


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

Volume I

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Atlantic Fleet Training and Testing

Draft Environmental Impact Statement / Overseas Environmental Impact Statement

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Environmental Impact Statement/Overseas Environmental Impact Statement for Atlantic Fleet Training and Testing
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Lead Agency:	United States Department of Navy
Cooperating Agency:	National Marine Fisheries Service
Title of Proposed Action:	Atlantic Fleet Training and Testing Activities
Designation:	**Draft Environmental Impact Statement/Overseas Environmental Impact Statement**

Abstract

The United States Department of the Navy (Navy) prepared this Draft Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to comply with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114. This EIS/OEIS evaluates the potential environmental impacts of conducting training and testing activities in the Atlantic Fleet Training and Testing (AFTT) Study Area after November 2018 into the future. The AFTT Study Area is located within the in-water areas of the western Atlantic Ocean along the eastern coast of North America, in portions of the Caribbean Sea and the Gulf of Mexico, at select Navy pierside locations, within port transit channels, near select civilian ports, and in bays, harbors, and inland waterways (e.g., lower Chesapeake Bay).

Three alternatives were analyzed in the Draft EIS/OEIS:

- The No Action Alternative considered that the Proposed Action would not take place (i.e., the proposed training and testing would not occur in the AFTT Study Area), and presented the resulting environmental effects from taking no action when compared with the effects of the Proposed Action.
- Alternative 1 (Preferred Alternative) reflects a representative year of training activity, rather than a maximum tempo of training activity in every year, a lower level of hull-mounted active sonar use from that conducted in the past and reflects the current practice of using synthetic training to meet some requirements. Alternative 1 proposes testing programs that are anticipated in any given year and limits the maximum amount of testing from occurring.
- Alternative 2 includes a higher number of training unit exercises and sonar hour use than Alternative 1 but is still a reduction from the past. Under this alternative, the Navy would be enabled to meet the highest levels of required readiness. Alternative 2 allows the Navy to meet all unit-level sonar training requirements through the conduct of discrete at-sea training exercises and not through the use of synthetic training. In Alternative 2, the maximum annual testing efforts predicted for each system or program could occur concurrently in any given year and the provision is included for high levels of annual testing of certain systems.

In this Draft EIS/OEIS, the Navy analyzed potential impacts on environmental resources resulting from activities under Alternatives 1 and 2. Under the No Action Alternative, this EIS/OEIS also includes an analysis of environmental effects from taking no action (activities would not occur) as a comparison to the effects of the Proposed Action. Evaluated resources included air quality, sediments and water quality, vegetation, invertebrates, marine habitats, reptiles, fishes, marine mammals, birds, cultural resources, socioeconomic resources, public health and safety, and cumulative impacts.

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

TABLE OF CONTENTS

List of Figures

List of Tables

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The United States (U.S.) Department of the Navy (Navy) prepared this Draft Environmental Impact Statement (EIS)/Overseas EIS (OEIS) to assess the potential environmental impacts associated with two categories of military readiness activities: training and testing. Collectively, the at-sea areas in this EIS/OEIS are referred to as the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area) (Figure ES-1). The Navy also prepared this EIS/OEIS to comply with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114.

Major conflicts, terrorism, lawlessness, and natural disasters all have the potential to threaten national security of the United States. United States national security, prosperity, and vital interests are increasingly tied to other nations because of the close relationships between the United States and other national economies. The Navy carries out training and testing activities to be able to protect the United States against its enemies, as well as to protect and defend the rights of the United States and its allies to move freely on the oceans. Training and testing activities that prepare the Navy to fulfill its mission to protect and defend the United States and its allies potentially impact the environment. These activities may trigger legal requirements identified in many U.S. federal environmental laws, regulations, and executive orders.

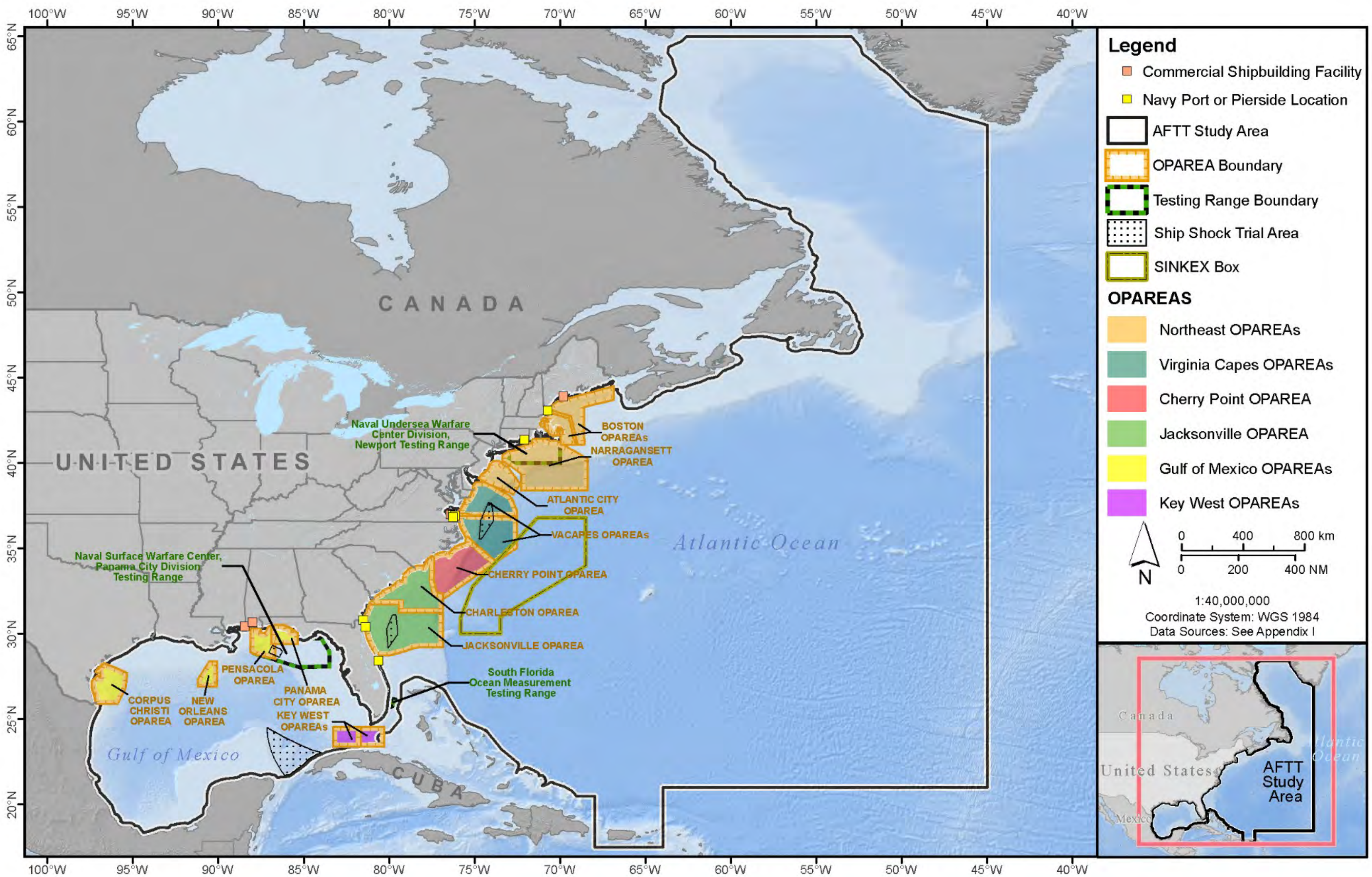
ES.2 PURPOSE AND NEED FOR PROPOSED MILITARY READINESS TRAINING AND TESTING ACTIVITIES

The purpose of the Proposed Action is to ensure that the Navy meets its mission under Title 10 United States Code Section 5062, which is to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is achieved in part by conducting training and testing within the Study Area.

ES.3 SCOPE AND CONTENT OF THE ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

In this EIS/OEIS, the Navy assessed military readiness activities that could potentially impact human and natural resources, especially marine mammals, sea turtles, and other marine resources. The range of alternatives includes a No Action Alternative and other reasonable courses of action. Direct, indirect, cumulative, short-term, long-term, irreversible, and irretrievable impacts were also analyzed. The Navy is the lead agency for the Proposed Action and is responsible for the scope and content of this EIS/OEIS. The National Marine Fisheries Service (NMFS) is a cooperating agency pursuant to 40 Code of Federal Regulations (CFR) section 1501.6 because of its expertise and regulatory authority over certain marine resources. Additionally, NMFS plans to use this document as its NEPA documentation for the rule making process under the Marine Mammal Protection Act (MMPA).

In accordance with the Council on Environmental Quality Regulations, 40 CFR section 1505.2, the Navy will issue a Record of Decision. The decision will be based on factors analyzed in this EIS/OEIS, including military training and testing objectives, best available science and modeling data, potential environmental impacts, and public interest.



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area, SINKEX = Sinking Exercises.

Figure ES-1: Atlantic Fleet Training and Testing Study Area

ES.3.1 National Environmental Policy Act

Federal agencies are required under NEPA to examine the environmental impacts of their proposed actions within the United States and its territories. An EIS is a detailed public document that provides an assessment of the potential effects that a major Federal action might have on the human environment, which includes the natural environment. The Navy undertakes environmental planning for major Navy actions occurring throughout the world in accordance with applicable laws, regulations, and Executive Orders. Presidential Proclamation 5928, issued December 27, 1988, extended the exercise of U.S. sovereignty and jurisdiction under international law to 12 nautical miles (NM); however, the proclamation expressly provides that it does not extend or otherwise alter existing Federal law or any associated jurisdiction, rights, legal interests, or obligations. Thus, as a matter of policy, the Navy analyzes environmental effects and actions within 12 NM under NEPA (an EIS).

ES.3.2 Executive Order 12114

This OEIS has been prepared in accordance with Executive Order 12114 (44 Federal Register 1957) and Navy implementing regulations in 32 CFR part 187, *Environmental Effects Abroad of Major Department of Defense Actions*. An OEIS is required when a proposed action and alternatives have the potential to significantly harm the environment of the global commons. The global commons are defined as geographical areas outside the jurisdiction of any nation and include the oceans outside of the territorial limits (more than 12 NM from the coast) and Antarctica but do not include contiguous zones and fisheries zones of foreign nations (32 Code of Federal Regulations section 187.3). The EIS and OEIS have been combined into one document, as permitted under NEPA and Executive Order 12114, to reduce duplication.

ES.3.3 Marine Mammal Protection Act

The MMPA of 1972 (16 United States Code [U.S.C.] section 1361 et seq.) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals on the high seas by vessels or persons subject to U.S. jurisdiction. The term "take," as defined in section 3 [16 U.S.C. section 1362(13)] of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment: Level A (potential injury) and Level B (potential behavioral disturbance).

The MMPA directs the Secretary of Commerce as delegated to NMFS to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The authorization must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock and its habitat, and on the availability of the species or stock for subsistence uses (where relevant, and requirements pertaining to the monitoring, and reporting of such taking.

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment and removed the "small numbers" provision as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government consistent with section 104(c)(3) (16 U.S.C. section 1374 [c][3]). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). A "military readiness activity" is defined as "all training and operations of the Armed Forces that relate to combat" and "the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use." Since the Proposed Action involves conducting military readiness activities, the relevant definition of harassment is any act that:

- injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment") or
- disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") [16 U.S.C. section 1362(18)(B)(i) and (ii)].

ES.3.4 Endangered Species Act

The Endangered Species Act [ESA of 1973 (16 U.S.C. section 1531 et seq.)] provides for the conservation of endangered and threatened species, and of the ecosystems on which they depend. The Act defines "endangered" species as a species in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. The U.S. Fish and Wildlife Service (USFWS) and NMFS jointly administer the ESA and are responsible for listing species (as threatened or endangered) and for designating critical habitat for listed species. Section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species, that agency is required to consult with the Service (NMFS or USFWS) that has jurisdiction over the species in question [50 CFR section 402.14(a)]. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be a prohibited taking under the act provided that such taking complies with the terms and conditions of an Incidental Take Statement.

ES.3.5 Additional Environmental Requirements Considered

The Navy must comply with all applicable federal environmental laws, regulations, and Executive Orders, including, but not limited to, those listed below. Further information on Navy compliance with these and other environmental laws, regulations, and Executive Orders can be found in Chapter 3 (Affected Environment and Environmental Consequences) and Chapter 6 (Regulatory Considerations).

- Abandoned Shipwreck Act
- Antiquities Act
- Clean Air Act
- Clean Water Act
- Coastal Zone Management Act
- Magnuson-Stevens Fishery Conservation and Management Act
- Migratory Bird Treaty Act
- National Historic Preservation Act

- National Marine Sanctuaries Act
- Rivers and Harbors Act
- Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*
- Executive Order 12962, *Recreational Fisheries*
- Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*
- Executive Order 13089, *Coral Reef Protection*
- Executive Order 13158, *Marine Protected Areas*
- Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*
- Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*

ES.4 PROPOSED ACTION AND ALTERNATIVES

The U.S. Navy proposes to conduct military readiness training activities and research, development, testing, and evaluation (hereinafter referred to as "testing") activities in the AFTT Study Area, as represented in (Figure ES-1). These military readiness activities include the use of active sonar and explosives within the in-water areas of the western Atlantic Ocean along the eastern coast of North America, in portions of the Caribbean Sea and the Gulf of Mexico, at select Navy pierside locations, within port transit channels, near select civilian ports, and in bays, harbors, and inland waterways (e.g., lower Chesapeake Bay). These military readiness activities are generally consistent with those analyzed in the AFTT EIS/OEIS completed in November 2013 and are representative of training and testing that the Navy has been conducting in the AFTT Study Area for decades.

ES.4.1 NO ACTION ALTERNATIVE

Under the No Action Alternative, the Proposed Action would not take place (i.e., the Navy would not conduct proposed training and testing activities in the AFTT Study Area). For NMFS, denial of an application for an incidental take authorization constitutes the NMFS No Action Alternative, which is consistent with NMFS' statutory obligation under the MMPA to grant or deny requests for take incidental to specified activities. The resulting environmental effects from taking no action will be compared with the effects of the Proposed Action.

ES.4.2 ALTERNATIVE 1

Alternative 1 is the Preferred Alternative.

ES.4.2.1 TRAINING

Under this alternative, the Navy proposes to conduct military readiness training activities into the reasonably foreseeable future, as necessary to meet current and future readiness requirements. These military readiness training activities include new activities as well as activities subject to previous analysis that are currently ongoing and have historically occurred in the Study Area. These activities account for force structure (organization of ships, weapons, and personnel) changes and include training with new aircraft, vessels, unmanned/autonomous systems, and weapon systems that will be introduced to the fleets after November 2018. The numbers and locations of all proposed training activities are provided in Table 2.6-1, in Section 2.6.1 (Proposed Training Activities).

Alternative 1 reflects a representative year of training to account for the natural fluctuation of training cycles and deployment schedules that generally limit the maximum level of training from occurring year after year in any five-year period. Using a representative level of activity rather than a maximum tempo of training activity in every year has reduced the amount of hull-mounted mid-frequency active sonar estimated to be necessary to meet training requirements, as discussed below. Both unit-level training and major training exercises are adjusted to meet this representative year.

Under Alternative 1, the Navy assumes that some unit-level training would be conducted using synthetic means (e.g., simulators). Additionally, this alternative assumes that some unit-level active sonar training will be completed through other training exercises. By using a representative level of training activity rather than a maximum level of training activity in every year.

The Optimized Fleet Response Plan (which outlines the training activities required to achieve a state of Naval readiness) and various training plans identify the number and duration of training cycles that could occur over a five-year period. Alternative 1 considers fluctuations in training cycles and deployment schedules that do not follow a traditional annual calendar but instead are influenced by in-theater demands and other external factors. Similar to unit-level training, this alternative does not analyze a maximum number of carrier strike group Composite Training Unit Exercises (one type of major exercise) every year, but instead assumes a maximum number of exercises would occur during two years of any five-year period. As a result, Alternative 1 will analyze a maximum of three Composite Training Unit Exercises in any given year and not more than 12 over any five-year period. This alternative does not provide for the conduct of a contingency Composite Training Unit Exercise in the Gulf of Mexico and, hence, incorporates a degree of risk that the Navy will not have sufficient capacity to support the full spectrum of training potentially necessary to respond to a future national emergency crisis.

ES.4.2.2 TESTING

Alternative 1 entails a level of testing activities to be conducted into the reasonably foreseeable future, with adjustments that account for changes in the types and tempo (increase or decrease) of testing activities, as necessary, to meet current and future military readiness requirements. This alternative includes the testing of new platforms, systems, and related equipment that will be introduced after November 2018. The majority of types of testing activities that would be conducted under this alternative are the same as or similar as those conducted currently or in the past. This alternative includes the testing of some new systems using new technologies and takes into account inherent uncertainties in this type of testing.

Under Alternative 1, the Navy proposes an annual level of testing that reflects the fluctuations in testing programs by recognizing that the maximum level of testing will not be conducted each year. This alternative contains a more realistic annual representation of activities, but includes years of a higher maximum amount of testing to account for these fluctuations. This alternative would not include the contingency for augmenting some weapon system tests, which would increase levels of annual testing of anti-submarine warfare and mine warfare systems, and presumes a typical level of readiness requirements. All proposed testing activities are listed in Table 2.6-2 through Table 2.6-4, in Section 2.6.2 (Testing).

ES.4.3 ALTERNATIVE 2

ES.4.3.1 TRAINING

As under Alternative 1, Alternative 2 includes new and ongoing activities. Under Alternative 2, training activities are based on requirements established by the Optimized Fleet Response Plan. Under this alternative, the Navy would be enabled to meet the highest levels of required military readiness by conducting the majority of its training live at sea, and by meeting unit level training requirements using dedicated, discrete training events, instead of combining them with other training activities as described in alternative 1. The numbers and locations of all proposed training activities are provided in Table 2.6 1, in Section 2.6.1 (Proposed Training Activities).

Alternative 2 reflects the maximum number of training activities that could occur within a given year, and assumes that the maximum level of activity would occur every year over any 5-year period. This allows for the greatest capacity for the Navy to maintain readiness when considering potential changes in the national security environment, fluctuations in training and deployment schedules, and potential in-theater demands. Both unit-level training and major training exercises are assumed to occur at a maximum level every year.

Additionally, this alternative will analyze three Composite Training Unit Exercises each year along with a contingency Composite Training Unit Exercise in the Gulf of Mexico each year, for a total number of Composite Training Unit Exercises to 20, including the Gulf of Mexico contingency Composite Training Unit Exercise, over any five-year period.

ES.4.3.2 Testing

Alternative 2 entails a level of testing activities to be conducted into the reasonably foreseeable future, and includes the testing of new platforms, systems, and related equipment that will be introduced after November 2018. The majority of testing activities that would be conducted under this alternative are the same as or similar to those conducted currently or in the past.

Alternative 2 would include the testing of some new systems using new technologies, taking into account the potential for delayed or accelerated testing schedules, variations in funding availability, and innovation in technology development. To account for these inherent uncertainties in testing, this alternative assumes that the maximum annual testing efforts predicted for each individual system or program could occur concurrently in any given year. This alternative also includes the contingency for augmenting some weapon systems tests in response to potential increased world conflicts and changing Navy leadership priorities as the result of a direct challenge from a naval opponent that possesses near-peer capabilities. Therefore, this alternative includes the provision for higher levels of annual testing of certain anti-submarine warfare and mine warfare systems to support expedited delivery of these systems to the fleet. All proposed testing activities are listed in Table 2.6-2 through Table 2.6-4, in Section 2.6.2 (Proposed Testing Activities).

ES.5 Summary of Environmental Effects

Environmental effects which might result from the implementing the Navy's Proposed Action or alternatives have been analyzed in this EIS/OEIS. Resource areas analyzed include air quality, sediments and water quality, vegetation, invertebrates, habitats, fishes, marine mammals, reptiles, birds and bats, cultural resources, socioeconomics, and public health and safety. Table ES 5-1 provides a comparison of the potential environmental impacts of the No Action Alternative, Alternative 1 (Preferred Alternative), and Alternative 2.

This Draft EIS/OEIS covers similar types of Navy training and testing activities in the same study area analyzed in the 2013 AFTT Final EIS/OEIS. The Navy has re-evaluated impacts from these ongoing activities in existing ranges and operating areas (OPAREAs) offshore of the eastern and gulf coasts. The Navy analyzed new or changing military readiness activities into the reasonably foreseeable future based on evolving operational requirements, including those associated with new platforms and systems not previously analyzed, and new inland water training locations. Additionally, the Navy thoroughly reviewed and incorporated the best available science relevant to analyzing the environmental impacts of the proposed activities. Changes from the 2013 AFTT Final EIS/OEIS include the following:

ES.5.1 SONAR AND EXPLOSIVES

The Navy's refined analysis of anti-submarine warfare activities results in reduced levels of active sonar analyzed. The new presentation of anti-submarine warfare activities more accurately reflects the variability in the number of certification related events (e.g., Composite Training Exercise) conducted per year due to varying deployment schedules and ship availabilities. This new analysis also better accounts for a portion of unit level surface ship Tracking Exercise requirements being met during coordinated/integrated anti-submarine warfare training and major training exercises, or through synthetic training. These refinements to the analysis result in fewer hours of acoustic sources, such as hull-mounted mid-frequency active acoustic systems, when estimating marine mammal exposures from training events.

This Draft EIS/OEIS supports the Navy's increased focus on live training to meet evolving Surface Warfare challenges. This results in a proposed increase in levels of Air-to-Surface Warfare activities and an increased reliance on non-explosive and explosive munitions usage of rockets, missiles, and bombs.

The number of Sinking Exercises proposed by the Navy has been reduced to reflect expected availability of Sinking Exercise targets.

Increases in training for Maritime Security Operations (e.g., Drug Interdiction, Anti-Piracy) are proposed to ensure Sailors are prepared to meet this important mission area.

The sonar bin list has been updated/refined to reflect new active sonar sources, such as high-frequency imaging sonars and broadband sound sources proposed for testing and experimentation. Similarly, specific existing bins were refined to better reflect testing realism in the analysis.

The majority of platforms, weapons and systems that were proposed for testing during the 2013-2018 timeframe are the same or very similar to those proposed for testing in the future. However, the Navy projects testing of some platforms, weapons and systems will increase, while others will decrease, as compared to the testing requirements that were proposed for the 2013-2018 timeframe. In comparison, the Navy is projecting a net increase in testing systems that use sonar and a net decrease for explosives use, as proposed under Alternative 1, of this EIS/OEIS.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2

