Draft

Supplemental Environmental Impact Statement/ Overseas Environmental Impact Statement Atlantic Fleet Training and Testing

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3.5 Invertebrates

INVERTEBRATES SYNOPSIS

The Action Proponents considered the stressors to invertebrates that could result from the Proposed Action in the Study Area. The following conclusions have been reached for the Preferred Alternative (Alternative 1):

- Acoustics: Available information indicates that invertebrate sound detection is primarily limited to low-frequency (less than 1 kilohertz [kHz]) particle motion and water movement that diminishes rapidly with distance from a sound source. The expected impact of noise would be mostly limited to offshore surface layers of the water column where zooplankton, squid, and jellyfish are prevalent at night when training and testing occur less frequently. In general, invertebrate populations are typically lower offshore, where most training and testing occurs, due to the scarcity of habitat structure and comparatively lower nutrient levels. At nearshore and inshore locations where occasional pierside sonar, air gun, or pile driving actions occur, the invertebrate communities are relatively resilient and occupy soft bottom or artificial (e.g., pier pilings) substrates. Because the number of individuals affected would be small relative to population numbers, population-level impacts are unlikely.
- Explosives: Explosives produce pressure waves that can harm invertebrates. Most explosives occur in offshore surface waters where zooplankton, squid, and jellyfish are most prevalent at night, which is when training and testing with explosives does not typically occur. Invertebrate populations are generally lower offshore than inshore due to the scarcity of habitat structure and comparatively lower nutrient levels. Exceptions occur where explosives are used on the bottom within nearshore or inshore waters on or near sensitive live hard bottom communities that are not mapped or otherwise protected. Soft bottom communities are resilient to occasional disturbances. Due to the relatively small number of individuals affected, population-level impacts are unlikely.
- Energy: The proposed activities would produce electromagnetic energy that briefly affects a very limited area of water, based on the relatively weak magnetic fields and mobile nature of the stressors. Whereas some invertebrate species can detect magnetic fields, the effect has only been documented at much higher field strength than what the proposed activities generate. High-energy lasers can damage invertebrates. However, the high-energy lasers of the Proposed Action are designed to turn off when they lose track of their target. Marine invertebrates would therefore not be exposed to the lasers.
- Physical disturbance and strike: Invertebrates could experience physical disturbance and strike impacts from vessels and in-water devices, military expended materials, seafloor devices, and pile driving. The 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

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INVERTEBRATES SYNOPSIS

occurring. Impacts on the bottom may also occur to relatively sparse deep-sea corals and sponges from military expended materials. Relatively few expended materials are used in nearshore and inshore bottom areas where invertebrates are the most abundant. Exceptions occur for actions taking place within inshore and nearshore waters over primarily soft bottom communities, such as vessel transits, inshore and 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. Accordingly, population-level impacts are unlikely.

- Entanglement: Invertebrates could be entangled by various expended materials (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 and rigid 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). Accordingly, population-level impacts are unlikely.
- Ingestion: Small, expended materials and material fragments pose an ingestion risk to some invertebrates. However, most military expended materials 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. Accordingly, population-level impacts are unlikely.

3.5.1 Introduction

The following sections describe the invertebrates found in the Study Area and evaluate potential impacts from proposed training and testing activities on these resources. Impacts to invertebrates from the Proposed Action were analyzed in the 2018 Final EIS/OEIS. The primary changes from the analysis are provided where they apply in subsequent sections.

3.5.2 Affected Environment

The affected environment provides the context for evaluating the effects of the Action Proponent's military readiness (training and testing) activities on marine invertebrates. With noted exceptions, the general background for invertebrates in the Study Area is not meaningfully different from what is described in the 2018 Final EIS/OEIS (Section 3.4.2, Affected Environment). See Appendix F (Biological Resources Supplemental Information) for updated details on the affected environment for invertebrates.

The Study Area is generally consistent with that analyzed in the 2018 Final Atlantic Fleet Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement (hereinafter referred to as the 2018 Final EIS/OEIS). Additions to the Study Area include pierside training and testing events and transit along established navigation channels from pierside locations to offshore range complexes in the Gulf of Mexico. United States (U.S.) Coast Guard activities are similar in nature to Navy activities and fall under the same stressor categories.

3.5.2.1 General Background

Invertebrates represent the most abundant form of animal life on Earth. Relative to other animals, they are generally small and low on the food chain.

There is updated information regarding the number and population status of species in the Study Area. However, a change in the number of species does not directly affect the analysis and conclusions.

3.5.2.1.1 Habitat Use

Habitat use by marine invertebrates varies by taxonomic group and includes the water column (i.e., pelagic species), seafloor (i.e., benthic species), and shorelines. A more detailed description of taxonomic groups and their location/habitat use in the Study Area is provided in Section 3.5.2.3 (Species Not Listed under the Endangered Species Act). Updated information includes the following:

- The dominant soft bottom habitats and depth distribution of benthic invertebrate sizes and densities in the offshore ocean.
- The distribution of shallow-water coral reefs, live hard bottoms, and deep-sea coral or sponge habitats (refer to Section 3.3, Habitats, for comprehensive mapping).
- The typical percent coverage in living invertebrates on these habitats.

3.5.2.1.2 Movement and Behavior

Marine benthic invertebrates may be sessile, sedentary (limited mobility), or highly mobile (but typically slower than large vertebrates). Pelagic marine invertebrates include plankton (organisms that do not swim or generally cannot swim faster than water currents) and nekton (active swimmers that can generally swim faster than water currents). Many marine invertebrates undergo daily migrations to surface waters at dusk and return to deeper waters at dawn. This includes small, microscopic zooplankton and larvae, larger crustaceans (e.g., small shrimp), squid, and jellyfish. Planktonic organisms vary in their swimming abilities, ranging from weak (e.g., larvae) to substantial (e.g., box jellyfish). Nekton (e.g., shrimps, squid) have relatively strong swimming ability, although they are typically smaller and slower than most vertebrate animals.

There is updated information regarding the daily vertical migrations of many pelagic invertebrates in the marine environment and distribution of aerial insects in the Study Area (Appendix F, Biological Resources Supplemental Information).

3.5.2.1.3 Sound Sensing and Production

The background information for hearing/sound sensing and vocalization/production for invertebrates in the Study Area as described in the 2018 Final EIS/OEIS (Section 3.4.2.1.3) has not appreciably changed. As such, the information presented in the 2018 Final EIS/OEIS remains valid.

3.5.2.1.4 General Threats

The general threats to marine invertebrates discussed in the 2018 Final EIS/OEIS include overexploitation and destructive fishing practices; habitat degradation from pollution and coastal development; disease; and invasive species, with compounding factors such as increasing temperature and decreasing pH of the ocean from effects linked to global climate change. New research and updates regarding general threats to invertebrates are provided in Appendix F (Biological Resources Supplemental Information). Updated information includes the following:

- Verification of numerous potential effects from the listed threats.
- The status of the listed threats, as well as emerging threats and threats to aerial insects.

3.5.2.2 Endangered Species Act-Listed Species

Table 3.5-1 shows the invertebrate species listed under the Endangered Species Act (ESA) in the Study Area. Designated critical habitat for ESA-listed invertebrate species in the Study Area is shown in Figure 3.5-1. Changes in the ESA listings and critical habitat designations since the 2018 Final EIS/OEIS include the following:

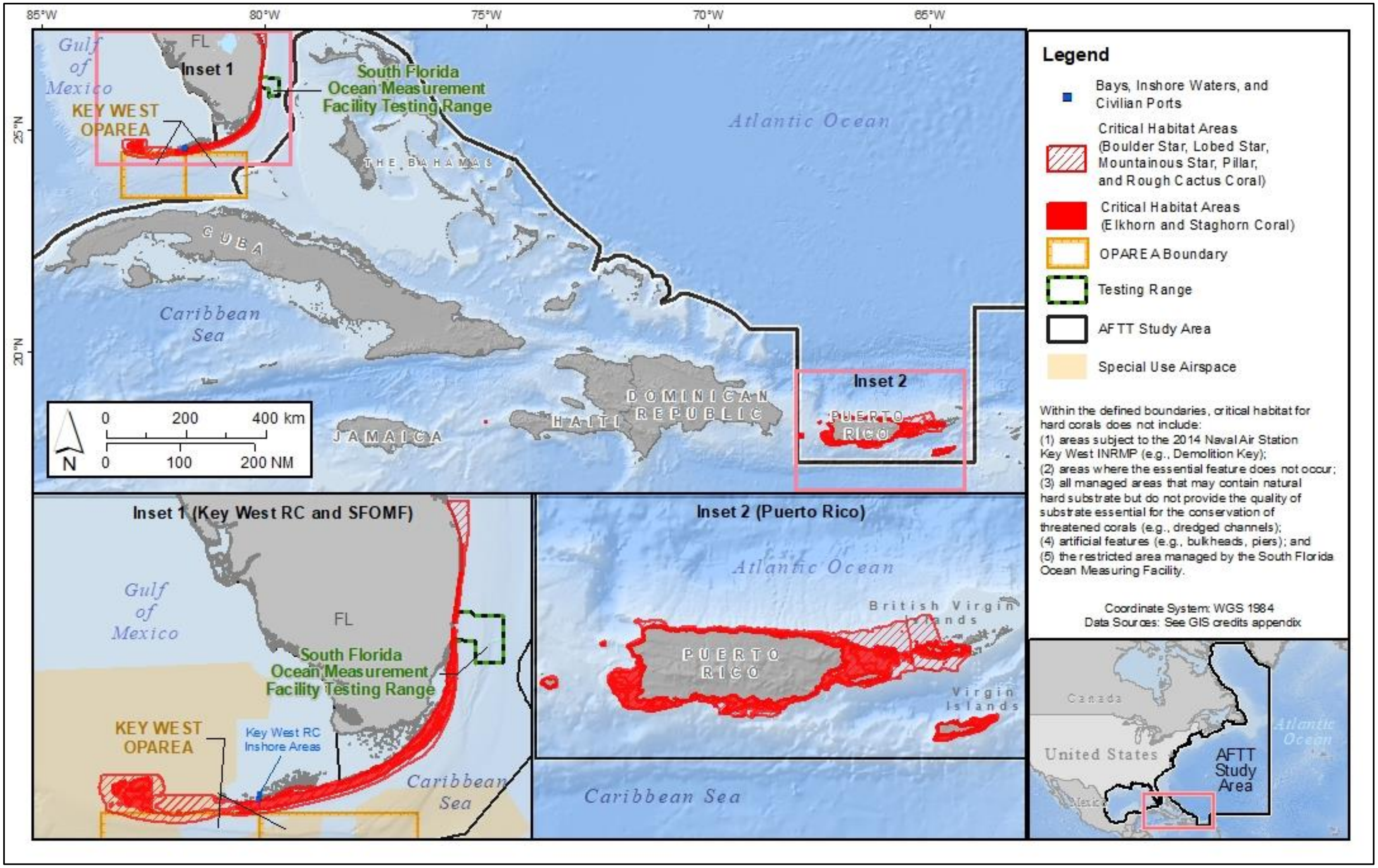
- Proposed listing of the queen conch (*Alger gigas*) as a threatened species on September 8, 2022 (87 *Federal Register* 55200; Horn et al., 2022), followed by listing as threatened on February 14, 2024 (89 *Federal Register* 11208).
- Designation of critical habitat for five Caribbean coral species on August 9, 2023 (88 *Federal Register* 54026). The critical habitat for these species extends into deeper water than the critical habitat for hard corals covered in the 2018 Final EIS/OEIS.
- Proposed Reclassification of pillar coral (*Dendrogyra cylindrus*) from Threatened to Endangered on August 29, 2023 (88 *Federal Register* 59494). The action was based on population declines and susceptibility to a recently emerged coral disease.

Detailed species descriptions, including status and management, habitat and geographic range, population trends, predator and prey interactions, and species-specific threats, are provided in Appendix F (Biological Resources Supplemental Information).

Table 3.5-1: Status and Occurrence of Endangered Species Act-Listed Invertebrate Species in the Study Area

Species Names and Regulatory Status			***Species Occurrence in the Study Area***		
Common Name	***Scientific Name***	***ESA Status/Critical Habitat***	***Range Complex/Testing Range***	***Range Complex Inshore Areas***	***Piers/Ports/ Coast Guard Stations***
Boulder star coral	*Orbicella franksi*	Threatened/Designated	SFOMF[1], Key West RC[1]	Key West RC Inshore[2]	Coast Guard Stations: Dania, FL; Miami, FL; Key West, FL
Elkhorn coral	*Acropora palmata*	Threatened/Designated			
Lobed star coral	*Orbicella annularis*	Threatened/Designated			
Mountainous star coral	*Orbicella faveolata*	Threatened/Designated			
Pillar coral	*Dendrogyra cylindrus*	Threatened (Proposed Endangered)/Designated			
Rough cactus coral	*Mycetophyllia ferox*	Threatened/Designated			
Staghorn coral	*Acropora cervicornis*	Threatened/Designated			
Queen conch	*Alger gigas*	Threatened	SFOMF[1], Key West RC[1]	Key West RC Inshore	Coast Guard Stations: Dania, FL; Miami, FL; Key West, FL

[1] Overlaps with species critical habitat.
[2] Mountainous star coral documented on artificial structures (HDR Environmental Operations and Construction Inc., 2013).
Notes: FL = Florida; RC = Range Complex; SFOMF = South Florida Ocean Measurement Facility Testing Range



Notes: AFTT: Atlantic Fleet Training and Testing; INRMP = Integrated Natural Resources Management Plan; OPAREA: operating area; RC = Range Complex

Figure 3.5-1: Critical Habitat for Elkhorn and Staghorn Coral and Five ESA-Listed Coral Species in the Study Area

3.5.2.3 Species Not Listed under the Endangered Species Act

Table 3.5-2 provides general descriptions of invertebrate groups and their location/habitat use in the Study Area. Updated information on hard coral species is provided in Appendix F (Biological Resources Supplemental Information), and pertains to habitat use.

