water column.<br>• Degradation of plastic materials could result in microplastic particles being released into the marine environment over time. Eventually, deposit-feeding, detritus-feeding, and filter-feeding invertebrates could ingest these particles. Ingestion of plastic particles may result in negative physical and chemical effects on invertebrates.<br>• Marine invertebrates may occasionally encounter and incidentally ingest chaff fibers when they ingest prey or water, but chaff poses little environmental risk to marine organisms at concentrations that could reasonably occur from military training and testing. |

#### 3.4.3.5.1 Military Expended Materials

##### 3.4.3.5.1.1 Effects from Military Expended Materials

**Training and Testing**. MEM from munitions associated with training and testing activities that could potentially be ingested by marine invertebrates include non-explosive practice munitions (small- and medium-caliber), small-caliber casings, fragments from high explosives, target fragments, chaff, canisters, and flare casings. These items could be expended throughout most of the Study Area but would be concentrated in the Hawaii Range Complex and SOCAL Range Complex.

It is possible, but unlikely, that invertebrates would ingest MEM. Some invertebrates could potentially ingest MEM fragments that have degraded to sediment size, chaff fibers, and particulate metals may be taken up by suspension feeders. In addition, small plastic pieces may be consumed by a wide variety of invertebrates with diverse feeding methods (detritivores, planktivores, deposit-feeders, filter-feeders, and suspension-feeders) in the water column or on the bottom. Adverse effects due to metal pieces on the bottom or in the water column are unlikely. Microplastic particles could affect individuals. Although the potential effects on invertebrate populations due to microplastic ingestion are currently uncertain, proposed activities would result in small amounts of plastic particles introduced to the marine environment compared to other sources. Effects on individuals are unlikely, and effects on populations would probably not be detectable. The locations, types, and number of military expended materials that pose a risk of being ingested would be the same under both alternatives.

Mitigation (e.g., not conducting gunnery activities within a specified distance of shallow-water coral reefs and precious coral beds) would be implemented to avoid potential effects from MEM on seafloor resources in mitigation areas throughout the Study Area (see Section 5.7). This mitigation would consequently help avoid potential effects on invertebrates associated with shallow-water coral reefs and precious coral beds.

ESA-listed abalone species occur in the California Study Area, but while possible, it is highly unlikely that ESA-proposed sunflower sea stars are present in the California Study Area. Potential effects on black abalone would be limited to individuals accidentally ingesting small fragments of exploded munitions as they scrape algae or biofilm (a thin layer of microorganisms) off hard substrates in shallow water. However, materials are primarily expended far from shore, in the open ocean where black abalone and sunflower sea stars do not occur. While the majority of MEM would be used in waters beyond white abalone habitat, there may be infrequent, rare use of select MEM in slightly shallower water. However, combined with very low numbers of white abalone, dispersion of individuals across various shallow water ridges, and low MEM use in white abalone habitat, the potential for ingestion and consequent effects would be low. However, due to the low overall abalone population density and the widely dispersed use of expendable materials, the potential for ingestion and consequent effects would be low.

**Modernization and Sustainment of Ranges**. No MEM are expected during modernization and sustainment of ranges activities.

**Conclusion**. Activities that include the use of MEM would not have reasonably foreseeable adverse effects on invertebrates for reasons previously analyzed in the 2018 HSTT and 2022 PMSR EIS/OEISs and presented in Table 3.4-8. Some of these reasons include the following: (1) MEM are typically too large to be consumed by most marine invertebrates; and (2) most MEM, such as chaff, poses little environmental risk to marine invertebrates at concentrations that could reasonably occur from military readiness activities.

#### 3.4.3.6 Secondary Stressors

The effects of explosives and MEM in terms of habitat disturbance are described in Section 3.5. The assessment of potential sediment and water quality degradation on aquatic life is covered in Section 3.2. The analysis of sediment and water quality degradation in Section 3.2 is sufficient to suggest that marine invertebrates do not have elevated sensitivities to the types of pollutants generated from military readiness activities. Supporting information on secondary stressors and their potential effects on marine invertebrates are provided in Appendix F.

Effects on invertebrate prey availability from military readiness activities would likely be insignificant overall based on the analysis conclusions for the direct stressors on their food resources (e.g., vegetation, other invertebrates, fish, other animal carcasses).

The analysis conclusions for secondary stressors associated with military readiness activities are consistent with a less than significant determination and therefore would result in an insignificant effect on marine invertebrates.

### 3.4.4 Combined Stressors

The analysis and conclusions for the potential effects from each of the individual stressors are discussed in the previous sections and are summarized in Section 3.4.4.2.1 and Table 3.4-5 for ESA-listed species. Stressors associated with military readiness activities do not typically occur in isolation but rather occur in some combination. For example, mine neutralization activities include elements of acoustic, physical disturbance and strike, entanglement, ingestion, and secondary stressors that are all coincident in space and time. An analysis of the combined effects of all stressors considers the potential consequences of additive and synergistic stressors. This analysis assumes that most exposures to stressors are non-lethal, and instead focuses on consequences potentially affecting the organism's fitness (e.g., physiology, behavior, reproductive potential). Invertebrates in the Study Area could potentially be affected by introduction of invasive species due to direct predation, competition for prey, or displacement from suitable habitat. Invasive species could be introduced by growth on vessel hulls or discharges of bilge water. Refer to Appendix C for a discussion of naval vessel discharges.