Resource Category	***Summary of Impacts***
Section 3.1-Air Quality	The Navy considered potential stressors that air quality could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **<u>No Action Alternative:</u>** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. The No Action Alternative would not measurably improve air quality in the Study Area because of the discontinuous nature of the events that constitute the Proposed Action and the fact that most of the air emissions that are generated occur at sea over a wide geographic area. The elimination of the air emissions associated with activities in the lower Chesapeake Bay and its tributaries may be beneficial to local air quality in this region because it is the area of highest activity in state waters. It should be noted that the air quality in this area already surpasses the National Ambient Air Quality Standards. **<u>Alternative 1 (Preferred Alternative):</u>** • <u>Criteria Pollutants</u>: The emission of criteria pollutants resulting from training and testing activities in the Study Area would not cause a violation or contribute to an ongoing violation of the National Ambient Air Quality Standards. **<u>Alternative 2:</u>** • <u>Criteria Pollutants</u>: The emission of criteria pollutants resulting from training and testing activities associated with Alternative 2 would increase slightly over emissions from Alternative 1; however, they would not cause a violation or contribute to an ongoing violation of the National Ambient Air Quality Standards.
Section 3.2-Sediments and Water Quality	The Navy considered all potential stressors that sediments and water quality could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **<u>No Action Alternative:</u>** • Under the No Action Alternative there would be no adverse impacts on sediments and water quality from training and testing activities. It is reasonable to assume that ceasing all training and testing activities involving the use of explosives and explosives byproducts, metals, chemicals other than explosives, and other military expended materials would decrease the amounts of these materials in marine waters and sediments. The effect, however, would likely not be measureable due to the slow, sometimes decades-long corrosion of metals on the seafloor.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.2-Sediments and Water Quality (continued)	**Alternative 1 (Preferred Alternative):** • Explosives and explosives byproducts: Impacts from explosives and explosives byproducts would be short-term and local. Impacts from unconsumed explosives and constituent chemical compounds would be minimal and limited to the area adjacent to the munition. Explosives and constituent compounds could persist in the environment depending on the integrity of the undetonated munitions casing and the physical conditions on the seafloor where the munition resides. Chemical and physical changes to sediments and water quality, as measured by the concentrations of contaminants or other anthropogenic compounds, may be detectable and would be below applicable regulatory standards for determining effects on biological resources and habitats. • Chemicals other than explosives: Impacts from other chemicals not associated with explosives would be both short-term and long-term depending on the chemical and the physical conditions on the seafloor where the source of the chemicals resides. Impacts would be minimal and localized to the immediate area surrounding the source of the chemical release. • Metals: Impacts from metals would be minimal and long-term and dependent on the metal and the physical conditions on the seafloor where the metal object (e.g., non-explosive munition) resides. Impacts would be localized to the area adjacent to the metal object. Concentrations of metal contaminants near the expended material or munition may be measureable and are likely to be similar to the concentrations of metals in sediments from nearby reference locations. • Other materials: Impacts from other expended materials not associated with munitions would be both short-term and long-term depending on the material and the physical conditions on the seafloor where the material resides. Impacts would be localized to the immediate area surrounding the material. Chemical and physical changes to sediments and water quality, as measured by the concentrations of contaminants or other anthropogenic compounds near the expended material, are not likely to be detectable and would be similar to the concentrations of chemicals and material residue from nearby reference locations. **Alternative 2:** • Explosives and explosives byproducts: Impacts from explosives under Alternative 2 for training and testing activities would be identical (less than 1 percent difference in any location or overall) to those of Alternative 1. • Chemicals other than explosives: Impacts from other chemicals not associated with explosives under Alternative 2 would increase slightly compared to those of Alternative 1 because of a small increase in expended materials, but the difference in impacts would be undetectable. • Metals: Impacts from other chemicals not associated with explosives under Alternative 2 would increase slightly compared to those of Alternative 1 because of a small increase in expended materials, but the difference in impacts would be undetectable. • Other military expended materials: Impacts from other chemicals not associated with explosives under Alternative 2 would increase slightly compared to those of Alternative 1 because of a small increase in expended materials, but the difference in impacts would be undetectable.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	*Summary of Impacts*
Section 3.3-Vegetation	The Navy considered all potential stressors that vegetation could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **<u>No Action Alternative:</u>** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various stressors would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. **<u>Alternative 1 (Preferred Alternative):</u>** • <u>Explosives:</u> Explosives could affect vegetation by destroying individual plants or damaging parts of plants; however, there would be no persistent or large-scale effects on the growth, survival, distribution or structure of vegetation due to relatively fast growth, resilience, and abundance of the most affected species (e.g., phytoplankton, seaweed). • <u>Physical Disturbance and Strikes:</u> Physical disturbance and strike could affect vegetation by destroying individual plants or damaging parts of plants; however, there would be no persistent or large-scale effects on the growth, survival, distribution or structure of vegetation due to relatively fast growth, resilience, and abundance of the most affected species (e.g., phytoplankton, seaweed). • <u>Entanglement:</u> Entanglement stressors are not applicable to vegetation due to the sedentary nature of vegetation and is not analyzed further in this section. • <u>Secondary:</u> Project effects on secondary stressors such as sediment, water, or air quality would be minor, temporary, and localized and could have short-term, small-scale secondary effects on vegetation; however, there would be no persistent or large-scale effects on the growth, survival, distribution, or structure of vegetation due to relatively fast growth, resilience, and abundance of the most affected species (e.g., phytoplankton, seaweed). **<u>Alternative 2:</u>** • <u>Explosives:</u> Impacts from explosives under Alternative 2 for training and testing activities would be virtually identical (less than 1 percent difference in any location or overall) to those of Alternative 1. • <u>Physical Disturbance and Strikes:</u> Compared to Alternative 1, under Alternative 2, training and testing activities would be similarly distributed across ranges and facilities, but the number of activities would increase by roughly 1 percent. The net impact on vegetation is still expected to be nearly identical to that of Alternative 1. • <u>Secondary:</u> The difference in project effects on secondary stressors between Alternative 1 and 2 is inconsequential.
Section 3.4-Invertebrates	The Navy considered all potential stressors that invertebrates could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **<u>No Action Alternative:</u>** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various stressors (e.g., military expended materials other than munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	*Summary of Impacts*
Section 3.4- Invertebrates (continued)	**Alternative 1 (Preferred Alternative):** • Acoustics: Invertebrates could be exposed to noise from the proposed training and testing activities. However, 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. Therefore, the expected impact of noise on invertebrates is correspondingly diminished and mostly limited to offshore surface layers of the water column where only zooplankton, squid, and jellyfish are prevalent mostly at night when training and testing occur less frequently. Offshore waters are considered to occur beyond areas near land where nutrients and habitat structures are typically more prevalent and often result in increased invertebrate abundance. Exceptions occur at nearshore and inland locations where occasional pierside sonar, air gun, or pile driving actions occur near relatively resilient soft bottom or artificial substrate communities. Because the number of individuals affected under these exceptions would be small relative to population numbers, population-level impacts are unlikely. • Explosives: Explosives produce pressure waves that can harm invertebrates in the vicinity of where they typically occur: mostly offshore surface waters where zooplankton, squid, and jellyfish are prevalent mostly at night when training and testing do not typically occur. Offshore waters occur beyond areas near land where nutrients and habitat structures are typically more prevalent and often result in increased invertebrate abundance. Exceptions occur where explosives are used on the bottom within nearshore or inland waters on or near sensitive hard bottom communities. Soft bottom communities are resilient to occasional disturbances. Due to the relatively small number of individuals affected, population-level impacts are unlikely. • Energy: The proposed action produces electromagnetic and high-energy laser energies that briefly affect 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 been documented at much higher field strength than what the proposed action generates. Though high-energy lasers can damage invertebrates, the effects are limited to surface waters where relatively few invertebrates species occur (e.g., zooplankton, squid, jellyfish) mostly at night when actions do not typically occur and only where the target is missed. Due to the relatively small number of individuals that may be affected, population-level impacts are unlikely. • Physical Disturbance and Strikes: Invertebrates could experience physical disturbance and strike impacts from vessels and in-water devices, military expended materials, seafloor devices, and pile driving. Most risk occurs offshore (away from areas near land where increased nutrient availability and habitat complexity may result in increased invertebrate abundance) and near the surface where relatively few invertebrates occur, and at night when actions are not typically occurring. The majority of expended materials are used in areas far from nearshore and inland bottom areas where invertebrates are the most abundant. Exceptions occur for actions taking place within inland and nearshore waters over primarily soft bottom communities, such as related to vessel transits, inshore and nearshore vessel training, nearshore explosive ordnance disposal, 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.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.4-Invertebrates (continued)	• <u>Entanglement:</u> Invertebrates could be entangled by various expended materials (e.g., wires, cables, decelerators/parachutes, biodegradable polymer). Most entanglement risk occurs in offshore areas where invertebrates are relatively less abundant. Offshore waters occur beyond areas near land where nutrients and habitat structures are typically more prevalent and often result in increased invertebrate abundance. The risk of entangling invertebrates is minimized by the typically rigid nature of the expended structures (e.g., wires, cables), although decelerators/parachutes have mesh that could pose a risk to invertebrates large and slow enough to be entangled (e.g., jellyfish). Deep water coral could also be entangled by drifting decelerators/parachutes, but a coincidence is highly unlikely given the extremely sparse coverage of corals in the deep ocean. Accordingly, population-level impacts are unlikely. • <u>Ingestion:</u> 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 in nearshore or inland locations where filter- or deposit-feeding invertebrates are more abundant relative to offshore waters. Furthermore, the vast majority of ingestible materials in the ocean originate from non-military sources. Accordingly, population-level impacts are unlikely. • <u>Secondary:</u> Secondary impacts on invertebrates are possible via changes to habitats (sediment or water) and to prey availability due to explosives, explosives byproducts, unexploded munitions, metals, and toxic expended material components. Other than bottom-placed explosives, the impacts are mostly in offshore waters where invertebrates are less abundant. The impacts of occasional bottom-placed explosives is mostly limited to nearshore soft bottom habitats that recover quickly from disturbance. Explosive byproducts are rapidly diluted by vast quantities of relatively clean seawater and further explosive byproducts are mostly common seawater constituents. Contamination from unexploded munitions is likely inconsequential because the material has low solubility in seawater and is slowly delivered to the water column. Heavy metals and chemicals such as unspent propellants can reach harmful levels around stationary range targets but are not likely in vast open waters where proposed action targets are typically mobile or temporarily stationary. Accordingly, overall impacts of secondary stressors on widespread invertebrate populations are not likely. Impacts due to decreased availability of prey items (fish and other invertebrates) would likely be undetectable. **<u>Alternative 2:</u>** • <u>Acoustics</u>: Potential impacts to invertebrates would be similar to those discussed for training and testing activities under Alternative 1. The only difference in sonar and other transducer use between Alternatives 1 and 2 is that the number of sonar hours used would be greater under Alternative 2. Air guns and pile driving impacts would be the same under Alternative 2. Potential impacts resulting from vessel noise would be similar to those discussed for activities under Alternative 1. Vessel use in the Study Area would increase by a very small amount (about one percent). The only difference in weapons noise impacts between Alternatives 1 and 2 is that the number of munitions used would be greater under Alternative 2. While the types of expected impacts to any individual invertebrate or group of invertebrates capable of detecting sounds produced during training and testing activities would remain the same, more animals could be affected.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.4-Invertebrates (continued)	• Explosives: The locations, number of events, and potential effects associated with explosives would be the same under Alternatives 1 and 2. • Energy: The locations, number of events, and potential effects associated with energy stressors would be the same under Alternatives 1 and 2. • Physical Disturbance and Strikes: Under Alternative 2, potential physical disturbance and strike impacts to invertebrates associated with training and testing activities would be similar to those discussed for activities under Alternative 1. The total area affected for all training and testing activities combined would increase by less than 1 acre under Alternative 2. There would be a very small increase in vessel and in-water device use in the Study Area. However, the difference would not result in substantive changes to the potential for or types of impacts on invertebrates. • Entanglement: There would be a small increase in the number of military expended materials associated with Alternative 2 activities. However, the increase is negligible and the potential impacts from wires and cables, decelerators/parachutes, and biodegradable polymer under Alternative 2 would be similar to that of Alternative 1. • Ingestion: Under Alternative 2, the locations and types of military expended materials used would be the same as those of Alternative 1. There would be an increase in the number of some items expended, such as targets, sonobuoys, bathythermograph equipment, and small decelerators/parachutes. This relatively small increase in the total number of items expended would not be expected to result in substantive changes to the type or degree of impacts to invertebrates. • Secondary: Secondary impacts on invertebrates resulting from Alternative 2 activities would be nearly identical to those for Alternative 1.
Section 3.5-Habitats	The Navy considered all potential stressors that habitats could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **No Action Alternative:** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various ingestion stressors (e.g., military expended materials other than munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. **Alternative 1 (Preferred Alternative):** • Explosives: Most of the high-explosive military expended materials would detonate at or near the water surface. The surface area of bottom substrate affected would be a tiny fraction of the total training and testing area available in the Study Area. • Physical Disturbance and Strikes: Most seafloor devices would be placed in areas that would result in minor and temporary bottom substrate impacts. Once on the seafloor and over time, military expended material would be buried by sediment, corroded from exposure to the marine environment, or colonized by benthic organisms. The surface area of bottom substrate affected over the short-term would be a tiny fraction of the total training and testing area available in the Study Area.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.5- Habitats (continued)	**Alternative 2:** • Explosives: Explosive activities would be nearly identical under Alternative 2 as those analyzed under Alternative 1, as only the frequency and duration of sonar activities would differ. In-water explosions under Alternative 2 training and testing activities would be limited to local and short-term impacts on marine habitat structure in the AFTT Study Area. • Physical Disturbance and Strikes: Most seafloor devices would be placed in areas that would result in minor and temporary bottom substrate impacts. Once on the seafloor and over time, military expended material would be buried by sediment, corroded from exposure to the marine environment, or colonized by benthic organisms. The surface area of bottom substrate affected over the short-term would be a tiny fraction of the total training and testing area available in the Study Area.
Section 3.6- Fishes	The Navy considered all potential stressors that fishes could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **No Action Alternative:** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. The combined impacts of all stressors for fishes would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities and no impacts on fish population would occur. **Alterantive1 (Preferred Alternative):** • Acoustics: The use of sonar and other transducers, air guns, pile driving, vessel noise, aircraft noise, and weapons noise could result in impacts on fishes in the Study Area. Some sonars and other transducers, vessel noise, and weapons noise could result in hearing loss, masking, physiological stress, or behavioral reactions. Aircraft noise would not likely result in impacts other than brief, mild behavioral responses in fishes that are close to the surface. Air guns and pile driving have the potential to result in the same effects in addition to mortality or injury. Most impacts, such as masking or behavioral reactions, are expected to be temporary and infrequent as most activities involving acoustic stressors would be at low levels of noise, temporary, localized, and infrequent. More severe impacts such as mortality or injury could lead to permanent or long-term consequences for individuals but, overall, long-term consequences for fish populations are not expected. • Explosives: The use of explosives could result in impacts on fishes within the Study Area. Sound and energy from explosions is capable of causing mortality, injury, hearing loss, masking, physiological stress, or behavioral responses. The time scale of individual explosions is very limited, and training and testing activities involving explosions are dispersed in space and time. Therefore, repeated exposure of individual fishes are unlikely. Most effects such as hearing loss or behavioral responses are expected to be short-term and localized. More severe impacts such as mortality or injury could lead to permanent or long-term consequences for individuals but, overall, long-term consequences for fish populations are not expected. • Energy: The use of electromagnetic devices may elicit brief behavioral or physiological stress responses only in those exposed fishes with sensitivities to the electromagnetic spectrum. This behavioral impact is expected to be temporary and minor. Similar to regular vessel traffic that is continuously moving and covers only a small spatial area during use, electromagnetic fields would be continuously moving and cover only a small spatial area during use, so population-level impacts are unlikely.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.6-Fishes (continued)	• Physical Disturbance and Strikes: Vessel strikes, in-water device strikes, military expended material strikes, and seafloor device strikes present a risk for collision with fishes, particularly near coastal areas, seamounts, and other bathymetric features where densities are higher. While the potential for physical disturbance and strikes of fishes can occur anywhere vessels are operated or training and testing activities occur, most fishes are highly mobile and have sensory capabilities which enable the detection and avoidance of vessels, expended materials, or objects in the water column or on the seafloor. • Entanglement: Fishes could be exposed to multiple entanglement stressors associated with Navy training and testing activities. The potential for impacts is dependent on the physical properties of the expended materials and the likelihood that a fish would encounter a potential entanglement stressor and then become entangled in it. Physical characteristics of wires and cables, decelerators/parachutes, and biodegradable polymers, combined with the sparse distribution of these items throughout the Study Area, indicates a very low potential for fishes to encounter and become entangled in them. Because of the low numbers of fish potentially impacted by entanglement stressors, population-level impacts are unlikely. • Ingestion: The likelihood that expended items would cause a potential impact on a given fish species depends on the size and feeding habits of the fish and the rate at which the fish encounters the item and the composition of the item. Military expended materials from munitions present an ingestion risk to fishes that forage in the water column and on the seafloor. Military expended materials other than munitions present an ingestion risk for fishes foraging at or near the surface while these materials are buoyant, and on the seafloor when the materials sink. Because of the low numbers of fish potentially impacted by ingestion stressors, population-level impacts are unlikely. • Secondary: Effects on sediment or water quality would be minor, temporary, and localized and could have short-term, small-scale secondary effects on fishes; however, there would be no persistent or large-scale effects on the growth, survival, distribution, or population-level of fishes. **Alternative 2:** • Acoustics: Potential impacts to fishes would be similar to those discussed for training activities under Alternative 1. The only difference in sonar and other transducer use between Alternatives 1 and 2 is that the number of sonar hours used would be greater under Alternative 2. Air guns and pile driving impacts would be the same under Alternative 2. Potential impacts resulting from vessel noise would be similar to those discussed for activities under Alternative 1. Vessel use in the Study Area would increase by a very small amount (about one percent). The only difference in weapons noise impacts between Alternatives 1 and 2 is that the number of munitions used would be greater under Alternative 2. While the types of expected impacts to any individual fish or group of fish capable of detecting sounds produced during testing activities would remain the same, more animals could be affected. • Explosives: The locations, number of events, and potential effects associated with explosives would be the same under Alternatives 1 and 2. • Energy: The locations, number of events, and potential effects associated with energy stressors would be the same under Alternatives 1 and 2.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.6-Fishes (continued)	• Physical Disturbance and Strikes: Under Alternative 2, potential physical disturbance and strike impacts to fishes associated with training and testing activities would be similar to those discussed for activities under Alternative 1. There would be a very small increase in vessel and in-water device use in the Study Area. However, the difference would not result in substantive changes to the potential for or types of impacts on fishes. • Entanglement: There would be a small increase in the number of military expended materials associated with Alternative 2 activities. However, the increase is negligible and the potential impacts from wires and cables, decelerators/parachutes, and biodegradable polymer under Alternative 2 would be similar to that of Alternative 1.
Section 3.7-Marine Mammals	The Navy considered all stressors that marine mammals could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the following stressors under the project alternatives: **No Action Alternative:** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various secondary stressors would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. **Alternative 1 (Preferred Alternative):** • Acoustics: Navy training and testing activities have the potential to expose marine mammals to multiple acoustic stressors. Exposure to sound-producing activities presents risks to marine mammals that could include temporary or permanent hearing threshold shift, auditory masking, physiological stress, or behavioral responses. Because individual animals would typically only experience a small number of behavioral responses or temporary hearing threshold shifts per year from exposure to acoustic stressors and are unlikely to incur substantive costs to the individual, population level effects are unlikely. • Explosives: Explosions underwater or near the surface present a risk to marine mammals located in close proximity to the explosion, because the resulting shock waves can cause injury or result in the death of an animal. Beyond the zone of injury, the impulsive, broadband noise introduced into the marine environment may cause temporary or permanent hearing threshold shift, auditory masking, physiological stress, or behavioral responses. Because most estimated impacts from explosions are behavioral responses or temporary threshold shifts and because the number of marine mammals potentially impacted by explosives are small compared to each species' respective abundance, population level effects are unlikely. • Energy: Navy training and testing activities have the potential to expose marine mammals to multiple energy stressors. The likelihood and magnitude of energy impacts depend on the proximity of marine mammals to energy stressors. Based on the relatively weak strength of the electromagnetic field created by Navy activities, a marine mammal would have to be in close proximity for there to be any effect, and impacts on marine mammal migrating behaviors and navigational patterns are not anticipated. Potential impacts from high-energy lasers would only result for marine mammals directly struck by the laser beam. Statistical probability analyses demonstrate with a high level of certainty that no marine mammals would be struck by a high-energy laser. Energy stressors associated with Navy training and testing activities are temporary and localized in nature and, based on patchy distribution of animals, no impacts to individual marine mammals and marine mammal populations are anticipated.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.7- Marine Mammals (continued)	• <u>Physical Disturbance and Strikes:</u> Marine mammals would potentially be exposed to multiple physical disturbance and strike stressors associated with Navy training and testing activities. The potential for impacts relies heavily on the probability that marine mammals would be in close proximity to a physical disturbance and strike stressor (e.g., a vessel or a non-explosive munition). Historical data on Navy ship strike records demonstrate a low occurrence of interactions with marine mammals over the last 10 years. Since the Navy does not anticipate a change in the level of vessel use compared to the last decade, the potential for striking a marine mammal remains low. Physical disturbance due to vessel movement and in-water devices, but any stress response of avoidance behavior would not be severe enough to have long-term fitness consequences for individual marine mammals. The use of in-water devices during Navy activities involves multiple types of vehicles or towed devices traveling on the water surface, through the water column, or along the seafloor, all of which having the potential to disturb or physically strike marine mammals. No recorded or reported instances of marine mammal strikes have resulted from in-water devices; therefore, impacts to individuals or long-term consequences to marine mammal populations are not anticipated. Potential physical disturbance and strike impacts from military expended materials and seafloor devices are determined through statistical probability analyses. Results for each of these physical disturbance and strike stressors suggests a very low potential for marine mammals to be struck by any of these items. Long-term consequences to marine mammal populations from physical disturbance and strike stressors associated with Navy training and testing activities are not anticipated. • <u>Entanglement:</u> Marine mammals could be exposed to multiple entanglement stressors associated with Navy training and testing activities. The potential for impacts is dependent on the physical properties of the expended materials and the likelihood that a marine mammal would encounter a potential entanglement stressor and then become entangled in it. Physical characteristics of wires and cables, decelerators/parachutes, and biodegradable polymers combined with the sparse distribution of these items throughout the Study Area indicate a very low potential for marine mammals to encounter and become entangled in them. Long-term impacts to individual marine mammals and marine mammal populations from entanglement stressors associated with Navy training and testing activities are not anticipated. • <u>Ingestion:</u> Navy training and testing activities have the potential to expose marine mammals to multiple ingestion stressors and associated impacts. The likelihood and magnitude of impacts depend on the physical properties of the military expended items, the feeding behaviors of marine mammals that occur in the Study Area, and the likelihood that a marine mammal would encounter and incidentally ingest the items. Adverse impacts from ingestion of military expended materials would be limited to the unlikely event that a marine mammal would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The likelihood that a marine mammal would encounter and subsequently ingest a military expended item associated with Navy training and testing activities is considered low. Long-term consequences to marine mammal populations from ingestion stressors associated with Navy training and testing activities are not anticipated.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.7- Marine Mammals (continued)	• <u>Secondary</u>: Marine mammals could be exposed to multiple secondary stressors (indirect stressors to habitat or prey) associated with Navy training and testing activities in the Study Area. In-water explosions have the potential to injure or kill prey species that marine mammals feed on within a small area affected by the blast; however, impacts would not substantially impact prey availability for marine mammals. Explosion byproducts and unexploded munitions would have no meaningful effect on wateror sediment quality; therefore, they are not considered to be secondary stressors for marine mammals. • Metals are introduced into the water and sediments from multiple types of military expended materials. Available research indicates metal contamination is very localized and that bioaccumulation resulting from munitions would not occur. Several Navy training and testing activities introduce chemicals into the marine environment that are potentially harmful in concentration; however, through rapid dilution, toxic concentrations are unlikely to be encountered by marine mammals. Furthermore, bioconcentration or bioaccumulation of chemicals introduced by Navy activities at levels that would significantly alter water quality and degrade marine mammal habitat has not been documented. The Navy's use of marine mammals is not likely to increase the risk of transmitting diseases or parasites to wild marine mammals. Secondary stressors from Navy training and testing activities in the Study Area are not expected to have short-term impacts on individual marine mammals or long-term impacts on marine mammal populations. **<u>Alternative 2:</u>** • <u>Acoustics:</u> Potential impacts to marine mammals would be similar to those discussed for training activities under Alternative 1. The only difference in sonar and other transducer use between Alternatives 1 and 2 is that the number of sonar hours used would be greater under Alternative 2. Air guns and pile driving impacts would be the same under Alternative 2. Potential impacts resulting from vessel noise would be similar to those discussed for activities under Alternative 1. Vessel use in the Study Area would increase by a very small amount (about one percent). The only difference in weapons noise impacts between Alternatives 1 and 2 is that the number of munitions used would be greater under Alternative 2. While the types of expected impacts to on any individual marine mammal would remain the same, more animals could be affected. • <u>Explosives:</u> The locations, number of events, and potential effects associated with explosives would be the same under Alternatives 1 and 2. • <u>Energy:</u> The locations, number of events, and potential effects associated with energy stressors would be the same under Alternatives 1 and 2. • <u>Physical Disturbance and Strikes:</u> Under Alternative 2, potential physical disturbance and strike impacts to marine mammals associated with training and testing activities would be similar to those discussed for activities under Alternative 1. There would be a very small increase in vessel and in-water device use in the Study Area. However, the difference would not result in substantive changes to the potential for or types of impacts on marine mammals. • <u>Entanglement:</u> There would be a small increase in the number of military expended materials associated with Alternative 2 activities. However, the increase is negligible and the potential impacts from wires and cables, decelerators/parachutes, and biodegradable polymer under Alternative 2 would be similar to that of Alternative 1.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.7-Marine Mammals (continued)	• Ingestion: Under Alternative 2, the locations and types of military expended materials used would be the same as those of Alternative 1. There would be an increase in the number of some items expended, such as targets, sonobuoys, bathythermograph equipment, and small decelerators/parachutes. This relatively small increase in the total number of items expended would not be expected to result in substantive changes to the type or degree of impacts to marine mammals. • Secondary: Secondary impacts on marine mammals resulting from Alternative 2 activities would be nearly identical to those from Alternative 1.
Section 3.8-Reptiles	The Navy considered all potential stressors that reptiles could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **No Action Alternative:** • Under the No Action Alternative, training and testing activities associated with the Proposed Action will not be conducted within the AFTT Study Area. Under this alternative, there would be no potential for impacts on sea turtles. The cessation of some stressors would be more beneficial than others. For instance, because of the localized and short-term duration of any potential impact from an electromagnetic field on a sea turtle, the potential benefits to sea turtles is not likely measureable. The removal of fast vessel movement training activities, however, would likely decrease behavioral impacts and responses to vessels, but again, the impact is likely short-term, with normal behaviors resuming within minutes of a passing vessel. Vessel strike risk would be reduced, which would likely increase survivability and individual fitness for a small number of sea turtles or crocodilians. Further, the synergistic effects of multiple stressors would not occur, thereby providing benefits to sea turtles and crocodilians by removing short-term and long-term potential impacts. The implementation of the No Action Alternative would remove risks of impacts associated with training and testing activities; however, monitoring data accumulated through range sustainment programs would cease. These data provide foundational data for the research and regulatory communities to assess ongoing threats and conservation status of various species. **Alternative 1 (Preferred Alternative):** • Acoustics: Navy training and testing activities have the potential to expose reptiles to multiple acoustic stressors, including sonars, other transducers, air guns, pile driving, and vessel, aircraft, and weapons noise. Reptiles could be affected by only a limited portion of acoustic stressors because reptiles have limited hearing abilities. Exposures to sound-producing activities present risks that could range from hearing loss, auditory masking, physiological stress, and changes in behavior; however, no injurious impacts are predicted due to exposure to any acoustic stressor. Because the number of sea turtles potentially impacted by sound-producing activities is small, population level effects are unlikely. Crocodilians considered in this analysis rarely occur in the Study Area, and few, if any, impacts are anticipated from acoustic stressors. • Explosives: Explosions in the water or near the water's surface present a risk to reptiles located in close proximity to the explosion, because the shock waves produced by explosives could cause injury or result in death; however, only one loggerhead sea turtle mortality is predicted. If a sea turtle is farther from an explosion, the intense, impulsive, broadband sounds introduced into the marine environment may cause hearing loss, auditory masking, physiological stress, or changes in behavior. Because the number of sea turtles potentially impacted by explosives is small, population level effects are unlikely.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.8- Reptiles (continued)	Crocodilians considered in this analysis would not co-occur with activities that use explosives, and no impacts on crocodilians are anticipated from explosives. • Energy: Navy training and testing activities have the potential to expose sea turtles to multiple energy stressors. The likelihood and magnitude of energy impacts depends on the proximity of sea turtles to energy stressors. Based on the relatively weak strength of the electromagnetic field created by Navy activities, impacts on sea turtles migrating behaviors and navigational patterns are not anticipated. Potential impacts from high-energy lasers would only result for sea turtles directly struck by the laser beam. Statistical probability analyses demonstrate with a high level of certainty that no sea turtles would be struck by a high-energy laser. Activities that generate electromagnetic fields or use high-energy lasers are not anticipated to impact crocodilians because these activities would not co-occur with crocodilian habitats. Energy stressors associated with Navy training and testing activities are temporary and localized in nature, and based on patchy distribution of animals, no impacts on individual reptile or reptile populations are anticipated. • Physical Disturbance and Strikes: Vessels, in-water devices, and seafloor devices present a risk for collision with sea turtles, particularly in coastal areas where densities are higher. Strike potential by expended materials is statistically small. Because of the low numbers of sea turtles potentially impacted by activities that may potentially cause a physical disturbance and strike, population level effects are unlikely. Crocodilians are expected to co-occur with vessels and in-water devices that move at low velocities, limiting potential behavioral impacts. No impacts on individual crocodilians or crocodilian populations are anticipated. • Entanglement: Sea turtles could be exposed to multiple entanglement stressors associated with Navy training and testing activities. The potential for impacts is dependent on the physical properties of the expended materials and the likelihood that a sea turtle would encounter a potential entanglement stressor and then become entangled in it. Physical characteristics of wires and cables, decelerators/parachutes, and biodegradable polymers combined with the sparse distribution of these items throughout the Study Area indicates a very low potential for sea turtles to encounter and become entangled in them. Long-term impacts on individual sea turtles and sea turtle populations from entanglement stressors associated with Navy training and testing activities are not anticipated. Entanglement stressors are not anticipated to impact crocodilians because activities that expend materials that present a potential entanglement risk would not co-occur with crocodilian habitats. • Ingestion: Navy training and testing activities have the potential to expose sea turtles to multiple ingestion stressors and associated impacts. The likelihood and magnitude of impacts depends on the physical properties of the military expended items, the feeding behaviors of sea turtles that occur in the Study Area, and the likelihood that a sea turtle would encounter and incidentally ingest the items. Adverse impacts from ingestion of military expended materials would be limited to the unlikely event that a sea turtle would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The likelihood that a sea turtle would encounter and subsequently ingest a military expended item associated with Navy training and testing activities is considered low. Long-term consequences to sea turtle populations from ingestion stressors associated with Navy training and testing activities are not anticipated. Ingestion stressors are not anticipated to impact crocodilians because activities that expend materials that present a potential ingestion risk would not co-occur with crocodilian habitats.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.8-Reptiles (continued)	• <u>Secondary:</u> Sea turtles could be exposed to multiple secondary stressors (indirect stressors to habitat or prey) associated with Navy training and testing activities in the Study Area. In-water explosions have the potential to injure or kill prey species that sea turtles feed on within a small area affected by the blast; however, impacts would not substantially impact prey availability for sea turtles. Explosion byproducts and unexploded munitions would have no meaningful effect on water or sediment quality; therefore they are not considered to be secondary stressors for sea turtles. Metals are introduced into the water and sediments from multiple types of military expended materials. Available research indicates metal contamination is very localized and that bioaccumulation resulting from munitions would not occur. Several Navy training and testing activities introduce chemicals into the marine environment that are potentially harmful in concentration; however, through rapid dilution, toxic concentrations are unlikely to be encountered by sea turtles. Furthermore, bioconcentration or bioaccumulation of chemicals introduced by Navy activities to levels that would significantly alter water quality and degrade sea turtle habitat has not been documented. Secondary stressors from Navy training and testing activities in the Study Area are not expected to have short-term impacts on individual sea turtles or long-term impacts on sea turtle populations. Secondary stressors discussed above would not co-occur with crocodilian habitats, and any indirect stressors to habitat or prey from training and testing activities are anticipated to be negligible. **<u>Alternative 2:</u>** • <u>Acoustics</u>: Potential impacts to reptiles would be similar to those discussed for training activities under Alternative 1. The only difference in sonar and other transducer use between Alternatives 1 and 2 is that the number of sonar hours used would be greater under Alternative 2. Air guns and pile driving impacts would be the same under Alternative 2. Potential impacts resulting from vessel noise would be similar to those discussed for activities under Alternative 1. Vessel use in the Study Area would increase by a very small amount (about one percent). The only difference in weapons noise impacts between Alternatives 1 and 2 is that the number of munitions used would be greater under Alternative 2. While the types of expected impacts to any individual reptile would remain the same, more animals could be affected. • <u>Explosives:</u> The locations, number of events, and potential effects associated with explosives would be the same under Alternatives 1 and 2. • <u>Energy:</u> The locations, number of events, and potential effects associated with energy stressors would be the same under Alternatives 1 and 2. • <u>Physical Disturbance and Strike:</u> Under Alternative 2, potential physical disturbance and strike impacts to reptiles would be similar to those discussed for activities under Alternative 1. There would be a very small increase in vessel and in-water device use in the Study Area. However, the difference would not result in substantive changes to the potential for or types of impacts on reptiles. • <u>Entanglement:</u> There would be a small increase in the number of military expended materials associated with Alternative 2 activities. However, the increase is negligible and the potential impacts from wires and cables, decelerators/parachutes, and biodegradable polymers under Alternative 2 would be similar to that of Alternative 1.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.8-Reptiles (continued)	• Ingestion: Under Alternative 2, the locations and types of military expended materials used would be the same as those of Alternative 1. There would be an increase in the number of some items expended, such as targets, sonobuoys, bathythermograph equipment, and small decelerators/parachutes. This relatively small increase in the total number of items expended would not be expected to result in substantive changes to the type or degree of impacts to reptiles. • Secondary: Secondary impacts on reptiles resulting from Alternative 2 training and testing activities would be nearly identical to those from Alternative 1.
Section 3.9-Birds and Bats	The Navy considered all potential stressors that birds and bats could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **No Action Alternative:** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various stressors would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. **Alternative 1 (Preferred Alternative):** • Acoustics: Navy training and testing activities have the potential to expose birds and bats to a variety of acoustic stressors. The exposure to underwater sounds by birds depends on the species and foraging method. Pursuit divers may remain underwater for minutes, increasing the chance of underwater sound exposure. The exposure to in-air sounds by birds and bats depends on the activity (in flight or on the water surface) and the proximity to the sound source. Because birds are less susceptible to both temporary and permanent threshold shift than mammals, unless very close to an intense sound source, responses by birds to acoustic stressors would likely be limited to short-term behavioral responses. Some birds may be temporarily displaced and there may be temporary increases in stress levels. Although individual birds may be impacted, population level impacts are not expected. Bats may be exposed to in-air sounds from Navy training and testing activities. Unlike other mammals, bats are not susceptible to temporary and permanent threshold shifts. Bats may be temporarily displaced during foraging, but would return shortly after the training or testing is complete. Although individual bats may be impacted, population level impacts are not expected. • Explosives: Navy training and testing activities have the potential to expose birds and bats to explosions in the water, near the water surface, and in air. Sounds generated by most small underwater explosions are unlikely to disturb birds and bats above the water surface. If a detonation is sufficiently large or is near the water surface, however, birds and bats above the pressure released at the air-water interface could be injured or killed. Detonations in air could injure birds and bats while either in flight or at the water surface; however, detonations in air during anti-air warfare training and testing would typically occur at much higher altitudes where seabirds, migrating birds, and bats are less likely to be present. Detonations may attract birds to possible fish kills, which could cause bird mortalities or injuries if there are multiple detonations in a single event. An explosive detonation would likely cause a startle reaction, as the exposure would be brief and any reactions are expected to be short-term. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.9-Birds and Bats (continued)	• <u>Energy:</u> The impact of energy stressors on birds and bats is expected to be negligible based on (1) the limited geographic area in which they are used, (2) the rare chance that an individual bird or bat would be exposed to these devices in use, and (3) the tendency of birds and bats to temporarily avoid areas of activity when and where the devices are in use. The impacts of energy stressors would be limited to individual cases where a bird or bat might become temporarily disoriented and change flight direction, or be injured. Although a small number of individuals may be impacted, the impact at the population level would be negligible. • <u>Physical Disturbance and Strikes:</u> There is the potential for individual birds to be injured or killed by physical disturbance and strikes during training and testing. However, there would not be long-term species or population level impacts due to the vast area over which training and testing activities occur and the small size of birds and their ability to flee disturbance. Impacts to bats would be similar to, but less than, those described for birds since bat occurrence in the Study Area is relatively scant compared to birds and because bats are most active from dusk through dawn. • <u>Entanglement:</u> Entanglement stressors have the potential to impact birds, including ESA-listed bird species. However, the likelihood is low because the relatively small quantities of materials that could cause entanglement would be dispersed over very wide areas, often in locations or depth zones outside the range or foraging abilities of most birds. A small number of individuals may be impacted, but no effects at the population level would be expected. The possibility that an individual of an ESA-listed bird species would become entangled is remote due to their rarity and limited overlap with Navy activities. Since bats considered in this analysis do not occur in the water column and rarely occur at the water surface in the Study Area, few, if any, impacts to bats are anticipated from entanglement stressors. • <u>Ingestion:</u> It is possible that persistent expended materials could be accidentally ingested by birds while they were foraging for natural prey items, though the probability of this event is low as (1) foraging depths of diving birds is generally restricted to the surface of the water or shallow depths, (2) the material is unlikely to be mistaken for prey, and (3) most of the material remains at or near the sea surface for a short length of time. No population-level effect to any bird species would be anticipated. Since bats considered in this analysis do not occur in the water column and rarely feed at the water surface in the Study Area, few, if any, impacts to bats are anticipated from ingestion stressors. • <u>Secondary:</u> There would be relatively localized, temporary impacts from water quality (turbidity) which may alter foraging conditions, but no impacts on prey availability. Since bats considered in this analysis do not occur in the water column and rarely occur at the water surface in the Study Area, few, if any, impacts to bats are anticipated from secondary stressors **<u>Alternative 2:</u>** • <u>Acoustics:</u> Alternative 2 has an increase in sonar use compared to Alternative 1; however, potential impacts from Alternative 2 activities would be similar to those as Alternative 1. While individual birds or bats may be impacted by training or testing activities, population level impacts are not expected. • <u>Explosives:</u> There would be a minor increase in explosives use under Alternative 2 compared to Alternative 1; however, the types of potential impacts and locations of impacts would be the same as those described under Alternative 1. Most impacts to individual birds and bats, if any, are expected to be minor and limited.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.9-Birds and Bats (continued)	Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected, and explosives will not have a significant adverse effect on populations of migratory bird species. • Energy: The number and distribution of training and testing activities using in-water electromagnetic devices under Alternative 2 would differ slightly from Alternative 1; however, the difference is inconsequential and the impacts would be essentially the same as for Alternative 1. Likewise, the number and distribution of training and testing activities using in-air electromagnetic devices under Alternative 2 would differ slightly from Alternative 1; however, the difference is inconsequential and the impacts would be essentially the same as for Alternative 1. The use of high energy lasers under Alternative 2 would be the same as under Alternative 1; therefore, impacts would be the same. • Physical Disturbance and Strikes: Under Alternative 2, potential impacts to birds or bats resulting from training and testing activities would be slightly greater but would still be inconsequential due to the relatively small number of individuals affected and the lack of population-level effects. • Entanglement: Under Alternative 2, increases in sonobuoy component release and the number of decelerators/parachutes that would be expended would proportionally increase the possibility of entanglement relative to Alternative 1. However, the likelihood of injury or mortality is still considered negligible, and the potential impacts from Alternative 2 activities would be the same as for Alternative 1. • Ingestion: Activities under Alternative 2 would generate the same types of ingestible materials generated under Alternative 1. While the quantities and locations of some expended materials would change slightly, the vast majority would be the same as under Alternative 1. Therefore, the implementation of Alternative 2 would have similar impacts to those of training and testing activities under Alternative 1. • Secondary: Potential impacts from secondary stressors under Alternative 2 would be the same as Alternative 1.
Section 3.10-Cultural Resources	The Navy considered all potential stressors that cultural resources could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **No Action Alternative:** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities. Baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities. **Alternative 1 (Preferred Alternative):** • Explosive: Explosive stressors resulting from underwater explosions creating shock waves and cratering of the seafloor would not result in adverse effects to known submerged cultural resources. Therefore, no submerged cultural resources are expected to be affected. • Physical Disturbance and Strikes: Physical disturbance and strike stressors resulting from in water devices, military expended materials, seafloor devices, pile driving, and vibration from sonic booms during training and testing activities would not result in adverse effects to known or unknown submerged cultural resources. Therefore, no submerged cultural resources are expected to be affected.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.10- Cultural Resources (continued)	**<u>Alternative 2:</u>** • <u>Explosive:</u> Under Alternative 2, training activities (including the use of explosives) would remain the same as those described under Alternative 1; therefore, potential impacts are expected to be the same as Alternative 1. • <u>Physical Disturbance and Strikes:</u> Under Alternative 2, the number of training activities using in-water devices is the same as under Alternative 1; therefore, potential impacts are expected to be the same as Alternative 1.
Section 3.11 – Socioeconomic Resources	The Navy considered all potential stressors that socioeconomics could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **<u>No Action Alternative:</u>** • Under the No Action Alternative, training and testing activities associated with the Proposed Action will not be conducted within the AFTT Study Area. Therefore, training and testing activities would not limit accessibility to air and sea space (although other Navy activities would still use established ranges, warning areas, and danger zones), generate airborne noise, or cause physical disturbances and strikes. No impacts on socioeconomic resources from these stressors would occur. Ceasing the proposed training and testing activities may reduce the number and types of jobs available in locations where the Navy is a vital or even the primary economic driver sustaining local communities. The secondary effects from reducing personnel who support Navy training and testing activities could include a decline in local business and a decrease in the need for infrastructure, such as schools. If jobs are relocated, a smaller population may no longer be able to sustain the local economy that developed to support the larger population. While more complex studies at the local level would need to be conducted to quantify potential socioeconomic impacts from ceasing training and testing activities, it is highly likely that many coastal communities would be impacted to varying degrees. **<u>Alternative 1 (Preferred Alternative)</u>** • <u>Accessibility:</u> Limits on accessibility to marine areas used by the public (e.g., fishing areas) in the Navy training and testing areas would be temporary and of short duration (hours). Restrictions would be lifted, and conditions would return to normal upon completion of training and testing activities. Minimal impacts on commercial and recreational fishing and tourism may occur; however, limits on accessibility would not result in a direct loss of income, revenue or employment, resource availability, or quality of experience. No impacts on sources for energy production and distribution, mineral extraction, commercial transportation and shipping, and aquaculture are anticipated. • <u>Airborne Acoustics:</u> Because the majority of Navy training and testing activities are conducted far from where tourism and recreational activities are concentrated, the impact of airborne noise would be negligible. The public may intermittently hear noise from transiting ships or aircraft overflights if they are in the general vicinity of a training or testing activity, but these occurrences would be infrequent. The infrequent exposure to airborne noise would not result in a direct loss of income, revenue or employment, resource availability, or quality of experience. No impacts on sources for energy production and distribution, mineral extraction, commercial transportation and shipping, and aquaculture are anticipated.

Table ES.5-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (continued)

Resource Category	***Summary of Impacts***
Section 3.11 – Socioeconomic Resources (continued)	• <u>Physical Disturbance and Strikes:</u> Because the majority of Navy training and testing activities are conducted farther from shore than where most recreational activities are concentrated, the potential for a physical disturbance or strike affecting recreational fishing or tourism is negligible. In locations where Navy training or testing occurs in nearshore areas (e.g., pierside), the Navy coordinates with civilian organizations to assure safe and unimpeded access and use of those areas. Based on the Navy's standard operating procedures and the large expanse of the testing and training ranges, the likelihood of a physical disturbance or strike disrupting sources for energy production and distribution, mineral extraction, commercial transportation and shipping, commercial and recreational fishing, aquaculture, and tourism would be negligible. Therefore, direct loss of income, revenue or employment, resource availability, or quality of experience would not be expected. **<u>Alternative 2:</u>** • <u>Accessibility:</u> Limits on accessibility to marine areas used by the public could increase under Alternative 2 due to an increase in some training and testing activities. However, the difference in potential impacts to access would be inconsequential. • <u>Airborne Acoustics:</u> The number of activities that could generate airborne noise detectable by the public would increase under Alternative 2. However, the difference in acoustic impacts would be inconsequential. • <u>Physical Disturbance and Strike:</u> Under Alternative 2, potential physical disturbance and strike impacts associated with training and testing activities would be similar to those discussed for activities under Alternative 1. There would be a very small increase in vessel and in-water device use in the Study Area. However, the difference would not result in substantive changes to the potential for or types of impacts.
Section 3.12 – Public Health and Safety	The Navy considered all potential stressors that public health and safety could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the project alternatives: **<u>No Action Alternative:</u>** • Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. There would be no appreciable change in potential impacts on public health and safety under the No Action Alternative, as these activities (currently or as proposed) would be unlikely to affect public health and safety. However, diminished military readiness under the No Action Alternative would adversely affect public health and safety. **<u>Alternative 1 (Preferred Alternative):</u>** • <u>Underwater Energy:</u> Impacts on public health and safety would be unlikely. • <u>In-Air Energy:</u> Impacts to public health and safety would be unlikely. • <u>Physical Interactions:</u> Impacts to public health and safety would be unlikely. • <u>Secondary Stressors:</u> (sediments and water quality): Impacts on public health and safety would be unlikely. **<u>Alternative 2:</u>** • <u>Underwater Energy:</u> Same as Alternative 1. • <u>In-Air Energy:</u> Same as Alternative 1. • <u>Physical Interactions:</u> Same as Alternative 1. • <u>Secondary Stressors:</u> Same as Alternative 1.

ES.5.2 Acoustic and Explosive Analysis

Improvements have been made to modeling explosive sources to optimize the analysis process and data handling. Statistical variability in the abundance of marine species were added to the marine species distribution process. The availability of additional systematic survey data as well as improvements to habitat modeling methods used to estimate species density resulted in substantial improvements to the species distribution. Marine species criteria and thresholds were also updated based on NMFS marine mammal criteria for permanent and temporary threshold shift for sonar and other transducers, pile driving, air guns and explosives. The Navy also used the best available science from the large number of behavioral response studies that have been conducted to-date to develop updated behavioral response functions (see U.S. Department of the Navy, 2017).

ES.6 Cumulative Impacts

Cumulative impacts were analyzed for each resource addressed in Chapter 3 (Affected Environment and Environmental Consequences) for the Action Alternatives in combination with past, present, and reasonably foreseeable future actions. Analysis was not separated by Alternative because the data available for the cumulative effects analysis was mostly qualitative in nature and, from a landscape-level perspective, these qualitative impacts are expected to be generally similar.

In accordance with Council on Environmental Quality guidance (Council on Environmental Quality 1997), the cumulative impacts analysis focused on impacts that are "truly meaningful." The level of analysis for each resource was commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences).

ES.6.1 Project and Other Activities Analyzed for Cumulative Impacts

Cumulative analysis includes consideration of past, present, and reasonably foreseeable future actions. For past actions, the cumulative impacts analysis only considers those actions or activities that have had ongoing impacts that may be additive to impacts of the Proposed Action. Likewise, present and reasonably foreseeable future actions selected for inclusion in the analysis are those that may have effects additive to the effects of the Proposed Action as experienced by specific environmental receptors.

The cumulative impacts analysis is not bounded by a specific future timeframe. The Proposed Action includes general types of activities addressed by this EIS/OEIS that are expected to continue indefinitely, and the associated impacts could occur indefinitely. Likewise, some reasonably foreseeable future actions and other environmental considerations addressed in the cumulative impacts analysis are expected to continue indefinitely (e.g., oil and gas production, maritime traffic, commercial fishing). While Navy training and testing requirements change over time in response to world events, it should be recognized that available information, uncertainties, and other practical constraints limit the ability to analyze cumulative impacts for the indefinite future.