Table 3.5-2: Major Taxonomic Groups of Marine Invertebrates in the Study Area

Marine Invertebrate Groups		***Habitats: Locations in the Study Area***		
Common Name (Classification)[1]	***Description***	***Range Complex/Testing Range***	***Range Complex Inshore***	***Piers/Ports/ Coast Guard Stations***
Foraminifera, radiolarians, ciliates (Kingdom Protozoa)	Planktonic or benthic single-celled organisms; shells typically made of calcium carbonate or silica	Water column or seafloor: All locations		
Sponges (Porifera)	Sessile (i.e., stationary) filter feeders; large species have calcium carbonate or silica structures embedded in cells to provide structural support	Hard bottom/artificial structures < 2,500 meters (m): All locations	Hard seafloor/artificial structures: All locations	
	Free-swimming larvae	Water column: All locations		
Corals, anemones, hydroids, jellyfish (Cnidaria)	Jellyfish.[2] Drifting filter feeders with gelatinous bodies and stinging cells	Water column: All locations		
	Shallow-water hard corals.[2,3] Sessile filter feeders that build complex structures on hard substrate in warm, shallow waters	Hard bottom/artificial structures < 90 m: SFOMF Key West RC	Hard seafloor/artificial structures: Key West RC Inshore	Coast Guard Stations: Dania, FL; Miami, FL; Key West, FL
	Deep-sea hard corals.[2] Sessile filter feeders that build piles of rubble on hard substrate in colder/deeper waters	Hard bottom/artificial structures < 2,500 m: All locations	Not present	
	Other sessile filter feeders with stinging cells (e.g., anemones, soft corals, hydroids)	Seafloor/artificial structures: All locations		
	Zooplankton and free-swimming larvae	Water column: All locations		
Flatworms (Platyhelminthes)	Non-segmented and soft-bodied marine worms	Water column or seafloor/artificial structures: All locations		
Ribbon worms (Nemertea)				
Roundworms (Nematoda)				

Table 3.5-2: Major Taxonomic Groups of Marine Invertebrates in the Study Area (continued)

Marine Invertebrate Groups		***Habitats: Locations in the Study Area***		
Common Name (Classification)[1]	***Description***	***Range Complex/Testing Range***	***Range Complex Inshore***	***Piers/Ports/ Coast Guard Stations***
Polychaetes (Annelida)	Segmented and soft-bodied marine worms; mostly deposit feeders	Seafloor/artificial structures: All locations		
Bryozoans (Bryozoa)	Colonial filter feeders with gelatinous or hard exteriors and a diverse array of growth forms and on a variety of substrates	Seafloor/artificial structures: All locations		
	Free-swimming larvae	Water column: All locations		
Cephalopods, bivalves, sea snails, chitons (Mollusca)	Squids. Soft-bodied pelagic and highly mobile predators	Water column: All locations		
	Snails.[3] Hard-shelled and slow-moving benthic predators, detritus feeders and herbivore grazers with a muscular foot	Seafloor/artificial structures: All locations		
	Oysters.[2] Hard-shelled, filter-feeding bivalves that form reefs	Not present	Hard seafloor/artificial structures: All locations	Artificial structures: Estuarine locations
	Other hard-shelled, filter-feeding bivalves (e.g., clams, scallops, mussels) and benthic cephalopods (e.g., octopus)	Seafloor/artificial structures: All locations		
	Free-swimming larvae	Water column: All locations		
Shrimp, crabs, lobsters, barnacles, copepods (Arthropoda), horseshoe crabs	Hard-shelled benthic predators, herbivores, scavengers, detritus feeders, and filter feeders; segmented bodies and external skeletons with jointed appendages	Seafloor/artificial structures: All locations		
	Zooplankton and free-swimming larvae	Water column: All locations		
Sea stars, sea urchins, sea cucumbers (Echinodermata)	Large benthic invertebrates with endoskeletons made of hard calcareous structures (plates, rods, spicules); five-sided radial symmetry; many species with tube feet; slow-moving	Seafloor/artificial structures: All locations		

Table 3.5-2: Major Taxonomic Groups of Marine Invertebrates in the Study Area (continued)

Marine Invertebrate Groups		Habitats: Locations in the Study Area		
Common Name (Classification)[1]	*Description*	*Range Complex/Testing Range*	*Range Complex Inshore*	*Piers/Ports/ Coast Guard Stations*
	predators, herbivores, detritus feeders, and suspension feeders			
	Free-swimming larvae	Water column: All locations		

[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] Taxonomic group contains species forming Essential Fish Habitats (refer to separate Essential Fish Habitat Assessments for more information).
[3] Taxonomic group contains ESA-listed species (refer to Section 3.5.2.2 for more information).
Notes: < = less than; FL = Florida; m = meters; RC = Range Complex; SFOMF = South Florida Ocean Measurement Facility Testing Range

3.5.3 Environmental Consequences

Under the No Action Alternative for all stressors and substressors, the Action Proponents would not conduct any of the proposed military readiness activities in the Study Area. Therefore, baseline conditions of the existing environment for invertebrates would either remain unchanged or would improve after cessation of ongoing military readiness activities. The No Action Alternative is not analyzed further in this section.

This section describes and evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) and stressors described in Section 3.0.3.3 (Identifying Stressors for Analysis) could potentially impact invertebrates known to occur in the Study Area.

The focus of analysis will be on multicellular marine invertebrates; the impact of the Proposed Action alternatives on unicellular invertebrates (Kingdom Protozoa) would be negligible due to their vast population, growth rate, resilience, and movement with the flows of water and substrate.

The stressors vary in intensity, frequency, duration, and location in the Study Area. The activities that involve each of the following stressors are identified in Appendix A (Activity Descriptions) and Appendix B (Activity Stressor Matrices). The stressors and substressors analyzed for invertebrates include the following:

- **acoustics** (sonar and other transducers; air guns; pile driving; vessel noise; aircraft noise; weapons noise)
- **explosives** (explosions in water)
- **energy** (in-water electromagnetic devices)
- **physical disturbance and strikes** (vessels and in-water devices; military expended materials; seafloor devices; pile driving)
- **entanglement** (wires and cables; decelerators/parachutes; biodegradable polymer)
- **ingestion** (military expended materials – munitions; military expended materials other than munitions)

A discussion of secondary stressors, to include the potential impacts to habitat or prey availability, and the potential impacts of all the stressors combined are provided at the end of the section.

The analysis of potential impacts to invertebrates considers standard operating procedures and mitigation measures that would potentially provide protection to invertebrates. Standard operating procedures relevant to invertebrates (e.g., using explosives, operating vessels safely, placing seafloor devices for retrieval) are detailed in Appendix A (Section A.2.7, Standard Operating Procedures). Details on mitigation measures relevant to invertebrates are referenced in Table 3.5-3. Mitigation measures specific to habitats that may include invertebrates (e.g., shallow-water coral reefs, live hard bottom) is referenced in Table 3.3-5 and shown in Figure 3.3-2 to Figure 3.3-5 of Section 3.3 (Habitats). Details on all mitigation measures are provided in Chapter 5 (Mitigation).

Table 3.5-3: Mitigation Requirement Summary by Stressor for Invertebrates

Applicable Stressor	*Requirements Summary and Protection Focus*	*Section Reference*
Explosives	Conduct visual observations for aggregations of jellyfish[1] during events involving explosive torpedoes and ship shock trials.	Section 5.6 (Visual Observations)
	Restrictions on detonating any in-water explosives within a horizontal distance from shallow-water coral reefs.	Section 5.7.1 (Shallow-Water Coral Reef Mitigation Areas)
	Restrictions on detonating explosives on or near the seafloor (e.g., explosive bottom-laid or moored mines) within a horizontal distance of 350 yards from artificial reefs, live hard bottom[2], submerged aquatic vegetation, and shipwrecks.	Section 5.7.2 (Artificial Reef, Live Hard Bottom, Submerged Aquatic Vegetation, and Shipwreck Mitigation Areas)
Physical disturbance and strike	Restrictions on: (1) setting vessel anchors within an anchor swing circle radius that overlaps shallow-water coral reefs (except in designated anchorages) (2) placing other seafloor devices too close to shallow-water coral reefs except in South Florida Ocean Measurement Facility Seafloor Mitigation Area (3) deploying non-explosive ordnance against surface targets too close to shallow-water coral reefs	Section 5.7.1 (Shallow-Water Coral Reef Mitigation Areas)
	Requirement to operate surface vessels in waters deep enough to avoid bottom scouring or prop dredging, with at least a 1-foot clearance between the deepest draft of the vessel (with the motor down) and the seafloor at mean low water.	Section 5.7.3 (Key West Range Complex Seafloor Mitigation Area)
Entanglements	Requirements to: (1) operate surface vessels in waters deep enough to avoid bottom scouring or prop dredging, with at least a 1-foot clearance between the deepest draft of the vessel (with the motor down) and the seafloor at mean low water. (2) use a real-time geographic information system and global positioning system (along with remote-sensing verification) during deployment, installation, and recovery of anchors and mine-like objects and during deployment of bottom-crawling unmanned underwater vehicles in waters deeper than 10 feet to avoid live hard bottom[2]	Section 5.7.4 (South Florida Ocean Measurement Facility Seafloor Mitigation Area)

Table 3.5-3: Mitigation Requirement Summary by Stressor for Invertebrates (continued)

Applicable Stressor	Requirements Summary and Protection Focus	Section Reference
	(3) deploy seafloor devices from surface vessels while holding a relatively fixed position over the intended mooring or deployment location using a dynamic positioning navigation system with global positioning system (4) minimize surface vessel movement and drift in accordance with mooring installation and deployment plans and will conduct activities during sea and wind conditions that allow vessels to maintain position and speed control during deployment, installation, and recovery of seafloor devices (5) not anchor surface vessels or moor over live hard bottom[2] (6) use semi-permanent anchoring systems that are assisted with riser buoys over soft bottom habitats to avoid contact of mooring cables any live hard bottom[2].	

[1] The mitigation was developed to protect possible indicators of sea turtle or marine mammal presence, which includes description of invertebrates resource (e.g., jellyfish).
[2] Includes shallow-water coral reefs as a type of live hard bottom.

The criteria for determining the significance of Proposed Action stressors on invertebrates are described in Table 3.5-4. The abbreviated analysis under each substressor and alternative provides the technical support for these determinations, with reference to the 2018 Final EIS/OEIS or supporting appendices for details.

Table 3.5-4: Criteria for Determining the Significance of Proposed Action Stressors on Invertebrates

Impact Descriptor	Context and Intensity	Significance Conclusions
Negligible	Impacts to marine invertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found in the Study Area. Impacts on habitat would be temporary (e.g., temporary placement of an object on the sea floor or increased turbidity) with no lasting damage or alteration.	Less than significant
Minor	Impacts to marine invertebrates would be temporary or short term (lasting several days to several weeks) but would not be outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. This could include temporary or repeated short-term stress responses without permanent physiological damage. Behavioral responses to disturbance by some individuals, groups, populations, or colonies could be expected, but only temporary disturbance of breeding, feeding, or other activities would occur, without any impacts on population levels. Displacement would be short term and limited to the Study Area or its immediate surroundings. Impacts on habitat (e.g., short-term placement of an object on the sea floor, increased turbidity, or loss of a small area of vegetation) would be easily recoverable, with no long-term or permanent damage or alteration.	Less than significant
Moderate	Impacts to marine invertebrates would be short or long term (lasting several months or longer) and outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. This	Less than significant

Table 3.5-4: Criteria for Determining the Significance of Proposed Action Stressors on Invertebrates (continued)

Impact Descriptor	*Context and Intensity*	*Significance Conclusions*
	could include physiological injury to individuals, repeated stress responses, or mortality. Behavioral responses to disturbance by numerous individuals could be expected in the Study Area, its immediate surroundings, or beyond. These could include negative impacts to breeding, feeding, growth, or other factors affecting population levels, including population-level mortality or extended displacement (up to 1 year) of large numbers (e.g., population level) of invertebrates. However, they would not threaten the continued existence of a stock, population, or species. Habitat would be potentially damaged or altered over the long term but would continue to support the species reliant on it.	
Major	Impacts to marine invertebrates would be short or long term and well outside the natural range of variability of species' populations, their habitats, or the natural processes sustaining them. Behavioral and stress responses would be repeated or permanent. Actions would affect any stage of a species' life cycle (i.e., breeding, feeding, growth, and maturity), alter population structure, genetic diversity, or other demographic factors, and/or cause mortality beyond a small number of individuals, resulting in a decrease in population levels. Displacement and stress responses would be short or long term within and well beyond the Study Area. Habitat would be degraded long term or permanently so that it would no longer support a sustainable fishery and/or would cause the population of a managed species to become stressed, less productive, or unstable.	Significant

With noted exceptions, the stressor background information and environmental consequences are not meaningfully different from what is described in the 2018 Final EIS/OEIS (Section 3.4.3, Environmental Consequences).

3.5.3.1 Acoustic Stressors

Table 3.5-5 contains brief summaries of background information that is relevant to the analyses of impacts for each acoustic substressor (sonar and other transducers, etc.) on invertebrates. Details on the updated information in general, as well as effects specific to each substressor, are provided in Appendix D (Acoustic and Explosive Impacts Supporting Information).

Table 3.5-5: Acoustic Stressors Background Information Summary

Substressor	*Background 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. • 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. • Noise exposure duration in many of the studies was far greater than that expected to occur during infrequent and localized activities.