There are generally two ways that an invertebrate could be exposed to multiple additive stressors. The first would be if an invertebrate were exposed to multiple sources of stress from a single event or activity within a single training or testing event (e.g., a mine warfare event may include the use of a sound source and a vessel). The potential for a combination of these effects from a single activity would depend on the range to effects of each of the stressors and the response or lack of response to that stressor. Secondly, an invertebrate could be exposed to multiple military readiness activities over the course of its life; however, training and testing activities are generally separated in space and time in such a way that it would be unlikely that any individual invertebrate would be exposed to stressors from multiple activities within a short timeframe. However, animals with a home range intersecting an area of concentrated activity have elevated exposure risks relative to animals that simply transit the area through a migratory corridor.

Multiple stressors may also have synergistic effects. For example, invertebrates that experience temporary hearing loss or injury from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Invertebrates that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to entanglement and physical strike stressors via malnourishment and disorientation. These interactions are speculative, and without data on the combination of multiple stressors, the synergistic effects from the combination of stressors are difficult to predict in any meaningful way.

The following analysis makes the reasonable assumption that the majority of exposures to individual stressors are non-lethal, and instead focuses on consequences potentially affecting invertebrate fitness (e.g., physiology, behavior, reproductive potential).

#### 3.4.4.1 Combined Effects of All Stressors

Most of the activities proposed under both Alternative 1 and Alternative 2 generally involve the use of moving platforms (e.g., ships, torpedoes) that may produce one or more stressors; therefore, if invertebrates were within the effects range of those activities, they may be introduced to multiple stressors at different times. The minimal effects of far-reaching stressors (e.g., sound pressures, particle motion) may also trigger some animals to leave the area ahead of a more damaging effect (e.g., physical disturbance or strike). Individual stressors that would otherwise have minimal to no effect may combine to have a measurable effect. Due to the wide dispersion of stressor sources, speed of the platforms, and general dynamic movement of many military readiness activities, it is unlikely that highly mobile invertebrates would occur in the potential effects range of multiple sources or sequential exercises. Military readiness activities that produce MEM that fall to the bottom have the greatest potential to effect attached/sessile and slow-moving organisms. Effects on sessile and slow-moving species in areas where military readiness activities are concentrated and consistently located could include strike, crushing, or being covered.

Although potential effects on invertebrates from military readiness activities may include injury and mortality, in addition to other effects such as physiological stress and behavioral effects, the combined effects under both Alternative 1 and Alternative 2 are not expected to lead to long-term consequences for invertebrate populations. Based on the general description of effects, the number of invertebrates affected is expected to be small relative to overall population sizes and would not be expected to yield any lasting effects on the survival, growth, recruitment, or reproduction of any invertebrate species.

The combined effect of all stressors on marine invertebrates is consistent with a less than significant determination.

### 3.4.5 Endangered Species Act Determinations

Pursuant to the ESA, the analyses in this section show that military readiness activities may affect ESA-listed black and white abalone and ESA-proposed sunflower sea stars and black abalone designated critical habitat. The Action Proponent is consulting with the National Marine Fisheries Service (and/or U.S. Fish and Wildlife Service) as required by section 7(a)(2) of the ESA. The summary of effects determinations for each ESA-listed species and/or designated critical habitat is provided in Table 3.4-9.

**Table 3.4-9: Marine Invertebrate ESA Effect Determinations for Military Readiness Activities Under Alternative 1**

| Species | Overall Determination | Acoustic Stressors | Explosive Stressors | Physical Disturbance and Strike Stressors | | | | Entanglement Stressors | | Ingestion Stressors | Indirect Effects |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sonar & Other Transducers | Explosions | Vessels & In-Water Devices | Military Expended Material | Seafloor Devices | Pile Driving | Wires & Cables | Decelerators/ Parachutes | Military Expended Materials | |
| **ESA-Listed Species** | | | | | | | | | | | |
| Black abalone | MA | NE | MA | MA | MA | NE | NE | NE | MA | NE | MA |
| White abalone | MA | NE | MA | MA | MA | NE | NE | NE | MA | NE | MA |
| **ESA-Proposed Species** | | | | | | | | | | | |
| Sunflower sea star | MA | NE | MA | MA | MA | NE | NE | NE | MA | NE | MA |
| **Critical Habitat** | | | | | | | | | | | |
| Black abalone | MA | NE | NE | NE | MA | NE | NE | NE | NE | NE | NE |

Notes: MA = May Affect, NE = No Effect

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