ES.6.2 Resource-Specific Cumulative Impact Conclusions

In accordance with Council on Environmental Quality guidance (Council on Environmental Quality, 1997), the following cumulative impacts analysis focuses on impacts that are "truly meaningful." The level of analysis for each resource is commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences) and/or the level to which impacts from the Proposed Action are expected to mingle with similar impacts from existing activities. A full analysis of potential cumulative impacts is provided for marine mammals and reptiles. Rationale is also provided for an abbreviated analysis of the following resources: air quality, sediments and water quality, vegetation, invertebrates, habitat, fishes, birds and bats, cultural resources, socioeconomics, and public health and safety.

ES.6.2.1 Air Quality

The area of greatest emissions in state waters is near the Virginia Capes Operational Area, specifically in the lower Chesapeake Bay, the York River, the James River, and their attendant tributaries. Training activities using small riverine boats and other vessels in this area were not analyzed in prior NEPA documents and account for approximately 2,600 tons per year of nitrogen oxide emissions. This represents about 21% of nitrogen oxide emissions for non-road and miscellaneous area sources in the Hampton Roads Intrastate Air Quality Control Region, which covers Isle of Wight, James City, Nansemond, Southampton, and York counties and the cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, Virginia Beach, and Williamsburg (U.S. Environmental Protection Agency, 2016). While the riverine training activities account for a substantial percentage of nonroad emissions in the region, the area is in attainment for all criteria pollutants and the level of activity has not changed appreciably over time. It is anticipated that these emissions, when added to the impacts of all other past, present and reasonably foreseeable future actions, would not result in measurable additional impacts on air quality in the Study Area or beyond.

ES.6.2.2 Sediments and Water Quality

It is possible that Navy stressors would combine with non-Navy stressors, particularly in nearshore areas and bays, such as Narragansett Bay or the Lower Chesapeake Bay, to exacerbate already impacted sediments and water quality. Although impacts may temporarily intermingle with other inputs in areas with degraded existing conditions, most of the Navy impacts to water quality and turbidity are expected to be negligible, isolated, and short-term, with disturbed sediments and particulate matter quickly dispersing within the water column or settling to the seafloor and turbidity conditions returning to background levels. The Proposed Action could incrementally contribute persistent metal and plastic materials primarily to the offshore ocean ecosystems. However, these relatively minute concentrations of Navy stressors are not likely to combine with other past, present, or reasonably foreseeable activities in a way that would cumulatively threaten the water and sediment quality within the Study Area.

ES.6.2.3 Vegetation

The effects of other past, present, and reasonably foreseeable actions on vegetation occur primarily in the coastal and inland waters and are associated with coastal development, maritime commerce, and the discharge of sediment and other pollutants. The Proposed Action is not expected to substantially contribute to losses of vegetation that would interfere with recovery in these regions. The incremental contribution of the Proposed Action would be insignificant as most of the proposed activities would occur in the open ocean and other areas where seagrasses and other attached marine vegetation do not grow; impacts would be localized; recovery would occur quickly; and none of the alternatives would compound impacts that have been historically significant to marine vegetation (loss of habitat due to development; nutrient loading; shading; turbidity; or changes in salinity, pH, or water temperature). Although vegetation is impacted by stressors throughout the Study Area, the Proposed Action is not likely to incrementally contribute to population- or ecosystem-level changes in the resource, and it is anticipated that the incremental contribution of the Proposed Action when added to the impacts of all other past, present and reasonably foreseeable future actions would not result in measurable additional impacts on vegetation in the Study Area or beyond.

ES.6.2.4 Invertebrates

Although marine invertebrates are impacted by other stressors in the ocean environment, the Proposed Action is not likely to incrementally contribute to population-level stress and decline of the resource. As impacts would be isolated, localized, and not likely to overlap with other relevant stressors, it is anticipated that the incremental contribution of the Proposed Action when added to the impacts of all other past, present and reasonably foreseeable future actions would not result in measurable additional impacts on invertebrates in the Study Area or beyond.

ES.6.2.5 Habitats

Although it is anticipated that damage to abiotic soft bottom habitat resulting from the Proposed Action would be limited and would recover, many other activities in the ocean are also impacting ocean bottom habitat. However, it is not likely that past, present, and future impacts would overlap Proposed Action activities in place or time before the craters or other impressions in soft bottom substrate fill in. Based on the analysis presented in Section 3.5 (Habitats) and the reasons summarized above, it is anticipated that the incremental contribution of the Proposed Action, when added to the impacts of all other past, present and reasonably foreseeable future actions, would not result in measurable additional impacts on habitats, including National Marine Sanctuaries, in the Study Area or beyond.

ES.6.2.6 Fishes

The aggregate impacts of past, present, and other reasonably foreseeable future actions contributing multiple water quality, noise, and physical risks to fishes will likely continue to have significant effects on individual fishes and fish populations. However, Navy training and testing activities are generally isolated from other activities in space and time and the majority of the proposed training and testing activities occur over a small spatial scale relative to the entire Study Area, have few participants, and are of a short duration. Thus, although it is possible that the Proposed Action could contribute incremental stressors to a small number of individuals, which would further compound effects on a given individual already experiencing stress, it is not anticipated that the Proposed Action has the potential to put additional stress on entire populations already in significant decline. Therefore, it is anticipated that the incremental contribution of the Proposed Action, when added to the impacts of all other past, present and reasonably foreseeable future actions, would not result in measurable additional significant impacts on fishes in the Study Area or beyond.

ES.6.2.7 Marine Mammals

The aggregate impacts of past, present, and other reasonably foreseeable future actions continue to have significant impacts on some marine mammal species in the Study Area. The Proposed Action could contribute incremental stressors to individuals, which would both further compound effects on a given individual already experiencing stress and in turn have the potential to further stress populations, some of which may already be in significant decline or in the midst of stabilization and recovery. However, with the implementation of standard operating procedures reducing the likelihood of overlap in time and space with other stressors and the implementation of mitigation measures reducing the likelihood of impacts, the incremental stressors anticipated from the Proposed Action are not anticipated to be significant.

ES.6.2.8 Reptiles

The aggregate impacts of past, present, and other reasonably foreseeable future actions continue to have significant impacts on all reptile species in the Study Area. The Proposed Action could contribute incremental stressors to individuals, which would further compound effects on a given individual already experiencing stress and in turn has the potential to further stress populations in significant decline or recovery efforts thereof. However, with the implementation of standard operating procedures reducing the likelihood of overlap in time and space with other stressors and the implementation of mitigation measures reducing the likelihood of impacts, the incremental stressors anticipated from the Proposed Action are not anticipated to be significant.

ES.6.2.9 BIRDS AND BATS

Although other past, present, and reasonably foreseeable actions individually and collectively cause widespread disturbance and mortality of bird and bat populations across the ocean landscape, the Proposed Action is not expected to substantially contribute to their diminishing abundance, induce widespread behavioral or physiological stress, or interfere with recovery from other stressors. It is anticipated that the incremental contribution of the Proposed Action, when added to the impacts of all other past, present and reasonably foreseeable future actions, would not result in significant impacts on birds and bats in the Study Area or beyond.

ES.6.2.10 CULTURAL RESOURCES

As discussed in Section 3.10 (Cultural Resources), stressors, including explosive and physical disturbance and strike stressors associated with the Proposed Action would not affect submerged prehistoric sites and submerged historic resources in accordance with Section 106 of the National Historic Preservation Act because mitigation measures have been implemented to protect and avoid these resources (Chapter 5, Mitigation). Furthermore, consultation with the appropriate State Historic Preservation Office will continue, as needed, for cultural resources located within state territorial waters (within 3 NM, with the exception of Texas, Puerto Rico, and Florida [Gulf Coast only], which have a 9 NM limit). The Proposed Action is not expected to result in impacts on cultural resources in the Study Area and likewise would not contribute incrementally to cumulative impacts on cultural resources.

ES.6.2.11 SOCIOECONOMICS

The analysis in Section 3.11 (Socioeconomics) indicates that the Proposed Action is not expected to result in impacts to socioeconomic resources in the Study Area and likewise would not contribute incrementally to cumulative socioeconomic impacts.

ES.6.2.12 PUBLIC HEALTH AND SAFETY

All Proposed Actions would be accomplished by technically qualified personnel and would be conducted in accordance with applicable Navy, state, and federal safety standards and requirements. The analysis presented in Section 3.12 (Public Health and Safety) indicates that the Proposed Action is not expected to result in impacts on public health and safety and likewise would not contribute incrementally to or combine with other impacts on health and safety within the Study Area.

ES.6.3 SUMMARY OF CUMULATIVE IMPACTS

The Action Alternatives would contribute incremental effects on the ocean ecosystem, which is already experiencing and absorbing a multitude of stressors to a variety of receptors. In general, it is not anticipated that the implementation of the Proposed Action would have meaningful contribution to the ongoing stress or cause significant collapse of any particular marine resource, but it would further cause minute impacts on resources that are already experiencing various degrees of interference and degradation. It is intended that the mitigation measures described in Chapter 5 (Mitigation) will further reduce the potential impacts of the Proposed Action in such a way that they are avoided to the maximum extent practicable and to ensure that impacts do not become cumulatively significant to any marine resource.

Marine mammals and sea turtles are the primary resources of concern for cumulative impacts analysis, however, the incremental contributions of the Proposed Action are not anticipated to meaningfully contribute to the decline of these populations or interfere with the recovery efforts thereof due to the implementation of standard operating procedures that reduce the likelihood of overlap in time and space and mitigation measures as described in Chapter 5 (Mitigation) that reduce the likelihood of impacts to both resources.

The aggregate impacts of past, present, and other reasonably foreseeable future actions have resulted in significant impacts on some marine mammal and all sea turtle species in the Study Area; however, the decline of these species is chiefly attributable to other stressors in the environment, including the synergistic effect of bycatch, entanglement, vessel traffic, ocean pollution, and coastal zone development. The analysis presented in Chapter 4 (Cumulative Impacts) and Chapter 3 (Affected Environment and Environmental Consequences) indicate that the incremental contribution of the Proposed Action to cumulative impacts on air quality, sediments and water quality, vegetation, invertebrates, marine habitats, fishes, birds and bats, cultural and socioeconomic resources, and public health and safety would not significantly contribute to cumulative stress on those resources.

ES.7 MITIGATION

In developing mitigation, the Navy considered the practicability of implementation and impacts on military readiness, in addition to the potential effectiveness of the mitigation in reducing or avoiding environmental impacts. In achieving this balance, the operational community, Navy planners, and Navy scientific experts worked very closely to develop mitigation options. The Navy has developed mitigation that is likely to be effective at avoiding or reducing impacts on one or more biological or cultural resources and is practicable to implement from a military readiness (i.e., operational) perspective.

The Chapter 3 (Affected Environment and Environmental Consequences) environmental analyses indicate that certain acoustic, explosive, and physical disturbance and strike stressors have the potential to impact certain biological resources. The Navy designed procedural mitigation to avoid or reduce potential impacts from those stressors.

The Navy will implement procedural mitigation under Alternative 1 or Alternative 2 of the Proposed Action whenever and wherever the applicable activities occur within the Study Area (see Table ES.7-1). For some activities the Navy will continue to implement extra procedural mitigation that was developed through previous consultations with NMFS or the USFWS that has been tailored to the discrete locations where the activities may occur. Details of the procedural mitigation that will be implemented are provided in Section 5.3 (Procedural Mitigation to be Implemented).

Table ES.7-1: Summary of Procedural Mitigation to be Implemented

Stressor or Activity	*Summary of Mitigation Requirements*	*Resource Protection Focus*
Environmental Awareness and Education	Afloat Environmental Compliance Training program for applicable personnel	Marine mammals, sea turtles
Active Sonar	Depending on sonar source: 1,000 yd. power down, 500 yd. power down, and 200 yd. shut down; or 200 yd. shut down	Marine mammals, sea turtles

Table ES.7-1: Summary of Procedural Mitigation to be Implemented (continued)

Stressor or Activity	*Summary of Mitigation Requirements*	*Resource Protection Focus*
Air Guns	150 yd.	Marine mammals, sea turtles
Pile Driving	100 yd.	Marine mammals, sea turtles
Weapons Firing Noise	30° on either side of the firing line out to 70 yd.	Marine mammals, sea turtles
Aircraft Overflight Noise	Distance from shore in the Virginia Capes Range Complex and Fisherman Island National Wildlife Refuge during explosive mine neutralization activities involving Navy divers	Birds (piping plover and other nesting birds)
Explosive Sonobuoys	600 yd.	Marine mammals, sea turtles
Explosive Torpedoes	2,100 yd.	Marine mammals, sea turtles
Explosive Medium- Caliber and Large-Caliber Projectiles	1,000 yd. (large-caliber projectiles), 600 yd. (medium-caliber projectiles during surface-to-surface activities), or 200 yd. (medium-caliber projectiles during air-to-surface activities)	Marine mammals, sea turtles
Explosive Missiles and Rockets	900 yd. (0.6–20 lb. net explosive weight), or 2,000 yd. (21–500 lb. net explosive weight)	Marine mammals, sea turtles
Explosive Bombs	2,500 yd.	Marine mammals, sea turtles
Sinking Exercises	2.5 NM	Marine mammals, sea turtles
Explosive Mine Countermeasure and Neutralization Activities	600 yd. (0.1–5 lb. net explosive weight), or 2,100 yd. (6–650 lb. net explosive weight)	Marine mammals, sea turtles
Explosive Mine Neutralization Activities Involving Navy Divers	500 yd. (0.1–20 lb. net explosive weight for positive control charges), or 1,000 yd. (21–60 lb. net explosive weight for positive control charges and all charges using time-delay fuses)	Marine mammals, sea turtles
Maritime Security Operations – Anti-Swimmer Grenades	200 yd.	Marine mammals, sea turtles
Line Charge Testing	900 yd.	Marine mammals, sea turtles, Gulf sturgeon
Ship Shock Trials	3.5 NM	Marine mammals, sea turtles
Vessel Movement	500 yd. (whales), or 200 yd. (other marine mammals)	Marine mammals
Towed In-Water Devices	250 yd.	Marine mammals
Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions	200 yd.	Marine mammals, sea turtles

Table ES.7-1: Summary of Procedural Mitigation to be Implemented (continued)

Stressor or Activity	*Summary of Mitigation Requirements*	*Resource Protection Focus*
Non-Explosive Missiles and Rockets	900 yd.	Marine mammals, sea turtles
Non-Explosive Bombs and Mine Shapes	1,000 yd.	Marine mammals, sea turtles

To further avoid or reduce impacts on marine mammals within large habitat ranges, key areas of biological importance, and to avoid or reduce impacts on biological and cultural resources that are associated with the seafloor, the Navy will implement additional mitigation within designated mitigation areas for the following features:

- Three North Atlantic right whale mitigation areas
- Planning awareness mitigation areas for marine mammal habitat
- Mitigation areas for biological and cultural resources associated with the seafloor

Details of the mitigation that will be implemented within each mitigation area are provided in Section 5.4 (Mitigation Areas to be Implemented) and summarized in Table ES. 7-2.

Tables ES.8-1 and Table ES.8-2 summarize the mitigation that the Navy will implement under Alternative 1 or Alternative 2 of the Proposed Action. For specific requirements, additional information, and clarifications to the tables' general summaries, see Section 5.3 (Procedural Mitigation to be Implemented) and Section 5.4 (Mitigation Areas to be Implemented).

Table ES.7-2: Summary of Mitigation to be Implemented within Mitigation Areas

Mitigation Area	*Summary of Mitigation Requirements*
Mitigation Areas for Seafloor Resources	
Shallow-water coral reefs	• The Navy will not conduct precision anchoring (except in designated anchorages). • The Navy will not conduct explosive mine countermeasure and neutralization activities or mine neutralization activities involving Navy divers. • The Navy will not conduct explosive or non-explosive small-, medium-, and large-caliber gunnery activities using a surface target. • The Navy will not conduct explosive or non-explosive missile and rocket activities using a surface target. • The Navy will not conduct explosive or non-explosive bombing or mine laying activities. • Within the South Florida Ocean Measurement Facility Testing Range, the Navy will implement additional measures, such as using real-time positioning and remote sensing information to avoid shallow-water coral reefs during deployment, installation, and recovery of anchors and mine-like objects, and during deployment of bottom-crawling unmanned underwater vehicles.

Table ES.7-2: Summary of Mitigation to be Implemented within Mitigation Areas (continued)

Mitigation Area	*Summary of Mitigation Requirements*
Live hard bottom	• The Navy will not conduct precision anchoring (except in designated anchorages). • The Navy will not conduct explosive mine countermeasure and neutralization activities or mine neutralization activities involving Navy divers. • Within the South Florida Ocean Measurement Facility Testing Range, the Navy will implement additional measures, such as using real-time positioning and remote sensing information to avoid live hard bottom during deployment, installation, and recovery of anchors and mine-like objects, and during deployment of bottom-crawling unmanned underwater vehicles.
Artificial reefs, Shipwrecks	• The Navy will not conduct precision anchoring (except in designated anchorages). • The Navy will not conduct explosive mine countermeasure and neutralization activities or mine neutralization activities involving Navy divers.
Mitigation Areas for Marine Mammals	
Northeast North Atlantic Right Whale Mitigation Area	The Navy will minimize use of active sonar to the maximum extent practicable. • The Navy will not use explosives that detonate in the water. • Non-explosive torpedo testing will be conducted during daylight hours in Beaufort sea state 3 or less; three Lookouts (one on a vessel and two in an aircraft during dedicated aerial surveys) and an additional Lookout on the submarine (when surfaced) will be used; during transits, ships will maintain a speed of no more than 10 knots; during firing, ships will maintain a speed of no more than 18 knots except for brief periods of time (e.g., 10–15 min.) during vessel target firing. • Navy will obtain the latest North Atlantic right whale sightings data. • Vessels will implement speed reductions after they observe a North Atlantic right whale if they are within 5 NM of a sighting reported within the past week and when operating at night or during periods of reduced visibility.
Gulf of Maine Planning Awareness Mitigation Area	• The Navy will not plan major training exercises. • The Navy will not conduct more than 200 hours of hull-mounted mid-frequency active sonar per year.
Northeast Planning Awareness Mitigation Areas, Mid-Atlantic Planning Awareness Mitigation Areas	• The Navy will avoid planning major training exercises to the maximum extent practicable. • The Navy will not conduct more than four major training exercises per year (all or a portion of the exercise).
Southeast North Atlantic Right Whale Mitigation Area (November 15 through April 15)	• The Navy will not conduct active sonar except as necessary for navigation and object detection training, and dipping sonar. • The Navy will not expend explosive or non-explosive ordnance. • The Navy will obtain the latest North Atlantic right whale sightings data. • Vessels will implement speed reductions after they observe a North Atlantic right whale if they are within 5 NM of a sighting reported within the past 12 hours and when operating at night or during

Table ES.7-2: Summary of Mitigation to be Implemented within Mitigation Areas (continued)

Mitigation Area	*Summary of Mitigation Requirements*
	periods of reduced visibility. • To the maximum extent practicable, vessels will minimize north-south transits.
Gulf of Mexico Planning Awareness Mitigation Areas	• The Navy will avoid planning major training exercises to the maximum extent practicable. • The Navy will not conduct more than one major training exercise per year (all or a portion of the exercise) in each area under Alternative 2; or any under Alternative 1.

As a result of the mitigation development and assessment process, the Navy found that some of the measures it considered were impracticable or not likely to be effective at avoiding or reducing impacts on biological resources. The measures considered but eliminated include:

- Measures pertaining to the action alternatives
  - Reducing training and testing with active sonar, modifying sonar sound sources, and time-of-day restrictions
  - Replacement of sonar training with computer simulated activities
  - Restricting the use of explosives
- Measures pertaining to procedural mitigation
  - Implementing active sonar ramp-up procedures
  - Restricting vessel speed
  - Increasing passive acoustic monitoring and visual observations
  - Increasing the size and types of mitigation zones beyond what is in Section 5.3 (Procedural Mitigation to be Implemented)
  - Adopting mitigation measures of foreign navies
  - Increasing reporting requirements
- Measures pertaining to oceanographic features or geographic locations oceanographic features or geographic locations”

ES.8 OTHER CONSIDERATIONS

ES.8.1 CONSISTENCY WITH OTHER FEDERAL, STATE AND LOCAL PLANS, POLICIES AND REGULATIONS

Based on an evaluation of consistency with statutory obligations, the Navy’s proposed training and testing activities would not conflict with the objectives or requirements of federal, state, regional, or local plans, policies, or legal requirements. The Navy will consult with regulatory agencies as appropriate during the NEPA process and prior to implementation of the Proposed Action to ensure all legal requirements are met.

ES.8.2 Relationship Between Short-term Use of the Environment and Maintenance and Enhancement of Long-term Productivity

In accordance with NEPA, this EIS/OEIS provides an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. The Proposed Action may result in both short- and long-term environmental effects. However, the Proposed Action would not be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or the general welfare of the public.

ES.8.3 Irreversible or Irretrievable Commitment of Resources

For the alternatives including the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Most impacts are short-term and temporary or, if long lasting, are negligible. No habitat associated with threatened or endangered species would be lost as result of implementation of the Proposed Action. Since there would be no building or facility construction, the consumption of materials typically associated with such construction (e.g., concrete, metal, sand, fuel) would not occur. Energy typically associated with construction activities would not be expended and irreversibly lost.

Implementation of the Proposed Action would require fuels used by aircraft and vessels. Since fixed- and rotary-wing flight and ship activities could increase, relative total fuel use could increase. Therefore, if total fuel consumption increased, this nonrenewable resource would be considered irretrievably lost.

ES.8.4 Energy Requirements and Conservation Potential of Alternatives and Mitigation Measures

Resources that will be permanently and continually consumed by project implementation include water, electricity, natural gas, and fossil fuels; however, the amount and rate of consumption of these resources would not result in significant environmental impacts or the unnecessary, inefficient, or wasteful use of resources. Prevention of the introduction of potential contaminants is an important component of standard procedures followed by the Navy. To the extent practicable, considerations in the prevention of introduction of potential contaminants are included.

Sustainable range management practices are in place that protect and conserve natural and cultural resources and preserve access to training areas for current and future training requirements while addressing potential encroachments that threaten to impact range and training area capabilities.

ES.9 Public Involvement

The first step in the NEPA process for an EIS is to prepare a Notice of Intent to develop an EIS. The Navy published a Notice of Intent for this EIS/OEIS in the Federal Register and several newspapers on November 12, 2015. In addition, Notice of Intent and Scoping Notification Letters were distributed to federal, state, and local elected officials and government agencies. The Notice of Intent provided an overview of the Proposed Action and the scope of the EIS/OEIS, and initiated the scoping process.

ES.9.1 Scoping Process

Scoping is an early and open process for developing the "scope" of issues to be addressed in an EIS and for identifying significant issues related to a proposed action. During scoping, the public helps define and prioritize issues by providing comments.

On November 12, 2015, postcards were mailed to 647 recipients on the project mailing list, including individuals, non-profit organizations, and for-profit organizations. The postcards provided information on the Proposed Action, methods for commenting, and the project website address to obtain more information.

To announce the scoping period, advertisements were placed in twenty-three newspapers throughout the AFTT Study Area. The advertisements included a description of the Proposed Action, the address of the project website, the duration of the comment period, and information on how to provide comments.

A project video was developed to support the scoping phase and provide information to the public on the types of training and testing the Navy conducts and its importance. The project video was uploaded to the project website.

ES.9.2 SCOPING COMMENTS

The Scoping comments could be submitted via the project website or by mail. The Navy received comments from Federal Agencies, State Agencies, Non-governmental Organizations, individuals and community groups. A total of 72 scoping comments were received. The comments requested the Navy analyze environmental issues from physical and biological resources, such as sonar impacts on marine mammals, to human resources, such as public health and safety. A sampling of some of the specific concerns follows.

- A True No Action Alternative Analysis
- Time-Area Management and Mitigation Areas
- Cumulative Impact Analysis
- Range of Alternatives
- Impacts of Training and Testing to Marine Mammals
- Impacts of Training and Testing to Marine Life

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

TABLE OF CONTENTS

List of Figures

List of Tables

ABBREVIATIONS AND ACRONYMS

ACRONYM	***DEFINITION***
AFTT	Atlantic Fleet Training and Testing
CFR	Code of Federal Regulation
DEIS	Draft Environmental Impact Statement
DoD	Department of Defense
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
MMPA	Marine Mammal Protection Act
Navy	U.S. Department of the Navy
NEPA	National Environmental Policy Act

ACRONYM	***DEFINITION***
NMFS	National Marine Fisheries Service
OEIS	Overseas Environmental Impact Statement
OPAREA	Operating Area
PTS	Permanent Threshold Shift
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TTS	Temporary Threshold Shift
U.S.C.	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service

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

TABLE OF CONTENTS

List of Figures

List of Tables

This section does not contain tables.

1 PURPOSE AND NEED

1.1 INTRODUCTION

The United States (U.S.) Department of the Navy (Navy) proposes to conduct military readiness training activities and research, development, testing, and evaluation (hereinafter referred to as "testing") activities in the Atlantic Fleet Training and Testing (AFTT) Study Area, as represented in Figure 1.2-1. These military readiness activities include the use of active sonar and explosives within existing range complexes and testing ranges, in high seas areas located in the Atlantic Ocean along the eastern coast of North America, in portions of the Caribbean Sea and the Gulf of Mexico, at Navy pier side locations, within port transit channels, near civilian ports, and in bays, harbors, and inland waterways (e.g., lower Chesapeake Bay). These military readiness activities are generally consistent with those analyzed in the AFTT Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) completed in August 2013 and are representative of training and testing that the Navy has been conducting in the AFTT Study Area for decades.

Major conflicts, terrorism, lawlessness, and natural disasters all have the potential to threaten national security of the United States. The security, prosperity, and vital interests of the United States are increasingly tied to other nations because of the close relationships between the United States and other national economies. The Navy operates on the world's oceans, seas, and coastal areas—the international maritime domain—on which 90 percent of the world's trade and two-thirds of its oil are transported. The majority of the world's population also lives within a few hundred miles of an ocean. The U.S. Navy carries out training and testing activities to be able to protect the United States against its potential adversaries, to protect and defend the rights of the United States and its allies to move freely on the oceans, and to provide humanitarian assistance.

A ***range complex*** is a set of adjacent areas of sea space, undersea space, and overlying airspace delineated for military training and testing activities. A ***test range*** is airspace or water surface areas where the Navy conducts a concentrated amount of testing activities. ***Divert airfields*** are airfields on land that are available for emergency use by aircraft operating at sea. Aircraft training activities at sea are typically conducted within 150 nautical miles of a divert airfield.

The Navy has historically used the areas along the eastern coast of the United States and in the Gulf of Mexico for training and testing. These areas have been designated by the Navy as "range complexes" and testing ranges (Figure 1.2-1). Range complexes provide controlled environments where military ship, submarine, and aircraft crews can train in realistic conditions while safely deconflicting with non-military activities, such as civilian shipping and aircraft. The combination of undersea ranges and operating areas (OPAREAs) with land training ranges, divert airfields, and nearshore amphibious landing sites is critical to realistic training and testing. A test range may have electronic instrumentation including radar, optical tracking and communication systems. Electronics on the ranges capture important data on the effectiveness of tactics and equipment—data that provide a feedback mechanism for training evaluation. While these at-sea areas provide ideal training and testing environments for the Navy, these are areas shared with civilian and commercial vessels and aircraft; these are not areas over which the Navy has exclusive jurisdiction. Training and testing activities, collectively referred to as military readiness activities, that prepare the Navy to fulfill its mission to protect and defend the United States and its allies have the potential to impact the environment.

The Navy prepared this EIS/OEIS to comply with the National Environmental Policy Act (NEPA) and Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions,* by assessing the potential environmental impacts associated with two categories of military readiness activities conducted at sea: training and testing. Collectively, the at-sea areas in this EIS/OEIS are referred to as the AFTT Study Area (Figure 1.2-1).

Training. Naval personnel (Sailors and Marines) first undergo entry-level (or schoolhouse) training, which varies according to their assigned warfare community (aviation, surface warfare, submarine warfare, and special warfare) and the community's unique requirements. Personnel then train within their warfare community at sea in preparation for deployment; each warfare community has primary mission areas (areas of specialized expertise that may involve or overlap with multiple warfare communities) that are described in detail in Chapter 2 (Description of Proposed Action and Alternatives).

Testing. The Navy researches, develops, tests, and evaluates new platforms[1], systems, and technologies, collectively known as testing. Many tests require realistic conditions at sea and can range from testing new software to complex operations of multiple systems and platforms. Testing activities may occur independent of or in conjunction with training activities.

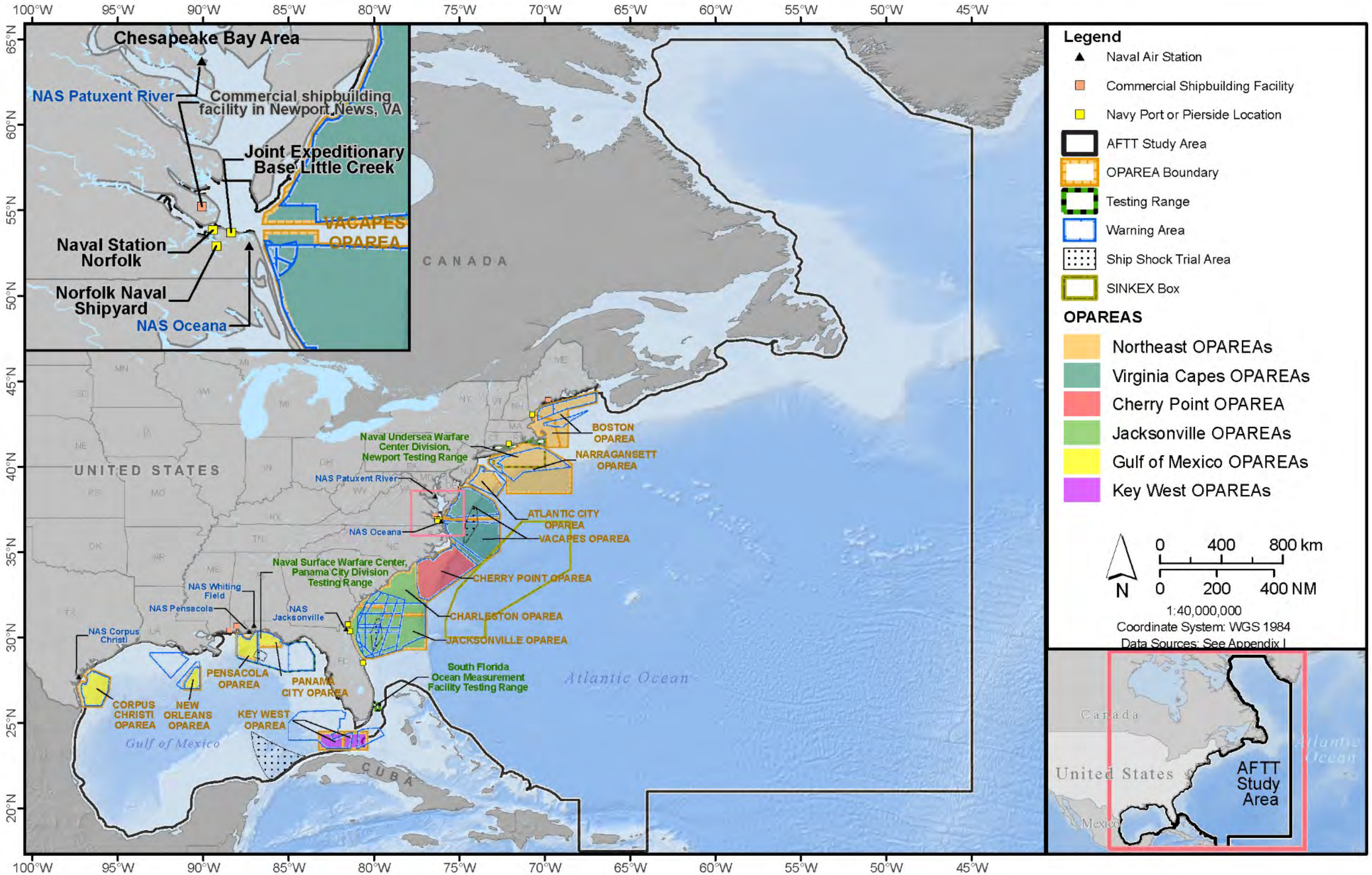
1.2 The Navy's Environmental Compliance and At-Sea Policy

In 2000, the Navy completed a review of its environmental compliance requirements for exercises and training at sea. The Navy then instituted a policy, known as the "At-Sea Policy," to ensure compliance with applicable environmental regulations and policies, and preserve the flexibility necessary for the Navy and Marine Corps to train and test at sea. This policy directed, in part, that Fleet Commanders develop a programmatic approach to environmental compliance at sea for ranges and OPAREAs within their respective geographic areas of responsibility (U.S. Department of the Navy, 2000). Those ranges affected by the "At-Sea Policy" are designated water areas, sometimes containing instrumentation, that are managed and used to conduct training and testing activities. Some ranges are further broken down into OPAREAs, to better manage and deconflict military readiness activities.

In 2005, the Navy and the National Oceanic and Atmospheric Administration reached an agreement on a coordinated programmatic strategy for assessing certain environmental effects of military readiness activities at sea. The Navy is currently in the third phase of implementing this programmatic approach.

Phase I of environmental planning. The first phase of the planning program was accomplished by the preparation and completion of individual or separate environmental documents for each range complex and OPAREA. The Navy prepared NEPA/Executive Order 12114 documents for range complexes, testing ranges, and OPAREAs off the east coast and in the Gulf of Mexico—the Atlantic Fleet Active Sonar Training EIS/OEIS, Virginia Capes EIS/OEIS, Cherry Point EIS/OEIS, Jacksonville Range Complex EIS/OEIS, Undersea Warfare Training Range EIS/OEIS, Gulf of Mexico EIS/OEIS, and Naval Surface Warfare Panama City Division EIS/OEIS—to analyze training and testing activities.

[1] Throughout this EIS/OEIS, ships, submarines, and aircraft may be referred to as "platforms"; weapons, combat systems, sensors, and related equipment may be referred to as "systems."



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; VACAPES: Virginia Capes.

Figure 1.2-1: Atlantic Fleet Training and Testing Study Area

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These range complexes pre-date World War II and have been used by U.S. naval forces continuously since then for training and testing activities. Phase I NEPA/Executive Order 12114 documents catalogued training and testing activities; analyzed potential environmental impacts; and supported other requirements under applicable environmental laws, regulations, and executive orders. For example, Marine Mammal Protection Act (MMPA) [16 United States Code (U.S.C.) sections 1361–1407] incidental take authorizations and incidental take statements under the Endangered Species Act (ESA) (16 U.S.C. sections 1531–1544) were issued by the National Marine Fisheries Service (NMFS) to the Navy for range complexes on the east coast and in the Gulf of Mexico and the Naval Surface Warfare Center, Panama City Division testing range in the Gulf of Mexico; those MMPA authorizations began expiring in early 2014.

Phase II of environmental planning. The second phase of the Navy's environmental compliance planning covered activities and existing ranges and OPAREAs previously analyzed in the Phase I NEPA/Executive Order 12114 documents and additional geographic areas including, but not limited to, pierside locations and transit corridors. The Phase II EIS/OEIS for AFTT combined the geographic scope of the range complexes and testing ranges off the east coast and in the Gulf of Mexico, as well as study areas covered in NEPA documents for other at-sea areas on the east coast, and analyzed ongoing, routine at-sea activities that occur during transit between these range complexes, testing ranges, and OPAREAs. The Navy expanded the geographic scope to include additional areas where military readiness activities historically occurred and also included new platforms and systems not addressed in previous NEPA/Executive Order 12114 documents. As was done in Phase I, the Navy used this analysis to support new regulatory consultations and new requests for Letters of Authorization (set to expire in 2018) under the MMPA and incidental take statements under the ESA.