Table 3.5-5: Acoustic Stressors Background Information Summary (continued)

Substressor	Background Information Summary
	• 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 impacts to invertebrate larval development and masking resulting from extended exposure. • 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. • Sonar and other transducer use in nearshore or inshore 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. • 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. • 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. • Direct injury from sonar and other transducers is highly unlikely and is not considered further in this analysis.
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. • Physical injury has not been reported in relatively large crustaceans exposed to seismic air guns at received levels comparable to the source level of Navy air guns operated at full capacity, but one study reported injury and mortality for zooplankton. • 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). • While behavioral reaction to air guns has not been documented for crustaceans, squid have exhibited startle and alarm responses at various sound levels. • 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). • Compared to offshore areas where air gun use would primarily affect invertebrates in the water column, air gun use at pierside locations would potentially affect a greater number of benthic and sessile invertebrates due to proximity to the bottom and structures (e.g., pilings) that may be colonized by slow-moving or sessile invertebrates. • 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. • Exposure to air gun shots has not caused mortality, and invertebrates typically recovered from injuries in controlled laboratory settings.

Table 3.5-5: Acoustic Stressors Background Information Summary (continued)

Substressor	Background 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. • 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. • Direct injury from vibratory pile driving, like other continuous sources, is highly unlikely and is 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. • 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 for longer time durations than what is 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. • 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 inshore waters that receive a high volume of ship or small craft traffic, where sound disturbance would be more frequent. • The relatively high frequency and intensity of vessel traffic in many inshore 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 impacts or behavioral adaptation are not expected. • Direct injury from vessel noise is highly unlikely and is not considered further in this analysis.
Aircraft noise	Invertebrates would likely only be temporarily affected by aircraft and missile overflight noise. • Impacts would likely be limited to pelagic invertebrates (e.g., squid, jellyfish, zooplankton) located near the surface. • 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.
Weapon noise	Invertebrates would likely only be temporarily affected by noise produced by muzzle blasts and impact of large non-explosive practice munitions. • Impacts would likely be limited to pelagic invertebrates (e.g., squid, jellyfish, zooplankton) located near the surface. • 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.

3.5.3.1.1 Impacts from Sonar and Other Transducers

Table 3.5-5 contains a summary of the background information used to analyze the potential impacts of sonar and other transducers on invertebrates. Many non-impulsive sounds associated with military readiness activities are produced by sonar. Other transducers include items such as acoustic projectors and countermeasure devices. For information on sonar and other transducers hours or counts proposed for each alternative, see Table 3.0-2 (Sonar and Transducer Sources Quantitatively Analyzed).

3.5.3.1.1.1 Impacts from Sonar and Other Transducers under Alternative 1

As discussed, in Section 3.0.3.3.1 (Acoustic Stressors), a detailed comparison of sonar quantities analyzed in the 2018 Final EIS/OEIS with sonar quantities under this Proposed Action is not feasible due to changes in the source binning process. However, the overall use of sonar and other transducers would decrease from the 2018 Final EIS/OEIS for both training and testing activities.

Under Alternative 1, changes from the 2018 Final EIS/OEIS for training activities using low-frequency sonar (in addition to other types of sonar) would include the following:

- There would be a small increase in unit-level anti-submarine warfare activities in the Gulf of Mexico Range Complex.

For all other locations, there would be a decrease or a similar number of activities that involve the use of low-frequency sonar to the 2018 Final EIS/OEIS.

Under Alternative 1, changes from the 2018 Final EIS/OEIS for testing activities using low-frequency sonars would include the following:

- Under anti-submarine warfare testing activities, there would be new events in the high seas, Gulf of Mexico Range Complex Inshore, Joint Expeditionary Base Little Creek, Naval Station Mayport, Naval Station Norfolk, Naval Submarine Base King Bay, and Naval Submarine Base New London.
- There would also be a notable increase in Anti-Submarine Warfare activities in Bath, Maine, and Pascagoula, Mississippi.

The greatest potential for measurable effects would be near the sources of low-frequency and high-intensity sonar described for Alternative 1 training activities in mostly the offshore marine environment. Sonar sources used primarily in the offshore environment would also be directed away from benthic habitats that are most productive in the nearshore environment. Per general description and location of impacts, the sonar and other transducer sounds associated with Alternative 1 training activities may result in brief, intermittent impacts to relatively few marine invertebrates close to low-frequency and high-intensity sound sources, but they are unlikely to impact survival, growth, recruitment, or reproduction of any marine invertebrate populations or subpopulations. Additionally, rare species are unlikely to be affected and common species could absorb impacts on relatively few individuals.

Pierside testing events generally occur over several hours of intermittent use. However, the intensity of testing activities in the offshore environment is generally lower than that of training activities.

Based on the updated background and analysis for training and testing under Alternative 1, sonar and other transducer impacts on invertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found within localized areas. This is consistent with a negligible impact on invertebrate populations.

The use of sonar and other transducers during training and testing activities under Alternative 1 may affect ESA-listed hard coral species and queen conch due to the overlap of the substressor with the species distribution in three locations (Key West Range Complex, Key West Range Complex Inshore, and

South Florida Ocean Measurement Facility). The Action Proponents are consulting with the National Marine Fisheries Service (NMFS) as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by sonar and other transducers (refer to Section 3.3, Habitats, for analysis of the impact of noise of abiotic substrate).

3.5.3.1.1.2 Impacts from Sonar and Other Transducers under Alternative 2

Under Alternative 2, sonar use during training activities would increase compared to Alternative 1:

- The maximum number of composite training exercises would occur each year, and an additional composite training exercise would occur in the Gulf of Mexico Range Complex.

Impacts from sonar and other transducers under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The quantities of sonar and other transducer activity (e.g., hours, counts) under Alternative 2 would increase only slightly over Alternative 1.

3.5.3.1.2 Impacts from Air Guns

Table 3.5-5 contains a summary of the background information used to analyze the potential impacts of air guns on invertebrates. For information on air gun counts proposed for each alternative, see Table 3.0-3 (Training and Testing Air Gun and Non-explosive Impulsive Sources Quantitatively Analyzed in the Study Area).

3.5.3.1.2.1 Impacts from Air Guns under Alternative 1

Air guns would not be used under training activities. The proposed use of air guns decreased overall for testing from the 2018 Final EIS/OEIS. Small air guns would be fired over a limited period within a single day. Air gun use would only occur in two testing activities: semi-stationary equipment testing and acoustic and oceanographic research. While air gun use during semi-stationary equipment testing may occur nearshore at Newport, Rhode Island, air gun use during acoustic and oceanographic research may occur in the Northeast, Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes.

Per general description and location of impacts, the air gun sounds associated with Alternative 1 testing activities may result in brief, intermittent impacts to relatively few marine invertebrates close to low-frequency and high-intensity sound sources, but they are unlikely to impact survival, growth, recruitment, or reproduction of any marine invertebrate populations or subpopulations. Additionally, rare species are unlikely to be affected and common species could absorb impacts on relatively few individuals.

Based on the updated background and analysis for testing under Alternative 1, air gun impacts on invertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found within localized areas. This is consistent with a negligible impact on invertebrate populations.

The use of air guns during testing activities under Alternative 1 is not applicable to ESA-listed hard coral species and queen conch due to lack of overlap with substressor locations.

Air guns used during testing activities are not applicable to critical habitat for ESA-listed coral species due to lack of overlap.

3.5.3.1.2.2 Impacts from Air Guns under Alternative 2

There would be no air gun use associated with training activities.

Impacts from air guns under Alternative 2 are not meaningfully different from Alternative 1 (Table 3.0-3, Training and Testing Air Gun and Non-Explosive Impulsive Sources Quantitatively Analyzed in the Study Area) and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for testing activities. Alternative 2 is the maximum number of air gun blasts that is included in the range of blasts for Alternative 1.

3.5.3.1.3 Impacts from Pile Driving

Table 3.5-5 contains a summary of the background information used to analyze the potential impacts of pile driving noise on invertebrates. Only port damage repair training includes pile driving. For information on pile driving quantities proposed for each alternative, see Table 3.0-4 (Number of Piles/Sheets Quantitatively Analyzed under Pile Driving and Removal Training Activities). The impact and vibratory pile driving hammers would expose invertebrates to impulsive and continuous non-impulsive broadband sounds, respectively.

3.5.3.1.3.1 Impacts from Pile Driving under Alternative 1

The activity type and location for pile driving activities for training have changed from the 2018 Final EIS/OEIS.

Under Alternative 1 for training:

- Pile driving would occur as part of Port Damage Repair training in Gulfport, Mississippi.
- Pile driving would no longer occur as part of the Elevated Causeway System at Joint Expeditionary Base Little Creek in the Virginia Capes Range Complex or Marine Corps Base Camp Lejeune in the Navy Cherry Point Range Complex.

There would be no pile driving or removal associated with testing activities.

Although some number of individuals would experience physiological and behavioral effects of pile driving in Gulfport, Mississippi, the activities would occur intermittently in very limited areas and would be of temporary duration. The activity is also occurring in a highly disturbed estuarine habitat that is different than the natural beach environments covered in the 2018 Final EIS/OEIS. The number of invertebrates affected in the highly altered locations would be small and resilient compared to overall population numbers. Pile driving and removal activities would be unlikely to impact survival, growth, recruitment, or reproduction of marine invertebrate populations or subpopulations. Additionally, rare species are unlikely to be affected due to chance encounters and common species could absorb impacts on relative few individuals.

Based on the updated background and analysis for training under Alternative 1, pile driving impacts on invertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found within localized areas. This is consistent with a negligible impact on invertebrate populations.

The use of pile driving during training activities under Alternative 1 is not applicable to ESA-listed hard coral species and queen conch due to the lack of overlap with the substressor location.

Pile driving noise is not applicable to the critical habitat for ESA-listed coral species due to lack of overlap with the substressor location.

3.5.3.1.3.2 Impacts from Pile Driving under Alternative 2

Impacts from pile driving during training under Alternative 2 are no different from Alternative 1 and therefore the conclusions for significance, ESA-listed species and critical habitat are the same.

There would be no pile driving or removal associated with testing activities.

3.5.3.1.4 Impacts from Vessel Noise

Table 3.5-5 contains a summary of the background information used to analyze the potential impacts of vessel noise on invertebrates. For information on the number of activities including vessel noise, see Table 3.0-9 (Number and Location of Activities Including Vessels) and Table 3.0-10 (Number and Location of Activities Including In-water Devices).

3.5.3.1.4.1 Impacts from Vessel Noise under Alternative 1

For both training and testing activities, vessel activity would decrease overall from the 2018 Final EIS/OEIS. This Supplemental EIS/OEIS will rely on the previous 2018 Final EIS/OEIS analysis of vessel noise, so impacts would be expected to be similar or lesser than previously concluded.

Under Alternative 1 for training:

- Vessel noise would occur in two locations that are new or not previously analyzed (Gulfport and Pascagoula, Mississippi, respectively). For all other locations, there would either be a decrease or similar events including vessel activity.

Under Alternative 1 for testing:

- Vessel noise would occur in seven locations not previous analyzed (inshore locations of the Northeast, Virginia Capes, and Gulf of Mexico Range Complexes; Other AFTT Areas; Hampton Roads, Virginia). There would also be notable increases in vessel activity at the Naval Surface Warfare Center Panama City Division Testing Range, Naval Station Norfolk, and Pascagoula, Mississippi. For all other locations, there would either be a decrease or similar amount of vessel activity.

For locations without a notable increase in vessel activity, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

For locations with a notable increase in activity, the impact analysis that was conducted in the 2018 Final EIS/OEIS would not change because the infrequent and localized nature of vessels noise remains an accurate characterization of the Proposed Action in those locations.

For the inshore testing locations not previously analyzed, standard operating procedures (e.g., vessel and in-water device safety) and mitigation implemented in the seafloor resource mitigation areas help to avoid close proximity to shallow waters where sensitive species are concentrated (e.g., oysters on reefs in Northeast Range Complexes Inshore). Furthermore, the locations not previously analyzed for testing were analyzed for training in the 2018 Final EIS/OEIS. The other locations not previously analyzed are port or pierside locations featuring artificial structures placed in soft bottom habitat with resilient soft bottom communities. These areas are also highly modified/disturbed due to human activity and frequent dredging.

The intermittent vessel noise produced during training and testing activities may briefly impact some individuals within a limited area, but exposures are not expected to impact survival, growth, recruitment, or reproduction of marine invertebrate populations or subpopulations. Concentrated vessel operation in areas such as port navigation channels could result in repeated noise exposure and chronic physiological or behavioral effects to individuals of local invertebrate subpopulations, particularly sessile species, located near the sound source. However, vessel noise would not be expected to adversely affect the viability of common or widely distributed invertebrate species within navigation channels and near naval port facilities. An impact on rare species in these highly altered habitats would be unlikely.

Based on the updated background and analysis for training and testing under Alternative 1, vessel noise impacts on invertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found within localized areas. This is consistent with a negligible impact on invertebrate populations.

The vessel noise during training and testing activities under Alternative 1 may affect ESA-listed hard coral species and queen conch due to the overlap of the substressor with the species distribution in three locations (Key West Range Complex – inshore and offshore and South Florida Ocean Measurement Facility). The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by vessel noise (refer to Section 3.3, Habitats, for analysis of the impact of noise on abiotic substrate).

3.5.3.1.4.2 Impacts from Vessel Noise under Alternative 2

Impacts from vessel noise under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species and critical habitat are the same for both training and testing. The number of activities including vessels or in-water devices increases only slightly over that of Alternative 1.

3.5.3.1.5 Impacts from Aircraft Noise

Table 3.5-5 contains a summary of the background information used to analyze the potential impacts of aircraft noise on invertebrates. For information on the number of activities including aircraft noise, see Table 3.0-16 (Number and Location of Activities with Aircraft).

3.5.3.1.5.1 Impacts from Aircraft Noise under Alternative 1

For both training and testing activities, aircraft activity would decrease overall from the 2018 Final EIS/OEIS. This Supplemental EIS/OEIS will rely on the previous 2018 Final EIS/OEIS analysis of aircraft noise, so impacts would be expected to be similar or lesser than previously concluded.

Under Alternative 1, the following changes exist from the 2018 Final EIS/OEIS for training activities:

- A notable increase in the Navy Cherry Point Range Complex.

Under Alternative 1, the following changes exist from the 2018 Final EIS/OEIS for testing activities:

- Aircraft use in the following area that was not previously analyzed: Other AFTT Areas.

Most pelagic invertebrates are present near the surface at night when aircraft noise occurs less often. There is also very low transmission of sound pressure across the air-water boundary. Aircraft noise typically occurs outside of state coastal waters in depths that would greatly reduce the sound reaching the bottom. Therefore, impacts to benthic invertebrates (e.g., deep-sea corals, bivalves, worms, and crabs) are not expected.

Per general description and location of impacts, the aircraft noise associated with Alternative 1 training and testing activities would be unlikely to impact survival, growth, recruitment, or reproduction of pelagic invertebrate populations or subpopulations. No impact of aircraft noise on benthic invertebrate population is expected. Additionally, rare species are unlikely to be affected due to chance encounters and common species could absorb impacts on relatively few individuals.

Based on the updated background and analysis for training and testing under Alternative 1, the impact of aircraft noise on invertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found within localized areas and near the surface. This is consistent with a negligible impact on pelagic invertebrate populations. Aircraft noise would not affect seafloor invertebrates where it typically occurs.

The aircraft noise during training and testing activities under Alternative 1 would not affect ESA-listed hard coral species and queen conch because they are seafloor invertebrates.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by aircraft noise (refer to Section 3.3, Habitats, for analysis of the impact of noise on abiotic substrate).

3.5.3.1.5.2 Impacts from Aircraft Noise under Alternative 2

Impacts from aircraft noise under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species and critical habitat are the same for both training and testing. The number of activities including aircraft under Alternative 2 would increase only slightly over Alternative 1.

3.5.3.1.6 Impacts from Weapons Noise

Table 3.5-5 contains a summary of the background information used to analyze the potential impacts of weapons noise on invertebrates. For information on the number of activities including weapons noise, see Table 3.0-11 (Number and Location of Non-explosive Practice Munitions Expended During Military Readiness Activities).

3.5.3.1.6.1 Impacts from Weapons Noise under Alternative 1

For both training and testing activities, weapons activity would decrease overall from the 2018 Final EIS/OEIS. This Supplemental EIS/OEIS will rely on the previous 2018 Final EIS/OEIS analysis of weapons noise, so impacts would be expected to be similar or lesser than previously concluded.

Most pelagic invertebrates are present near the surface at night when weapons firing and launch occurs less often. There is also very low transmission of sound pressure across the air-water boundary. Weapons firing and launch typically occurs outside of state coastal waters in depths that would greatly reduce the sound reaching the bottom. Therefore, impacts to benthic invertebrates (e.g., deep-sea corals, bivalves, worms, and crabs) are not expected.

Per general description and location of impacts, the weapons firing associated with Alternative 1 training and testing activities would be unlikely to impact survival, growth, recruitment, or reproduction of pelagic invertebrate populations or subpopulations. No impact of weapons noise on benthic invertebrate population is expected. Additionally, rare species are unlikely to be affected due to chance encounters and common species could absorb impacts on relatively few individuals.

Based on the updated background and analysis for training and testing under Alternative 1, the impact of weapon noise on invertebrates would be limited to temporary (lasting up to several hours) behavioral and stress-startle responses to individual invertebrates found within localized areas and near the surface. This is consistent with a negligible impact on pelagic invertebrate populations. Weapons noise would not affect seafloor invertebrates where it typically occurs.

The weapons noise during training and testing activities under Alternative 1 would not affect ESA-listed hard coral species and queen conch because they are seafloor invertebrates.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by weapons noise (refer to Section 3.3, Habitats, for analysis of the impact of noise on abiotic substrate).

3.5.3.1.6.2 Impacts from Weapons Noise under Alternative 2

Impacts from weapons noise under Alternative 2 are no different from Alternative 1 and therefore the conclusions for significance, ESA-listed species and critical habitat are the same for both training and testing. The number of items generating weapons firing noise (e.g., non-explosive and explosive practice munitions) under Alternative 2 is the same as Alternative 1.

3.5.3.2 Explosive Stressors

This section summarizes the potential impacts of explosives used during military readiness activities within the Study Area. Table 3.5-6 contains a brief summary of background information that is relevant to analyses of impacts from explosive stressors. Details on the updated information in general, as well as effects specific to each substressor, is provided in Appendix D (Acoustic and Explosive Impacts Supporting Information).

Table 3.5-6: Explosive Stressors Background Information Summary

Substressor	***Background 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 impacts to coral polyps, or fragmentation and siltation of the corals. • 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. • 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). • 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.
Explosions in the air	In-air detonations at or near the water surface could transmit sound and energy into the water and impact invertebrates. Detonations that occur at higher altitudes would not propagate enough sound and energy into the water to result in impacts to invertebrates and therefore are not analyzed in this section.

The Action Proponents will implement mitigation tailored to reducing the impact of explosives in the water on sensitive habitats that feature living organisms, including ESA-listed coral species and queen conch in the mitigation areas identified in Table 3.5-4. The mitigation areas that are not specific to invertebrates are mapped and described in Section 3.3 (Habitats) because they primarily address impacts on the seafloor habitat of invertebrates and other biological resources (e.g., live hard bottom). The critical habitat for ESA-listed coral species depicted in Figure 3.5-1 encompasses the sensitive habitats noted as mitigation areas in Section 3.3.

3.5.3.2.1 Impacts from Explosives

Table 3.5-6 contains a summary of the background information used to analyze the potential impacts of explosives on invertebrates. For information on explosive sizes and quantities for each alternative, see Table 3.0-5 (Explosive Sources Quantitatively Analyzed that Could Be Used Underwater or at the Water Surface).

In the unlikely event that underwater explosives are used near unmapped hard bottom (hard coral and sponge habitat), some individual corals could be damaged. The mitigation areas will reduce or eliminate the impact of bottom-placed explosives on mapped shallow-water coral reefs and live hard bottom inhabited by ESA-listed coral species and queen conch, and other reef-associated invertebrates. All mapped sensitive habitat features within the Study Area occur completely within mitigation areas (e.g., shallow-water coral reefs, live hard bottom), with the exception of Key West Range Complex Inshore. In that location, though the sensitive habitat features are not within a mitigation area, explosive charges used there are very small and placed either on the seafloor or on a seafloor device (e.g., metal plate or steel frame) with the explosive energy directed upward.

The minimal overlap of critical habitats for coral and mitigation areas is due to how the critical habitat areas are mapped with only qualifiers for presence of hard substrate (refer to text in Figure 3.5-1). Jellyfish aggregations are not a stationary feature that can be estimated in terms of overlap and coverage.

3.5.3.2.1.1 Impacts from Explosives under Alternative 1

The use of explosives would generally decrease from the 2018 Final EIS/OEIS for both training and testing activities. Notably, for testing there would be no use of bin E17 (greater than 14,500 – 58,000 pounds [lb.] net explosive weight [NEW]) and reduced use of bin E16 (greater than 7,250 to 14,500 lb. NEW) for ship shock trials. There is also a reduction in use of most of the largest explosive bins for both training and testing, and an extremely large decrease in explosives associated with medium-caliber gunnery (bin E1 [0.1 to 0.25 lb. NEW]). Very few detonations would occur at inshore locations and would involve the use of smaller charge sizes (E5 or below). Additionally, small ship shock trials could occur in Virginia Capes, Jacksonville, or the Gulf of Mexico Range Complexes.

The majority of underwater explosions occur on the surface and typically in offshore locations beyond state waters and in depths greater than 100 feet (30 meters), where invertebrate size and abundance is generally low compared to estuarine and nearshore ocean waters. In addition, invertebrate abundances in offshore surface waters tend to be lower during the day, when surface explosions typically occur, than at night. Relatively few activities including explosives underwater occur within state waters.

Based on the relative footprints and location of explosives use under Alternative 1 for training and testing (refer to Section 3.3, Habitats, for analysis summary) and the general description of impacts, there would be: (1) an unlikely spatial coincidence between explosive impacts and the distribution of sensitive invertebrates (e.g., reef-building corals growing on 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. The effects of this substressor on marine invertebrates are therefore not expected to result in detectable changes in their growth, survival, or propagation, and are not expected to result in population-level impacts or affect the distribution, abundance, or productivity of invertebrate species; rare species are unlikely to be affected by chance encounters and common species could absorb impacts on relatively few individuals.

The analysis conclusions for underwater explosives use with training and testing activities under Alternative 1 are consistent with a moderate (due to limited potential injury/mortality) impact on invertebrate populations.

The use of explosives in water during training and testing activities under Alternative 1 may affect ESA-listed coral species and queen conch. The distribution of these species coincides with the stressor occurring in the Key West Range Complex (offshore and inshore locations). Queen conch would be relatively more vulnerable to explosives in water than ESA-listed coral species based on its more varied use of seafloor habitats. The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals may be affected by explosives in water where there is unmapped natural hard substrate in the narrow band of critical habitat area overlapping the Key West Range Complex (Figure 3.5-1) (refer to Section 3.3, Habitats, for analysis of explosive impacts on hard substrate). Critical habitat is not designated is some areas of the Key West Range Complex Inshore that are subject to the Naval Air Station Key West Integrated Natural Resources Management Plan (within 50 yards of shore).

3.5.3.2.1.2 Impacts from Explosives under Alternative 2

Impacts from explosives in water under Alternative 2 are no different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The explosive sizes and numbers under Alternative 2 are the same as Alternative 1.

3.5.3.3 Energy Stressors

Table 3.5-7 contains brief summaries of the background information that is relevant to the analyses of impacts of in-water electromagnetic devices on invertebrates. The background information for energy stressor effects on invertebrates in the Study Area as described in the 2018 Final EIS/OEIS (Section 3.4.3.3) has not appreciably changed. As such, the information presented in the 2018 Final EIS/OEIS remains valid.

Table 3.5-7: Energy Stressors Background Information Summary

Substressor	*Background Information Summary*
In-water electromagnetic devices	Available information suggests sensitivity to magnetic and electric fields in at least three marine invertebrate phyla: Mollusca, Arthropoda, and Echinodermata. • The primary potential effect on sensitive marine invertebrates would be temporary directional disorientation for individuals encountering a human-produced magnetic field. For example, an individual could be confused or change its movement direction while exposed to a field. However, a limited number of studies suggest that other effects, such as changes in embryo development, are possible within relatively strong fields for an extended time (10 to 150 minutes). • Given the exponential drop in field strength with distance and association with the physical presence of mobile in-water devices well above the bottom, the potential for effects on benthic invertebrates is unlikely. • For pelagic invertebrates, the effects would occur only at very close ranges and for a very short time.
In-air electromagnetic devices	In-air electromagnetic devices are not applicable to invertebrates because of the lack of transmission of electromagnetic radiation across the air/water interface and distant proximity to in-air sources. In-air electromagnetic energy effects will not be analyzed further in this section.
High-energy lasers	High-energy laser weapons are designed to disable surface targets and turn off when they lose track of the target. Marine invertebrates would therefore not be exposed to the laser.

3.5.3.3.1 Impacts from In-Water Electromagnetic Devices

Table 3.5-7 contains a summary of the background information used to analyze the potential impacts of in-water electromagnetic devices on invertebrates. The in-water devices producing an electromagnetic field are towed or unmanned mine countermeasure systems. The electromagnetic field is produced to simulate a vessel's magnetic field. In an actual mine-clearing operation, the intent is that the electromagnetic field would trigger an enemy mine designed to sense a vessel's magnetic field. In-water electromagnetic energy associated with the Proposed Action alternatives produce a strong enough field for effects on invertebrates within a few feet of their source. For information on the number of location of activities including in-water electromagnetic devices, see Table 3.0-6 (Number and Location of Activities Using In-water Electromagnetic Devices).

3.5.3.3.1.1 Impacts from In-Water Electromagnetic Devices under Alternative 1

For both training and testing activities, in-water electromagnetic device activity would decrease overall from the 2018 Final EIS/OEIS (Table 3.0-6, Number and Location of Activities Using In-water Electromagnetic Devices).

Under Alternative 1 for training:

- In-water electromagnetic devices would occur in two areas not previously analyzed (Key West Range Complex and Virginia Capes Range Complex Inshore). There would also be notable increases in in-water electromagnetic devices in the Virginia Capes and Gulf of Mexico Range Complexes. For all other locations, there would either be a decrease or similar amount of in-water electromagnetic devices.

Under Alternative 1 for testing:

- In-water electromagnetic devices would occur in two areas not previously analyzed (Northeast Range Complexes and Hampton Roads, Virginia) for the 2018 Final EIS/OEIS. There would also be a notable increase in in-water electromagnetic devices in the Naval Surface Warfare Center Panama City Testing Area. For all other locations, there would either be a decrease or cessation of in-water electromagnetic devices.

For locations without notable increases in activity, the impact analysis that was conducted in the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

For locations with notable increase in activity, the impact analysis that was conducted in the 2018 Final EIS/OEIS would not change because the infrequent and localized nature of in-water electromagnetic device activity remains an accurate characterization of the Proposed Action in those locations.

For the locations not previously analyzed, standard operating procedures (e.g., in-water device safety) will help reduce potential impacts to invertebrates. Sensitive invertebrates (e.g., jellyfish, mollusks) are also not likely to be affected by the distant and moving electromagnetic energy sources.