Phase III of environmental planning. The third phase of the Navy's environmental compliance planning covers similar types of Navy training and testing activities as was analyzed in Phase II. The Navy has re-evaluated impacts from these ongoing activities in existing ranges, OPAREAs, and testing ranges, including activities that occur during transit between these range complexes, testing ranges, and OPAREAs; and additionally analyzed new or changing military readiness activities into the reasonably foreseeable future based on evolving operational requirements, including those associated with new platforms and systems not previously analyzed. The Navy has thoroughly reviewed and incorporated into this analysis the best available science relevant to analyzing the environmental impacts of the proposed activities. As with previous Phases, the Navy will use this new analysis to support environmental compliance with other applicable environmental laws, such as the MMPA and ESA.

1.3 Proposed Action

The Navy's Proposed Action, described in detail in Chapter 2 (Description of Proposed Action and Alternatives), is to conduct military readiness activities in the western Atlantic Ocean off the east coast of the United States, in the Gulf of Mexico, and portions of the Caribbean Sea. These activities will also occur at Navy pierside locations, Navy-contracted shipbuilder locations, port transit channels, and select bays, harbors and inland waters, e.g., Chesapeake Bay (see Figure 1.2-1 and Section 2.1, Description of the Atlantic Fleet Training and Testing Study Area, for more detail on the geographic areas analyzed with regard to the Proposed Action).

1.4 Purpose of and Need for Proposed Military Readiness Training and Testing Activities

The purpose of the Proposed Action is to ensure that the Navy meets its mission, which is to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is achieved in part by conducting training and testing within the Study Area in accordance with established Navy military readiness requirements. The following sections provide an overview of the need for military readiness activities.

1.4.1 Why the Navy Trains

> Title 10 section 5062 of the U.S. C. provides: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of naval forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with integrated joint mobilization plans, for the expansion of the peacetime components of the Navy to meet the needs of war."

As described above, the Navy is statutorily mandated to protect U.S. national security by being ready, at all times, to effectively prosecute war and defend the nation by conducting operations at sea. The Navy is essential to protecting U.S. national interests, considering that 70 percent of the earth is covered in water, 80 percent of the planet's population lives within close proximity to coastal areas, and 90 percent of global commerce is conducted by sea. Naval forces must be ready for a variety of military operations—from large-scale conflict to maritime security to humanitarian assistance/disaster relief—to address the dynamic, social, political, economic, and environmental issues that occur in today's rapidly evolving world. Through its continuous presence on the world's oceans, the Navy can respond to a wide range of situations because, on any given day, over one-third of its ships, submarines, and aircraft are deployed overseas. Units must be able to respond promptly and effectively while forward deployed. This presence helps to dissuade aggression, which prevents conflict escalation, and provides the President with options to promptly address global contingencies. Before deploying, naval forces must train to develop a broad range of capabilities to respond to threats, from full-scale armed conflict in a variety of different geographic areas and environmental conditions to humanitarian assistance and disaster relief efforts. This also prepares Navy personnel to be proficient in operating and maintaining the equipment, weapons, and systems they will use to conduct their assigned missions. The training process provides personnel with an in-depth understanding of their individual limits and capabilities; the training process also helps the testing community improve new weapon systems' capabilities and effectiveness.

Modern weapons bring both unprecedented opportunities and challenges to the Navy. For example, precision (or smart) weapons help the Navy accomplish its mission with greater accuracy with far less collateral damage than in past conflicts; however, modern weapons are also very complex to use. Military personnel must train regularly with these weapons to understand the capabilities, limitations, and operations of the platform or system, as well as how to keep them operational under difficult conditions and without readily available technical or logistical assistance.

Modern military actions require teamwork among hundreds or thousands of people, across vast geographic areas, and the coordinated use of various equipment, ships, aircraft, and vehicles (e.g., unmanned aerial vehicles) to achieve success. Personnel increase in skill level by completing basic and specialized individual military training, then they advance to intermediate (e.g., unit-level training) and larger exercise training events, which culminate in advanced, integrated training composed of large groups of personnel and, in some instances, joint service exercises.[2]

Military readiness training must be as realistic as possible to provide the experiences vital to success and survival during military operations because simulated training, even in technologically advanced simulators, cannot duplicate the complexity faced by Sailors and Marines in the real world. While simulators and synthetic training are critical elements that provide early skill repetition and enhance teamwork, there is no substitute for live training in a realistic environment. Just as a pilot would not be ready to fly solo after simulator training, a Navy commander cannot allow military personnel to engage in real combat activities based merely on simulator training.

The large size of the range complex is essential to allow for realistic training scenarios that prepare Sailors and Marines for real-world operations. Only a large range complex offers the space necessary for operations such as the launch and recovery of aircraft or replenishment maneuvers which require a straight line course at a fixed speed for a sustained period of time. For example, in light wind conditions, to maintain a safe wind speed over the carrier's deck of 20 knots, flight operations taking 30 minutes to an hour would require traveling in a straight line over a distance of at least 10–20 nautical miles (NM) before any restrictive boundary was approached. Furthermore, multiple fixed wing aircraft landing on an aircraft carrier must be organized into a holding pattern, typically located 10–50 NM distance from the carrier, depending on several factors, including weather conditions, visibility, the number of aircraft waiting to land, and the condition of the aircraft (e.g., fuel remaining). To practice this maneuver safely away from civilian airspace, the carrier would need to be 20–50 NM away from any OPAREA boundary. In short, safe and effective Navy training often requires expansive operating areas due to a number of complex and interrelated factors.

The Navy also requires extensive areas of ocean to conduct its training in order to properly separate and coordinate different training events so that individual training events do not interfere with each other and do not interfere with public and commercial vessels and aircraft. For example, hazardous activities such as gunnery or missile fire from a vessel in one training event would need to be conducted away from other training events. Additionally, large areas of ocean are required to ensure different training events can be conducted safely while minimizing the risks inherent in military training, such as aircraft flying too closely to one another or to commercial airways. Navy ships must also train to operate at long distances—often hundreds of miles—from each other while still maintaining a common picture of the "battlespace" so that individual Navy units can be coordinated to achieve a common objective. Separation of Navy units may also be required to ensure that participants of other exercises do not experience interference with sensors.

This need for expansive sea space is even more critical today as the Navy has a renewed emphasis on "sea control," which is the need to secure large areas of oceans from other highly capable naval forces. When the Cold War ended, the Navy emerged unchallenged and dominant. That dominance allowed the Navy to focus on projecting power ashore. The balance between sea control and power projection tipped strongly in favor of the latter, and the Navy's surface force evolved accordingly. The Navy's

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[2] Large group exercises may include carrier strike groups and expeditionary strike groups. Joint exercises may be with other U.S. services and other nations.

proficiency in land-attack and maritime security operations reached new heights, while foundational skills in anti-submarine warfare and anti-surface warfare slowly began to erode. The emergence of more sophisticated capabilities by potential adversaries will require us to operate farther from their coastline in times of conflict, and the modernization of navies able to challenge the U.S. Navy directly means that control of the seas can no longer be assumed. In response, the Navy is developing a model of "distributed lethality," which is intended to enhance the offensive power of individual surface ships. This allows them to deploy in dispersed formations in order to control large areas of the sea (e.g., hundreds of thousands of square miles) from which the Navy can operate seamlessly in time of conflict.

1.4.2 Optimized Fleet Response Plan

The Fleet Response Plan that the Navy operated under during Phase I and II emphasized constant readiness. The Fleet Response Plan identified the number of personnel and vessels that had to be ready to deploy on short notice (i.e., surge) in order to respond to rapidly evolving world events. For example, the Fleet Response Plan mandated that the Navy be able to deploy six aircraft carrier strike groups[3] within 3 months of a crisis and follow those with two more strike groups within 3 months after the first six deployed. Additionally, the Fleet Response Plan was based on a notional maintenance schedule and strike group deployments of 6 months in length and approximately 27 months between deployments. However, due to world events and the need for naval forces to be located overseas, Navy vessels were actually deployed for longer periods, resulting in longer maintenance periods. The Fleet Response Plan no longer represented actual fleet readiness preparation.

In December 2014 the Navy initiated the Optimized Fleet Response Plan, which reinforces the three tenets of "Warfighting First – Operate Forward – Be Ready" (U.S. Department of the Navy, 2014b). The Optimized Fleet Response Plan achieves this by better aligning manning distribution with operational requirements; optimizing maintenance and modernization plans; improving the overall quality of work and life balance for personnel; and ensuring that forces deploy with the right capabilities, properly trained and equipped to meet mission objectives. Like the previous plan, the Optimized Fleet Response Plan maintains a surge requirement by sustaining readiness of deployment-certified forces to enable three aircraft carrier strike groups in both the Atlantic and Pacific Oceans to respond to a national crisis. The Optimized Fleet Response Plan is now based on notional 7-month deployments and approximately 36 months between deployments. Following the Optimized Fleet Response Plan allows the Navy to respond timely to global events with the proper forces while maintaining a structured process that ensures continuous availability of trained, ready Navy forces.

The Optimized Fleet Response Plan outlines the training activities required to achieve a state of military readiness that will allow Navy personnel to execute operations as ordered by their commanders, to include responding to a conflict. The plan uses a building-block approach where initial basic training complements later phases of more complex training, with each phase building upon the skills obtained in the previous phase. Specifically, training activities proceed in five phases: maintenance, basic, advanced, integrated, and sustainment, as depicted in Figure 1.4-1. The training events that occur in each of these phases are designed to prepare Sailors for the multitude of contingencies they may face,

[3] While strike groups could be configured differently, a typical aircraft carrier strike group would include an aircraft carrier, a guided missile cruiser, two guided missile destroyers, an attack submarine, and a supply ship.

ranging from large strike group level activities such as defending against submarine or mine threats, conducting long-range bombing missions, putting Marines ashore in a hostile environment, to humanitarian responses for natural catastrophes such as earthquakes and hurricanes. To ensure Sailors and Marines can perform the variety of missions they could face, the training building blocks are designed to maximize their effectiveness at accomplishing the mission safely and professionally.

The Optimized Fleet Response Plan cycle starts at the beginning of the maintenance phase and ends upon the beginning of the next maintenance phase, as detailed below. Readiness increases throughout the cycle and culminates with the highest level of readiness at the end of the integrated or advanced phase.

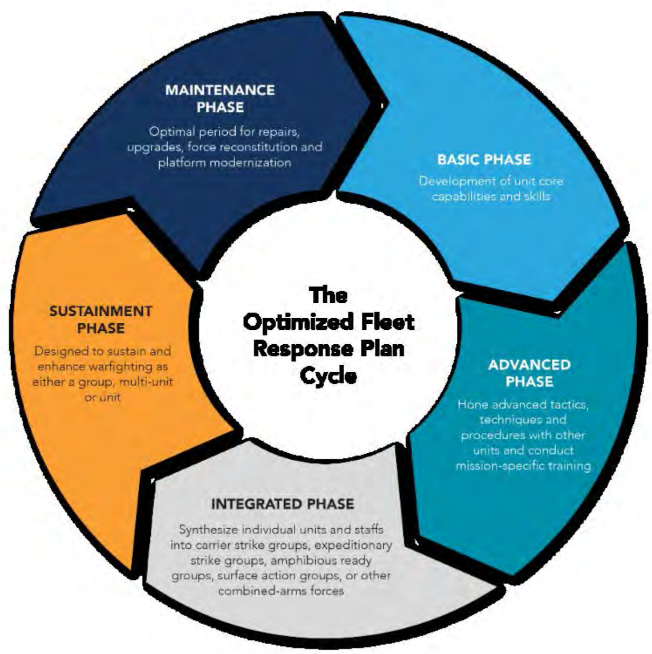

Figure 1.4-1: Optimized Fleet Response Plan

1.4.2.1 Maintenance Phase

The beginning of the maintenance phase signals the start of the Optimized Fleet Response Plan cycle. The goal of this phase is on-time completion of maintenance and modernization so that units are able to begin training and adhere to the Optimized Fleet Response Plan training schedule. All deployable Navy forces have a maintenance phase, which varies among different types of forces. The maintenance phase is critical to the success of Optimized Fleet Response Plan since this represents the ideal time for major shipyard repairs, upgrades, and platform modernization. Also during this phase, Navy forces will complete required inspections, certifications, assist visits, and individual and team training to achieve required levels of personnel, equipment, supply, and ordnance readiness.

1.4.2.2 Basic Phase

The intent of the basic phase is to focus on the development of core capabilities and skills through the completion of basic-level training, inspections, certifications, and assessments. Achieving required levels of personnel, equipment, supply, and ordnance readiness is essential to success in subsequent Optimized Fleet Response Plan phases. Units that have completed all basic phase requirements are ready for more complex training and are capable of independent operations in support of homeland security, humanitarian assistance, and disaster relief missions.

The basic phase consists of training exercises performed by individual ships and aircraft and is mostly characterized as unit-level training. Unit-level training focuses on fundamental combat skills for a unit, such as an individual ship. Operating area and range support requirements for unit-level training are relatively modest compared to large-scale, major exercises. Coordinated unit-level exercises involve two or more units, such as ships, aircraft, or both, and are also included in the basic phase. These exercises further refine the basic, fundamental skills while increasing difficulty by requiring coordination with other units.

Due to the repetition required in unit-level training, proximity of local range complexes to the locations where Sailors and Marines are stationed is important, as it reduces the amount of travel time and training costs during the basic phase of training. Access to local ranges also increases the time these Sailors and Marines can spend at home, with their families and communities before going on long deployments.

Ships and aircraft conducting basic phase training are likely operating in the same range complex or OPAREA where other units are conducting unrelated activities in basic phase, integrated phase, or sustainment phase. Without sufficiently sized OPAREAs, this necessary, simultaneous training could not occur.

1.4.2.3 Advanced Phase

The purpose of the advanced phase is to build on unit warfighting capabilities through academic, synthetic and live training in advanced training, tactics, and procedures in all mission areas within a challenging warfighting environment. This phase provides an opportunity to hone advanced training, tactics, and procedures with other units and conduct mission-specific training to meet mission requirements while maintaining proficiency attained in the basic phase. The advanced phase provides a sufficient block of time to complete required inspections, certifications, assessments, visits, and training. This phase includes attainment of acceptable unit warfighting proficiency in all required mission areas and completion of mission-specific training for identified mission sets. Upon completion of advanced phase, most Navy forces will aggregate into a strike group, amphibious ready group, or other combined arms force and commence the integrated phase of training. There are some forces, such as independent deployers, that do not require an integrated phase and will be certified to deploy following the advanced phase.

1.4.2.4 Integrated Phase

The goal of the integrated phase is to provide these units and staffs advanced warfare skills in a challenging, multi-dimensional, and realistic threat warfare environment. This phase allows members of a combined force to build on individual and unit-level skills and conduct multi-unit in-port and at-sea training, culminating in an assessment of their performance under high-end and high-stress realistic threat conditions. The integrated phase combines the units that have completed the advanced phase of training into strike groups (such as an Amphibious Ready Group). Strike groups are composed of multiple ships and aircraft operating together but covering many, sometimes thousands of square miles to simulate a real-world situation. For example, a strike group may be expected to operate in coordinated fashion in the entire Persian Gulf or Mediterranean Sea. Major exercises in this phase require access to large, relatively unrestricted areas of ocean and airspace, multiple targets, and unique range attributes (complex and varying oceanographic features, close proximity to naval bases, and land-based targets).

The integrated phase concludes with certification for deployment, meaning that the strike group has demonstrated the skills and proficiencies across the entire spectrum of warfare that may be needed during deployment.

1.4.2.5 Sustainment Phase

The sustainment phase includes all activities and training following certification for deployment until the next maintenance phase begins. The goal of the sustainment phase is to provide strike groups with training that allows forces to maintain their highest level of readiness and proficiency, as well as the ability to evaluate new and developing technologies, and evaluate and develop new tactics. The strike group needs to continue training after certification for deployment and upon return from deployment up until it enters the maintenance phase, to maintain its perishable skills.

Similar to the integrated phase, sustainment exercises require access to large, relatively unrestricted areas of ocean and airspace and unique range attributes to support the scenarios.

Ships and aircraft conducting sustainment phase training are likely operating in the same range complex or OPAREA where other units are conducting unrelated activities in the basic phase, advanced phase, integrated phase, or sustainment phase. Without sufficiently sized OPAREAs, this necessary, simultaneous training could not occur.

1.4.3 Why the Navy Tests

The Navy's research and acquisition community, including research funding organizations, laboratory facilities and systems commands, have a mission to provide weapons, systems, and platforms for the men and women of the Navy that support their missions and give them a technological edge over the United States' adversaries. This community is at the forefront of researching, developing, testing, evaluating, acquiring, and delivering modern platforms, systems, and related equipment to meet Fleet capability and readiness requirements while providing the necessary high return on investment to the American taxpayer. The Navy's research funding organizations and laboratories concentrate primarily on the development of new science and technology and include the initial testing of concepts that are relevant to the Navy of the future. The results of these research efforts carry forward to the ship, aircraft, and weapon system products developed by systems commands, who support the full lifecycle of product and service delivery from research and development, to testing, acquisition, and deployment, to operations and logistics support, including maintenance, repair, and modernization of Navy platforms (e.g., ships, aircraft), weapon systems, and components. Testing begins at the research and development phase and continues through to the final certification of systems and hardware. For example, the building of a new ship would involve the development of all the software and hardware systems within the ship, the construction of the ship itself, and testing the ship's seaworthiness and operation of its systems. After delivery to the fleet, the testing community supports maintenance, provides updates to software and hardware systems, and may include training Sailors on the operation of the ship's systems.

The Navy's research, acquisition, and testing community includes the following:

- Naval Air Systems Command, which develops, acquires, delivers, and sustains naval aviation aircraft, weapons, and systems with proven capability and reliability to ensure Sailors and Marines achieve mission success
- Naval Sea Systems Command, which develops, acquires, delivers, and maintains surface ships, submarines, unmanned vehicles, and weapon system platforms that provide the right capability to the Sailors and Marines.
- Office of Naval Research, which is a research funding organization that plans, fosters, encourages, and conducts a broad program of scientific research (at universities, industry, small

business, etc.) that promotes future naval sea power, enhances national security, and meets the complex technological challenges of today's world. The Office of Naval Research is also a parent command for the Naval Research Laboratory, which operates as the Navy's corporate research laboratory and conducts a multidisciplinary program of scientific research.

- Space and Naval Warfare Systems Command, which provides the Sailor with knowledge superiority by developing, delivering, and maintaining effective, capable, and integrated command, control, communications, computer, intelligence, and surveillance systems.

The Navy's systems commands design, test, and build component, system, and platforms to address requirements identified by the fleet. The Navy's systems commands must test and evaluate the platform, system, or upgrade to validate whether it performs as expected and to determine whether it is operationally effective, suitable, survivable, and safe for its intended use by the fleet.

1.4.3.1 Types of Testing

Testing performed by the Navy's research and acquisition community can be categorized as scientific research testing, performance and specification testing, developmental testing, operational testing, fleet training support, follow-on test and evaluation, lot acceptance testing, or maintenance and repair testing. Fleet training events often offer the most suitable environment for testing a system because training events are designed to accurately replicate operational conditions. Testing, therefore, is often embedded in fleet training events such that distinguishing a testing event from a training event would be difficult for an observer, as the only difference could be the purpose for which the activity was being conducted. Categories of testing events include:

- **Scientific research testing.** Scientific research testing is required to evaluate emerging threats or technology enhancement before development of a new system. As an example, testing might occur on a current weapon system to determine if a newly developed technology would improve system accuracy or enhance safety to personnel. Additionally, scientific research involves the use of devices to measure the properties of the environment in which a system may operate. For example, acoustic propagation experiments are conducted in particular environments to see how far acoustic signals produced by current and future operational systems could travel. Other research activities involve the transmission of acoustic signals designed to convey information from one platform to another. This "acoustic communication" is also very dependent on environmental conditions and needs to be studied where a variety of these conditions occur.
- **Performance and specification testing.** Performance and specification tests are required prior to Navy acceptance of a new system or platform. These tests may be conducted on a Navy testing range, in a Navy range complex, or at pierside locations; these tests are sometimes done in conjunction with fleet training activities.
- **Developmental testing.** Developmental tests are conducted to assist in the design of a platform or system and to ensure that technical performance specifications have been met. For example, a weapon system may be tested using prescribed settings (e.g., a specific run pattern) to ensure the full range of system parameters can be met.
- **Operational testing.** Operational tests are conducted by specialized Navy units to evaluate the platform or system under conditions as it would be used by the fleet during operations. For example, a weapons system may be tested without prearranged settings, such that the

specialized unit conducting the test can make adjustments as necessary for the prevailing conditions.

- **Fleet training support.** Fleet training support is conducted when systems still under development may be integrated on ships or aircraft for testing, and new platforms and systems are transitioned to the fleet once they are ready for operational use. During this effort, the Navy's systems commands may provide training on the operation, maintenance, and repair of the system during developmental testing activities.
- **Follow-on test and evaluation.** A follow-on test and evaluation occurs when a platform receives a new system, after a significant upgrade to an existing system, or when the system failed to meet performance specifications during previous testing. Follow-on tests and evaluations ensure that the modified or new system meets performance requirements and does not conflict with existing platform systems and subsystems.
- **Lot acceptance testing.** Lot acceptance tests evaluate systems from the Department of Defense contractor's production line to ensure that the manufacturer is producing systems that conform to specifications and perform as designed. Lot acceptance testing serves as the Navy's quality control check of the system before it is delivered to the fleet.
- **Maintenance and repair testing.** Following periodic maintenance, overhaul, modernization, or repair of systems, testing of the systems may be required to assess performance. These testing activities may be conducted at sea, shipyards, or Navy piers.

Preparatory checks of a platform or system are often made during Navy repair and construction activities prior to actual testing to ensure the platform or system is operating properly before expending the often-considerable resources involved in conducting a full-scale test. For example, a surface combatant may conduct a functional check of its hull-mounted sonar system in a nearshore area before conducting a more rigorous test of the sonar system farther offshore.

1.4.3.2 Methods of Testing

The Navy uses a number of different testing methods, including computer simulation and analysis, throughout the development of platforms and systems. Although computer simulation is a key component in the development of platforms and systems, it cannot provide information on how a platform or system will perform or whether it will be able to meet performance and other specification requirements in the environment in which it is intended to operate. Actual performance data are needed. For this reason, platforms and systems must undergo at-sea testing at some point in the development process. Thus, as with fleet training, the research and acquisition community requires access to large, relatively unrestricted ocean OPAREAs, multiple strike targets, and unique range attributes to support its testing requirements.

Navy platforms and systems must be tested and evaluated within the broadest range of operating conditions available (e.g., bathymetry, topography, geography, oceanographic conditions) because Navy personnel must be capable and confident to perform missions within the wide range of conditions that exist worldwide.

However, forecasting when technologies will be mature for testing is not easy. Programs and projects that have successfully completed the research and development stage and are determined mature enough to transition into an official, fully funded program have more defined test requirements. However, programs and projects are still subject to fiscal constraints and technical challenges that can often delay their development or even cancel continuation. Technical issues can require that systems or platforms undergo additional tests. Continued upgrades and maintenance of systems may occur on variable schedules due to availability, emergent requirements, or unforeseen system issues. Therefore, the types, amounts, and locations of testing activities may vary across different programs and projects in any given year. For all of these reasons, capturing the future testing requirements for platform, weapons, and system programs is challenging and reflects the system commands' best estimation based on historical and current best available information. To ensure comprehensive environmental impact analysis in this EIS/OEIS, the Navy assumes that all proposed testing projects will proceed as scheduled, with no unexpected delays.

1.5 Overview and Strategic Importance of Existing Range Complexes and Testing Ranges

The range complexes and testing ranges analyzed in this EIS/OEIS have each existed for many decades, some dating back to the 1940s. Range use and infrastructure have developed over time as military readiness requirements in support of modern warfare have evolved.

Proximity of the AFTT range complexes to naval homeports and air stations is strategically important to the Navy. Close access allows for efficient execution of military readiness activities including maintenance functions, as well as access to alternate airfields when necessary in order to provide for a margin of safety. Fuel is saved and equipment is exposed to less wear when ranges are near where the platforms are based. The proximity of training to homeports also ensures that Sailors and Marines do not need to spend unnecessary time away from their families during the training cycle. Additionally, the Navy is required to track and, where possible, limit the amount of time Sailors and Marines spend deployed from home (U.S. Department of the Navy, 2014a). Less time away from home is an important factor in military readiness, morale, and retention. The proximate availability of the AFTT range complexes is critical to Navy efforts in these areas.

The following range complexes and testing ranges are located in the AFTT Study Area and are described in further detail in Section 2.1 (Description of the Atlantic Fleet Training and Testing Study Area), as depicted in Figure 1.2-1:

- Northeast Range Complexes
- Naval Undersea Warfare Center Division, Newport Testing Range
- Virginia Capes Range Complex
- Navy Cherry Point Range Complex
- Jacksonville Range Complex
- Naval Surface Warfare Center Carderock Division, South Florida Ocean Measurement Facility Testing Range
- Key West Range Complex
- Gulf of Mexico Range Complex
- Naval Surface Warfare Center, Panama City Division Testing Range

1.6 The Environmental Planning Process

This EIS/OEIS is designed to comply with the requirements of both NEPA and Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions,* and support additional legal compliance requirements, as further described below. Since NEPA does not apply globally, President Carter issued Executive Order 12114 in 1979, furthering the purpose of NEPA by creating similar procedures for federal agency activities affecting the environment of the global commons outside U.S. jurisdiction. Thus, the Navy undertakes environmental planning for major Navy actions occurring throughout the world in accordance with applicable laws, regulations, and executive orders.

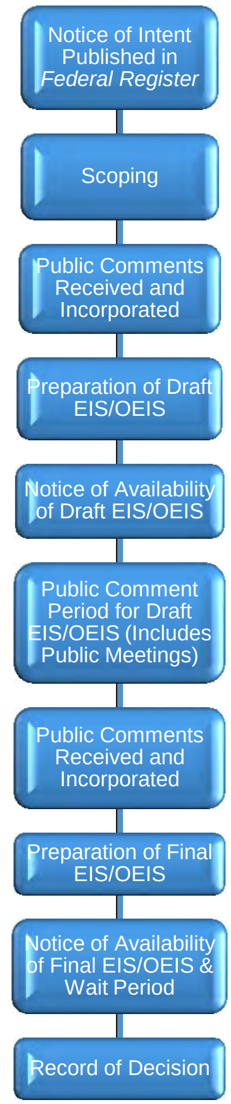

Figure 1.6-1: National Environmental Policy Act Process

1.6.1 National Environmental Policy Act Requirements

When developing an EIS, the first step in the NEPA process (Figure 1.6-1) is to prepare a Notice of Intent to develop an EIS. The Notice of Intent is published in the *Federal Register* and in local newspapers and provides an overview of the proposed action and the scope of the EIS. The Notice of Intent is also the first step in engaging the public, initiating the scoping process.

Scoping is an early and open process for developing the "scope" of issues to be addressed in an EIS and for identifying significant issues related to a proposed action. During this process, the public helps define and prioritize issues through written comments.

After the scoping process, a Draft EIS is prepared to assess potential impacts of the proposed action and alternatives on the environment. When completed, a Notice of Availability is published in the *Federal Register* and notices are placed in local or regional newspapers announcing the availability of the Draft EIS. The Draft EIS is circulated for public review and comment.

The Final EIS addresses all public comments received on the Draft EIS. Responses to public comments may include correction of data, clarifications of and modifications to analytical approaches, and inclusion of new or additional data and scientific information or analyses or explain why the comments do not warrant further agency response.

Finally, the decision-maker will issue a Record of Decision no earlier than 30 days after the Final EIS is made available to the public.

For a description of how the Navy complies with each of these requirements during the development of the AFTT EIS/OEIS, please see Chapter 8 (Public Involvement).

1.6.2 Executive Order 12114

Executive Order 12114 of 1979, *Environmental Impacts Abroad of Major Federal Actions*, furthers the purpose of NEPA by directing federal agencies to provide for informed environmental decision making for major federal actions outside the United States and its territories. Presidential Proclamation 5928, issued December 27, 1988, extended the exercise of U.S. sovereignty and jurisdiction under international law to 12 NM; however, the proclamation expressly provides that it does not extend or otherwise alter existing federal law or any associated jurisdiction, rights, legal interests, or obligations. Thus, as a matter of policy, the Navy analyzes environmental effects and actions within 12 NM under NEPA (an EIS) and those effects occurring beyond 12 NM under the provisions of Executive Order 12114 (an OEIS).

1.6.3 Other Environmental Requirements Considered

The Navy must comply with all applicable federal environmental laws, regulations, and executive orders, including, but not limited to, those listed below. Further information can be found in Chapter 6 (Regulatory Considerations).

1.6.3.1 Federal Statutes

The following are federal statutes that are most relevant to the analysis of impacts in this EIS/OEIS.

1.6.3.1.1 Clean Air Act

The purpose of the Clean Air Act (42 U.S.C. sections 7401–7671q) is to protect public health and welfare by the control of air pollution at its source and set forth primary and secondary National Ambient Air Quality Standards to establish criteria for states to attain, or maintain, these minimum standards. Non-criteria air pollutants that can affect human health are categorized as hazardous air pollutants under section 112 of the Clean Air Act. The U.S. Environmental Protection Agency identified 189 hazardous air pollutants such as benzene, perchloroethylene, and methylene chloride. Section 176(c)(1) of the Clean Air Act, commonly known as the General Conformity Rule, requires federal agencies to ensure that their actions conform to applicable state implementation plans for achieving and maintaining the National Ambient Air Quality Standards for criteria pollutants.

1.6.3.1.2 Clean Water Act

The Clean Water Act (33 U.S.C. sections 1251–1376) regulates discharges of pollutants in surface waters of the United States. The Uniform National Discharge Standards (40 Code of Federal Regulations part 1700) govern discharges incidental to the normal operation of Navy ships at sea.

1.6.3.1.3 Endangered Species Act

The ESA of 1973 (16 U.S.C. sections 1531–1544) provides for the conservation of endangered and threatened species and the ecosystems on which they depend. The act defines an endangered species as a species in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The U.S. Fish and Wildlife Service (USFWS) and NMFS jointly administer the ESA and are responsible for listing species as threatened or endangered and for designating critical habitat for listed species. The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species. Section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species, that agency is required to consult with the service (NMFS or USFWS) that has jurisdiction over the species (50 Code of Federal Regulations part 402.14(a)). Consultation will conclude with preparation of a biological opinion that determines whether the federal agency action will jeopardize listed species or adversely modify or destroy critical habitat. An incidental take statement is also included in every biological opinion where take is anticipated. This incidental take statement allows the proposed action to occur without being subject to penalties under the ESA.

1.6.3.1.4 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. sections 1801–1882), enacted in 1976 and amended by the Sustainable Fisheries Act in 1996, mandates identification and conservation of essential fish habitat. Essential fish habitat is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities. Federal agencies are required to consult with NMFS and to prepare an essential fish habitat assessment if potential adverse effects on essential fish habitat are anticipated from their activities. Any federal agency action that is authorized, funded, undertaken, or proposed to be undertaken that may affect fisheries is subject to the Magnuson-Stevens Fishery Conservation and Management Act. In addition, federal agencies shall consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this act.

1.6.3.1.5 Marine Mammal Protection Act

The MMPA of 1972 established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals on the high seas by vessels or persons subject to U.S. jurisdiction. The term "take," as defined in section 3 (16 U.S.C. section 1362 (13)) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment: Level A (potential injury) and Level B (potential behavioral disturbance).

The MMPA directs the Secretary of Commerce, as delegated to NMFS, to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens or agencies who engage in a specified activity (other than commercial fishing) within a specified geographical region if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigatable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The regulation must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for subsistence uses (where relevant), and requirements pertaining to monitoring and reporting of such taking.

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment, removed the "specified geographic area" requirement, and removed the small numbers provision as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government consistent with section 104(c)(3) (16 U.S.C. section 1374(c)(3)). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). A "military readiness activity" is defined as "all training and operations of the Armed Forces that relate to combat" and the "adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use." For military readiness activities, the relevant definition of harassment is any act that:

- injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment") or
- disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 U.S.C. section 1362(18)(B)(i) and (ii)).

1.6.3.1.6 Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (16 U.S.C. sections 703–712) and the Migratory Bird Conservation Act (16 U.S.C. sections 715–715d, 715e, 715f–715r) of February 18, 1929, are the primary laws in the United States established to conserve migratory birds. The Migratory Bird Treaty Act prohibits the taking, killing, or possessing of migratory birds or the parts, nests, or eggs of such birds, unless permitted by regulation.

The 2003 National Defense Authorization Act provided interim authority to members of the Armed Forces to incidentally take migratory birds during approved military readiness activities without violating the Migratory Bird Treaty Act. The National Defense Authorization Act provided this interim authority to give the Secretary of the Interior time to exercise his/her authority under section 704(a) of the Migratory Bird Treaty Act to prescribe regulations authorizing such incidental take. The Secretary of the Interior delegated this task to the USFWS. On February 28, 2007, the USFWS issued a final military readiness rule authorizing members of the Armed Forces to incidentally take migratory birds during military readiness activities.

1.6.3.1.7 National Historic Preservation Act

The National Historic Preservation Act of 1966 (54 U.S.C. section 300101 et seq.) establishes preservation as a national policy and directs the federal government to provide leadership in preserving, restoring, and maintaining the historic and cultural environment. Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment. The National Historic Preservation Act created the National Register of Historic Places, the list of National Historic Landmarks, and the State Historic Preservation Offices to help protect each state's historical and archaeological resources. Section 110 of the National Historic Preservation Act requires federal agencies to assume responsibility for the preservation of historic properties owned or controlled by them and to locate, inventory, and nominate all properties that qualify for the National Register. Agencies shall exercise caution to assure that significant properties are not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate. The National Historic Preservation Act applies to cultural resources evaluated in this EIS/OEIS.

1.6.3.1.8 National Marine Sanctuaries Act

Under the Marine Protection, Research, and Sanctuaries Act of 1972 (also known as the National Marine Sanctuaries Act), the Secretary of Commerce may establish a national marine sanctuary for marine areas with special conservation, recreational, ecological, historical, cultural, archaeological, scientific, educational, or aesthetic qualities. Day-to-day management of national marine sanctuaries has been delegated by the Secretary of Commerce to the National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries. Once a sanctuary is designated, the Secretary of Commerce may authorize activities in the sanctuary only if they can be certified to be consistent with the National Marine Sanctuaries Act and can be carried out within the regulations for the sanctuary. Regulations exist for each sanctuary, and military activities may be authorized within those regulations. Additionally, the National Marine Sanctuaries Act requires federal agencies whose actions are "likely to destroy, cause the loss of, or injure a sanctuary resource" to consult with the program before taking the action. In these cases, the Office of National Marine Sanctuaries is required to recommend reasonable and prudent alternatives to protect sanctuary resources if the action is likely to destroy, cause the loss of, or injure a sanctuary resource. If the federal agency decides not to follow the recommendations, it must respond in writing to the Office of National Marine Sanctuaries.

1.6.3.2 Executive Orders

The following are Executive Orders that are most relevant to the analysis of impacts in this EIS/OEIS.

1.6.3.2.1 Executive Order 13693, *Planning for Federal Sustainability in the Next Decade*

Executive Order 13693 was issued in March 2015 and revoked Executive Order 13423 and Executive Order 13514. The goal of Executive Order 13693 is to maintain federal leadership in sustainability and greenhouse gas emission reductions. Specifically, Executive Order 13693 looks to cut the federal government's greenhouse gas emissions 40 percent over the next decade, relative to 2008 levels, by increasing efficiency and improving environmental performance.

1.6.3.2.2 Executive Order 13158, *Marine Protected Areas*

Executive Order 13158 (65 *Federal Register* 34909) was authorized in May 2000 to protect special natural and cultural resources by strengthening and expanding the nation's system of marine protected areas. The purpose of the order is to (1) strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded marine protected areas; (2) develop a scientifically based, comprehensive national system of marine protected areas representing diverse U.S. marine ecosystems and the nation's natural and cultural resources; and (3) avoid causing harm to marine protected areas through federally conducted, approved, or funded activities.

1.6.3.2.3 Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*

Executive Order 13547 (75 *Federal Register* 43023) was issued in 2010. It is a comprehensive national policy for the stewardship of the ocean, our coasts, and the Great Lakes. This order adopts the recommendations of the Interagency Ocean Policy Task Force and directs executive agencies to implement the recommendations under the guidance of a National Ocean Council. This order establishes a national policy to ensure the protection, maintenance, and restoration of the health of ocean, coastal, and Great Lakes ecosystems and resources; enhance the sustainability of ocean and coastal economies; preserve our maritime heritage; support sustainable uses and access; provide for adaptive management to enhance our understanding of and capacity to respond to climate change and ocean acidification; and coordinate with our national security and foreign policy interests.

Key to implementing this executive order is the establishment of Regional Planning Bodies and development of Regional Marine Plans. Within the AFTT Study Area, the Northeast and Mid-Atlantic Regional Planning Bodies developed Plans that were certified by the National Ocean Council in December 2016. In those Plans, the Department of Defense committed to using the Plans and Regional

Data Portals to inform pertinent environmental programs, initiatives, and planning documents. The Regional Ocean Plans and Data Portals were used as a resource throughout the development of this EIS.

1.7 Scope and Content

In this EIS/OEIS, the Navy analyzed military readiness training and testing activities that could potentially impact human and natural resources, especially marine mammals, sea turtles, and other marine resources. The range of alternatives includes the No Action Alternative and two action alternatives. In this EIS/OEIS, the Navy analyzed direct, indirect, and cumulative impacts. The Navy is the lead agency for the Proposed Action and is responsible for the scope and content of this EIS/OEIS. The NMFS is a cooperating agency because of its expertise and regulatory authority over certain marine resources. Additionally, this EIS/OEIS may be adopted by NMFS to address NEPA requirements associated with the MMPA rule-making process and to support the issuance of the Letters of Authorization to the Navy.

In accordance with the Council on Environmental Quality Regulations, 40 Code of Federal Regulations part 1505.2, the Navy will issue a Record of Decision that provides the rationale for choosing one of the alternatives. The NMFS plans to adopt this EIS/OEIS and issue a separate Record of Decision prior to issuance of any regulations or letters of authorization under section 101(a)(5)(A) of the MMPA.

1.8 Organization of this Environmental Impact Statement/Overseas Environmental Impact Statement

This EIS/OEIS is organized as follows:

- Chapter 1 describes the purpose of and need for the Proposed Action.
- Chapter 2 describes the Proposed Action, alternatives considered but eliminated in the EIS/OEIS, and alternatives to be carried forward for analysis in the EIS/OEIS.
- Chapter 3 describes the existing conditions of the affected environment and analyzes the potential impacts of the proposed training and testing activities for each alternative.
- Chapter 4 describes the analysis of cumulative impacts, which are the impacts of the Proposed Action when added to past, present, and reasonably foreseeable future actions.
- Chapter 5 describes the protective measures the Navy evaluated that could mitigate impacts to the environment.
- Chapter 6 describes considerations required by NEPA and describes how the Navy complies with other federal, state, and local plans, policies, and regulations.
- Chapter 7 includes a list of preparers of this EIS/OEIS.
- Chapter 8 includes a list of agencies, government officials, tribes, groups, and individuals on the distribution list for receipt of the Draft EIS/OEIS.
- Appendices provide technical information that supports the EIS/OEIS analyses and its conclusions.

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

TABLE OF CONTENTS

List of Figures

List of Tables

2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The United States (U.S.) Department of the Navy (Navy) proposes to conduct military readiness training activities, and research, development, testing, and evaluation (hereinafter referred to as "testing") activities in the Atlantic Fleet Training and Testing (AFTT) Study Area, as represented in Figure 2.1-1. These military readiness activities include the use of active sonar and explosives within existing range complexes and testing ranges and additional areas located in the Atlantic Ocean along the eastern coast of North America, in portions of the Caribbean Sea and the Gulf of Mexico, at Navy pierside locations, within port transit channels, near civilian ports, and in bays, harbors, and inland waterways (e.g., lower Chesapeake Bay). These military readiness activities are generally consistent with those analyzed in the AFTT Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) completed in August 2013 and are representative of training and testing that the Navy has been conducting in the AFTT Study Area for decades.

In this chapter, the Navy builds upon the purpose and need to train and test by describing the Study Area and identifying the primary mission areas under which these military readiness activities are conducted. Each warfare community, e.g., aviation, surface, submarine, expeditionary, conducts activities that contribute to the success of a primary mission area (described in Section 2.2, Primary Mission Areas). Each primary mission area requires unique skills, sensors, weapons, and technologies to accomplish the mission. For example, under the anti-submarine warfare primary mission area, surface, submarine, and aviation warfare communities each utilize different skills, sensors, and weapons to locate, track, and eliminate submarine threats. The testing community contributes to the success of anti-submarine warfare by anticipating and identifying technologies and systems that respond to the needs of the warfare communities. As each warfare community develops its basic skills and integrates them into combined units and strike groups, the problems of communication, coordination and planning, movement, and positioning of naval forces and targeting/delivery of weapons become increasingly complex. This complexity creates a need for coordinated training and testing between the fleets and systems commands.

This chapter describes the training and testing activities, which compose the Proposed Action, necessary to meet military readiness requirements. These activities are then analyzed for their potential effects on the environment in the following chapters of this EIS/OEIS. For further details regarding specific training and testing activities, please see Appendix A (Navy Activity Descriptions). In accordance with the Marine Mammal Protection Act (MMPA), the Navy plans to submit to the National Marine Fisheries Service (NMFS) an application requesting authorization for the take of marine mammals incidental to training and testing activities described in this EIS/OEIS. NMFS' proposed action will be a direct outcome of responding to the Navy's request for an incidental take authorization pursuant to the MMPA.

2.1 DESCRIPTION OF THE ATLANTIC FLEET TRAINING AND TESTING STUDY AREA

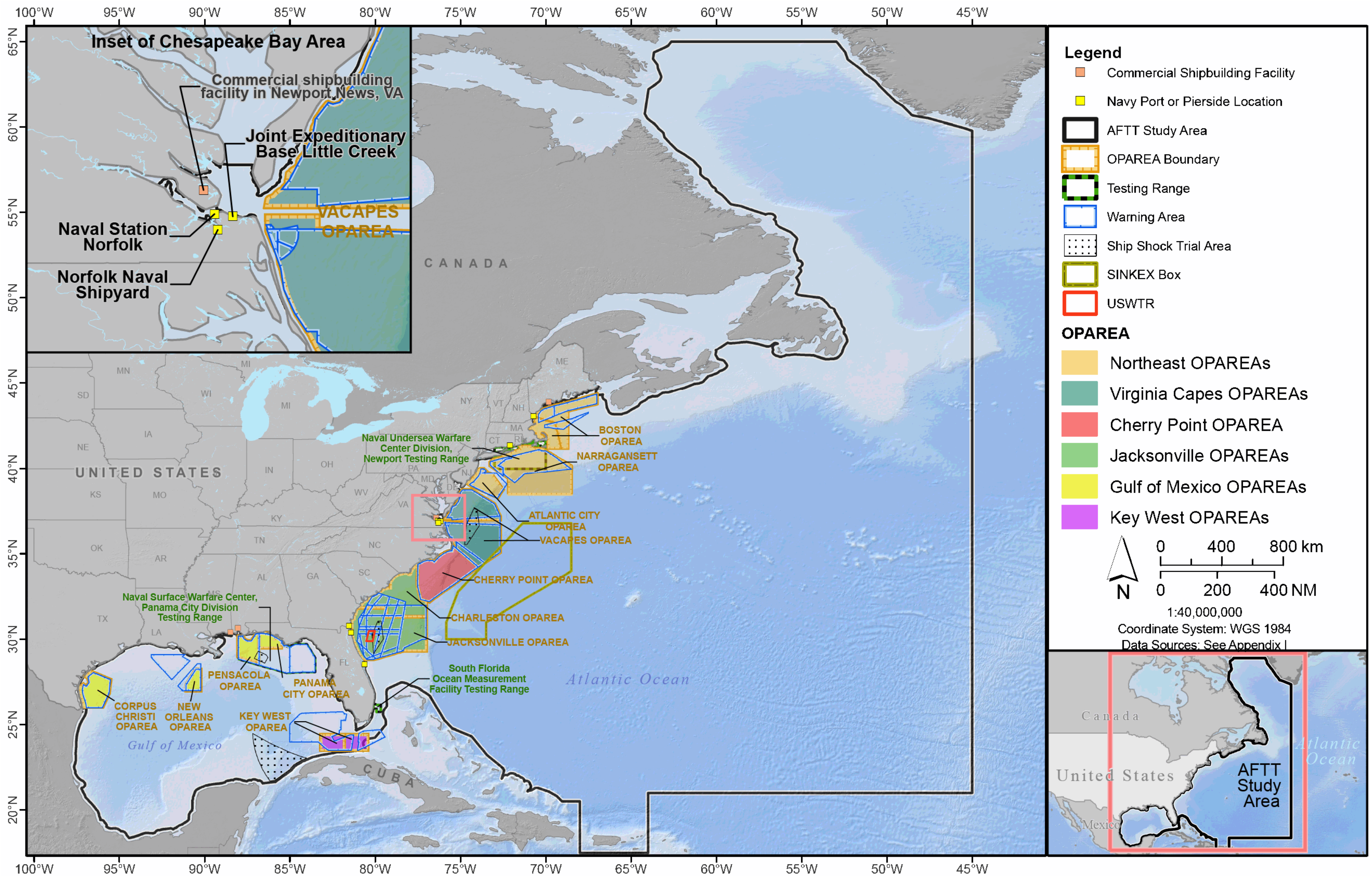
The AFTT EIS/OEIS Study Area includes areas of the western Atlantic Ocean along the east coast of North America, portions of the Caribbean Sea, and the Gulf of Mexico. The Study Area begins at the mean high tide line along the U.S. coast and extends east to the 45-degree west longitude line, north to the 65 degree north latitude line, and south to approximately the 20-degree north latitude line. The Study Area also includes Navy pierside locations and port transit channels, bays, harbors, and inland waterways, and civilian ports where training and testing occurs (Section 2.1.10, Inshore Locations). The Study Area generally follows the Commander Task Force 80 area of operations, covering approximately

2.6 million square nautical miles (NM^2) of ocean area, and includes designated Navy range complexes and associated operating areas (OPAREAs) and special use airspace. While the AFTT Study Area itself is very large, it is important to note that the vast majority of Navy training and testing occurs in designated range complexes and testing ranges, as explained in Section 1.4 (Purpose of and Need for Proposed Military Readiness Training and Testing Activities).

A Navy range complex consists of geographic areas that encompasses a water component (above and below the surface) and airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur. Range complexes include established operating areas and special use airspace, which may be further divided to provide better control of the area for safety reasons. The terms used to describe the components of the range complexes are described below:

- **Airspace**
  - **Special Use Airspace**. Airspace of defined dimensions where activities must be confined because of their nature or where limitations may be imposed upon aircraft operations that are not part of those activities (Federal Aviation Administration Order 7400.8). Types of special use airspace most commonly found in range complexes include the following:
    - **Restricted Areas**. Airspace where aircraft are subject to restriction due to the existence of unusual, often invisible hazards (e.g., release of ordnance) to aircraft. Some areas are under strict control of the Department of Defense (DoD) and some are shared with non-military agencies.
    - **Warning Areas**. Areas of defined dimensions, extending from 3 nautical miles (NM) outward from the coast of the United States, which serve to warn non-participating aircraft of potential danger.
    - **Air Traffic Control Assigned Airspace**. Airspace of defined vertical/lateral limits, assigned by Air Traffic Control, for the purpose of providing air traffic segregation between the specified activity being conducted within the assigned airspace and other instrument flight rules traffic.
- **Sea and Undersea Space**
  - **Operating Areas**. An ocean area defined by geographic coordinates with defined surface and subsurface areas and associated special use airspace. OPAREAs include the following:
    - **Restricted Areas**. A restricted area is a defined water area for the purpose of prohibiting or limiting public access to the area. Restricted areas generally provide security for government property and also provide protection to the public from the risks of damage or injury arising from the government's use of that area (Title 33 Code of Federal Regulations [CFR] part 334).

The Study Area includes only the in-water components of the range complexes and testing ranges; land components associated with the range complexes and testing ranges are not included in the Study Area and no activities on these land areas are included as part of the Proposed Action. The Study Area also includes various bays, harbors, inland waterways, and pierside locations, which are within the boundaries of the range complexes, but are detailed separately in Section 2.1.10 (Inshore Locations).



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; VACAPES: Virginia Capes

Figure 2.1-1: Atlantic Fleet Training and Testing Study Area

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The Study Area is depicted in Figure 2.1-1. Regional maps contained in Figure 2.1-2 through Figure 2.1-4 are provided for additional detail of the range complexes and testing ranges. The range complexes and testing ranges are described in the following sections.

2.1.1 Northeast Range Complexes

The Northeast Range Complexes include the Boston Range Complex, Narragansett Bay Range Complex, and Atlantic City Range Complex (Figure 2.1-2). These range complexes span 761 miles (mi.) along the coast from Maine to New Jersey. The Northeast Range Complexes include special use airspace with associated warning areas and surface and subsurface sea space of the Boston OPAREA, Narragansett Bay OPAREA, and Atlantic City OPAREA.

2.1.1.1 Airspace

The Northeast Range Complexes include over 25,000 NM^2 of special use airspace. The altitude at which aircraft may fly varies from just above the surface to 60,000 feet (ft.), except for one specific warning area (W-107A) in the Atlantic City Range Complex, which is 18,000 ft. to unlimited altitudes. Six warning areas are located within the Northeast Range Complexes.

2.1.1.2 Sea and Undersea Space

The Northeast Range Complexes include three OPAREAs—Boston, Narragansett Bay, and Atlantic City. These OPAREAs encompass over 45,000 NM^2 of sea space and undersea space. The Boston, Narragansett Bay, and Atlantic City OPAREAs are offshore of the states of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey. The OPAREAs of the three complexes are outside 3 NM but within 200 NM from shore.

2.1.2 Naval Undersea Warfare Center Division, Newport Testing Range

The Naval Undersea Warfare Center Division, Newport Testing Range includes the waters of Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, and Long Island Sound (Figure 2.1-2).

2.1.2.1 Airspace

A portion of Naval Undersea Warfare Center Division, Newport Testing Range is under restricted area R-4105A, known as No Man's Land Island. A minimal amount of testing occurs in the airspace within Naval Undersea Warfare Center Division, Newport Testing Range.

2.1.2.2 Sea and Undersea Space

Three restricted areas are located within the Naval Undersea Warfare Center Division, Newport Testing Range:

- Coddington Cove Restricted Area (0.5 NM^2 adjacent to Naval Undersea Warfare Center Division, Newport)
- Narragansett Bay Restricted Area (6.1 NM^2 area surrounding Gould Island), including the Hole Test Area and the North Test Range
- Rhode Island Sound Restricted Area, a rectangular box (27.2 NM^2) located in Rhode Island and Block Island Sounds

2.1.3 Virginia Capes Range Complex

The Virginia Capes Range Complex spans 270 mi. along the coast from Delaware to North Carolina from the shoreline to 155 NM seaward (Figure 2.1-2). The Virginia Capes Range Complex includes special use airspace with associated warning and restricted areas, and surface and subsurface sea space of the Virginia Capes OPAREA. The Virginia Capes Range Complex also includes established mine warfare training areas located within the lower Chesapeake Bay and off the coast of Virginia.

2.1.3.1 Airspace

The Virginia Capes Range Complex includes over 28,000 NM^2 of special use airspace. Flight altitudes range from surface to ceilings of 18,000 ft. to unlimited altitudes. Five warning areas are located within the Virginia Capes Range Complex. Restricted airspace extends from the shoreline to approximately the 3 NM state territorial sea limit within the Virginia Capes Range Complex and is designated as R-6606.

2.1.3.2 Sea and Undersea Space

The Virginia Capes Range Complex shore boundary roughly follows the shoreline from Delaware to North Carolina; the seaward boundary extends 155 NM into the Atlantic Ocean proximate to Norfolk, Virginia. The Virginia Capes OPAREA encompasses over 27,000 NM^2 of sea space and undersea space. The Virginia Capes OPAREA is offshore of the states of Delaware, Maryland, Virginia, and North Carolina.

2.1.4 Navy Cherry Point Range Complex

The Navy Cherry Point Range Complex, off the coast of North Carolina and South Carolina, encompasses the sea space from the shoreline to 120 NM seaward. The Navy Cherry Point Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Cherry Point OPAREA (Figure 2.1-3). The Navy Cherry Point Range Complex is adjacent to the U.S. Marine Corps Cherry Point and Camp Lejeune Range Complexes associated with Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

2.1.4.1 Airspace

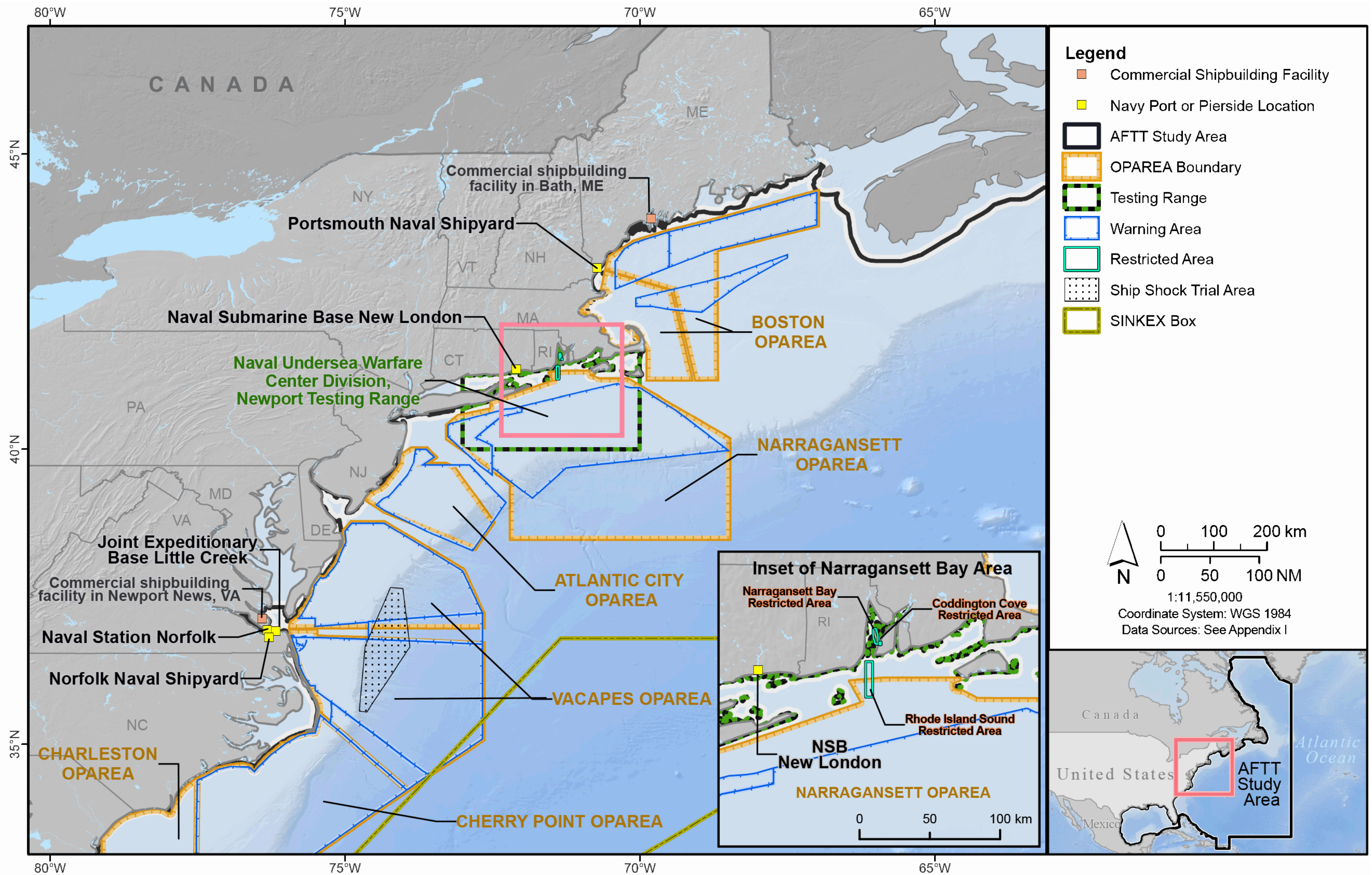
The Navy Cherry Point Range Complex includes over 18,000 NM^2 of special use airspace. The airspace varies from the surface to unlimited altitudes. A single warning area is located within the Navy Cherry Point Range Complex.

2.1.4.2 Sea and Undersea Space

The Navy Cherry Point Range Complex is roughly aligned with the shoreline and extends out 120 NM into the Atlantic Ocean. The Navy Cherry Point OPAREA encompasses over 18,000 NM^2 of sea space and undersea space.

2.1.5 Jacksonville Range Complex

The Jacksonville Range Complex spans 520 mi. along the coast from North Carolina to Florida from the shoreline to 250 NM seaward. The Jacksonville Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Charleston and Jacksonville OPAREAs. The Undersea Warfare Training Range is located within the Jacksonville Range Complex (Figure 2.1-3).



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; VACAPES: Virginia Capes; NSB: Naval Submarine Base

Figure 2.1-2: Study Area, Mid-Atlantic Region

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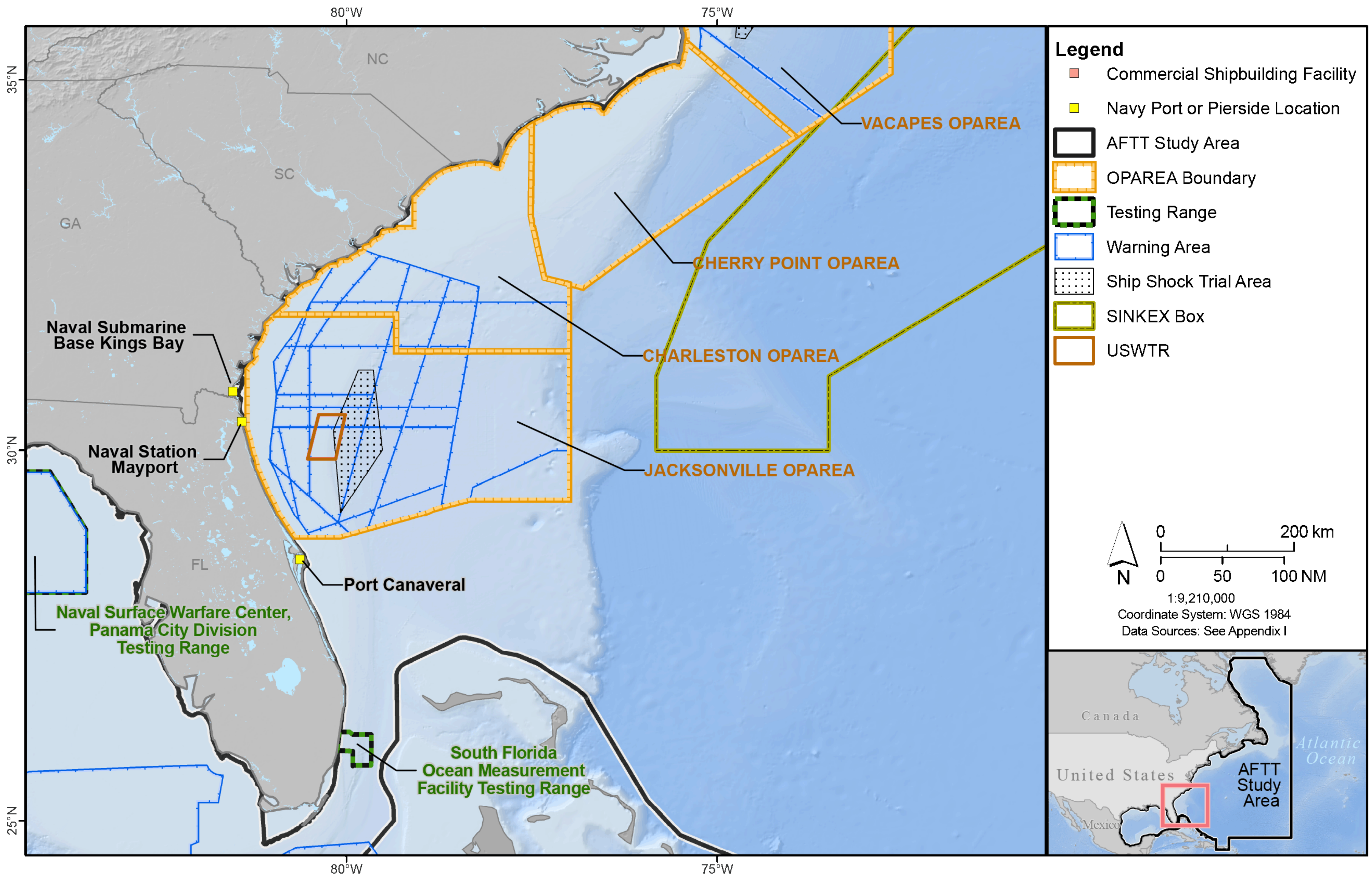

Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; VACAPES: Virginia Capes

Figure 2.1-3: Study Area, Southeast Region

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2.1.5.1 Airspace

The Jacksonville Range Complex includes approximately 40,000 NM^2 of special use airspace. Flight altitudes range from the surface to unlimited altitudes. Nine warning areas are located within the Jacksonville Range Complex.

2.1.5.2 Sea and Undersea Space

The Jacksonville Range Complex shore boundary roughly follows the shoreline and extends out 250 NM into the Atlantic Ocean proximate to Jacksonville, Florida. The Jacksonville Range Complex includes two OPAREAs: Charleston and Jacksonville. Combined, these OPAREAs encompass over 50,000 NM^2 of sea space and undersea space. The Charleston and Jacksonville OPAREAs are offshore of the states of North Carolina, South Carolina, Georgia, and Florida. The Undersea Warfare Training Range is located within the Jacksonville Range Complex.

2.1.6 Naval Surface Warfare Center Carderock Division, South Florida Ocean Measurement Facility Testing Range

The Naval Surface Warfare Center Carderock Division operates the South Florida Ocean Measurement Facility Testing Range, an offshore testing area in support of various Navy and non-Navy programs. The South Florida Ocean Measurement Facility Testing Range is located adjacent to the Port Everglades entrance channel in Fort Lauderdale, Florida (Figure 2.1-3). The test area at the South Florida Ocean Measurement Facility Testing Range includes an extensive cable field located within a restricted anchorage area and two designated submarine OPAREAs.

2.1.6.1 Airspace

The South Florida Ocean Measurement Facility Testing Range does not have associated special use airspace. The airspace adjacent to the South Florida Ocean Measurement Facility Testing Range is managed by the Fort Lauderdale International Airport. Air operations at the South Florida Ocean Measurement Facility Testing Range are coordinated with Fort Lauderdale International Airport by the air units involved in the testing events.

2.1.6.2 Sea and Undersea Space

The South Florida Ocean Measurement Facility Testing Range is divided into four subareas:

- The Port Everglades Shallow Submarine OPAREA is a 120-NM^2 area that encompasses nearshore waters from the shoreline to 900 ft. deep and 8 NM offshore.
- The Training Minefield is a 41-NM^2 area used for special purpose surface ship and submarine operations where the test vessels are restricted from maneuvering and require additional protection. This Training Minefield encompasses waters from 60 to 600 ft. deep and from 1 to 3 NM offshore.
- The Port Everglades Deep Submarine OPAREA is a 335-NM^2 area that encompasses the offshore range from 900 to 2,500 ft. in depth and from 9 to 25 NM offshore.
- The Port Everglades Restricted Anchorage Area is an 11-NM^2 restricted anchorage area ranging in depths from 60 to 600 ft. where the majority of the South Florida Ocean Measurement Facility Testing Range cables run from offshore sensors to the shore facility and where several permanent measurement arrays are used for vessel signature acquisition.

2.1.7 Key West Range Complex

The Key West Range Complex lies off the southwestern coast of mainland Florida and along the southern Florida Keys, extending seaward into the Gulf of Mexico 150 NM and south into the Straits of Florida 60 NM. The Key West Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Key West OPAREA (Figure 2.1-4).

2.1.7.1 Airspace

The Key West Range Complex includes over 20,000 NM^2 of special use airspace. Flight altitudes range from the surface to unlimited altitudes. Eight warning areas, Bonefish Air Traffic Control Assigned Airspace, and Tortugas Military OPAREA are located within the Key West Range Complex.

2.1.7.2 Sea and Undersea Space

The Key West OPAREA is over 8,000 NM^2 of sea space and undersea space south of Key West, Florida.

2.1.8 Naval Surface Warfare Center, Panama City Division Testing Range

The Naval Surface Warfare Center, Panama City Division Testing Range is located off the panhandle of Florida and Alabama, extending from the shoreline to 120 NM seaward, and includes St. Andrew Bay. Naval Surface Warfare Center, Panama City Division Testing Range also includes special use airspace and offshore surface and subsurface waters of offshore OPAREAs (Figure 2.1-4).

2.1.8.1 Airspace

Special use airspace associated with Naval Surface Warfare Center, Panama City Division Testing Range includes three warning areas.

2.1.8.2 Sea and Undersea Space

The Naval Surface Warfare Center, Panama City Division Testing Range includes the waters of St. Andrew Bay and the sea space within the Gulf of Mexico from the mean high tide line to 120 NM offshore. The Panama City OPAREA covers just over 3,000 NM^2 of sea space and lies off the coast of the Florida panhandle. The Pensacola OPAREA lies off the coast of Alabama and Florida west of the Panama City OPAREA and totals just under 5,000 NM^2.

2.1.9 Gulf of Mexico Range Complex

Unlike most of the range complexes previously described, the Gulf of Mexico Range Complex includes geographically separated areas throughout the Gulf of Mexico. The Gulf of Mexico Range Complex includes special use airspace with associated warning areas and restricted airspace and surface and subsurface sea space of the Panama City, Pensacola, New Orleans, and Corpus Christi OPAREAs (Figure 2.1-4).

2.1.9.1 Airspace

The Gulf of Mexico Range Complex includes approximately 20,000 NM^2 of special use airspace. Flight altitudes range from the surface to unlimited altitudes. Six warning areas are located within the Gulf of Mexico Range Complex. Restricted airspace associated with the Pensacola OPAREA, designated R-2908, extends from the shoreline to approximately 3 NM offshore.

2.1.9.2 Sea and Undersea Space

The Gulf of Mexico Range Complex encompasses approximately 17,000 NM^2 of sea and undersea space and includes 285 NM of coastline. The OPAREAs span from the eastern shores of Texas to the western panhandle of Florida. They are described as follows:

- Panama City OPAREA lies off the coast of the Florida panhandle and totals approximately 3,000 NM^2.
- Pensacola OPAREA lies off the coast of Florida west of the Panama City OPAREA and totals approximately 4,900 NM^2.
- New Orleans OPAREA lies off the coast of Louisiana and totals approximately 2,600 NM^2.
- Corpus Christi OPAREA lies off the coast of Texas and totals approximately 6,900 NM^2.

2.1.10 Inshore Locations

Although within the boundaries of the range complexes detailed in Section 2.1.1 (Northeast Range Complex) through Section 2.1.9 (Gulf of Mexico Range Complex), various inshore locations, including piers, bays, and civilian ports, are identified in Appendix A (Navy Activity Descriptions) for various activities (Figure 2.1-5).