Based on the relative amount and location of in-water electromagnetic device use, and the general description of impacts, the potential exposure is not expected to yield any lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. Additionally, rare species are unlikely to be affected due to chance encounters and common species could absorb impacts on relative few individuals.

The analysis conclusions for in-water electromagnetic device use with training and testing activities under Alternative 1 are consistent with a negligible impact on invertebrate populations.

The use of in-water electromagnetic devices during training and testing activities under Alternative 1 may affect ESA-listed coral species and queen conch due to their membership in a relatively sensitive taxonomic group.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) would not be affected by in-water electromagnetic devices used for training (refer to Section 3.3, Habitats, for analysis of the impact of electromagnetic energy on abiotic substrate). Use of in-water devices for testing is not applicable to the critical habitat for ESA-listed corals due to lack of geographic overlap with the stressor.

3.5.3.3.1.2 Impacts from In-Water Electromagnetic Devices under Alternative 2

Impacts from in-water electromagnetic devices under Alternative 2 are no different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The number of activities including use of in-water electromagnetic devices under Alternative 2 is the same as Alternative 1.

3.5.3.4 Physical Disturbance and Strike Stressors

Table 3.5-8 contains brief summaries of background information that is relevant to analyses of impacts for each physical disturbance and strike substressor (vessels and in-water devices, military expended materials, seafloor devices, and pile driving). The background information for physical disturbance and strike stressor effects on invertebrates in the Study Area as described in the 2018 Final EIS/OEIS (Section 3.4.3.4) has not appreciably changed. As such, the information presented in the 2018 Final EIS/OEIS remains valid.

Table 3.5-8: Physical Disturbance and Strike Stressors Background Information Summary

Substressor	*Background 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 coastal 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. • 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). • 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. • 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. • The potential for vessels to disturb invertebrates on or near the bottom and along the shoreline would occur mostly during nearshore and inshore 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.

Table 3.5-8: Physical Disturbance and Strike Stressors Background Information Summary (continued)

Substressor	*Background Information Summary*
	• Although amphibious vehicles are designed to touch the bottom, they are generally used along ocean beaches and similar high-energy shorelines where the invertebrates present are small and resilient to frequent disturbance. • Invertebrates inhabiting shallow bottoms and shoreline (e.g., oysters, mussels, snails) 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.
Aircraft and aerial targets	Impacts from aircraft and aerial targets are not applicable and will not be analyzed further in this section. The presence of aerial invertebrates (e.g., butterflies) over open waters of the Study Area is discounted in Appendix F (Biological Resources Supplemental Information).
Military expended materials	Military expended materials 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. • Most release of military expended materials occurs in the confines of established at-sea training and testing areas far from shore, although there is some release of expended materials within inshore (e.g., marine markers in the VACAPES RC Inshore) and nearshore locations (e.g., Navy Cherry Point Range Complex). • 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. • After striking the surface or being launched underwater, military expended materials 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. • The dampening effect of water would reduce the impact of military expended materials on mostly soft or intermediate bottom communities (84% of the Study Area locations less than 2,500 meters [m] deep; see Table 3.3-1, Percent Coverage of Seafloor Habitats and Abiotic Substrate Types in Training and Testing Locations of the Study Area) that are resilient to disturbance and would thus recover quickly in the unlikely event of a disturbance or strike. • 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 military expended materials. Heavy expended materials 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. • Military expended materials 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 impact of lighter materials on benthic invertebrates would also be

Table 3.5-8: Physical Disturbance and Strike Stressors Background Information Summary (continued)

Substressor	*Background Information Summary*
	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, inshore habitats from at-sea training and testing areas would be low based on the prevailing ocean currents depicted in Figure 3.3-6 through Figure 3.3-10 (water column figures). • Potential impacts 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 on hard bottom habitat is also relatively low given their typically low percent coverage on suitable habitat (Appendix F, Biological Resources Supplemental Information).
Seafloor devices	Seafloor devices are either stationary (e.g., mine shapes, anchors, bottom-placed instruments) or move very slowly along the bottom (e.g., bottom-crawling unmanned underwater vehicles) where they may temporarily disturb the bottom before being recovered. • Seafloor device impacts pose little threat to highly mobile organisms (e.g., squid, shrimp) in the water column. Impacts to 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. • Impacts to 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 impact would be greater for relatively fragile invertebrate parts (e.g., coral polys). • Although intentional placement of seafloor devices on bottom structure is avoided to ensure recovery, seafloor devices placed in depths less than about 2,500 m may inadvertently impact 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 (Appendix F, Biological Resources Supplemental Information). • Seafloor devices are most likely to impact invertebrates inhabiting soft and intermediate bottom habitats. The benthic invertebrates living in these vast areas of the seafloor (84% of Study Area locations less than 2,500 m deep; see Table 3.3-1, Percent Coverage of Seafloor Habitats and Abiotic Substrate Types in Training and Testing Locations of the Study Area) tend to be softer bodied and resilient to disturbance (e.g., deposit-feeding worms) than invertebrates growing on relatively scarce hard bottom.
Pile driving	Pile driving and removal involves both impact and vibratory methods in soft substrate. Pile driving may have the potential to impact estuarine soft bottom communities temporarily during driving, removal, and in the short term thereafter. The impacts to benthic invertebrates include displacement in the footprint of the pilings, sediment disturbances during driving and extraction, and loss of sessile invertebrates that colonize the pilings prior to removal.

Notes: % = percent; m = meters; OPAREA = operating area; RC = Range Complex; VACAPES = Virginia Capes

The Action Proponents will implement mitigation tailored to reducing the impact of physical disturbance and strike on sensitive habitats that feature invertebrates, including ESA-listed coral species and queen conch in the mitigation areas identified in Table 3.5-4. The mitigation area restrictions are mapped and described in Section 3.3 (Habitats) because they primarily address impacts on the seafloor habitat of invertebrates and other biological resources. The critical habitat for ESA-listed coral species depicted in Figure 3.5-1 encompasses the sensitive habitats in Key West Range Complex (offshore and inshore locations) and the South Florida Ocean Measurement Facility shown in Section 3.3.

3.5.3.4.1 Impacts from Vessels and In-Water Devices

Table 3.5-8 contains a summary of the background information used to analyze the potential impacts of vessels and in-water devices on invertebrates. For information on the number of activities including vessels and in-water devices, see Table 3.0-9 (Number and Location of Activities Including Vessels) and Table 3.0-10 (Number and Location of Activities include In-water Devices).

The seafloor resource mitigation identified in Table 3.5-4 will reduce or eliminate the potential impacts from vessel disturbance on ESA-listed coral species and queen conch, and other shallow-water habitats in the Key West Range Complex and South Florida Ocean Measurement Facility (refer to Section 3.3, Habitats, for a detailed mapping of the mitigation). Mitigation areas relevant to these species cover nearly all of the locations where training and testing occurs. In other shallow areas where vessel or in-water device use is proposed, the avoidance of features that could damage the vessel or in-water device (e.g., seafloor in general and hard substrate in particular) is part of standard operating procedures.

3.5.3.4.1.1 Impacts from Vessels and In-Water Devices under Alternative 1

For both training and testing activities, vessel and in-water device activity would decrease overall from the 2018 Final EIS/OEIS (Tables 3.0-9, Number and Location of Activities Including Vessels, and Table 3.0-10, Number and Location of Activities Including In-water Devices).

Under Alternative 1 for training:

- Vessel activity would occur in two locations that are new or not previously analyzed (Gulfport and Pascagoula and Gulfport, Mississippi, respectively). For all other locations, there would either be a decrease or similar amount of vessel activity.
- In-water device activity (including both expended and recovered water-based targets) would occur in one location not previously analyzed (Northeast Range Complexes Inshore). For all other locations, there would either be a decrease, similar amount, or cessation of in-water device activity.

Under Alternative 1 for testing:

- Vessel activity would occur in seven locations not previously analyzed (inshore locations of the Northeast, Virginia Capes, and Gulf of Mexico Range Complexes; Other AFTT Areas; Hampton Roads, Virginia). There would also be notable increases in vessel activity at the Naval Surface Warfare Center Panama City Division Testing Range, Naval Station Norfolk, and Pascagoula, Mississippi. For all other locations, there would either be a decrease or similar amount of vessel activity.
- In-water device activity (including both expended and recovered water-based targets) would occur in four locations not previously analyzed (Gulf of Mexico Range Complex Inshore; Bath, Maine; Newport, Rhode Island; Pascagoula, Mississippi). For all other locations, there would either be a decrease or similar amount of in-water device activity.

For locations without a notable increase in vessel and in-water device activity, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

For locations with a notable increase in activity, the impact analysis that was conducted in the 2018 Final EIS/OEIS would not change because the infrequent and localized nature of vessels activity remains an accurate characterization of the Proposed Action in those locations.

For the inshore locations that are new or not previously analyzed, standard operating procedures (e.g., vessel and in-water device safety) and mitigation implemented in the seafloor resource mitigation areas would help to avoid impacting shallow waters where sensitive species are concentrated (e.g., oysters on reefs in the Northeast Range Complexes Inshore). Furthermore, the locations not previously analyzed for testing were analyzed for training in the 2018 Final EIS/OEIS. The other locations that are new or not previously analyzed are port or pierside locations featuring artificial structures placed in soft bottom habitat with resilient soft bottom communities. These areas are also highly modified/disturbed due to human activity and frequent dredging.

Based on the relative amount and location of vessels and in-water devices under Alternative 1 for training and testing and the general description of impacts, there would be (1) avoidance of sensitive invertebrates growing on hard substrate, per standard operating procedures and mitigation measures; (2) a quick recovery of invertebrate taxa in waters that are more likely impacted (e.g., shallow soft bottom communities); and (3) only short-term impacts from most vessel and in-water device movements and local disturbances of the surface water column, with some temporary increase in suspended sediment in shallow areas. The effects of this substressor on marine invertebrates are therefore not expected to result in detectable changes in their growth, survival, or propagation, and are not expected to result in population-level impacts or affect the distribution, abundance, or productivity of invertebrates; rare species are unlikely to be affected due to chance encounters and common species could absorb impacts on relatively few individuals.

The analysis conclusions for vessel and in-water device use with training and testing activities under Alternative 1 are consistent with a moderate (due to limited potential for injury/mortality) impact on invertebrate populations.

The use of vessels and in-water devices during training and testing activities under Alternative 1 may affect ESA-listed coral species and queen conch where the species are using shallow-water habitats in the Key West Range Complex – inshore and offshore locations, and in the South Florida Ocean Measurement Facility.

Critical habitat for ESA-listed corals (natural hard substrate; Figure 3.5-1) will not be affected by vessels and in-water devices (refer to Section 3.3, Habitats, for analysis of physical disturbance and strike potential on hard abiotic substrate) due to standard operating procedures over features that could damage the vessel or in-water device.

3.5.3.4.1.2 Impacts from Vessels and In-Water Devices under Alternative 2

Impacts from vessels and in-water device activities under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The number of activities including vessels or in-water devices increases only slightly over that of Alternative 1.

3.5.3.4.2 Impacts from Military Expended Materials

Table 3.5-8 contains a summary of the background information used to analyze the potential impacts of military expended materials on invertebrates. For information on the type, number, and location of military expended materials, see Table 3.0-11 (Number and Location of Non-explosive Practice Munitions Expended During Military Readiness Activities), Table 3.0-12 (Number and Location of Explosives that May Result in Fragments During Military Readiness Activities), Table 3.0-13 (Number of Location of Targets Expended During Military Readiness Activities), Table 3.0-14 (Number and Location of Other Military Materials Expended During Military Readiness Activities), Table 3.0-17 (Number and Location of Wires and Cables Expended During Military Readiness Activities), and Table 3.0-18 (Number and Location of Activities Including Biodegradable Polymers during Testing).

The mitigation measures identified in Table 3.5-4 will reduce or eliminate the potential impacts by locating some military expended materials away from ESA-listed coral species and reef-associated species (refer to Section 3.3, Habitats, for detailed mapping of the mitigation). Mapped sensitive habitat features (e.g., shallow-water coral reefs) within the Study Area only occur within mitigation areas. In other areas where military expended materials are proposed, the impact is limited by the distance from shore (e.g., most heavy munitions limited to areas outside of state waters) which places most impacts seaward of dynamic and productive nearshore habitats.

The combination of mitigation areas for shallow-water coral reefs and agreement to follow national marine sanctuary regulations protects nearly all seafloor habitats and associated invertebrates less than 30 m deep in the Key West Range Complex (offshore and inshore locations) from the direct strike potential from most military expended materials.

3.5.3.4.2.1 Impacts from Military Expended Materials under Alternative 1

For both training and testing activities, the number of military expended materials would decrease overall from the 2018 Final EIS/OEIS (Table 3.0-11, Number and Location of Non-explosive Practice Munitions Expended during Military Readiness Activities, through Table 3.0-18, Number and Location of Activities Including Biodegradable Polymers during Testing).

Under Alternative 1 for training:

- Military expended materials would occur in one location not previously analyzed (Gulf of Mexico Range Complex Inshore), and there would be a notable increase in the Key West Range Complex Inshore from the 2018 Final EIS/OEIS. For all other locations, there would either be a decrease, similar amount, or cessation of military expended materials.

Under Alternative 1 for testing:

- Military expended materials would occur in three locations not previously analyzed (Other AFTT Areas; Naval Submarine Base Kings Bay, and Port Canaveral, Florida) in the 2018 Final EIS/OEIS. For all other locations, there would either be a decrease or similar amount of military expended materials.

For locations without a notable increase in military expended materials, the analysis from the 2018 Final EIS/OEIS remains valid, and the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

For locations not previously analyzed and notable increases in activity, the impact analysis that was conducted in the 2018 Final EIS/OEIS has been updated per quantitative analysis detailed in Section 3.3 (Habitats). Qualitative aspects of the analysis include the potential for lighter expended materials (e.g., decelerators/parachutes) to drift into shallow, inshore habitats covered earlier in this section for military readiness activities.