2.1.10.1 Pierside Locations

For purposes of this EIS/OEIS, pierside locations include channels and transit routes in ports and facilities associated with the following Navy ports and naval shipyards:

- Portsmouth Naval Shipyard, Kittery, Maine
- Naval Submarine Base New London, Groton, Connecticut
- Naval Station Norfolk, Norfolk, Virginia
- Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach, Virginia
- Norfolk Naval Shipyard, Portsmouth, Virginia
- Naval Submarine Base Kings Bay, Kings Bay, Georgia
- Naval Station Mayport, Jacksonville, Florida
- Port Canaveral, Cape Canaveral, Florida

Navy-contractor shipyards in the following cities are also in the Study Area:

- Bath, Maine
- Groton, Connecticut
- Newport News, Virginia
- Mobile, Alabama
- Pascagoula, Mississippi

2.1.10.2 Bays, Harbors, and Inland Waterways

Inland waterways used for training and testing activities include:

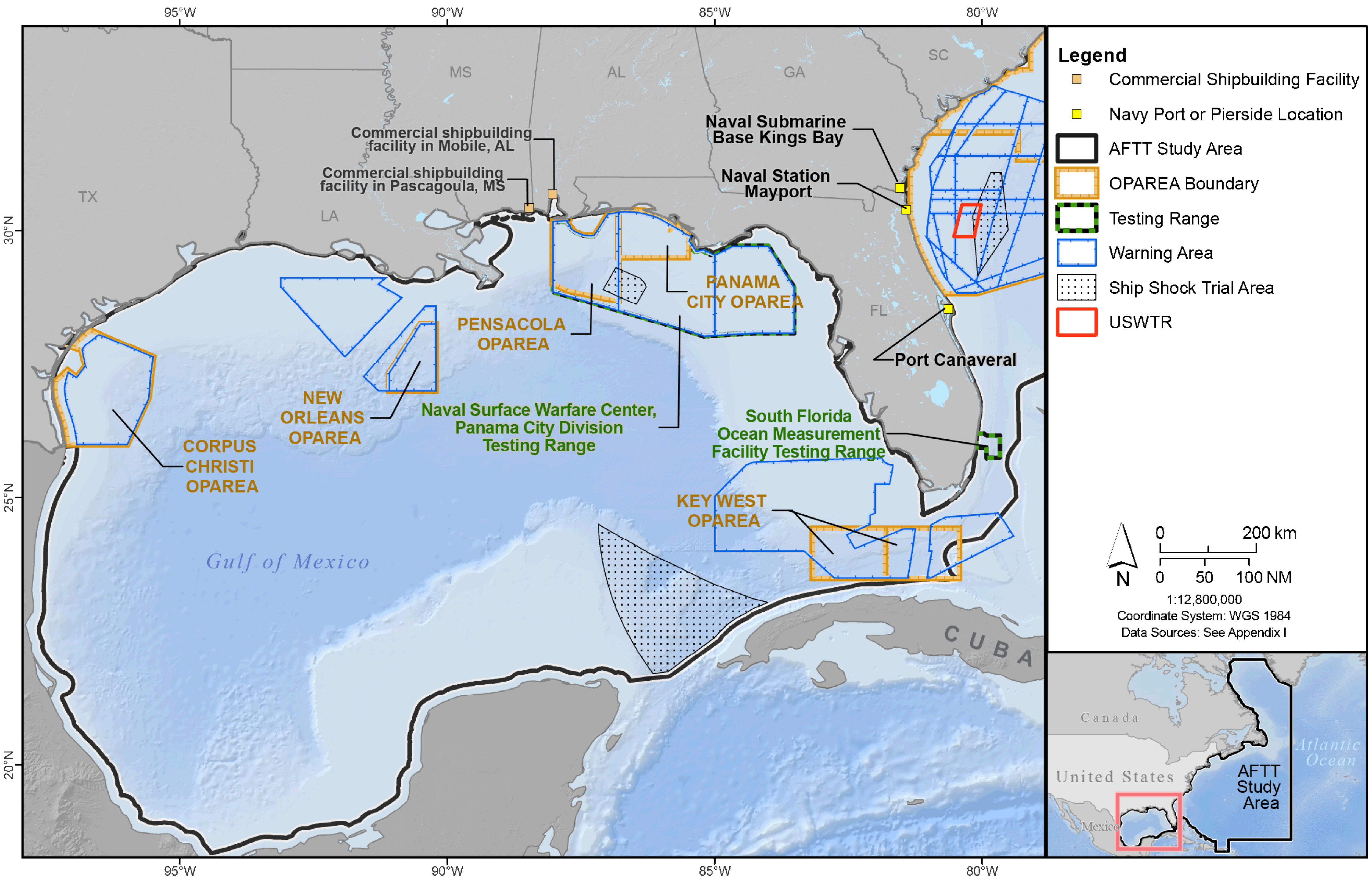
- Narragansett Bay Range Complex/Naval Undersea Warfare Center Division, Newport Testing Range: Thames River, Narragansett Bay
- Virginia Capes Range Complex: James River and tributaries, Broad Bay, York River
- Jacksonville Range Complex: southeast Kings Bay, Cooper River, St. Johns River
- Gulf of Mexico Range Complex/Naval Surface Warfare Center, Panama City Division: St. Andrew Bay

2.1.10.3 Civilian Ports

Civilian ports included for civilian port defense training events are listed in Section A.2.7.3 of Appendix A (Navy Activity Descriptions) and include:

- Boston, Massachusetts
- Earle, New Jersey
- Kings Bay, Georgia
- Mayport, Florida
- Savannah, Georgia

- Delaware Bay, Delaware
- Hampton Roads, Virginia
- Morehead City, North Carolina
- Wilmington, North Carolina
- Port Canaveral, Florida
- Tampa, Florida
- Beaumont, Texas
- Corpus Christi, Texas



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

Figure 2.1-4: Study Area, Gulf of Mexico Region

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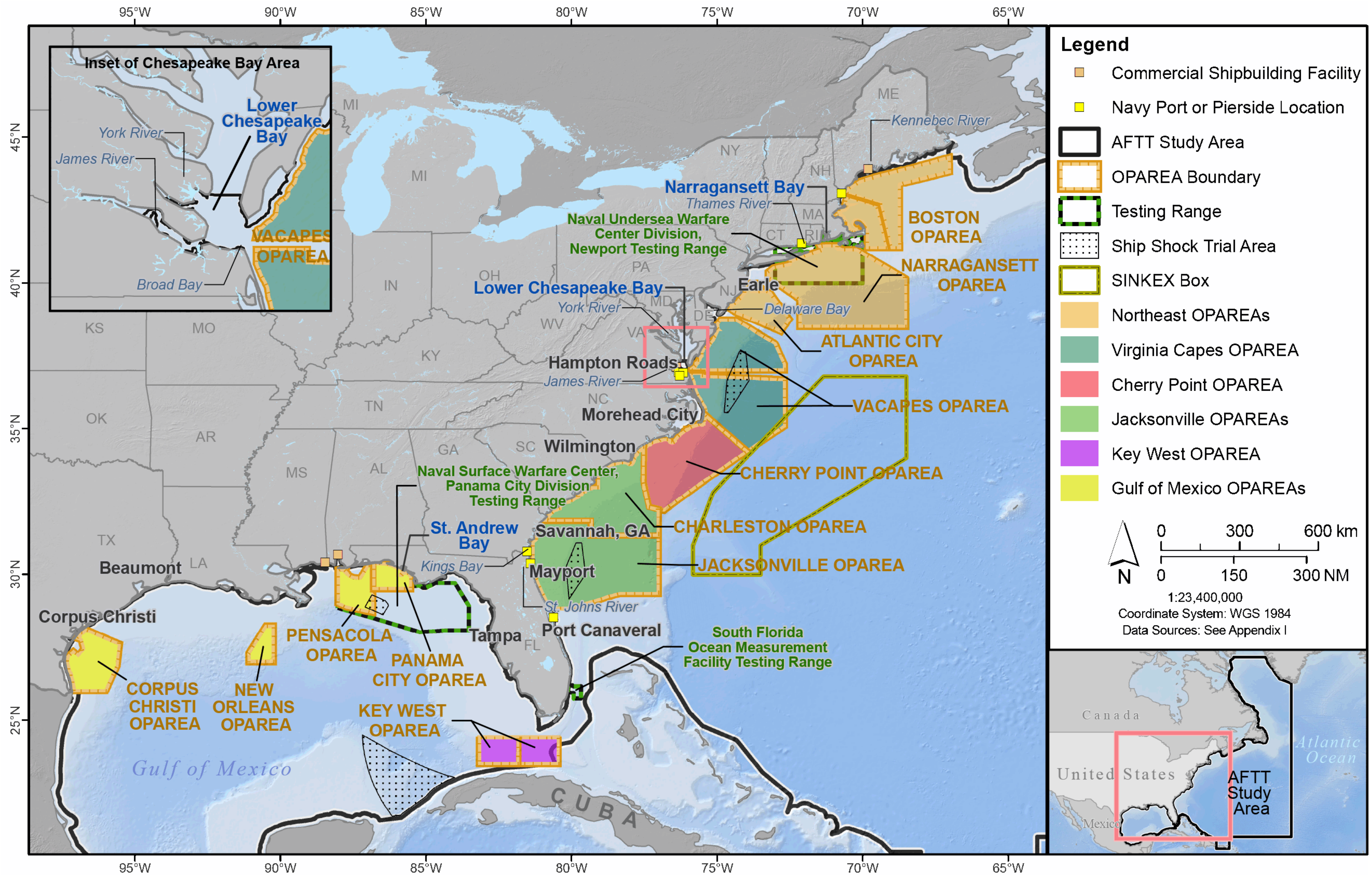

Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

Figure 2.1-5: Study Area, Inshore Locations

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2.2 Primary Mission Areas

The Navy categorizes its activities into functional warfare areas called primary mission areas. These activities generally fall into the following seven primary mission areas:

- air warfare
- amphibious warfare
- anti-submarine warfare
- electronic warfare
- expeditionary warfare
- mine warfare
- surface warfare

Most activities addressed in this EIS/OEIS are categorized under one of these primary mission areas; the testing community has three additional categories of activities for vessel evaluation, unmanned systems, and acoustic and oceanographic science and technology. Activities that do not fall within these areas are listed as “other activities”. Each warfare community (surface, subsurface, aviation, and special warfare) may train in some or all of these primary mission areas. The research and acquisition community also categorizes most, but not all, of its testing activities under these primary mission areas. A description of the sonar, munitions, targets, systems and other material used during training and testing activities within these primary mission areas is provided in Appendix A (Navy Activity Descriptions).

2.2.1 Air Warfare

The mission of air warfare is to destroy or reduce enemy air and missile threats (including unmanned airborne threats) and serves two purposes: to protect U.S. forces from attacks from the air and to gain air superiority. Air warfare provides U.S. forces with adequate attack warnings, while denying hostile forces the ability to gather intelligence about U.S. forces.

Aircraft conduct air warfare through radar search, detection, identification, and engagement of airborne threats. Surface ships conduct air warfare through an array of modern anti-aircraft weapon systems such as aircraft detecting radar, naval guns linked to radar-directed fire-control systems, surface-to-air missile systems, and radar-controlled cannons for close-in point defense.

Testing of air warfare systems is required to ensure the equipment is fully functional under the conditions in which it will be used. Tests may be conducted on radar and other early warning detection and tracking systems, new guns or gun rounds, and missiles. Testing of these systems may be conducted on new ships and aircraft, and on existing ships and aircraft following maintenance, repair, or modification. For some systems, tests are conducted periodically to assess operability. Additionally, tests may be conducted in support of scientific research to assess new and emerging technologies.

2.2.2 Amphibious Warfare

The mission of amphibious warfare is to project military power from the sea to the shore (i.e., attack a threat on land by a military force embarked on ships) through the use of naval firepower and expeditionary landing forces. Amphibious warfare operations include small unit reconnaissance or raid missions to large-scale amphibious exercises involving multiple ships and aircraft combined into a strike group.

Amphibious warfare training ranges from individual, crew, and small unit events to large task force exercises. Individual and crew training include amphibious vehicles and naval gunfire support training. Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Large-scale amphibious exercises involve ship-to-shore maneuver, naval fire support, such as shore bombardment, air strikes, and attacks on targets that are in close proximity to friendly forces.

Testing of guns, munitions, aircraft, ships, and amphibious vessels and vehicles used in amphibious warfare are often integrated into training activities and, in most cases, the systems are used in the same manner in which they are used for fleet training activities. Amphibious warfare tests, when integrated with training activities or conducted separately as full operational evaluations on existing amphibious vessels and vehicles following maintenance, repair, or modernization, may be conducted independently or in conjunction with other amphibious ship and aircraft activities. Testing is performed to ensure effective ship-to-shore coordination and transport of personnel, equipment, and supplies. Tests may also be conducted periodically on other systems, vessels, and aircraft intended for amphibious operations to assess operability and to investigate efficacy of new technologies.

2.2.3 Anti-Submarine Warfare

The mission of anti-submarine warfare is to locate, neutralize, and defeat hostile submarine forces that threaten Navy forces. Anti-submarine warfare is based on the principle that surveillance and attack aircraft, ships, and submarines all search for hostile submarines. These forces operate together or independently to gain early warning and detection and to localize, track, target, and attack submarine threats.

Anti-submarine warfare training addresses basic skills such as detecting and classifying submarines, as well as evaluating sounds to distinguish between enemy submarines and friendly submarines, ships, and marine life. More advanced training integrates the full spectrum of anti-submarine warfare from detecting and tracking a submarine to attacking a target using either exercise torpedoes (i.e., torpedoes that do not contain a warhead) or simulated weapons. These integrated anti-submarine warfare training exercises are conducted in coordinated, at-sea training events involving submarines, ships, and aircraft.

Testing of anti-submarine warfare systems is conducted to develop new technologies and assess weapon performance and operability with new systems and platforms, such as unmanned systems. Testing uses ships, submarines, and aircraft to demonstrate capabilities of torpedoes, missiles, countermeasure systems, and underwater surveillance and communications systems. Tests may be conducted as part of a large-scale fleet training event involving submarines, ships, fixed-wing aircraft, and helicopters. These integrated training events offer opportunities to conduct research and acquisition activities and to train aircrew in the use of new or newly enhanced systems during a large-scale, complex exercise.

2.2.4 Electronic Warfare

The mission of electronic warfare is to degrade the enemy's ability to use electronic systems, such as communication systems and radar, and to confuse or deny them the ability to defend their forces and assets. Electronic warfare is also used to detect enemy threats and counter their attempts to degrade the electronic capabilities of the Navy.

Typical electronic warfare training activities include threat avoidance, signals analysis for intelligence purposes, and use of airborne and surface electronic jamming devices to defeat tracking and communications systems.

Testing of electronic warfare systems is conducted to improve the capabilities of systems and ensure compatibility with new systems. Testing involves the use of aircraft, surface ships, and submarine crews to evaluate the effectiveness of electronic systems. Similar to training activities, typical electronic warfare testing activities include the use of airborne and surface electronic jamming devices (including testing chaff and flares, see Appendix A, Navy Activity Descriptions, for a description of these devices) to defeat tracking and communications systems. Chaff tests evaluate newly developed or enhanced chaff, chaff dispensing equipment, or modified aircraft systems' use against chaff deployment. Flare tests evaluate deployment performance and crew competency with newly developed or enhanced flares, flare dispensing equipment, or modified aircraft systems' use against flare deployment.

2.2.5 Expeditionary Warfare

The mission of expeditionary warfare is to provide security and surveillance in the littoral (at the shoreline), riparian (along a river), or coastal environments. Expeditionary warfare is wide ranging and includes defense of harbors, operation of remotely operated vehicles, defense against swimmers, and boarding/seizure operations.

Expeditionary warfare training activities include underwater construction team training, dive and salvage operations, diver propulsion device training and testing, and parachute insertion.

2.2.6 Mine Warfare

The mission of mine warfare is to detect, classify, and avoid or neutralize (disable) mines to protect Navy ships and submarines and to maintain free access to ports and shipping lanes. Mine warfare also includes offensive mine laying to gain control of or deny the enemy access to sea space. Naval mines can be laid by ships, submarines, or aircraft.

Mine warfare neutralization training includes exercises in which ships, aircraft, submarines, underwater vehicles, unmanned vehicles, or marine mammal detection systems search for mine shapes. Personnel train to destroy or disable mines by attaching underwater explosives to or near the mine or using remotely operated vehicles to destroy the mine.

Testing and development of mine warfare systems is conducted to improve sonar, laser, and magnetic detectors intended to hunt, locate, and record the positions of mines for avoidance or subsequent neutralization. Mine warfare testing and development falls into two primary categories: mine detection and classification, and mine countermeasure and neutralization. Mine detection and classification testing involves the use of air, surface, and subsurface vessels and uses sonar, including towed and side-scan sonar, and unmanned vehicles to locate and identify objects underwater. Mine detection and classification systems are sometimes used in conjunction with a mine neutralization system. Mine countermeasure and neutralization testing includes the use of air, surface, and subsurface units to evaluate the effectiveness of tracking devices, countermeasure and neutralization systems, and general purpose bombs to neutralize mine threats. Most neutralization tests use mine shapes, or non-explosive practice mines, to evaluate a new or enhanced capability. For example, during a mine neutralization test, a previously located mine is destroyed or rendered nonfunctional using a helicopter or manned/unmanned surface vehicle based system that may involve the deployment of a towed neutralization system.

A small percentage of mine warfare tests require the use of high-explosive mines to evaluate and confirm the ability of the system to neutralize a high-explosive mine under operational conditions. The majority of mine warfare systems are deployed by ships, helicopters, and unmanned vehicles. Tests may also be conducted in support of scientific research to support these new technologies.

2.2.7 Surface Warfare

The mission of surface warfare is to obtain control of sea space from which naval forces may operate and entails offensive action against other surface, subsurface, and air targets while also defending against enemy forces. In surface warfare, aircraft use cannons, air-launched cruise missiles, or other precision-guided munitions; ships employ torpedoes, naval guns, and surface-to-surface missiles; and submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles.

Surface warfare training includes surface-to-surface gunnery and missile exercises, air-to-surface gunnery and missile exercises, and submarine missile or torpedo launch events, and other munitions against surface targets.

Testing of weapons used in surface warfare is conducted to develop new technologies and to assess weapon performance and operability with new systems and platforms, such as unmanned systems. Tests include various air-to-surface guns and missiles, surface-to-surface guns and missiles, and bombing tests. Testing events may be integrated into training activities to test aircraft or aircraft systems in the delivery of ordnance on a surface target. In most cases the tested systems are used in the same manner in which they are used for fleet training activities.

2.3 Proposed Activities

The Navy has been conducting military readiness activities in the Study Area for well over a century and with active sonar for over 70 years. The tempo and types of training and testing activities have fluctuated because of the introduction of new technologies, the evolving nature of international events, advances in warfighting doctrine and procedures, and changes in force structure (organization of ships, weapons, and personnel). Such developments influenced the frequency, duration, intensity, and location of required training and testing activities. This EIS/OEIS (Phase III) reflects the most up to date compilation of training and testing activities deemed necessary to accomplish military readiness requirements. The types and numbers of activities included in the Proposed Action accounts for fluctuations in training and testing in order to meet evolving or emergent military readiness requirements. For the purposes of this EIS/OEIS, the term “ship” is inclusive of surface ships and surfaced submarines. The term “vessel” is inclusive of ships and small boats (e.g., rigid-hull inflatable boats). In the following sections, the proposed training and testing activities are detailed.

2.3.1 Proposed Training Activities

A major training exercise comprises several “unit level” type exercises conducted by several units operating together while commanded and controlled by a single commander. These exercises typically employ an exercise scenario developed to train and evaluate the strike group in naval tactical tasks. In a major training exercise, most of the operations and activities being directed and coordinated by the strike group commander are identical in nature to the operations conducted during individual, crew, and smaller unit level training events. In a major training exercise, however, these disparate training tasks are conducted in concert, rather than in isolation. Some integrated or coordinated anti-submarine warfare exercises are similar in that they are composed of several unit level exercises but are generally on a smaller scale than a major training exercise, are shorter in duration, use fewer assets, and use fewer hours of hull-mounted sonar per exercise. Coordinated training exercises involve multiple units working together to meet unit-level training requirements, whereas integrated training exercises involve multiple units working together to certify for deployment. These coordinated exercises are conducted under anti-submarine warfare. Three key factors used to identify and group the exercises are the scale of the exercise, duration of the exercise, and amount of hull-mounted sonar hours modeled/used for the exercise.

Table 2.3-1 provides the differences between major ASW training events and smaller integrated/coordinated anti-submarine exercises based on scale, duration, and sonar hours for the purposes of exercise reporting requirements.

The training activities proposed by the Navy are described in Table 2.3-2, which include the activity name and a short description of the activity. Appendix A (Navy Activity Descriptions) has more detailed descriptions of the activities.

Table 2.3-1: Major ASW Training Exercises and Integrated/Coordinated Training

	Exercise Group	*Description*	*Scale*	*Duration*	*Location*	*Exercise Examples*	*Modeled Hull-Mounted Sonar per Exercise*
Major Training Exercise	Large Integrated ASW	Larger-scale, longer duration integrated ASW exercises	Greater than 6 surface ASW units (up to 30 with the largest exercises), 2 or more submarines, multiple ASW aircraft	Generally greater than 10 days	JAX RC Navy Cherry Point RC VACAPES RC	COMPTUEX	>500 hours
Major Training Exercise	Medium Integrated ASW	Medium-scale, medium duration integrated ASW exercises	Approximately 3–8 surface ASW units, at least 1 submarine, multiple ASW aircraft	Generally 4–10 days	JAX RC Navy Cherry Point RC VACAPES RC	FLEETEX/ SUSTEX	100–500 hours
Integrated/ Coordinated Training	Small Integrated ASW	Small-scale, short duration integrated ASW exercises	Approximately 3–6 surface ASW units, 2 dedicated submarines, 2–6 ASW aircraft	Generally less than 5 days	JAX RC Navy Cherry Point RC VACAPES RC	SWATT, NUWTAC	50–100 hours
Integrated/ Coordinated Training	Medium Coordinated ASW	Medium-scale, medium duration, coordinated ASW exercises	Approximately 2–4 surface ASW units, possibly a submarine, 2–5 ASW aircraft	Generally 3-10 days	JAX RC Navy Cherry Point RC VACAPES RC	TACDEVEX	Less than 100 hours
Integrated/ Coordinated Training	Small Coordinated ASW	Small-scale, short duration, coordinated ASW exercises	Approximately 2–4 surface ASW units, possibly a submarine, 1–2 ASW aircraft	Generally 2–4 days	JAX RC Navy Cherry Point RC VACAPES RC	ARG/MEU, Group Sail	Less than 50 hours

Notes: ASW: anti-submarine warfare; JAX: Jacksonville; RC: Range Complex; VACAPES: Virginia Capes; COMTUEX: Composite Training Unit Exercise; FLEETEX/SUSTEX: Fleet Exercise/Sustainment Exercise; SWATT: Surface Warfare Advanced Tactical Training Exercise; NUWTAC: Navy Undersea Warfare Training Assessment Course; TACDEVEX: Tactical Development Exercise; ARG/MEU: Amphibious Ready Group/Marine Expeditionary Unit

Table 2.3-2: Proposed Training Activities

Activity Name	Activity Description
Major Training Exercises – Large Integrated Anti-Submarine Warfare	
Composite Training Unit Exercise	Aircraft carrier and its associated aircraft integrate with surface and submarine units in a challenging multi-threat operational environment in order to certify them for deployment. Only the anti-submarine warfare portion of a Composite Training Unit Exercises is included in this activity; other training objectives are met via unit level training described in each of the primary mission areas below.
Major Training Exercises – Medium Integrated Anti-Submarine Warfare	
Fleet Exercises/Sustainment Exercise	Aircraft carrier and its associated aircraft integrate with surface and submarine units in a challenging multi-threat operational environment in order to maintain their ability to deploy. Fleet Exercises and Sustainment Exercises are similar to Composite Training Unit Exercises, but are shorter in duration.
Integrated/Coordinated Training – Small Integrated Anti-Submarine Warfare Training	
Naval Undersea Warfare Training Assessment Course	Multiple ships, aircraft, and submarines integrate the use of their sensors to search for, detect, classify, localize, and track a threat submarine in order to launch an exercise torpedo.
Surface Warfare Advanced Tactical Training	Multiple ships and aircraft use sensors, including sonobuoys, to search, detect, and track a threat submarine. Surface Warfare Advanced Tactical Training exercises are not dedicated anti-submarine warfare events and involve multiple warfare areas.
Integrated/Coordinated Training – Medium Coordinated Anti-Submarine Warfare Training	
Anti-Submarine Warfare Tactical Development Exercise	Surface ships, aircraft, and submarines coordinate to search for, detect, and track submarines.
Integrated/Coordinated Training – Small Coordinated Anti-Submarine Warfare Training	
Amphibious Ready Group/Marine Expeditionary Unit Exercise	Navy and Marine Corps forces conduct advanced training at sea in preparation for deployment.
Group Sail	Surface ships and helicopters search for, detect, and track threat submarines. Group Sails are not dedicated anti-submarine warfare events and involve multiple warfare areas; non-anti-submarine warfare training objectives are met via unit level training described in the primary mission areas below.
Air Warfare	
Air Combat Maneuver	Fixed-wing aircrews aggressively maneuver against threat aircraft to gain tactical advantage.
Air Defense Exercises	Aircrews and ship crews conduct defensive measures against threat aircraft or simulated missiles.
Gunnery Exercise Air-to-Air Medium-Caliber	Fixed-wing aircraft fire medium-caliber guns at air targets.
Gunnery Exercise Surface-to-Air Large-Caliber	Surface ship crews fire large-caliber guns at air targets.
Gunnery Exercise Surface-to-Air Medium-Caliber	Surface ship crews fire medium-caliber guns at air targets.
Missile Exercise Air-to-Air	Fixed-wing and helicopter aircrews fire air-to-air missiles at air targets.
Missile Exercise Surface-to-Air	Surface ship crews fire surface-to-air missiles at air targets.

Table 2.3-2: Proposed Training Activities (continued)

Activity Name	*Activity Description*
Missile Exercise Man-Portable Air Defense System	Personnel employ shoulder-fired surface-to-air missiles at air targets.
Amphibious Warfare	
Amphibious Marine Expeditionary Unit Integration Exercise	Navy and Marine Corps forces conduct integration training at sea in preparation for deployment certification.
Amphibious Assault	Large unit forces move ashore from amphibious ships at sea for the immediate execution of inland objectives.
Amphibious Raid	Small unit forces move from amphibious ships at sea to shore locations for a specific short-term mission. These are quick operations with as few personnel as possible.
Amphibious Vehicle Maneuvers	Personnel operate amphibious vehicles for driver training.
Humanitarian Assistance Operations	Navy and Marine Corps forces evacuate noncombatants from hostile or unsafe areas or provide humanitarian assistance in times of disaster.
Marine Expeditionary Unit Certification Exercise	Amphibious Ready Group exercises are conducted to validate the Marine Expeditionary Unit's readiness for deployment and includes small boat raids; visit, board, search, and seizure training; helicopter and mechanized amphibious raids; and a non-combatant evacuation operations.
Naval Surface Fire Support Exercise – At Sea	Surface ship crews use large-caliber guns to support forces ashore; however, the land target is simulated at sea. Rounds are scored by passive acoustic buoys located at or near the target area.
Naval Surface Fire Support Exercise – Land-Based Target	Surface ship crews fire large-caliber guns at land-based targets to support forces ashore.
Anti-Submarine Warfare	
Anti-Submarine Warfare Torpedo Exercise – Helicopter	Helicopter aircrews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.
Anti-Submarine Warfare Torpedo Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft aircrews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.
Anti-Submarine Warfare Torpedo Exercise – Ship	Surface ship crews search for, track, and detect submarines. Exercise torpedoes are used.
Anti-Submarine Warfare Torpedo Exercise – Submarine	Submarine crews search for, track, and detect submarines. Exercise torpedoes are used.
Anti-Submarine Warfare Tracking Exercise – Helicopter	Helicopter aircrews search for, track, and detect submarines.
Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft aircrews search for, track, and detect submarines.
Anti-Submarine Warfare Tracking Exercise – Ship	Surface ship crews search for, track, and detect submarines.
Anti-Submarine Warfare Tracking Exercise – Submarine	Submarine crews search for, track, and detect submarines.
Electronic Warfare	
Counter Targeting Chaff Exercise – Aircraft	Fixed-winged aircraft and helicopter aircrews deploy chaff to disrupt threat targeting and missile guidance radars.
Counter Targeting Chaff Exercise – Ship	Surface ship crews deploy chaff to disrupt threat targeting and missile guidance radars.
Counter Targeting Flare Exercise	Fixed-winged aircraft and helicopter aircrews deploy flares to disrupt threat infrared missile guidance systems.

Table 2.3-2: Proposed Training Activities (continued)

Activity Name	Activity Description
Electronic Warfare Operations	Aircraft and surface ship crews control the electromagnetic spectrum used by enemy systems to degrade or deny the enemy's ability to take defensive actions.
High-Speed Anti-Radiation Missile Exercise	Aircrews launch a High-Speed Anti-Radiation Missile against threat radar sites.
Expeditionary Warfare	
Dive and Salvage Operations	Navy divers perform dive operations and salvage training.
Maritime Security Operations – Anti-Swimmer Grenades	Small boat crews engage in force protection activities by using anti-swimmer grenades to defend against hostile divers.
Personnel Insertion/Extraction – Air	Personnel are inserted into and extracted from an objective area by airborne platforms.
Personnel Insertion/Extraction – Surface and Subsurface	Personnel are inserted into and extracted from an objective area by small boats or subsurface platforms.
Personnel Insertion/Extraction Training – Swimmer/Diver	Divers and swimmer infiltrate harbors, beaches, or moored vessels and conduct a variety of tasks.
Underwater Construction Team Training	Navy divers conduct underwater repair and construction.
Mine Warfare	
Airborne Mine Countermeasures – Mine Detection	Helicopter aircrews detect mines using towed or laser mine detection systems.
Airborne Mine Countermeasures – Towed Mine Neutralization	Helicopter crews tow systems through the water, which are designed to disable or trigger mines.
Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercise	Maritime security personnel train to protect civilian ports against enemy efforts to interfere with access to those ports.
Coordinated Unit-Level Helicopter Airborne Mine Countermeasure Exercise	A detachment of helicopter aircrews train as a unit in the use of airborne mine countermeasures, such as towed mine detection and neutralization systems.
Mine Countermeasures – Mine Neutralization – Remotely Operated Vehicles	Ship, small boat, and helicopter crews locate and disable mines using remotely operated underwater vehicles.
Mine Countermeasures – Ship Sonar	Ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.
Mine Laying	Fixed-winged aircraft drop non-explosive mine shapes.
Mine Neutralization – Explosive Ordnance Disposal	Personnel disable threat mines using explosive charges.
Underwater Mine Countermeasures Raise, Tow, Beach, and Exploitation Operations	Personnel locate mines, perform mine neutralization, raise and tow the mines to the beach, and conduct exploitation operations for intelligence gathering.
Surface Warfare	
Bombing Exercise Air-to-Surface	Fixed-wing aircrews deliver bombs against surface targets.
Fast Attack Craft and Fast Inshore Attack Craft Exercise	Navy surface ship and helicopter crews defend against small boat attacks.
Gunnery Exercise Air-to-Surface Medium-Caliber	Fixed-wing and helicopter aircrews fire medium-caliber guns at surface targets.
Gunnery Exercise	Helicopter and tilt-rotor aircrews use small-caliber guns to engage surface

Table 2.3-2: Proposed Training Activities (continued)

Activity Name	Activity Description
Air-to-Surface Small-Caliber	targets.
Gunnery Exercise Surface-to-Surface Boat Medium-Caliber	Small boat crews fire medium-caliber guns at surface targets.
Gunnery Exercise Surface-to-Surface Boat Small-Caliber	Small boat crews fire small-caliber guns at surface targets.
Gunnery Exercise Surface-to-Surface Ship Large-Caliber	Surface ship crews fire large-caliber guns at surface targets.
Gunnery Exercise Surface-to-Surface Ship Medium-Caliber	Surface ship crews fire medium-caliber guns at surface targets.
Gunnery Exercise Surface-to-Surface Ship Small-Caliber	Surface ship crews fire small-caliber guns at surface targets.
Integrated Live Fire Exercise	Naval forces defend against a swarm of surface threats (ships or small boats) with bombs, missiles, rockets, and small-, medium- and large-caliber guns.
Laser Targeting – Aircraft	Fixed-wing and helicopter aircrews illuminate targets with targeting and directed energy lasers.
Laser Targeting – Ship	Surface ship crews illuminate air and surface targets with targeting and directed energy lasers.
Maritime Security Operations	Helicopter, surface ship, and small boat crews conduct a suite of maritime security operations.
Missile Exercise Air-to-Surface	Fixed-wing and helicopter aircrews fire air-to-surface missiles at surface targets.
Missile Exercise Air-to-Surface Rocket	Helicopter aircrews fire both precision-guided and unguided rockets at surface targets.
Missile Exercise Surface-to-Surface	Surface ship crews defend against surface threats (ships or small boats) and engage them with missiles.
Sinking Exercise	Aircraft, ship, and submarine crews deliberately sink a seaborne target, usually a decommissioned ship (made environmentally safe for sinking according to U.S. Environmental Protection Agency standards), with a variety of munitions.
Other Training Activities	
Elevated Causeway System	A temporary pier is constructed off the beach. Supporting pilings are driven into the sand and then later removed.
Precision Anchoring	Anchors are released in designated locations or moored to a buoy.
Search and Rescue	Surface ships, small boats, and helicopter rescue personnel at sea.
Submarine Navigation	Submarine crews operate sonar for navigation and object detection while transiting into and out of port during reduced visibility.
Submarine Sonar Maintenance and Systems Checks	Maintenance of submarine sonar systems is conducted pierside or at sea.
Submarine Under Ice Certification	Submarine crews train to operate under ice. Ice conditions are simulated during training and certification events.
Surface Ship Object Detection	Surface ship crews operate sonar for navigation and object detection while transiting in and out of port during reduced visibility.

Table 2.3-2: Proposed Training Activities (continued)

Activity Name	*Activity Description*
Surface Ship Sonar Maintenance and Systems Checks	Maintenance of surface ship sonar systems is conducted pierside or at sea.
Waterborne Training	Small boat crews conduct a variety of training, including launch and recovery, mooring to buoys, anchoring, and maneuvering. Small boats include rigid hull inflatable boats, and riverine patrol, assault and command boats up to approximately 50 feet in length.

2.3.2 Proposed Testing Activities

The Navy's research and acquisition community engages in a broad spectrum of testing activities in support of the fleet. These activities include, but are not limited to, basic and applied scientific research and technology development; testing, evaluation, and maintenance of systems (e.g., missiles, radar, and sonar) and platforms (e.g., surface ships, submarines, and aircraft); and acquisition of systems and platforms to support Navy missions and give a technological edge over adversaries. The individual commands within the research and acquisition community included in this EIS/OEIS are Naval Air Systems Command, Naval Sea Systems Command, and the Office of Naval Research.

The Navy operates in an ever-changing strategic, tactical, financially constrained, and time-constrained environment. Testing activities occur in response to emerging science or fleet operational needs. For example, future Navy experiments to develop a better understanding of ocean currents may be designed based on advancements made by non-government researchers not yet published in the scientific literature. Similarly, future but yet unknown Navy operations within a specific geographic area may require development of modified Navy assets to address local conditions. Such modifications must be tested in the field to ensure they meet fleet needs and requirements. Accordingly, generic descriptions of some of these activities are the best that can be articulated in a long-term, comprehensive document, like this EIS/OEIS.

Some testing activities are similar to training activities conducted by the fleet. For example, both the fleet and the research and acquisition community fire torpedoes. While the firing of a torpedo might look identical to an observer, the difference is in the purpose of the firing. The fleet might fire the torpedo to practice the procedures for such a firing, whereas the research and acquisition community might be assessing a new torpedo guidance technology or testing it to ensure the torpedo meets performance specifications and operational requirements.

2.3.2.1 Naval Air Systems Command Testing Activities

Naval Air Systems Command testing activities generally fall in the primary mission areas used by the fleets. Naval Air Systems Command activities include, but are not limited to, the testing of new aircraft platforms (e.g., the F-35 Joint Strike Fighter aircraft), weapons, and systems (e.g., newly developed sonobuoys) that will ultimately be integrated into fleet training activities. In addition to the testing of new platforms, weapons, and systems, Naval Air Systems Command also conducts lot acceptance testing of weapons and systems, such as sonobuoys.

The majority of testing activities conducted by Naval Air Systems Command are similar to fleet training activities, and many platforms and systems currently being tested are already being used by the fleet or will ultimately be integrated into fleet training activities. However, some testing activities may be conducted in different locations and in a different manner than similar fleet training activities and, therefore, the analysis for those events and the potential environmental effects may differ. Training with systems and platforms delivered to the fleet within the timeframe of this document are analyzed in the training sections of this EIS/OEIS. Table 2.3-3 addresses Naval Air Systems Command's proposed testing activities.