Based on quantitative analysis, the total shallow-water coral reef area impacted by military expended materials in the Key West Range Complex and South Florida Ocean Measurement Facility would be less than 0.13 acre annually. However, the area of impacted shallow-water coral reefs is overestimated due to mitigation measures that apply to a subset of military expended materials. This area represents less than one thousandth of one percent of available shallow-water coral reef habitat in Study Area locations (refer to figures in Section 3.3, Habitats, for mapping). The majority of military expended material footprints would impact soft bottom communities or the bathyal/abyssal zone where invertebrates are relatively sparse. Expended material footprints coincide with oyster beds/reefs in the range complex inshore locations of the Northeast, Virginia Capes, and Gulf of Mexico Range Complexes. Expended material footprints associated with port and pierside locations impact mostly resilient soft bottom communities.

Whereas it is possible for a portion of expended items to impact hard substrate and associated sensitive invertebrate communities, the number of exposed individuals would not likely affect the overall viability of populations or species. While the potential for overlap between proposed activities and invertebrates is reduced for those species living sparsely in relatively rare habitats, if overlap does occur, any potential impacts would be amplified. Within the far greater area of soft bottom habitat, the impact of military expended materials is likely to cause injury or mortality to individual benthic invertebrates. However, the number of individuals affected would be small relative to the total population, 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 military expended material becomes part of the bottom (e.g., buried or encrusted with sessile organisms).

Based on the relative amount, impact footprint, and location of material expended and the general description of impacts, activities involving military expended materials 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. Additionally, rare species are unlikely to be affected due to the low chance of encounter, and common species could absorb impacts on relatively few individuals.

The analysis conclusions for military expended material associated with training and testing activities under Alternative 1 are consistent with a moderate (due to limited potential for injury/mortality) impact on invertebrate populations.

The military expended materials associated with training and testing activities under Alternative 1 may affect both ESA-listed coral species and queen conch, as the distribution of the stressor coincides with these species in the Key West Range Complex (offshore and inshore locations) and South Florida Ocean Measurement Facility. The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) may be affected by military expended materials (refer to Section 3.3, Habitats, for analysis of physical disturbance and strike potential on hard abiotic substrate).

3.5.3.4.2.2 Impacts from Military Expended Materials under Alternative 2

Impacts from military expended materials under Alternative 2 are not meaningfully different from Alternative 1 and therefore the impact conclusions are the same for both training and testing. The increase in footprint from Alternative 1 to 2 is only 0.026 acres and located mostly in the Gulf of Mexico Range Complex, with relatively small footprints in the other range complexes.

3.5.3.4.3 Impacts from Seafloor Devices

Table 3.5-8 contains a summary of the background information used to analyze the potential impacts of seafloor devices on invertebrates. For information on the type, number, and location of military expended materials, see Table 3.0-15 (Number and Location of Activities that Use Seafloor Devices).

Proposed mitigation identified in Table 3.5-4 will reduce or eliminate the potential impacts by locating most seafloor devices away from ESA-listed coral species and other invertebrates inhabiting live hard bottom (refer to Section 3.3, Habitats, for detailed mapping and description of the mitigation). Due to the prevalence of shallow-water hard coral species in the South Florida Ocean Measurement Facility, there is additional mitigation that ensures placement of seafloor devices away from any sensitive habitats.

The combination of mitigation areas for shallow-water coral reefs and agreement to follow national marine sanctuary regulations protects nearly all seafloor habitats and associated invertebrates less than 30 m deep in the Key West Range Complex (offshore and inshore locations) from the direct strike potential from seafloor devices.

3.5.3.4.3.1 Impacts from Seafloor Devices under Alternative 1

For both training and testing activities, the proposed use of seafloor devices would increase from the 2018 Final EIS/OEIS devices (Table 3.0-15, Number and Location of Activities that Use Seafloor Devices).

Under Alternative 1 for training:

- Seafloor device use would occur in four locations that are new or not previously analyzed (Northeast Range Complexes; Other AFTT Areas; Jacksonville Range Complex Inshore, Naval Station Mayport, and Gulfport, Mississippi). There would also be notable increases in seafloor devices at the Virginia Capes Range Complex (offshore and inshore locations) and Key West Range Complex Inshore. For all other locations, there would either be a decrease, similar amount, or cessation of seafloor device use.

Under Alternative 1 for testing:

- Seafloor device use would occur in five locations not previously analyzed (Virginia Cape Range Complex Inshore, Key West Range Complex Inshore, Naval Submarine Base New London, Naval Station Mayport, and Port Canaveral, Florida). There would also be notable increases in seafloor devices in the Northeast and Jacksonville Range Complexes, and in the Naval Surface Warfare Center Panama City Division Testing Range. For all other locations, there would either be a decrease or similar amount of seafloor device use.

For locations without a notable increase in seafloor devices, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

For locations with notable increases in activity, the impact analysis that was conducted in the 2018 Final EIS/OEIS would not change because the infrequent and localized nature of seafloor device activity remains an accurate characterization of the Proposed Action in those locations.

For the inshore locations not previously analyzed, standard operating procedures and seafloor resource mitigation measures that apply to mine shapes and other devices moored to the bottom would help to avoid impacting sensitive habitats for invertebrates (e.g., oyster bed/reefs, shallow-water coral reefs, live hard bottoms). In the unlikely event of a seafloor device coinciding with sensitive invertebrates, the impact is expected to be minimal and temporary (e.g., crushing/abrasion).

Other new locations include port or pierside locations, which feature artificial structures in soft bottom habitat with relatively resilient invertebrate communities. These areas are highly modified/disturbed due to human activity and frequent dredging.

Based on the relative amount and location of seafloor device use under Alternative 1 for training and testing and the general description of impacts, there would be (1) a limited spatial coincidence between device disturbance zones and the distribution of sensitive invertebrates; and (2) only short-term impacts from most local disturbances of the seafloor, with some temporary increase in suspended sediment in mostly soft bottom areas. The effects of this substressor on marine invertebrates are therefore not expected to result in detectable changes in their growth, survival, or propagation, and are not expected to result in population-level impacts or affect the distribution, abundance, or productivity of invertebrates; rare species are unlikely to be affected due to chance encounters and common species could absorb impacts on relatively few individuals.

The analysis conclusions for seafloor devices use with training and testing activities under Alternative 1 are consistent with a moderate (due to limited potential for injury/mortality) impact on sessile or slow-moving invertebrate populations.

The use of seafloor devices during training and testing activities under Alternative 1 may affect both ESA-listed coral species and queen conch. The distribution of the stressor coincides with these species in three locations (Key West Range Complex—offshore and inshore locations and South Florida Ocean Measurement Facility). Queen conch would be relatively more vulnerable to seafloor device impacts than ESA-listed coral species based on its more varied use of seafloor habitats. ESA-listed coral species habitats are protected by applicable standard operating procedures, mitigation measures, and national marine sanctuary regulations. The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) may be affected by seafloor devices (refer to Section 3.3, Habitats, for analysis of physical disturbance and strike potential on hard abiotic substrate).

3.5.3.4.3.2 Impacts from Seafloor Devices under Alternative 2

Impacts from seafloor device activities under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The number of activities including seafloor devices under Alternative 2 would increase only slightly over Alternative 1.

3.5.3.4.4 Impacts from Pile Driving

Table 3.5-8 contains a summary of the background information used to analyze the potential impacts of pile driving on invertebrates. Only port damage repair training includes pile driving (Table 3.0-4, Number of Piles/Sheets Quantitatively Analyzed under Pile Driving and Removal Training Activities).

3.5.3.4.4.1 Impacts from Pile Driving under Alternative 1

Under Alternative 1 for training:

- Pile driving would occur in one new location (Gulfport, Mississippi) that it did not occur in for the 2018 Final EIS/OEIS.
- Pile driving would no longer occur as part of the Elevated Causeway System at Joint Expeditionary Base Little Creek in the Virginia Capes Range Complex or Marine Corps Base Camp Lejeune in the Navy Cherry Point Range Complex.

There would be no pile driving or removal associated with testing activities.

Installation and removal of piles could crush or injure invertebrates due to direct physical impact. Direct impacts would be most likely for sessile or slow-moving species. Individuals located near the activities but not directly impacted could be disturbed and show behavioral reactions. Bottom disturbance resulting from pile installation and removal would also result in sediment displacement and episodes of turbidity. Suspended sediment particles may affect respiratory organs or impair the ability of filter-feeding invertebrates to obtain food. During the relatively short duration that piles are in the water, limited colonization of the piles by fast-growing, sedentary invertebrates would likely occur. Adults of mobile species such as crabs could use the piles for foraging or refuge. Removal of the piles would result in mortality to limited mobility and attached sessile species, and displacement and possibly injury to more mobile species.

Compared to overall population size, only a very small number of individuals would be affected by the proposed pile driving along an artificial shoreline in Gulfport, Mississippi. In addition, pile driving events would occur infrequently, and impacts to the resilient soft substrate in an already highly modified environment would be recoverable. Effects to overall invertebrate populations would not be discernable. Additionally, rare species are unlikely to be affected due to chance encounters and common species could absorb impacts on relatively few individuals.

The analysis conclusions for pile driving for training under Alternative 1 are consistent with a moderate (due to limited potential for injury/mortality) impact on invertebrate populations.

The pile driving associated with training activities under Alternative 1 is not applicable to either ESA-listed coral species or queen conch due to lack of coincidence with the substressor location.

An impact on critical habitat for ESA-listed corals by pile driving is not applicable due to lack of coincidence with the substressor location.

3.5.3.4.4.2 Impacts from Pile Driving under Alternative 2

Impacts from pile driving during training under Alternative 2 are no different from Alternative 1 and therefore the conclusions for ESA-listed species, critical habitat, and significance are the same.

There would be no pile driving associated with testing activities.

3.5.3.5 Entanglement Stressors

Most expended materials do not have the characteristics required to entangle marine species. Wires and cables, decelerators/parachutes, and biodegradable polymer are the expended materials most likely to entangle marine invertebrates.

Table 3.5-9 contains brief summaries of background information that is relevant to analyses of impacts for each entanglement substressor (wires and cables, decelerators/parachutes, and biodegradable polymer).

The background information for entanglement stressor effects on invertebrates in the Study Area as described in the 2018 Final EIS/OEIS (Section 3.4.3.5) has not appreciably changed. As such, the information presented in the 2018 Final EIS/OEIS remains valid.

Table 3.5-9: Entanglement Stressors Background Information Summary

Substressor	*Background Information Summary*
Wires and cables	Fiber-optic cables, torpedo guidance wires, sonobuoy wires, and expendable bathythermograph wires would be expended during military readiness activities. • 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 impact 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. • 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. • 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	At water impact, the decelerator/parachute assembly is expended and sinks away from the unit. • Small and medium decelerator/parachute assemblies may remain at the surface for 5 to 15 seconds before drifting to the bottom, where it becomes flattened and more of a physical disturbance stressor than an entanglement stressor. • 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. • 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.
Biodegradable polymer	Biodegradable polymer materials are configured into a non-woven mat that can be deployed on the water surface. Once wet, the fiber mats turn into more of a viscous fiber material which increases its ability to adhere to surfaces. The materials would degrade into smaller pieces within a few days to weeks, after which time the entanglement potential would cease. • Impacts to pelagic invertebrates would most likely be limited to temporary displacement as the biodegradable polymer material floats past an animal. • Although it is unlikely that most invertebrates would become entangled in the biodegradable polymer material, entanglement is conceivable for both small and large invertebrates that occur in the water column (e.g., zooplankton, jellyfish, and squid). • Entanglement impacts to benthic species are not expected due to the buoyancy and relatively rapid degradation of the items.

3.5.3.5.1 Impacts from Wires and Cables

Table 3.5-9 contains a summary of the background information used to analyze the potential impacts of wires and cables on invertebrates. Table 3.0-17 (Number and Location of Wires and Cables Expended During Military Readiness Activities) indicates the number and location of wires and cables expended during military readiness activities for Alternatives 1 and 2.

3.5.3.5.1.1 Impacts from Wires and Cables under Alternative 1

For training activities, the use of wires and cables would increase overall from the 2018 Final EIS/OEIS, and for testing activities, the use of wires and cables would decrease overall (Table 3.0-17, Number and Location of Wires and Cables Expended during Military Readiness Activities).

Under Alternative 1 for training:

- The use of wires and cables would occur in one location not previously analyzed (Key West Range Complex). There would also be a notable increase in the use of wires and cables in the Virginia Capes and Jacksonville Range Complexes. For all other locations, there would be a similar amount of wires and cables.

Under Alternative 1 for testing

- The use of wires and cables would occur in one area not previously analyzed (Other AFTT Areas) for the 2018 Final EIS/OEIS. There would also be a notable increase in wires and cables in the Virginia Capes and Key West Range Complexes. For all other locations, there would either be a decrease or similar amount of wires and cables.

For locations without a notable increase in wires and cables, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

For locations with notable increases in activity, the impact analysis that was conducted in the 2018 Final EIS/OEIS would not change because the infrequent and localized nature of wire and cable releases remains an accurate characterization of the Proposed Action in those locations.

Although activities will occur in locations not previously analyzed, there would be no change in the impact analysis conducted in the 2018 Final EIS/OEIS because the likelihood of invertebrates encountering a wire or cable and becoming entangled remains low for mobile species (e.g., jellyfish, sea snails, lobsters) and is not applicable for sessile species (e.g., hard corals, sponges).

Based on the relative amount and location of wires and cables and the general description of effects, the impact 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 though they could 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. This is especially true where benthic invertebrate sizes and densities are relatively low (e.g., Other AFTT Areas).

The analysis conclusions for wires and cables as an entanglement stressor associated with training and testing activities under Alternative 1 are consistent with a minor (due to limited potential for entanglement and injury) impact on mobile invertebrate populations.

The entangling aspect of wires and cables associated with training and testing activities under Alternative 1 may affect ESA-listed queen conch. The effect of wire and cables on ESA-listed corals species was covered under physical disturbance and strike; the entangling aspect of wires and cables will have no effect on ESA-listed coral species. The distribution of the stressor coincides with queen conch in two locations (Key West Range Complex and South Florida Ocean Measurement Facility). The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by entanglement from wires and cables. The effect of wires and cables on critical habitat for ESA-listed corals was covered under physical disturbance and strike.

3.5.3.5.1.2 Impacts from Wires and Cables under Alternative 2

Impacts from wires and cables under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The number of wires and cables used under Alternative 2 would increase only slightly over Alternative 1.

3.5.3.5.2 Impacts from Decelerators/Parachutes

Table 3.5-9 contains a summary of the background information used to analyze the potential impacts of decelerators/parachutes on invertebrates. Table 3.0-14 (Number and Location of Other Military Materials Expended during Military Readiness Activities) indicates the number and location of decelerators/parachutes expended during military readiness activities for Alternatives 1 and 2.

3.5.3.5.2.1 Impacts from Decelerators/Parachutes under Alternative 1

For both training and testing activities, decelerator/parachute use would increase from the 2018 Final EIS/OEIS (Table 3.0-14, Number and Location of Other Military Materials Expended during Military Readiness Activities).

Under Alternative 1 for training:

- Decelerators/parachutes would be used in the same locations as for the 2018 Final EIS/OEIS. However, there would be notable increases in the Virginia Capes and Jacksonville Range Complexes. For all other locations, there would be a similar amount of decelerators/parachutes.

Under Alternative 1 for testing:

- Decelerators/parachutes would be used in one area (Other AFTT Areas) that was not previously analyzed, and there would be notable increases in the Northeast, Virginia Capes, and Key West Range Complexes. For all other locations, there would either be a decrease or similar amount of decelerators/parachutes.

For locations without a notable increase in decelerators/parachutes, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

Although Other AFTT Areas is a location not previously analyzed for testing and there would be notable increases in decelerators/parachutes in some locations, these increases would not change the impact analysis that was conducted in the 2018 Final EIS/OEIS because the likelihood of invertebrates encountering a decelerator/parachute and becoming entangled remains low for mobile species (e.g., jellyfish, sea snails, lobsters) and is not applicable for sessile species (e.g., hard corals, sponges). This is especially true where benthic invertebrate sizes and densities are relatively small and low (e.g., Other AFTT areas).

Based on the relative amount and location of decelerators/parachutes, most marine invertebrates would not encounter a decelerator/parachute. In the unlikely event of a coincidence of decelerators/parachutes and susceptible invertebrates, the impact is not likely to cause injury or mortality to individuals based on the general description of impacts, and population-level impacts 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. In addition, marine invertebrates are not particularly susceptible to entanglement stressors, as most would avoid entanglement due to size. Activities involving decelerators/parachutes are also 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.

The analysis conclusions for decelerators/parachutes as an entanglement stressor associated with training and testing activities under Alternative 1 are consistent with a minor (due to limited potential for entanglement and injury) impact on mobile invertebrate populations.

The entangling aspect of decelerators/parachutes associated with training and testing activities under Alternative 1 may affect ESA-listed queen conch. The effect of decelerators/parachutes on ESA-listed corals species was covered under physical disturbance and strike; the entangling aspect of decelerators/parachutes will have no effect on ESA-listed coral species. The distribution of the stressor coincides with queen conch in two locations (Key West Range Complex and South Florida Ocean Measurement Facility). The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by entanglement from decelerators/parachutes. The effect of decelerators/parachutes on critical habitat for ESA-listed corals was covered under physical disturbance and strike.

3.5.3.5.2.2 Impacts from Decelerators/Parachutes under Alternative 2

Impacts from decelerators/parachutes under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The number of decelerators/parachutes used under Alternative 2 would increase only slightly over Alternative 1.

3.5.3.5.3 Impacts from Biodegradable Polymer

Table 3.5-9 contains a summary of the background information used to analyze the potential impacts of biodegradable polymer on invertebrates. Table 3.0-18 (Number and Location of Activities Including Biodegradable Polymers during Testing) indicates the number and location of activities including biodegradable polymers for Alternatives 1 and 2. Section 3.0.3.3.5 (Entanglement Stressors) describes a new type of biodegradable polymer vessel stopping technology not analyzed in the 2018 Final EIS/OEIS.

3.5.3.5.3.1 Impacts from Biodegradable Polymer under Alternative 1

There would be no use of biodegradable polymers associated with training activities.

The proposed use of biodegradable polymer would decrease overall for testing from the 2018 Final EIS/OEIS (Table 3.0-18, Number and Location of Activities Including Biodegradable Polymers during Testing).

Under Alternative 1 for testing:

- Activities using biodegradable polymer would occur in three locations not previously analyzed (Northeast Range Complexes, Navy Cherry Point Range Complex, and Joint Expeditionary Base Little Creek). For all other locations, there would be a decrease in the activities using biodegradable polymer.

For locations with a decrease in biodegradable polymer use, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among these locations has not changed.

Although activities will occur in locations not previously analyzed, these changes would not affect the impact analysis that was conducted in the 2018 Final EIS/OEIS because the likelihood of invertebrates encountering a biodegradable polymer and becoming entangled remains low for mobile species (e.g., jellyfish, sea snails, lobsters) and, not applicable for sessile benthic species (e.g., hard corals, sponges).

Based on the relative amount and location of biodegradable polymer use, the vast majority of marine invertebrates would not encounter a biodegradable polymer regardless of the configuration being used. In the unlikely event of a coincidence of stressor and susceptible invertebrates, it is conceivable that a pelagic invertebrate such as zooplankton or jellyfish could be temporarily entangled in biodegradable polymer material, although the probability is low due to the polymer designs. The most likely effect would be temporary displacement as the material floats past an animal. Impacts to benthic species would not be expected. Activities involving biodegradable polymer as an entanglement risk would be unlikely to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

The analysis conclusions for biodegradable polymer as an entanglement stressor associated with testing activities under Alternative 1 are consistent with a minor (due to limited potential for entanglement and injury) impact on mobile invertebrate populations.

The entangling aspect of biodegradable polymers associated with testing activities under Alternative 1 may affect ESA-listed queen conch if it reaches the bottom intact. The distribution of the stressor coincides with queen conch in one location (Key West Range Complex). The entangling aspect of biodegradable polymer would have no effect on ESA-listed coral species.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by entanglement from biodegradable polymers. The effect of biodegradable polymers on critical habitat for ESA-listed corals was covered under physical disturbance and strike.

3.5.3.5.3.2 Impacts from Biodegradable Polymer under Alternative 2

There would be no use of biodegradable polymers associated with training activities.

Impacts from biodegradable polymer use during testing under Alternative 2 are no different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same. The number of events using biodegradable polymer under Alternative 2 is the same as Alternative 1.

3.5.3.6 Ingestion Stressors

The analysis of ingestion stressors on marine invertebrates is differentiated by munitions and expended materials other than munitions.

The difference between the military expended materials categories is related to shape and material composition; munitions are aero- and/or hydrodynamic and composed of mostly hard metal or concrete whereas other types of military expended materials can be composed of a great variety of materials (e.g., metal, concrete, plastic, rubber, silicon, fabric) and components (e.g., circuit boards, batteries, electric motors). Both material categories break down through time and use of explosives, which is of greater concern to filter- or deposit-feeding invertebrates than intact items or components. Synthetic bio-inspired slime is a new type of biodegradable polymer that may present an ingestion risk to some marine invertebrates.

Table 3.5-10 contains brief summaries of background information that is relevant to analyses of impacts for each ingestion substressor (military expended materials that are munitions and military expended materials other than munitions). The background information for ingestion stressor effects on invertebrates in the Study Area as described in the 2018 Final EIS/OEIS (Section 3.4.3.6) has not appreciably changed. As such, the information presented in the 2018 Final EIS/OEIS remains valid.

Table 3.5-10: Ingestion Stressors Background Information Summary

Substressor	*Background Information Summary*
Military expended materials – munitions	Ingestion of intact military expended materials that are munitions 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. 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.
Military expended materials other than munitions	Most military expended materials other than munitions would sink to the bottom, while some could persist at the surface or in the water column for some time. • 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. • 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 to invertebrates. Porter et al., found microplastic burden to be highest in the omnivores, predators, and deposit feeders. • Marine invertebrates may occasionally encounter and incidentally ingest chaff fibers when they ingest prey or water, but chaff poses little environmental risk to marine

Table 3.5-10: Ingestion Stressors Background Information Summary (continued)

Substressor	Background Information Summary
	organisms at concentrations that could reasonably occur from military training and testing. • As biodegradable polymers break down into smaller pieces, they may be consumed by indiscriminate filter feeders in the water column. As a natural substance that is normally produced by biodegradable polymer to ward off potential predators (Taylor et al., 2023), the consumption of tiny bits of organic slime is not likely to have adverse effects on a consumer.

3.5.3.6.1 Impacts from Military Expended Materials – Munitions

Table 3.5-10 contains a summary of the background information used to analyze the potential impacts of military expended materials that are munitions on invertebrates. For more information on the location and number of military expended materials that are ingestible munitions see Table 3.0-11, (Number and Location of Non-Explosive Practice Munitions Expended during Military Readiness Activities) and Table 3.0-12 (Number and Location of Explosives that May Result in Fragments Used during Military Readiness Activities).

3.5.3.6.1.1 Impacts from Military Expended Materials – Munitions under Alternative 1

For both training and testing activities, military expended materials - munitions would decrease from the 2018 Final EIS/OEIS (Table 3.0-11, Number and Location of Non-Explosive Practice Munitions Expended during Military Readiness Activities, and Table 3.0-12, Number and Location of Explosives that May Result in Fragments Used during Military Readiness Activities).

Under Alternative 1 for training:

- Ingestible munitions (including fragments from explosive munitions) would occur in the same locations as they did in the 2018 Final EIS/OEIS. There would be a notable increase in the Key West Range Complex Inshore, but for all other locations, there would either be a decrease, similar amount, or cessation of ingestible munitions.

Under Alternative 1 for testing:

- Ingestible munitions would occur in one location not previously analyzed (Naval Undersea Warfare Center Division, Newport Testing Area). For all other locations, there would be a decrease in the amount of ingestible munitions.

For both training and testing, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

Although there are locations not previously analyzed and there would be a notable increase in military expended materials – munitions in one location, these increases would not change the impact analysis that was conducted in the 2018 Final EIS/OEIS because the likelihood of invertebrates encountering a munition or munition fragment and consuming it remains low for indiscriminate feeders (e.g., deposit feeders, omnivores) and is negligible for discriminant feeders (e.g., squid, crabs, filter feeders).

The heavy materials comprising munitions would degrade into fragments that remain in the sediment posing an ingestion risk to only deposit feeders. Based on the relative amount and location of expended munitions and the general description of effects, an impact on individual invertebrates is unlikely, and impacts on populations would probably not be detectable.

The analysis conclusions for ingestible munitions or munition fragments associated with training and testing activities under Alternative 1 are consistent with a minor (due to limited potential for ingestion and injury) impact on invertebrate populations.

The ingestible munitions or munition fragments associated with training and testing activities under Alternative 1 may affect ESA-listed coral species and queen conch when munitions fragments are suspended in the water column or on the bottom. The distribution of the stressor coincides with these species in two locations (Key West Range Complex and Key West Range Complex Inshore).

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by ingestion of military expended materials that are munitions. The effect of military expended materials on critical habitat for ESA-listed corals was covered under physical disturbance and strike.

3.5.3.6.1.2 Impacts from Military Expended Materials – Munitions under Alternative 2

Impacts from military expended materials – munitions under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing. The number of ingestible munitions or munition fragments used under Alternative 2 would increase only slightly over Alternative 1.

3.5.3.6.2 Impact from Military Expended Materials Other Than Munitions

Table 3.5-10 contains a summary of the background information used to analyze the potential impacts of military expended materials other than munitions on invertebrates. For more information on the location and number of military expended materials that are ingestible munitions see Table 3.0-14, (Number and Location of Other Military Materials Expended during Military Readiness Activities).

3.5.3.6.2.1 Impacts from Military Expended Materials Other Than Munitions under Alternative 1

For both training and testing activities, military expended materials other than munitions, would decrease from the 2018 Final EIS/OEIS (Table 3.0-14, Number and Location of Other Military Materials Expended during Military Readiness Activities).

Under Alternative 1 for training:

- Ingestible military expended materials other than munitions would no longer occur at one location (Virginia Capes Range Complex Inshore) that they did in the 2018 Final EIS/OEIS. However, there would be a notable increase in military expended materials other than munitions at the Virginia Capes Range Complex and the Key West Range Complex. For all other locations, there would either be a decrease or similar amount of military expended materials other than munitions.

Under Alternative 1 for testing:

- Ingestible military expended materials other than munitions would occur in one location not previously analyzed (Other AFTT Areas). For all other locations, there would either be a decrease or similar amount of military expended materials other than munitions.
- Activities using biodegradable polymer would occur in three locations not previously analyzed (Northeast Range Complexes, Navy Cherry Point Range Complex, and Joint Expeditionary Base Little Creek) for the 2018 Final EIS/OEIS. For all other locations, there would be a decrease in the

activities using biodegradable polymer (Table 3.0-18, Number and Location of Activities Including Biodegradable Polymers during Testing).

For locations without a notable increase in ingestible military expended materials other than munitions, the analysis from the 2018 Final EIS/OEIS remains valid; the updates to the affected environment noted in Section 3.5.2 (Affected Environment) do not alter the analysis because the general distribution and sensitivity of invertebrate taxa among training and testing locations has not changed.