Table 2.3-3: Naval Air Systems Command's Proposed Testing Activities

Activity Name	***Activity Description***
Air Warfare	
Air Combat Maneuver Test	Aircrews engage in flight maneuvers designed to gain a tactical advantage during combat.
Air Platform Weapons Integration Test	Test performed to quantify the compatibility of weapons with the aircraft from which they would be launched or released. Non-explosive weapons or shapes are used.
Air Platform-Vehicle Test	Test performed to quantify the flying qualities, handling, airworthiness, stability, controllability, and integrity of an air platform or vehicle. No explosive weapons are released during an air platform/vehicle test.
Air-to-Air Weapons System Test	Test to evaluate the effectiveness of air-launched weapons against designated air targets.
Air-to-Air Gunnery Test – Medium-Caliber	Test performed to evaluate the effectiveness of air-to-air guns against designated airborne targets. Fixed-wing aircraft may be used.
Air-to-Air Missile Test	Test performed to evaluate the effectiveness of air-launched missiles against designated airborne targets. Fixed-wing aircraft will be used.
Intelligence, Surveillance, and Reconnaissance Test	Aircrews use all available sensors to collect data on threat vessels.
Anti-Submarine Warfare	
Anti-Submarine Warfare Torpedo Test	This event is similar to the training event torpedo exercise. Test evaluates anti-submarine warfare systems onboard rotary-wing (e.g., helicopter) and fixed-wing aircraft and the ability to search for, detect, classify, localize, track, and attack a submarine or similar target.
Anti-Submarine Warfare Tracking Test – Helicopter	This event is similar to the training event anti-submarine warfare tracking exercise – helicopter. The test evaluates the sensors and systems used to detect and track submarines and to ensure that helicopter systems used to deploy the tracking system perform to specifications.
Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft	The test evaluates the sensors and systems used by maritime patrol aircraft to detect and track submarines and to ensure that aircraft systems used to deploy the tracking systems perform to specifications and meet operational requirements.
Kilo Dip	Functional check of a helicopter deployed dipping sonar system prior to conducting a testing or training event using the dipping sonar system.
Sonobuoy Lot Acceptance Test	Sonobuoys are deployed from surface vessels and aircraft to verify the integrity and performance of a production lot or group of sonobuoys in advance of delivery to the fleet for operational use.
Electronic Warfare	
Chaff Test	This event is similar to the training event chaff exercise. Chaff tests evaluate newly developed or enhanced chaff, chaff dispensing equipment, or modified aircraft systems against chaff deployment. Tests may also train pilots and aircrews in the use of new chaff dispensing equipment. Chaff tests are often conducted with flare tests and air combat maneuver events, as well as other test events, and are not typically conducted as standalone tests.
Electronic Systems Evaluation	Test that evaluates the effectiveness of electronic systems to control,

Table 2.3-3: Naval Air Systems Command's Proposed Testing Activities (continued)

Activity Name	*Activity Description*
	deny, or monitor critical portions of the electromagnetic spectrum. In general, electronic warfare testing will assess the performance of three types of electronic warfare systems: electronic attack, electronic protect, and electronic support.
Flare Test	This event is similar to the training event flare exercise. Flare tests evaluate newly developed or enhanced flares, flare dispensing equipment, or modified aircraft systems against flare deployment. Tests may also train pilots and aircrews in the use of newly developed or modified flare deployment systems. Flare tests are often conducted with chaff tests and air combat maneuver events, as well as other test events, and are not typically conducted as standalone tests.
Mine Warfare	
Airborne Dipping Sonar Minehunting Test	A mine-hunting dipping sonar system that is deployed from a helicopter and uses high-frequency sonar for the detection and classification of bottom and moored mines.
Airborne Laser Based Mine Detection System Test	An airborne mine hunting test of a laser based mine detection system that is operated from a helicopter and evaluates the system's ability to detect, classify, and fix the location of floating mines and mines moored near the surface. The system uses a low-energy laser to locate mines.
Airborne Mine Neutralization System Test	A test of the airborne mine neutralization system evaluates the system's ability to detect and destroy mines from an airborne mine countermeasures capable helicopter. The airborne mine neutralization system uses up to four unmanned underwater vehicles equipped with high-frequency sonar, video cameras, and explosive and non-explosive neutralizers.
Airborne Sonobuoy Minehunting Test	A mine-hunting system made up of a field of sonobuoys deployed by a helicopter. A field of sonobuoys, using high-frequency sonar, is used to detect and classify bottom and moored mines.
Mine Laying Test	Fixed-wing aircraft evaluate the performance of mine laying equipment and software systems to lay mines. A mine test may also train aircrews in laying mines using new or enhanced mine deployment system.
Surface Warfare	
Air-to-Surface Bombing Test	This event is similar to the training event bombing exercise air-to-surface. Fixed-wing aircraft test the delivery of bombs against surface maritime targets with the goal of evaluating the bomb, the bomb carry and delivery system, and any associated systems that may have been newly developed or enhanced.
Air-to-Surface Gunnery Test	This event is similar to the training event gunnery exercise air-to-surface. Fixed-wing and rotary-wing aircrews evaluate new or enhanced aircraft guns against surface maritime targets to test that the guns, gun ammunition, or associated systems meet required specifications or to train aircrews in the operation of a new or enhanced weapon system.
Air-to-Surface Missile Test	This event is similar to the training event missile exercise air-to-surface. Test may involve both fixed-wing and rotary-wing aircraft launching missiles at surface maritime targets to evaluate the weapon system or as part of another system's integration test.
High-Energy Laser Weapons Test	High-energy laser weapons tests evaluate the specifications, integration, and performance of an aircraft-mounted, approximately 25 kilowatt,

Table 2.3-3: Naval Air Systems Command's Proposed Testing Activities (continued)

Activity Name	*Activity Description*
	high-energy laser used to disable small surface vessels.
Laser Targeting Test	Aircrews illuminate enemy targets with lasers.
Rocket Test	Rocket tests evaluate the integration, accuracy, performance, and safe separation of guided and unguided 2.75-inch rockets fired from a hovering or forward-flying helicopter.
Other Testing Activities	
Acoustic and Oceanographic Research	Active transmissions within the band 10 hertz–100 kilohertz from sources deployed from ships and aircraft.
Air Platform Shipboard Integrate Test	Fixed-wing and rotary-wing aircraft are tested to determine operability from shipboard platforms, performance of shipboard physical operations, and to verify and evaluate communications and tactical data links.
Maritime Security	Maritime patrol aircraft participate in maritime security activities and fleet training events. Aircraft identify, track, and monitor foreign merchant vessels suspected of non-compliance with United Nations-allied sanctions or conflict rules of engagement.
Shipboard Electronic Systems Evaluation	Tests measure ship antenna radiation patterns and test communication systems with a variety of aircraft.
Undersea Range System Test	Following installation of a Navy underwater warfare training and testing range, tests of the nodes (components of the range) will be conducted to include node surveys and testing of node transmission functionality.

2.3.2.2 Naval Sea Systems Command Testing Activities

Naval Sea Systems Command activities are generally aligned with the primary missions areas used by the fleets. Additional activities include, but are not limited to, vessel evaluation, unmanned systems, and other testing activities. In this EIS/OEIS, pierside testing at Navy and contractor shipyards consists only of system testing.

Testing activities are conducted throughout the life of a Navy ship, from construction through deactivation from the fleet, to verification of performance and mission capabilities. Activities include pierside and at-sea testing of ship systems, including sonar, acoustic countermeasures, radars, launch systems, weapons, unmanned systems, and radio equipment; tests to determine how the ship performs at sea (sea trials); development and operational test and evaluation programs for new technologies and systems; and testing on all ships and systems that have undergone overhaul or maintenance.

One ship of each new class (or major upgrade) of combat ships constructed for the Navy typically undergoes an at-sea ship shock trial. A ship shock trial consists of a series of underwater detonations that send shock waves through the ship's hull to simulate near misses during combat. A shock trial allows the Navy to assess the survivability of the hull and ship's systems in a combat environment as well as the capability of the ship to protect the crew. Table 2.3-4 describes Naval Sea Systems Command's proposed testing activities.

Table 2.3-4: Naval Sea Systems Command's Proposed Testing Activities

Activity Name	*Activity Description*
Anti-Submarine Warfare	
Anti-Submarine Warfare Mission Package Testing	Ships and their supporting platforms (e.g., helicopters, unmanned aerial systems) detect, localize, and attack submarines.
At-Sea Sonar Testing	At-sea testing to ensure systems are fully functional in an open ocean environment.
Countermeasure Testing	Countermeasure testing involves the testing of systems that will detect, localize, track, and attack incoming weapons including marine vessel targets. Testing includes surface ship torpedo defense systems and marine vessel stopping payloads.
Pierside Sonar Testing	Pierside testing to ensure systems are fully functional in a controlled pierside environment prior to at-sea test activities.
Submarine Sonar Testing/ Maintenance	Pierside testing of submarine systems occurs periodically following major maintenance periods and for routine maintenance.
Surface Ship Sonar Testing/ Maintenance	Pierside and at-sea testing of ship systems occur periodically following major maintenance periods and for routine maintenance.
Torpedo (Explosive) Testing	Air, surface, or submarine crews employ explosive and non-explosive torpedoes against artificial targets.
Torpedo (Non-Explosive) Testing	Air, surface, or submarine crews employ non-explosive torpedoes against submarines or surface vessels. When performed on a testing range, these torpedoes may be launched from a range craft or fixed structures and may use artificial targets.
Electronic Warfare	
Radar and Other System Testing	Test may include radiation of military or commercial radar communication systems (or simulators), or high-energy lasers. Testing may occur aboard a ship against drones, small boats, rockets, missiles, or other targets.
Mine Warfare	
Mine Countermeasure and Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines and mine-like objects.
Mine Countermeasure Mission Package Testing	Vessels and associated aircraft conduct mine countermeasure operations.
Mine Detection and Classification Testing	Air, surface, and subsurface vessels and systems detect, classify, and avoid mines and mine-like objects. Vessels also assess their potential susceptibility to mines and mine-like objects.
Surface Warfare	
Gun Testing – Large-Caliber	Crews defend against targets with large-caliber guns.
Gun Testing – Medium-Caliber	Airborne and surface crews defend against targets with medium-caliber guns.
Gun Testing – Small-Caliber	Airborne and surface crews defend against targets with small-caliber guns.
Kinetic Energy Weapon Testing	A kinetic energy weapon uses stored energy released in a burst to accelerate a projectile.
Missile and Rocket Testing	Missile and rocket testing includes various missiles or rockets fired from submarines and surface combatants. Testing of the launching system and ship defense is performed.
Unmanned Systems	
Underwater Search, Deployment, and Recovery	Various underwater, bottom crawling, robotic vehicles are utilized in underwater search, recovery, installation, and scanning activities.
Unmanned Aerial System Testing	Unmanned aerial systems are launched from a platform (e.g., fixed platform or submerged submarine) to test the capability to extend the

Table 2.3-4: Naval Sea Systems Command's Proposed Testing Activities (continued)

Activity Name	Activity Description
	surveillance and communications range of unmanned underwater vehicles, manned and unmanned surface vehicles, and submarines.
Unmanned Surface Vehicle System Testing	Testing involves the development or upgrade of unmanned surface vehicles. This may include testing of mine detection capabilities, evaluating the basic functions of individual platforms, or complex events with multiple vehicles.
Unmanned Underwater Vehicle Testing	Testing involves the development or upgrade of unmanned underwater vehicles. This may include testing of mine detection capabilities, evaluating the basic functions of individual platforms, or complex events with multiple vehicles.
Vessel Evaluation	
Aircraft Carrier Sea Trials – Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
Air Defense Testing	Test the ship's capability to detect, identify, track, and successfully engage live and simulated targets. Gun systems are tested using explosive or non-explosive rounds.
Hydrodynamic and Maneuverability Testing	Submarines maneuver in the submerged operating environment.
In-Port Maintenance Testing	Each combat system is tested to ensure they are functioning in a technically acceptable manner and are operationally ready to support at-sea testing.
Large Ship Shock Trial	Underwater detonations are used to test new ships or major upgrades.
Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
Signature Analysis Operations	Surface ship and submarine testing of electromagnetic, acoustic, optical, and radar signature measurements.
Small Ship Shock Trial	Underwater detonations are used to test new ships or major upgrades.
Submarine Sea Trials – Propulsion Testing	Submarine is run at high speeds in various formations and depths.
Submarine Sea Trials – Weapons System Testing	Submarine weapons and sonar systems are tested at-sea to meet integrated combat system certification requirements.
Surface Warfare Testing	Tests capability of shipboard sensors to detect, track, and engage surface targets. Testing may include ships defending against surface targets using explosive and non-explosive rounds, gun system structural test firing and demonstration of the response to Call for Fire against land-based targets (simulated by sea-based locations).
Total Ship Survivability Trials	Series of simulated "realistic" weapon hit scenarios with resulting damage and recoverability exercises against an aircraft carrier.
Undersea Warfare Testing	Ships demonstrate capability of countermeasure systems and underwater surveillance, weapons engagement, and communications systems. This tests ships' ability to detect, track, and engage underwater targets.
Vessel Signature Evaluation	Surface ship, submarine, and auxiliary system signature assessments. This may include electronic, radar, acoustic, infrared, and magnetic signatures, refueling capabilities.
Other Testing Activities	
Acoustic Component Testing	Various surface vessels, moored equipment, and materials are tested to evaluate performance in the marine environment.

Table 2.3-4: Naval Sea Systems Command's Proposed Testing Activities (continued)

Activity Name	*Activity Description*
Chemical and Biological Simulant Testing	Chemical-biological agent simulants are deployed against surface ships.
Insertion/Extraction	Testing of submersibles capable of inserting and extracting personnel and payloads into denied areas from strategic distances.
Line Charge Testing	Surface vessels deploy line charges to test the capability to safely clear an area for expeditionary forces.
Non-Acoustic Component Testing	Tests of towed or floating buoys for communications through radio-frequencies or two-way optical communications between an aircraft and underwater system(s).
Payload Deployer Testing	Launcher systems are tested to evaluate performance.
Semi-Stationary Equipment Testing	Semi-stationary equipment (e.g., hydrophones) is deployed to determine functionality.
Towed Equipment Testing	Surface vessels or unmanned surface vehicles deploy and tow equipment to determine functionality of towed systems.

2.3.2.3 Office of Naval Research Testing Activities

As the Department of the Navy's science and technology provider, the Office of Naval Research provides technology solutions for Navy and Marine Corps needs. The Office of Naval Research's mission is to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power and the preservation of national security. The Office of Naval Research manages the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation. The Office of Naval Research is also a parent organization for the Naval Research Laboratory, which operates as the Navy's corporate research laboratory and conducts a broad multidisciplinary program of scientific research and advanced technological development. Testing conducted by the Office of Naval Research in the AFTT Study Area includes acoustic and oceanographic research, large displacement unmanned underwater vehicle (innovative naval prototype) research, and emerging mine countermeasure technology research. Table 2.3-5 describes the Office of Naval Research's proposed testing activities.

Table 2.3-5: Office of Naval Research Proposed Testing Activities

Activity Name	*Activity Description*
Acoustic and Oceanographic Science and Technology	
Acoustic and Oceanographic Research	Research using active transmissions from sources deployed from ships and unmanned underwater vehicles. Research sources can be used as proxies for current and future Navy systems.
Emerging Mine Countermeasure Technology Research	Test involves the use of broadband acoustic sources on unmanned underwater vehicles.
Large Displacement Unmanned Underwater Vehicle Testing	Autonomy testing and environmental data collection with Large Displacement Unmanned Underwater Vehicles.

2.3.3 Standard Operating Procedures

For training and testing to be effective, units must be able to safely use their sensors and weapon systems as they are intended to be used in a real-word situation and to their optimum capabilities. While standard operating procedures are designed for the safety of personnel and equipment and to ensure the success of training and testing activities, their implementation often yields additional benefits on environmental, socioeconomic, public health and safety, and cultural resources.

Navy standard operating procedures have been developed and refined over years of experience and are broadcast via numerous naval instructions and manuals, including, but not limited to:

- ship, submarine, and aircraft safety manuals
- ship, submarine, and aircraft standard operating manuals
- Fleet Area Control and Surveillance Facility range operating instructions
- fleet exercise publications and instructions
- Naval Sea Systems Command test range safety and standard operating instructions
- Navy instrumented range operating procedures
- naval shipyard sea trial agendas
- research, development, test, and evaluation plans
- naval gunfire safety instructions
- Navy planned maintenance system instructions and requirements
- Federal Aviation Administration regulations
- International Regulations for Preventing Collisions at Sea

Because standard operating procedures are essential to safety and mission success, the Navy considers them to be part of the proposed activities under each alternative and has included them in the Chapter 3 (Affected Environment and Environmental Consequences) environmental analysis for each resource. Standard operating procedures that are recognized as providing a potential secondary benefit on environmental, socioeconomic, public health and safety, or cultural resources during training and testing activities are discussed in the sections below. Standard operating procedures (which are implemented regardless of their secondary benefits) are different from mitigation measures (which are designed entirely for the purpose of avoiding potential impacts of the Proposed Action). Information on mitigation measures is provided in Chapter 5 (Mitigation), and activities associated with these mitigation measures are provided in Section 2.3.4 (Mitigation Measures).

2.3.3.1 Sea Space and Airspace Deconfliction

The Navy schedules training and testing activities to minimize sea space and airspace conflicts within ranges and throughout the Study Area and to avoid interaction with established commercial air traffic routes and commercial vessel shipping lanes. Navy events may change mid-stream based on evaluators' assessments of performance and other conditions (such as weather or mechanical issues), which often precludes the use of a permission scheme for access to sea space. The Navy deconflicts the sea space and airspace used during training and testing activities to allow for the necessary separation of multiple Navy units to ensure safety for civilian personnel, commercial aircraft, commercial vessels, Sailors, and Navy assets (and to prevent interference with equipment sensors).

The standard operating procedures for sea space and airspace deconfliction could result in a secondary benefit to socioeconomic resources and public health and safety through a reduction in the potential for interactions with civilians and commercial vessels and aircraft.

2.3.3.2 Vessel Safety

Ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when moving through the water (underway). Watch personnel undertake extensive training in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. Training includes on-the-job instruction and a formal Personal Qualification Standard program (or equivalent program for supporting contractors or civilians), to certify that they have demonstrated all necessary skills. Skills include detection and reporting of floating or partially submerged objects. Watch personnel include officers, enlisted men and women, and civilians operating in similar capacities. Their duties as watchstanders may be performed in conjunction with other job responsibilities, such as navigating the ship or supervising other personnel. While on watch, personnel employ visual search techniques, including the use of binoculars and scanning techniques in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. After sunset and prior to sunrise, watch personnel employ night visual search techniques, which could include the use of night vision devices.

A primary duty of watch personnel is to ensure safety of the ship, and this includes the requirement to detect and report all objects and disturbances sighted in the water that may be indicative of a threat to the ship and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per safety requirements, watch personnel also report any marine mammals sighted that have the potential to be in the direct path of the ship as a standard collision avoidance procedure. Because watch personnel are primarily posted for safety of navigation, range clearance, and man-overboard precautions, they are not normally posted while ships are moored to a pier. When anchored or moored to a buoy, a watch team is still maintained but with fewer personnel than when underway. When moored or at anchor, watch personnel may maintain security and safety of the ship by scanning the water for any indications of a threat (as described above).

Navy vessels operate in accordance with the navigation rules established by the U.S. Coast Guard. All vessels operating on the water are required to follow the International Navigation Rules (Commandant Instruction M16672.2D). Navigation rules are formalized in the Convention on the International Regulations for Preventing Collisions at Sea, 1972. Applicable navigation requirements include, but are not limited to, Rule 5 (Lookouts) and Rule 6 (Safe Speed). These rules require that vessels at all times proceed at a safe speed so that proper and effective action can be taken to avoid collision and so they can be stopped within a distance appropriate to the prevailing circumstances and conditions. For more information about general vessel operating speeds, see Section 3.0.3.3.4.1 (Vessels and In-Water Devices).

The standard operating procedures for vessel safety could result in a secondary benefit to public health and safety and marine mammals through a reduction in the potential for vessel strike.

2.3.3.3 Aircraft Safety

Pilots of Navy aircraft make every attempt to avoid large flocks of birds to reduce the safety risk involved with a potential bird strike. Since 2011, the Navy has required that all Navy flying units report all bird strikes through the Web-Enabled Safety System Aviation Mishap and Hazard Reporting System.

The standard operating procedures for aircraft safety could result in a secondary benefit to birds through a reduction in the potential for aircraft strike.

2.3.3.4 High-Powered Laser Safety

The Navy operates laser systems approved for fielding by the Laser Safety Review Board or service equivalent. Only properly trained and authorized personnel operate high-powered laser devices in OPAREAs in accordance with authorized standard operating procedures. Prior to commencing activities involving lasers, the operator ensures that the area is clear of unauthorized persons in the laser impact area by performing a search of the area. Ranges where lasers are used are required to have a Laser Range Safety Certification Report that is updated every 3 years.

The standard operating procedures for laser safety could result in a secondary benefit to public health and safety through a reduction in the potential for interaction with lasers.

2.3.3.5 Weapons Firing Safety

A Notice to Mariners is usually issued in advance of gunnery activities, the exception being for small-caliber crew-served weapons training when the immediate area around the ship is cleared visually. A notice is also issued in advance of explosive bombing activities when they are conducted in an area that does not already have a standing Notice to Mariners. More information on Notices to Mariners is found in Section 3.12.2.1.1 (Sea Space).

Most weapons firing activities that involve the use of explosive ordnance are conducted during daylight hours. All missile and rocket firing activities are carefully planned in advance and conducted under strict procedures that place the ultimate responsibility for range safety on the Officer Conducting the Exercise or civilian equivalent. The weapons firing hazard range must be clear of non-participating vessels and aircraft before firing activities will commence. The size of the firing hazard range is based on the farthest firing range capability of the weapon being used. All weapons firing stops when the Range Safety Officer receives a cease fire order or when the line of fire is endangering any object other than the designated target.

Pilots of Navy aircraft are not authorized to expend ordnance, fire missiles, or drop other airborne devices through extensive cloud cover where visual clearance of the air and surface area is not possible. The two exceptions to this requirement are: (1) when operating in the open ocean, clearance of the air and surface through radar surveillance is acceptable and (2) when the Officer Conducting the Exercise or civilian equivalent accepts responsibility for the safeguarding of airborne and surface traffic.

During activities that involve recoverable targets (e.g., aerial drones), the Navy recovers the target and any associated parachutes to the maximum extent practicable consistent with personnel and equipment safety. Recovery of these items helps minimize materials that remain, which could potentially alert enemy forces to the presence of U.S. Navy assets during real world situations.

The standard operating procedures for weapons firing safety could result in a secondary benefit to public health and safety through a reduction in the potential for interaction with weapons firing activities and expended materials. The standard operating procedure for conducting activities in daylight hours and recovering targets and parachutes could result in a secondary benefit to biological resources through a reduction in the potential for impacts from explosives and military expended materials (by increasing the effectiveness of visual observations for mitigation) and physical disturbance and strike stressors.

2.3.3.6 Target Deployment Safety

The deployment of targets is dependent upon environmental conditions. The Beaufort sea state scale is a standardized measurement of the weather conditions, based primarily on wind speed. The scale is divided into levels from 0 to 12, with 12 indicating the most severe weather conditions (e.g., hurricane force winds). At Beaufort sea state number 4, wave heights typically range from 3.5 to 5 ft. Firing exercises involving the integrated maritime portable acoustic scoring and simulation system are typically conducted in daylight hours in Beaufort sea state number 4 conditions or better to ensure safe operating conditions during buoy deployment and recovery.

The standard operating procedures for target deployment safety could result in a secondary benefit to public health and safety, and to marine mammals and sea turtles (by increasing the effectiveness of visual observations for mitigation) through a reduction in the potential for interaction with the weapons firing activities associated with the use of the deployed targets.

2.3.3.7 Swimmer Defense Activity Safety

A Notice to Mariners is issued in advance of all swimmer defense activities. A daily in situ calibration of the sound source levels is used to establish a clearance area to the 145 decibels referenced to 1 micropascal (dB re 1 µPa) sound pressure level threshold for non-participant personnel safety. A hydrophone is used during the calibration sequences in order to confirm the clearance area. Small boats patrol the 145 dB re 1 µPa sound pressure level area during all activities. Boat crews are equipped with binoculars and remain vigilant for non-participant divers and boats, swimmers, snorkelers, and dive flags. If a non-participating swimmer, snorkeler, or diver is observed entering into the area of the swimmer defense system, the power levels of the defense system are reduced. An additional 100-yard buffer is applied to the initial sighting location of the non-participant as an additional precaution, and this buffer area is used to determine if the non-participant is within the 145 dB re 1 µPa zone. If the area cannot be maintained free of non-participating swimmers, snorkelers, and divers, the activity will cease until the non-participant has moved outside the area.

The standard operating procedures for swimmer defense safety could result in a secondary benefit to public health and safety and socioeconomic resources through a reduction in the potential for interaction with swimmer defense activities.

2.3.3.8 Pierside Testing Safety

The *U.S. Navy Dive Manual* (U.S. Department of the Navy, 2011) prescribes safe distances for divers from active sonar sources and underwater explosions. Safety precautions for use of electromagnetic energy are specified in DoD Instruction 6055.11 (U.S. Department of Defense, 2009) and Military Standard 464A (U.S. Department of Defense, 2002). These distances are used as the standard safety buffers for underwater energy to protect Navy divers. If unauthorized personnel were detected within the exercise area, the activity would be temporarily halted until the area was again cleared and secured.

The standard operating procedures in place for sonar use, electromagnetic energy, and underwater explosions around diving activities could result in secondary benefits to public safety by reducing the potential for pierside testing to impact commercial or civilian divers.

2.3.3.9 Underwater Detonation Safety

Underwater detonation training takes place in specially designated areas, and Notice to Mariners are issued when the events are scheduled. These areas are not near popular dive sights; however, if divers are present, the training or testing activity would be postponed or cancelled.

The standard operating procedures for underwater detonation safety could result in a secondary benefit to public health and safety, cultural resources, protected species, and socioeconomic resources through a reduction in the potential for interaction with underwater detonation activities.

2.3.3.10 Sonic Booms

As a general policy, sonic booms shall not be intentionally generated below 30,000 ft. of altitude unless over water and more than 30 mi. from inhabited land areas or islands. Deviations from this policy may be authorized only under one of the following conditions:

- tactical missions
- phases of formal training syllabus flights
- research, test, and operational suitability test flights

The standard operating procedures for sonic booms could result in a secondary benefit to public health and safety through a reduction in the potential for exposure to sonic booms.

2.3.3.11 Unmanned Aerial, Surface, and Subsurface Vehicle Safety

For activities involving unmanned aerial, surface, and subsurface vehicles, the Navy evaluates the need to publish a Notice to Airmen or Mariners based on the scale, location, and timing of the activity. Notices to Mariners or Airmen are issued, when necessary, to inform the public of training and testing activities so that they may stay clear of these areas and safety will be ensured. Unmanned aerial systems are operated in accordance with Federal Aviation Administration air traffic organization policy as specified in Office of the Chief of Naval Operations Instructions 3710, 3750, and 4790.

The standard operating procedures for unmanned aerial, surface, and subsurface vehicle safety could result in a secondary benefit to public health and safety through a reduction in the potential for interaction with these platforms.

2.3.3.12 Towed In-Water Device Safety

Prior to deploying a towed in-water device from a manned platform, the Navy searches the intended path of the device for any floating debris (e.g., driftwood) and other objects (e.g., concentrations of floating vegetation), which have the potential to obstruct or damage the device.

The standard operating procedure for towed in-water device safety could result in a secondary benefit to marine mammals and vegetation through a reduction in the potential for physical disturbance and strike of a towed in-water device.

2.3.3.13 Ship Shock Trial Safety

The Navy may conduct ship shock trials in three distinct areas within the Study Area (Figure 2.3-1). Notices to Mariners and Airmen are issued in advance of all ship shock trial activities to alert the public to stay clear of the area. An area with a 5-NM radius is established around the detonation point to exclude all non-participating vessels and aircraft. This area will be established 5 to 6 hours prior to each detonation and may continue post-detonation for a total of exclusionary time of up to 12 hours. This area is an electronic emissions control zone that virtually eliminates the possibility of an inadvertent detonation caused by a radio or radar-induced electrical current in the explosive firing circuit. This area also provides for safe maneuvering of the explosive-laden operations vessel. Since the ship being tested and the operations vessel are not stationary during the ship shock trial activities, the associated area around the detonation point moves with the vessel. If a non-participating vessel or aircraft is detected within a 10-NM radius of ship shock trial activities, the non-participant is warned to alter course. This is necessary for operational security and to allow large vessels sufficient time to change course to avoid entering the clearance area. Ship shock trial testing is immediately stopped when a non-participating vessel or aircraft enters or is detected within the 5-NM clearance area. These security measures continue until the area is clear of non-participating vessels and aircraft.

In the unlikely event a charge fails to explode, additional attempts to detonate the charge would be made. If detonation fails, the explosive would be recovered and disarmed. If the explosive cannot be detonated or disarmed, to safeguard human life, the explosive is disposed at sea in accordance with established Ammunition and Explosives Safety Afloat requirements. The location of any disposal is recorded.

The standard operating procedures for ship shock trial safety could result in a secondary benefit to public health and safety through a reduction in the potential for interaction with ship shock trial activities.

2.3.3.14 Pile Driving Safety

Due to pile driving system design and operation, the Navy performs soft starts during impact installation of each pile to ensure proper operation of the diesel impact hammer. During a soft start, an initial set of strikes from the impact hammer at reduced energy are performed before it can be operated at full power and speed. The energy reduction of an individual hammer cannot be quantified because they vary by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer “bouncing” as it strikes the pile resulting in multiple “strikes.”

The standard operating procedures for pile driving safety could result in a secondary benefit to marine mammals, sea turtles, and fish because soft starts may “warn” these resources and cause them to move away from the sound source before impact pile driving increases to full operating capacity.

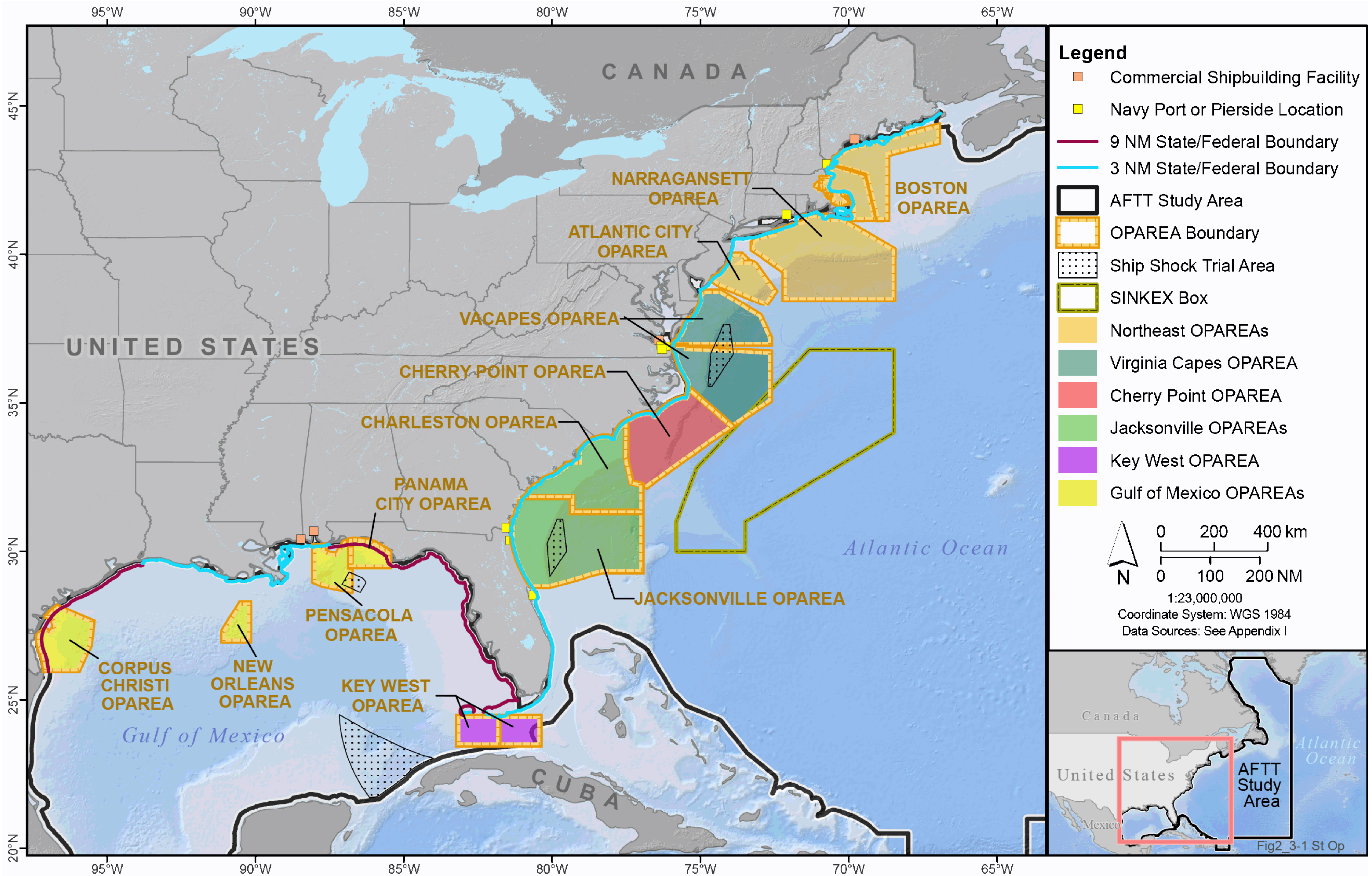
2.3.3.15 Sinking Exercise Safety

The Navy is required to conduct sinking exercises greater than 50 NM from land and in waters at least 6,000 ft. deep (40 CFR section 229.2). Within the Study Area, the Navy conducts sinking exercises only within a designated sinking exercise area (Figure 2.3-1). The Navy selected the sinking exercise area to avoid established commercial air traffic routes, commercial vessel shipping lanes, and areas used for recreational activities, and to allow for the necessary separation of Navy units to ensure safety for civilian personnel, commercial aircraft, commercial vessels, Sailors, and Navy assets.

The standard operating procedures for sinking exercise safety could result in a secondary benefit to public health and safety and socioeconomics through a reduction in the potential for interaction with sinking exercise activities.

2.3.3.16 Coastal Zone

As a matter of practice, the Navy typically does not conduct certain activities in coastal areas due to specific mission requirements. By deciding not to conduct certain activities in these coastal areas, potential impacts can be avoided in those areas. The coastal zone is 3 NM from shore for all states but Texas, the Florida Gulf coast, and Puerto Rico, which have a 9-NM limit. Training and testing activities that typically do not occur in the coastal zone are listed in Table 2.3-6 and Table 2.3-7, respectively.



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; SINKEX: Ship Sinking Exercises; VACAPES: Virginia Capes

Figure 2.3-1: Ship Shock Trial and Sinking Exercise Areas with Standard Operating Procedures

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Table 2.3-6: Training Activities Typically Not Occurring in the Coastal Zone[1]

Air Warfare	Mine Warfare
• Air Combat Maneuver • Air Defense Exercise • Gunnery Exercises o all Air-to-Air o all Surface-to-Air • Missile Exercises o Air-to-Air o Surface-to-Air ***Amphibious Warfare*** • Naval Surface Fire Support Exercise-At Sea • Naval Surface Fire Support Exercise-Land Based Target ***Anti-Submarine Warfare*** • Torpedo Exercise o Helicopter o Maritime Patrol Aircraft o Submarine o Ship • Tracking Exercise o Helicopter o Maritime Patrol Aircraft o Submarine o Ship ***Integrated/Coordinated Anti-Submarine Warfare*** • Anti-Submarine Warfare Tactical Development Exercise • Group Sail • Navy Undersea Warfare Training Assessment Course • Surface Warfare Advanced Tactical Training	• Mine Detection o Mine Countermeasure Exercise – Ship Sonar • Mine Laying o Aircraft o Submarine launched ***Surface Warfare*** • Gunnery Exercises o All Air-to-Surface o All Surface-to-Surface • Missile Exercise o Air-to-Surface (Missile and Rocket) o Surface-to-Surface • Laser Targeting o Aircraft o Ship • Integrated Live Fire • Bombing Exercise • Sinking Exercise[2] ***Major Training Exercise*** • Composite Training Unit Exercise • Fleet Exercise/Sustainment Exercise ***Other Training Activities*** • Submarine Navigation • Submarine Under Ice Certification ***Electronic Warfare*** • Counter Targeting o Chaff-Aircraft o Chaff-Ship o Flare-Aircraft

[1] Coastal Zone is 3 nautical miles everywhere in the Study Area with the exceptions of the Gulf coast of Florida, Texas, and Puerto Rico where the coastal zone is 9 nautical miles.
[2] This activity cannot occur in the coastal zone.

Table 2.3-7: Testing Activities Typically Not Occurring in the Coastal Zone[1]

Air Warfare	Surface Warfare
• Air Combat Maneuver Test • Air Platform Weapons Integration Test • Air Platform-Vehicle Test • Air-to-Air Weapons System Test o Air-to-Air Gunnery Test – Medium-Caliber o Air-to-Air Missile Test • Intelligence, Surveillance, and Reconnaissance Test ***Anti-Submarine Warfare*** • Anti-Submarine Warfare Torpedo Test • Anti-Submarine Warfare Tracking Test – Helicopter Kilo Dip • Sonobuoy Lot Acceptance Test • Torpedo (Explosive) Testing[2]	• Air-to-Surface Bombing Test • Air-to-Surface Gunnery Test • Air-to-Surface Missile Test • High-Energy Laser Weapons Test • Laser Targeting Test • Rocket Test • Gun Testing – Large-Caliber • Gun Testing – Medium-Caliber • Gun Testing – Small-Caliber • Kinetic Energy Weapon Testing • Missile and Rocket Testing ***Other Testing Activities*** • Air Platform Shipboard Integrate Test

Table 2.3-7: Testing Activities Typically Not Occurring in the Coastal Zone (continued)

Air Warfare	*Surface Warfare*
Integrated/Coordinated Anti-Submarine Warfare	• Maritime Security • Shipboard Electronic Systems Evaluation • Acoustic Component Testing • Chemical and Biological Simulant Testing (coastal zone of Maine only) • Hydrodynamic and Maneuverability Testing • Non-Acoustic Component Testing • Signature Analysis Operations • Underwater Search, Deployment, and Recovery • Acoustic and Oceanographic Research • Emerging Mine Countermeasure Technology Research • Large Displacement Unmanned Underwater Vehicle Testing
• At-Sea Sonar Testing • Anti-Submarine Warfare Tactical Development Exercise • Group Sail • Navy Undersea Warfare Training Assessment Course • Surface Warfare Advanced Tactical Training	
Electronic Warfare	
• Chaff Test • Electronic Systems Evaluation • Flare Test	
Mine Warfare	
• Mine Laying Test	
Vessel Evaluation	
• Aircraft Carrier Sea Trials – Propulsion Testing • Air Defense Testing • Propulsion Testing • Surface Warfare Testing • Small Ship Shock Trial[2] • Large Ship Shock Trial[2] • Submarine Sea Trials – Propulsion Testing • Submarine Sea Trials – Weapons System Testing • Total Ship Survivability Trials	

[1] Coastal Zone is 3 nautical miles everywhere in the Study Area with the exceptions of the Gulf coast of Florida, Texas, and Puerto Rico where the coastal zone is 9 nautical miles.
[2] This activity cannot occur in the coastal zone.