Although there is a location not previously analyzed for testing, overall, there would be a decrease in expended materials in the Study Area. The impact analysis that was conducted in the 2018 Final EIS/OEIS remains valid because the likelihood of invertebrates encountering ingestible military expended material other than munitions and consuming it remains low for indiscriminate feeders (e.g., omnivores, deposit feeders) and negligible for discriminant feeders (e.g., squid, crabs, filter feeders).

In addition to metal or concrete fragments in the sediment, small plastic (or otherwise light) fragments may be consumed by a wide variety of invertebrates with indiscriminate feeding methods (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, Action Proponent activities would result in a small number of plastic particles introduced to the marine environment compared to other sources. In the unlikely event of a coincidence of biodegradable polymers and susceptible invertebrates, it is conceivable that an indiscriminate feeder (e.g., jellyfish, filter-feeding zooplankton, deposit-feeding worm) could ingest a fragment of polymer. Considering the organic and non-toxic composition of the material, the effect would likely be negligible. Activities involving biodegradable polymer as an ingestion risk would be unlikely to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels. Overall, impacts on invertebrate populations due to military expended materials other than munitions would probably not be detectable.

The analysis conclusions for ingestible non-munitions other than munitions associated with training and testing activities under Alternative 1 are consistent with a minor (due to limited potential for ingestion and injury) impact on invertebrate populations.

The ingestible military expended materials other than munitions associated with training and testing activities under Alternative 1 may affect both ESA-listed coral species and queen conch because they are filter and deposit feeders, respectively. The distribution of the stressor coincides with these species in two locations (Key West Range Complex and South Florida Ocean Measurement Facility). The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) will not be affected by ingestion of military expended materials other than munitions. The effect of military expended materials on critical habitat for ESA-listed corals was covered under physical disturbance and strike.

3.5.3.6.2.2 Impacts from Military Expended Materials Other Than Munitions under Alternative 2

Impacts from military expended materials other than munitions under Alternative 2 are no different from Alternative 1 and therefore the conclusions for significance impacts, ESA-listed species and critical habitat are the same for both training and testing. The number of ingestible non-munitions under Alternative 2 is the same as Alternative 1.

3.5.3.7 Secondary Stressors

This section analyzes potential impacts on invertebrates exposed to stressors indirectly through impacts on their habitat (explosives and explosive byproducts, unexploded munitions, metals, chemicals) and/or prey availability. Table 3.5-11 contains brief summaries of background information that is relevant to the analyses of impacts for each substressor (explosives via habitat, etc.). The background information for secondary stressor effects on invertebrates in the Study Area as described in the 2018 Final EIS/OEIS (Section 3.4.3.7) has not appreciably changed. As such, the information presented in the 2018 Final EIS/OEIS remains valid.

Table 3.5-11: Secondary Stressor Background Information Summary

Indirect Links	*Substressors*	*Background Information Summary*
Habitat	Explosives	• Explosions on or near the bottom in areas of soft substrate would not cause an overall reduction in the surface area or volume of sediment available to benthic invertebrates. • Activities that inadvertently result in explosions on or near hard bottom habitat or reefs could break hard structures and reduce the amount of colonizing surface available to encrusting organisms (e.g., corals, sponges). Refer to Section 3.3 (Habitats) for a more comprehensive summary of direct impacts to habitat.
	Explosive byproducts and unexploded munitions	• High-order explosions consume most of the explosive material, and byproducts would therefore not degrade sediment or water quality or result in indirect stressors to marine invertebrates. • Low-order detonations and unexploded munitions may result in the presence of explosive material in sediments or the water column. However, toxicity and other effects are generally associated with exposure to higher concentrations than those expected to occur due to military readiness activities. • Munitions constituents and degradation products in sediments would likely be detectable only within a few feet, and the range of toxic sediment conditions could be less (inches). Due to low solubility and dilution, invertebrates would be exposed to chemical byproducts in the water column only in the immediate vicinity of degrading explosives (inches or less).
	Chemicals	• Potentially harmful chemicals introduced into the marine environment consist mostly of propellants and combustion products, other fuels, polychlorinated biphenyls in target vessels, other chemicals associated with munitions, and simulants. • Ammonium perchlorate (a rocket and missile propellant) is the most common chemical used. Other representative chemicals with potential to affect invertebrates include propellant combustion products such as hydrogen cyanide and ammonia. • Most propellants are consumed during normal operations, and the failure rate of munitions using propellants and other combustible materials is low. • Most byproducts occur naturally in seawater and are readily degraded by biotic and abiotic processes. All chemicals are quickly diluted by water movement. • Target vessels are selected from a list of Navy-approved vessels that have been cleaned in accordance with U.S. Environmental Protection Agency guidelines. This procedure minimizes the

Table 3.5-11: Secondary Stressor Background Information Summary (continued)

Indirect Links	*Substressors*	*Background Information Summary*
		amount of polychlorinated biphenyls entering the marine environment. • Overall, concentrations of chemicals in sediment and water are not likely to cause injury or mortality to marine invertebrates, gametes, eggs, or larvae.
	Metals	• Metals are introduced into seawater and sediments as a result of military readiness activities involving vessel hulks, targets, munitions, and other military expended materials. • Secondary effects may occur when marine invertebrates are exposed to concentrations above background levels by contact with the metal, contact with trace amounts in the sediment or water, and ingestion of contaminated sediments. • Because metals tend to precipitate out of seawater and often concentrate in sediments, potential adverse indirect impacts are much more likely via sediment than water. However, studies have found the concentrations of metals in the sediments within military ranges or munitions disposal sites, where deposition of metals is very high, to be localized and rarely above biological effects levels. • Impacts to invertebrates, eggs, or larvae would likely be limited to exposure in the sediment within a few inches of the object. • Concentrations of metals in sea water related to training and testing activities are unlikely to be high enough to cause injury or mortality to marine invertebrates.
Prey availability	All stressors	The potential for primary stressors to impact invertebrate prey populations is directly related to their impacts on biological resources consumed by invertebrates (e.g., mostly vegetation and other invertebrates but also fish and other animal carcasses).

3.5.3.7.1 Impact of Secondary Stressors

3.5.3.7.1.1 Impacts from Secondary Stressors Under Alternative 1

The impacts of explosives and military expended materials in terms of abiotic substrate disturbance are described in Section 3.3 (Habitats). Most detonations would occur in waters greater than 200 feet in depth, and greater than 3 nautical miles from shore, although mine warfare, demolition, and some testing detonations would occur in shallow water close to shore. In deep waters, explosions would not likely damage habitat because the explosion would not be on or proximate to the sea floor. These habitats include corals, seagrass beds, and other benthic habitats that are used by resources. The assessment of potential sediment and water quality degradation on aquatic life, including representative marine invertebrates, is covered in Section 3.2 (Sediment and Water Quality). Considering the literature on other marine invertebrates does not suggest an elevated sensitivity to pollutants from the Proposed Action alternatives, the analysis of sediment and water quality degradation in Section 3.2 is sufficient to cover the impact on invertebrates.

Impacts on invertebrate prey availability from the Proposed Action alternatives would likely be negligible to moderate overall based on the analysis conclusions for the direct stressors on their food resources (e.g., vegetation, other invertebrates, fish, other animal carcasses).

The impact of the Proposed Action on secondary stressors were considered negligible to moderate (depending on the primary stressor) on invertebrate populations.

The secondary stressors associated with training and testing activities under Alternative 1 may affect both ESA-listed coral species and queen conch. The distribution of the secondary stressors coincides with these species in three locations (Key West Range Complex – Inshore and Offshore and South Florida Ocean Measurement Facility). The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) may be affected by secondary stressor (via explosive byproducts and military expended materials).

3.5.3.7.1.2 Impacts from Secondary Stressors Under Alternative 2

Impacts from secondary stressors under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance, ESA-listed species, and critical habitat are the same for both training and testing.

3.5.3.8 Combined Stressors

As described in Section 3.0.3.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the potential for combined impacts of all stressors from the Proposed Action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the sections above. Stressors associated with proposed 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 impacts of all stressors considers the potential consequences of additive and synergistic stressors from the Proposed Action, as described below.

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 impacts 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 impacts 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 impacting invertebrate fitness (e.g., physiology, behavior, reproductive potential).

3.5.3.8.1 Combined Impacts of All Stressors under Alternative 1

Most of the activities proposed under Alternative 1 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 impact (e.g., physical disturbance or strike). Individual stressors that would otherwise have minimal to no impact 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. Impacts would be more likely to occur to sessile and slow-moving species in areas where military readiness activities are concentrated and consistently located.

Although potential impacts on invertebrates from military readiness activities under Alternative 1 may include injury and mortality, in addition to other effects such as physiological stress, masking, and behavioral effects, the combined impacts are not expected to lead to long-term consequences for invertebrate populations. Based on the general description of impacts, the number of invertebrates impacted 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 impact of all stressors from Alternative 1 are considered moderate (due to limited potential for injury/mortality) on invertebrate populations.

Critical habitat for ESA-listed corals (e.g., natural hard substrate; Figure 3.5-1) may be affected by combined stressors that are individually applicable (e.g., explosives, physical disturbance and strike).

3.5.3.8.2 Combined Impacts of All Stressors under Alternative 2

The combined impacts of stressors under Alternative 2 are not meaningfully different from Alternative 1 and therefore the conclusions for significance are the same for both training and testing.

3.5.4 ENDANGERED SPECIES ACT DETERMINATIONS

The Action Proponents have concluded that military readiness activities may affect the ESA-listed coral species and queen conch described in Section 3.5.2.2 (Endangered Species Act-Listed Species) for Alternative 1. The Action Proponents have also concluded that military readiness activities may affect designated critical habitat for the ESA-listed coral species listed in Table 3.5-1. The Action Proponents are consulting with NMFS as required by section 7(a)(2) of the ESA. The summary of effects determinations for each ESA-listed species is provided in Table 3.5-12 for training and testing.

Table 3.5-12: Invertebrate Species Determinations for Military Readiness Activities under Alternative 1 (Preferred Alternative)

Species	DPS/Critical Habitat	Effect Determinations by Stressor																						
		Acoustic						Explosive		Energy			Physical Disturbance and Strike						Entanglement			Ingestion		
		Sonar and Other Transducers	*Air Guns*	*Pile Driving Noise*	*Vessel Noise*	*Aircraft Noise*	*Weapons Noise*	*Explosions in Air*	*Explosions in Water*	*In-Air Electromagnetic Devices*	*In-water Electromagnetic Devices*	*High-Energy Lasers*	*Vessels*	*In-Water Devices*	*Aircraft and Aerial Targets*	*Military Expended Materials*	*Seafloor Devices*	*Pile Driving*	*Wires and Cables*	*Decelerators/Parachutes*	*Biodegradable Polymer[1]*	*Military Expended Materials-Munitions*	*Military Expended Materials - Other[1]*	*Secondary*
Training Activities																								
Boulder star, lobed star, mountainous star, pillar, and rough cactus coral	ESA-listed threatened species	MA	N/A	N/A	MA	NE	NE	N/A	MA	N/A	MA	N/A	MA	MA	N/A	MA	MA	N/A	NE	NE	N/A	MA	MA	MA
	Critical habitat (hard substrate)	NE	N/A	N/A	NE	NE	NE	N/A	MA	N/A	NE	N/A	NE	NE	N/A	MA	MA	N/A	NE	NE	N/A	NE	NE	MA
Elkhorn and staghorn coral	ESA-listed threatened species	MA	N/A	N/A	MA	NE	NE	N/A	MA	N/A	MA	N/A	MA	MA	N/A	MA	MA	N/A	NE	NE	N/A	MA	MA	MA
	Critical habitat (hard substrate)	NE	N/A	N/A	NE	NE	NE	N/A	MA	N/A	NE	N/A	NE	NE	N/A	MA	MA	N/A	NE	NE	N/A	NE	NE	MA
Queen conch	ESA-listed threatened species	MA	N/A	N/A	MA	NE	NE	N/A	MA	N/A	MA	N/A	MA	MA	N/A	MA	MA	N/A	MA	MA	N/A	MA	MA	MA
Testing Activities																								
Boulder star, lobed star, mountainous star, pillar, and rough cactus coral	ESA-listed threatened species	MA	N/A	N/A	MA	NE	NE	N/A	MA	N/A	N/A	N/A	MA	MA	N/A	MA	MA	N/A	NE	NE	NE	MA	MA	MA
	Critical habitat (hard substrate)	NE	N/A	N/A	NE	NE	NE	N/A	MA	N/A	N/A	N/A	NE	NE	N/A	MA	MA	N/A	NE	NE	NE	NE	NE	MA
Elkhorn and staghorn coral	ESA-listed threatened species	MA	N/A	N/A	MA	NE	NE	N/A	MA	N/A	N/A	N/A	MA	MA	N/A	MA	MA	N/A	NE	NE	NE	MA	MA	MA
	Critical habitat (hard substrate)	NE	N/A	N/A	NE	NE	NE	N/A	MA	N/A	N/A	N/A	NE	NE	N/A	MA	MA	N/A	NE	NE	NE	NE	NE	MA
Queen conch	ESA-listed threatened species	MA	N/A	N/A	MA	NE	NE	N/A	MA	N/A	N/A	N/A	MA	MA	N/A	MA	MA	N/A	MA	MA	MA	MA	MA	MA

[1] Includes new material (biodegradable polymer).

Notes: ESA = Endangered Species Act; MA = may affect; N/A = not applicable, either because the activity does not coincide with species range or does not occur with any training or testing events (e.g., there are no testing activities that involve the use of pile driving); NE = no effect. The determinations for likelihood of adverse effects are pending consultation with the National Marine Fisheries Service.

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