2.3.4 MITIGATION MEASURES

The Navy implements mitigation to avoid potential impacts from the Proposed Action on biological, cultural, and socioeconomic resources. The Navy will implement procedural mitigation (which is mitigation that is applied whenever and wherever an applicable activity takes place in the Study Area) or mitigation within mitigation areas (which are geographic locations within the Study Area where the Navy will implement additional mitigation during all or part of the year) for the stressors and geographic locations listed in Table 2.3-8 and in Appendix A (Navy Activity Descriptions). Figure 2.4-1 provides an overview of the areas in which the Navy will implement geographic mitigations. See Chapter 5 (Mitigation) for a full discussion of how the Navy developed mitigation, and a complete presentation of the procedural mitigation and mitigation areas that will be implemented under Alternative 1 or Alternative 2 of the Proposed Action. The final suite of mitigation measures resulting from the ongoing planning, consultation, and permitting processes will be documented in the Final EIS/OEIS, the Navy's Record of Decision, and all applicable authorizations or consultation documents.

Table 2.3-8: Summary of Mitigation for Stressors and Geographic Locations

Chapter 5 (Mitigation) Section	*Activity Category, Stressor, or Geographic Location that Incorporates Procedural Mitigation or Mitigation Areas*
Section 5.3.2, Acoustic Stressors	Low-Frequency Active Sonar Mid-Frequency Active Sonar

Table 2.3-8: Summary of Mitigation for Activity Categories, Stressors, and Geographic Locations (continued)

Chapter 5 (Mitigation) Section	*Activity Category, Stressor, or Geographic Location that Incorporates Procedural Mitigation or Mitigation Areas*
	High-Frequency Active Sonar Air Guns Pile Driving Weapons Firing Noise Aircraft Overflight Noise
Section 5.3.3, Explosive Stressors	Explosive Sonobuoys Explosive Torpedoes Explosive Medium- and Large-Caliber Projectiles Explosive Missiles Explosive Bombs Sinking Exercises Mine Countermeasure and Neutralization Activities Using Towed Influence Mine Sweep Systems and Unmanned/Remotely Operated Mine Neutralization Systems Mine Neutralization Activities Using Explosive Ordnance Disposal Maritime Security Operations – Anti-Swimmer Grenades Line Charge Testing Ship Shock Trials
Section 5.3.4, Physical Disturbance and Strike Stressors	Vessel Movement Towed In-Water Devices Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions Non-Explosive Missiles Non-Explosive Bombs
Section 5.4, Mitigation Areas to be Implemented	Areas with Seafloor Resources Areas off the Northeastern United States Areas off the Mid-Atlantic and Southeastern United States Areas in the Gulf of Mexico

2.4 Action Alternative Development

The identification, consideration, and analysis of alternatives are critical components of the National Environmental Policy Act (NEPA) process and contribute to the goal of objective decision-making. The Council on Environmental Quality developed regulations to implement NEPA and these regulations require the decision maker to consider the environmental effects of the proposed action and a range of alternatives (including the no action alternative) to the proposed action (40 CFR section 1502.14). Council on Environmental Quality guidance further provides that an EIS must rigorously and objectively explore all reasonable alternatives for implementing the proposed action and, for alternatives eliminated from detailed study, briefly discuss the reasons for having been eliminated. To be reasonable, an alternative, except for the no action alternative, must meet the stated purpose of and need for the proposed action. An alternative that does not meet the stated purpose of and need for the proposed action is not considered reasonable.

The Navy developed the alternatives considered in this EIS/OEIS after careful assessment by subject matter experts, including military commands that utilize the ranges, military range management professionals, and Navy environmental managers and scientists. The Navy also used new or updated military policy and historical data in developing alternatives.

For example, one military policy used to inform the alternatives development was the Optimized Fleet Response Plan, discussed in Section 1.4.2 (Optimized Fleet Response Plan), which changed how the Navy meets its readiness requirements. The data developed from the Optimized Fleet Response Plan informs the level of training, including the use of sonar sources and explosives, required by the Navy to meet its Title 10 responsibilities, which includes to maintain, train, and equip combat ready forces. Additionally, during prior phases of comprehensive environmental planning, the Navy assumed that all unit-level sonar training requirements were met through independent training events, meaning each active sonar training requirement was analyzed as a discrete event. This was done for two reasons. First, there was insufficient data to determine if training requirements were being met through means other than live at-sea training, such as through the use of simulated training. Second, since this data was unavailable during prior phases of environmental planning, the Navy wanted to ensure it did not underestimate the potential effects of these activities when seeking MMPA/Endangered Species Act (ESA) permits, resulting in permits with insufficient authority to support the Navy's requirements. This could have resulted in the possibility of exceeding permit limits and resulted in non-compliance with the law.

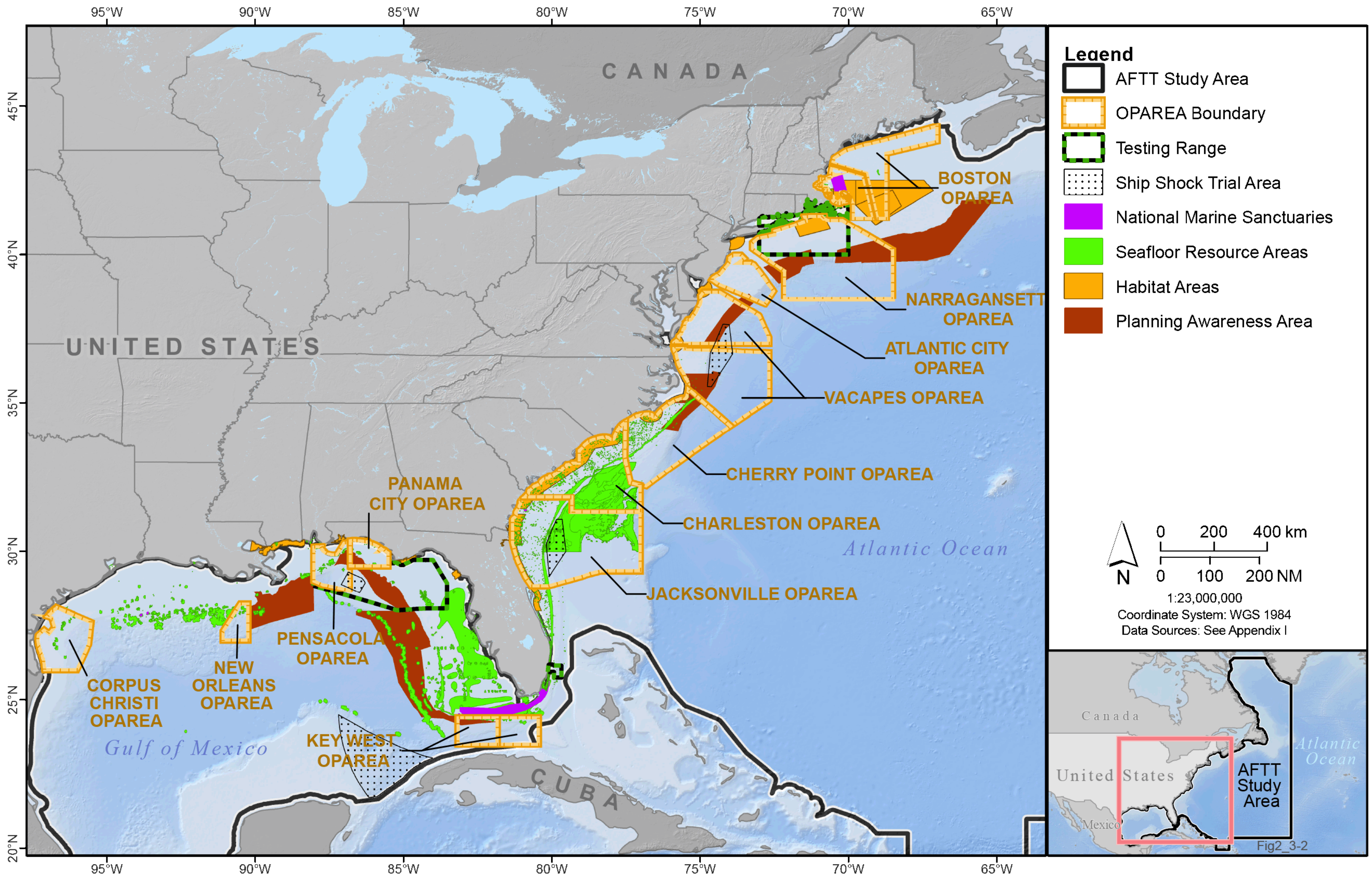
Through the collection of several years of classified sonar use data, the Navy produced a more refined analysis of the amount of sonar usage that the Navy anticipates will be necessary to meet its training and testing requirements, which underlie the development of the action alternatives.

With regards to testing activities, as previously stated, the level of activity in any given year is highly variable and is dependent on technological advancements, emergent requirements identified during operations, and fiscal fluctuations. Therefore, the environmental analysis must consider all testing activities that could possibly occur to ensure that the analysis fully captures the potential environmental effects. These factors were considered in alternatives carried forward for consideration and analyses as described in Section 2.5 (Alternatives Carried Forward).

2.4.1 Training

The analysis of sonar use showed that ships are meeting their active sonar training requirements through a variety of methods. Ships are limited in the number of underway days that are available to conduct at-sea training during the training cycle due to training schedules and constrained fuel resources. Sailors are required to conduct a variety of unit-level training events, throughout all training phases to maintain readiness and conduct this training through a variety of methods, including simulators, unit-level live training at sea, and unit-level training accomplished in conjunction with other training exercises.

Simulators are sufficient to develop basic operator efficiency and can also be used for basic training of watch teams. While this does build proficiency, it cannot replicate the real world complexities sailors will have to deal with while deployed. Operating active sonar in the ocean is extremely complex due to numerous environmental factors that affect how sound travels through water, which cannot be realistically replicated. Only by training in the actual ocean environment can ship crews learn how to deal with these rapidly changing parameters and optimize their sensors to locate underwater objects such as submarines and mines. In summary, while simulators are an important tool for attaining and maintaining readiness, they cannot completely replace live training at sea.



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; SINKEX: Ship Sinking Exercises; VACAPES: Virginia Capes

Figure 2.4-1: Geographic Areas Where Navy Proposes to Conduct Mitigation Measures

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To maximize training effectiveness during limited at-sea opportunities, the Navy takes advantage of training events that can meet multiple training requirements. For example, during an integrated or major training exercise that tracks a submarine with active sonar, units can also take credit for their unit level training requirement to maintain proficiency in tracking submarines with active sonar. In previous environmental analyses, the Navy assumed that each requirement was met through independent training events. However, Navy's analysis has found that, in some instances, multiple requirements (i.e., unit level, integrated, and major training requirements) could be met during one activity. This ability to meet multiple requirements during one activity effectively reduces the number of times the activity needs to be conducted and, therefore, the sound energy transmitted into the water.

The Optimized Fleet Response Plan also influences the amount of active sonar transmitted during training. Under the prior Fleet Response Plan, as discussed in Section 1.4.2 (Optimized Fleet Response Plan), the Navy was required to be prepared to deploy eight carrier strike groups within 6 months. This meant that Navy units had to accomplish all training requirements from the basic phase through the integrated phase in a 6-month period. Although this level of training would occur if the Navy had to respond to a major national security crisis, this level of training has not been conducted in recent years. Instead, the Navy has been responding to significant but more regional challenges through routine deployments while still maintaining a stabilizing and continuous presence around the globe. From an environmental planning and permitting perspective, the combination of analyzing a year where world events require certification and deployment of eight carrier strike groups and repeating the maximum certification and deployment requirement every year resulted in the Navy's analyses and permits overestimating the number of training requirements. This also then overestimated the potential effects of that training over the 5-year MMPA incidental take authorization period. Up until this point, the current force structure (the number of ships, submarines, and aircraft) has resulted in significantly less active sonar use than what was analyzed in the previous environmental planning compliance documents and as reflected in the 2013–2018 permits. The Navy considered this data in developing the action alternatives.

2.4.2 Testing

As described in Section 1.4.3 (Why the Navy Tests), there are multiple factors that make it challenging for the Navy to accurately predict future testing requirements. Testing conducted on past systems is not a reliable predictor of future testing duration and tempo, since testing requirements and funding can change. Also, testing of a given system does not occur on a predictable annual cycle but rather in discrete test phases that differ in duration and frequency. Some test phases are relatively short, up to a year, while others can take multiple years. The duration and timing of testing will vary depending on federal funding cycles and the success of past test events. The time, place, and details of future testing depend on scientific developments that are not easy to predict, and experimental designs may evolve with emerging science and technology. Even with these challenges, the Navy makes every effort to accurately forecast all future testing requirements.

In order to adequately support Navy testing requirements that are driven by the need to support fleet readiness, alternatives must have an annual capacity to conduct the research, development, and testing to support the following:

- new systems and new technologies
- upgrades to existing systems

- testing of existing systems after repair and maintenance activities
- routine lot acceptance testing of systems

Depending on emerging national security interests or threats to U.S. forces, the Navy may begin rapid development projects that were unanticipated at the time of initial environmental planning. Additionally, the potential that naval forces may need to quickly respond to world conflict or evolving threats may mean that sometimes technical evaluation and operational evaluation of a system could be expedited and occur in the same year. Therefore, the planning for future testing must accommodate these emergent requirements as much as possible. Based on these many uncertainties, the Navy's projected testing requirements and requested authorizations for testing within the AFTT Study Area provides the Navy the ability to test to a potential foreseeable annual maximum level. The maximum level is used in the analysis and authorization to ensure that Navy does not underestimate the potential impacts during the analysis. Consequently, Navy testing during any given year of an authorization timeframe can be less than the levels analyzed.

2.4.3 Alternatives Eliminated from Further Consideration

Alternatives eliminated from further consideration are described below. The Navy determined that these alternatives did not meet the purpose of and need for the Proposed Action after a thorough consideration of each.

2.4.3.1 Alternative Training and Testing Locations

Navy ranges have evolved over the decades and, considered together, allow for the entire spectrum of training and testing to occur in a given range complex or testing range. While some unit-level training and some testing activities may require only one training element (airspace, sea surface space, or undersea space), more advanced training and testing events may require a combination of air, surface, and undersea space as well as access to land ranges. The ability to utilize the diverse and multi-dimensional capabilities of each range complex or testing range allows the Navy to develop and maintain high levels of readiness. The Study Area, and the range complexes and testing ranges it contains, has attributes necessary to support effective training and testing. No other locations match the Study Area attributes, which are as follows:

- proximity of range complexes and testing ranges off the east coast of the United States and within the Gulf of Mexico to each other
- proximity to the homeport regions of Norfolk, Virginia; Camp Lejeune in Jacksonville, North Carolina; and Jacksonville, Florida, as well as the Navy command headquarters, training schools, ships, submarines, aircraft squadrons, and Marine Corps forces located in each of those locations
- proximity to shore-based facilities, infrastructure, and the logistical support provided for testing activities
- proximity to military families, minimizing the length of time Sailors and Marines spend deployed away from home and benefitting overall readiness
- presence of unique training and testing ranges, which include the established mine warfare capabilities in the Virginia Capes Range Complex, the instrumented water ranges located at the South Florida Ocean Measurement Facility Testing Range, and naval training beaches located at Marine Corps Base Camp Lejeune capable of supporting large-scale amphibious training events

- environmental conditions (i.e., bathymetry, topography, and weather) found in the Study Area that maximize the training realism and testing effectiveness

The uniquely interrelated nature of the features and attributes of the range complexes and testing ranges located within the Study Area (as detailed in Section 2.1, Description of the Atlantic Fleet Training and Testing Study Area) provides the training and testing support needed for complex military activities. There is no other series of integrated ranges in the Atlantic Ocean that affords this level of operational support and comprehensive integration for range activities. There are no other potential locations in the Atlantic, where roughly half of the U.S. Navy's fleet is located, where land ranges, OPAREAs, undersea terrain and ranges, testing ranges, and military airspace combine to provide the venues necessary for the training and testing realism and effectiveness required to train and certify naval forces ready for combat operations.

2.4.3.2 Simulated Training and Testing Only

The Navy currently uses simulation for training and testing whenever possible (e.g., command and control exercises are conducted without operational forces); however, there are significant limitations, and its use cannot replace live training or testing.

To detect and counter mine shapes and hostile submarines, the Navy uses both passive and active sonar. Sonar proficiency is a complex and perishable skill that requires regular, hands-on training in realistic and diverse conditions. More than 300 extremely quiet, newer-generation submarines are operated by more than 40 nations worldwide, and these numbers are growing. These difficult-to-detect submarines, as well as torpedoes and underwater mines, are true threats to global commerce, national security, and the safety of military personnel. As a result, defense against enemy submarines is a top priority for the Navy. Anti-submarine warfare training and testing activities include the use of active and passive sonar systems and small explosive charges, which prepare and equip Sailors for countering threats. Inability to train with sonar would eliminate or diminish anti-submarine warfare readiness. Failure to detect and defend against hostile submarines can cost lives, such as the 46 Sailors who lost their lives when a Republic of Korea frigate (CHEONAN) was sunk by a North Korean submarine in March 2010.

There are limits to the realism that current simulation technology can presently provide. Unlike live training, computer-based training does not provide the requisite level of realism necessary to attain combat readiness. Today's simulation technology does not permit anti-submarine warfare training with the level of detail required to maintain proficiency. While simulators are used for the basic training of sonar technicians, they are of limited value beyond basic training. A simulator cannot match the dynamic nature of the environment, such as bathymetry and sound propagation properties, or the training activities involving several units with multiple crews interacting in a variety of acoustic environments.

Computer simulation can provide familiarity and complement live training; however, it cannot provide the fidelity and level of training necessary to prepare naval forces for deployment. Sonar operators must train regularly and frequently to develop and maintain the skills necessary to master the process of identifying underwater threats in the complex subsurface environment. Sole reliance on simulation would deny service members the ability to develop battle-ready proficiency in the employment of active sonar in the following areas:

- Bottom bounce and other environmental conditions. Sound hitting the ocean floor (bottom bounce) reacts differently depending on the bottom type and depth. Likewise, sound passing through changing currents, eddies, or across differences in ocean temperature, pressure, or salinity is also affected. Both of these are extremely complex and difficult to simulate, and both are common in actual sonar operations.

- Mutual sonar interference. When multiple sonar sources are operating in the vicinity of each other, interference due to similarities in frequency can occur. Again, this is a complex variable that must be recognized by sonar operators but is difficult to simulate with any degree of fidelity.
- Interplay between ship and submarine target. Ship crews, from the sonar operator to the ship's Captain, must react to the changing tactical situation with a real, thinking adversary (a Navy submarine for training purposes). Training in actual conditions with actual submarine targets provides a challenge that cannot be duplicated through simulation.
- Interplay between anti-submarine warfare teams in the strike group. Similar to the interplay required between ships and submarine targets, a ship's crew must react to all changes in the tactical situation, including changes from cooperating ships, submarines, and aircraft.

Similar to the challenges presented in the training situations above, operational testing cannot be based exclusively on computer modeling or simulation either (see 10 U.S.C. sections 2366 and 2399). At-sea testing provides the critical information on operability and supportability needed by the Navy to make decisions on the procurement of platforms and systems, ensuring that what is purchased performs as expected and that tax dollars are not wasted. This testing requirement is also critical to protecting the Sailors and Marines who depend on these technologies to execute their mission with minimal risk to themselves.

As the acquisition authority for the Navy, the Systems Commands are responsible for administering large contracts for the Navy's procurement of platforms and systems. These contracts include performance criteria and specifications that must be verified to ensure that the Navy accepts platforms and systems that support the warfighter's needs. Although simulation is a key component in platform and systems development, it does not adequately provide information on how a system will perform or whether it will be available to meet performance and other specification requirements because of the complexity of the technologies in development and marine environments in which they will operate. For this reason, at some point in the development process, platforms and systems must undergo at-sea or in-flight testing. Therefore, simulation as an alternative that replaces training and testing in the field does not meet the purpose of and need for the Proposed Action and has been eliminated from detailed study.

2.4.3.3 Training and Testing Without the Use of Active Sonar

As explained in Section 2.4.3.2 (Simulated Training and Testing Only), in order to detect and counter submerged mines and hostile submarines, the Navy uses both passive and active sonar. Sonar proficiency is a complex and perishable skill that requires regular, hands-on training in realistic and diverse conditions. Active sonar is needed to find and counter newer-generation submarines around the world, which are growing in number, as are torpedoes and underwater mines, which are true threats to global commerce, national security, and the safety of military personnel. As a result, defense against enemy submarines is a top priority for the Navy.

2.5 Alternatives Carried Forward

The Navy's anticipated level of training and testing activity evolves over time based on numerous factors as discussed in the preceding paragraphs in Section 2.4 (Action Alternative Development). Additionally, over the past several years, the Navy's ongoing sonar reporting program has gathered classified data regarding the number of hull-mounted mid-frequency sonar hours used to meet anti-submarine warfare requirements, which has increased understanding of how sonar training hours are generated. This data allows for a more accurate projection of the number of active sonar hours required to meet anti-submarine warfare training requirements into the reasonably foreseeable future.

In light of this information, the Navy was able to better formulate a range of reasonable alternatives that meet Navy training requirements while reflecting a lower, and more realistic, impact on the environment. This analysis of ongoing activities also provides a more accurate assessment of the Navy's current impact on the environment from ongoing Navy training and testing when compared to the currently permitted activities.

2.5.1 No Action Alternative

As mentioned above in Section 2.4 (Action Alternative Development), the Council on Environmental Quality implementing regulations require that a range of alternatives to the proposed action, including a No Action Alternative, be analyzed to provide a clear basis for choice among options by the decision maker and the public (40 CFR 1502.14). Council on Environmental Quality guidance identifies two approaches in developing the No Action Alternative (46 *Federal Register* 18026). One approach for activities that have been ongoing for long periods of time is for the No Action Alternative to be thought of in terms of continuing the present course of action, or current management direction or intensity, such as the continuation of Navy training and testing at sea in the AFTT Study Area at current levels, even if separate legal authorizations under the MMPA and ESA are required. Under this approach, which was used in Phases I and II of the Navy's environmental planning and compliance program for training and testing activities at sea, the analysis compares the effects of continuing current activity levels (i.e., the "status quo") with the effects of the Proposed Action. The second approach depicts a scenario where no authorizations or permits are issued, the Navy's training and testing activities do not take place, and the resulting environmental effects from taking no action are compared with the effects of the Proposed Action. This approach is being applied in Phase III of the Navy's environmental planning and compliance program, including in this EIS/OEIS.

Under the No Action Alternative analyzed in this EIS/OEIS, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Consequently, the No Action Alternative of not conducting the proposed live, at-sea training and testing in the AFTT Study Area is inherently unreasonable in that it does not meet the Navy's purpose and need (see Section 1.4, Purpose and Need for Proposed Military Readiness Training and Testing Activities) for the reasons noted in the next four paragraphs. However, the analysis associated with the No Action Alternative is carried forward in order to compare the magnitude of the potential environmental effects of the Proposed Action with the conditions that would occur if the Proposed Action did not occur (see Section 3.0, Introduction).

From NMFS' perspective, pursuant to its obligation to grant or deny permit applications under the MMPA, the No Action Alternative involves NMFS denying Navy's application for an incidental take authorization under Section 101(a)(5)(A) of the MMPA. If NMFS were to deny the Navy's application, the Navy would not be authorized to incidentally take marine mammals in the AFTT Study Area, and under the No Action Alternative, as explained above, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area.

Cessation of proposed Navy at-sea training and testing activities would mean that the Navy would not meet its statutory requirements and would be unable to properly defend itself and the United States from enemy forces, unable to successfully detect enemy submarines, and unable to effectively use its weapons systems or defensive countermeasures. Navy personnel would essentially not be taught how to use Navy systems in any realistic scenario. For example, sonar proficiency, which is a complex and perishable skill, requires regular, hands-on training in realistic and diverse conditions in order to detect and counter hostile submarines. Inability to train with active sonar would result in no or greatly diminished anti-submarine warfare capability.

Additionally, without proper training, individual Sailors and Marines serving onboard Navy vessels would not be taught how to properly operate complex equipment in inherently dynamic and dangerous environments. Thus, even during routine non-combat operations, it is likely that there would be an increase in the number of mishaps, potentially resulting in the death or serious injury of Sailors and Marines. As it stands, even with high levels of training and a culture of safety, injuries and death do occur. Failing to allow our Sailors and Marines to achieve and maintain the skills necessary to defend the United States and its interests will result in an unacceptable increase in the danger they willingly face.

Finally, the lack of live training and testing would require a higher reliance on simulated training and testing. While the Navy continues to research new ways to provide realistic training through simulation, there are limits to the realism that current technology can provide. While simulators are used for the basic training of sonar technicians, they are of limited utility beyond basic training. A simulator cannot match the dynamic nature of the environment, such as bathymetry and sound propagation properties, or the training activities involving several units with multiple crews interacting in a variety of acoustic environments. Sole reliance on simulation would deny service members the ability to develop battle-ready proficiency in the employment of active sonar (Section 2.4.3.2, Simulated Training and Testing Only).

2.5.2 ALTERNATIVE 1

Alternative 1 is the Preferred Alternative.

2.5.2.1 Training

Under this alternative, the Navy proposes to conduct military readiness training activities into the reasonably foreseeable future, as necessary to meet current and future readiness requirements. These military readiness training activities include new activities as well as activities subject to previous analysis that are currently ongoing and have historically occurred in the Study Area. The requirements for the types of activities to be conducted, as well as the intensity at which they need to occur, have been validated by senior Navy leadership. Specifically, training activities are based on the requirements of the Optimized Fleet Response Plan and on changing world events, advances in technology, and Navy tactical and strategic priorities. These activities account for force structure changes and include training with new aircraft, vessels, unmanned/autonomous systems, and weapon systems that will be introduced to the fleets after November 2018. The numbers and locations of all proposed training activities are provided in Section 2.6.1 (Proposed Training Activities).

Alternative 1 reflects a representative year of training to account for the natural fluctuation of training cycles and deployment schedules that generally influences the maximum level of training that may occur year after year in any 5-year period. Using a representative level of activity rather than a maximum tempo of training activity in every year has reduced the amount of hull-mounted mid-frequency active sonar estimated to be necessary to meet training requirements, as discussed below. Both unit-level training and major training exercises are adjusted to meet this representative year, as discussed below.

Under Alternative 1, the Navy assumes that some unit-level training would be conducted using synthetic means (e.g., simulators). Additionally, this alternative assumes that some unit-level active sonar training will be completed through other training exercises. By using a representative level of training activity rather than a maximum level of training activity in every year, this alternative accepts a degree of risk that if global events necessitated a rapid expansion of military training that Navy would not have sufficient capacity in its MMPA and ESA authorizations to carry out those training requirements.

The Optimized Fleet Response Plan and various training plans identify the number and duration of training cycles that could occur over a 5-year period. Alternative 1 considers fluctuations in training cycles and deployment schedules that do not follow a traditional annual calendar but instead are influenced by in-theater demands and other external factors. Similar to unit-level training, this alternative does not analyze a maximum number carrier strike group Composite Training Unit Exercises (one type of major exercise) every year, but instead assumes a maximum number of exercises would occur during 2 years of any 5-year period. As a result, Alternative 1 will analyze a maximum of 3 Composite Training Unit Exercises in any given year and not more than 12 over any 5-year period. This alternative does not provide for the conduct of a contingency Composite Training Unit Exercise in the Gulf of Mexico and, hence, incorporates a degree of risk that the Navy will not have sufficient capacity in potential MMPA permits to support the full spectrum of training potentially necessary to respond to a future national emergency crisis.

2.5.2.2 Testing

Alternative 1 entails a level of testing activities to be conducted into the reasonably foreseeable future, with adjustments that account for changes in the types and tempo (increases or decreases) of testing activities to meet current and future military readiness requirements. This alternative includes the testing of new platforms, systems, and related equipment that will be introduced after November 2018. The majority of testing activities that would be conducted under this alternative are the same as or similar as those conducted currently or in the past. This alternative includes the testing of some new systems using new technologies and takes into account inherent uncertainties in this type of testing.

Under Alternative 1, the Navy proposes an annual level of testing that reflects the fluctuations in testing programs by recognizing that the maximum level of testing will not be conducted each year. This alternative contains a more realistic annual representation of activities, but includes years of a higher maximum amount of testing to account for these fluctuations. This alternative would not include the contingency for augmenting some weapon system tests, which would increase levels of annual testing of anti-submarine warfare and mine warfare systems, and presumes a typical level of readiness requirements. The numbers and locations of all proposed testing activities are provided in Section 2.6.2 (Proposed Testing Activities).

2.5.2.3 Mitigation Measures

In addition to standard operating procedures, the Navy proposes to implement procedural and geographic/temporal mitigation measures for Alternative 1, in addition to changes or additions to those mitigation measures as discussed in Chapter 5 (Mitigation). The final suite of mitigation measures resulting from the ongoing planning, consultation, and permitting processes will be documented in the Final EIS/OEIS, the Navy's Record of Decision, and all applicable authorizations or consultation documents. These measures apply to both training and testing activities.

2.5.3 Alternative 2

2.5.3.1 Training

As under Alternative 1, this alternative includes new and ongoing activities. Under Alternative 2, training activities are based on requirements established by the Optimized Fleet Response Plan. Under this alternative, the Navy would be enabled to meet the highest levels of required military readiness by conducting the majority of its training live at sea, and by meeting unit level training requirements using dedicated, discrete training events, instead of combining them with other training activities as described in alternative 1. The numbers and locations of all proposed training activities are provided in Table 2.6 1, in Section 2.6.1 (Proposed Training Activities).

Alternative 2 reflects the maximum number of training activities that could occur within a given year, and assumes that the maximum level of activity would occur every year over any 5-year period. This allows for the greatest capacity for the Navy to maintain readiness when considering potential changes in the national security environment, fluctuations in training and deployment schedules, and potential in-theater demands. Both unit-level training and major training exercises are assumed to occur at a maximum level every year.

Additionally, this alternative will analyze 3 Composite Training Unit Exercises each year along with a contingency Composite Training Unit Exercise in the Gulf of Mexico each year, for a total number of 20 Composite Training Unit Exercises, including the Gulf of Mexico contingency Composite Training Unit Exercise, over any 5-year period.

2.5.3.2 Testing

Like Alternative 1, Alternative 2 entails a level of testing activities to be conducted into the reasonably foreseeable future and includes the testing of new platforms, systems, and related equipment that will be introduced beginning in November 2018. The majority of testing activities that would be conducted under this alternative are the same as or similar as those conducted currently or in the past.

Alternative 2 would include the testing of some new systems using new technologies, taking into account the potential for delayed or accelerated testing schedules, variations in funding availability, and innovations in technology development. To account for these inherent uncertainties in testing, this alternative assumes that the maximum annual testing efforts predicted for each individual system or program could occur concurrently in any given year. This alternative also includes the contingency for augmenting some weapon systems tests in response to potential increased world conflicts and changing Navy leadership priorities as the result of a direct challenge from a naval opponent that possesses near-peer capabilities. Therefore, this alternative includes the provision for higher levels of annual testing of certain anti-submarine warfare and mine warfare systems to support expedited delivery of these systems to the fleet. All proposed testing activities are listed in Table 2.6-2 through Table 2.6-4, in Section 2.6 (Proposed Training and Testing Activities for Both Alternatives).

2.5.3.3 Mitigation Measures

In addition to standard operating procedures, the Navy proposes to implement procedural and geographic/temporal mitigation measures for Alternative 2, in addition to changes or additions to those mitigation measures as discussed in Chapter 5 (Mitigation). The final suite of mitigation measures resulting from the ongoing planning, consultation, and permitting processes will be documented in the Final EIS/OEIS, the Navy's Record of Decision, and all applicable authorizations or consultation documents. These measures apply to both training and testing activities.

2.5.4 Comparison of Proposed Sonar and Explosive Use in the Action Alternatives to the 2013–2018 MMPA Permit Allotment

2.5.4.1 Training

As a comparison to the amount of training analyzed in the previous environmental planning compliance documents and as reflected in the 2013–2018 MMPA permit (Phase II), the Navy considered the type of sonar source that resulted in the greatest number of exposures to marine mammals, which was identified as hull-mounted mid-frequency active sonar. The differences between use of this system from Phase II to Phase III are best identified in three ways: (1) completion of unit-level training via synthetic means or through other training exercises, (2) reduction of sonar hours associated with a Composite Training Unit Exercise, and (3) reduction in the number of Composite Training Unit Exercises expected over a 5-year period.

During Phase II, all unit-level training using hull-mounted mid-frequency sonar was assumed to be conducted during discrete training events. However, current practice indicates that some unit-level training is completed through synthetic training, as well as concurrent with other training exercises (e.g., unit-level training can be completed simultaneously during the conduct of an integrated training exercise). Alternative 1 accounts for the use of synthetic training and concurrent unit-level training within other exercises, although this assumes risk in the event additional live training is necessary. To preserve the ability for the Navy to conduct all unit-level sonar training as discrete, at-sea exercises, Alternative 2 does not provide for the reduction in hours for this type of activity.

Composite Training Unit Exercises are major exercises that involve multiple platforms and numerous hours of sonar to meet mission objectives. During Phase II, each Composite Training Unit Exercise was assumed to require 1,000 hours of hull-mounted mid-frequency sonar. Through analysis of data collected during the Phase II permit period, the Navy determined that this assumption overestimated the amount of hull-mounted mid-frequency sonar that was typically used in a Composite Training Unit Exercise by 400 hours. As such, for both Alternatives 1 and 2, an estimated 600 hours of hull-mounted mid-frequency sonar is included for each Composite Training Unit Exercise.

Comparisons of proposed hull-mounted mid-frequency sonar hours to the hours permitted from 2013 to 2018 are depicted in Figure 2.5-1 and Figure 2.5-2.

The Fleet Response Plan, in place during Phase II, identified a requirement to conduct four Composite Training Unit Exercises per year along the U.S. East Coast, and a contingency Composite Training Unit Exercise in the Gulf of Mexico was also included, resulting in a total of five exercises analyzed per year. For Phase III, the number of Composite Training Unit Exercises to be conducted is reduced, with fewer proposed exercises in Alternative 1 and Alternative 2. Alternative 1 reduces (from the 2013–2018 permitted level) the number of Composite Training Unit Exercises to be conducted during any 5-year period along the east coast by analyzing representative years (in addition to maximum planned years) of training activity to account for the variability of training cycles and deployment schedules. Alternative 1 analyzes 2 years of three Composite Training Unit Exercises (maximum years) and 3 years of two Composite Unit Training Exercises (representative years) occurring along the east coast. Alternative 2 analyzes a maximum number of Composite Training Unit Exercises planned per year (three) along the east coast and a contingency exercise in the Gulf of Mexico every year in a 5-year period. As such, Alternative 2 provides for 4 Composite Training Unit Exercises each year, for a total of 20 over the 5-year period. A comparison of the number of Composite Training Unit Exercises from the 2013–2018 permitted levels to the action alternatives is provided in Figure 2.5-3.

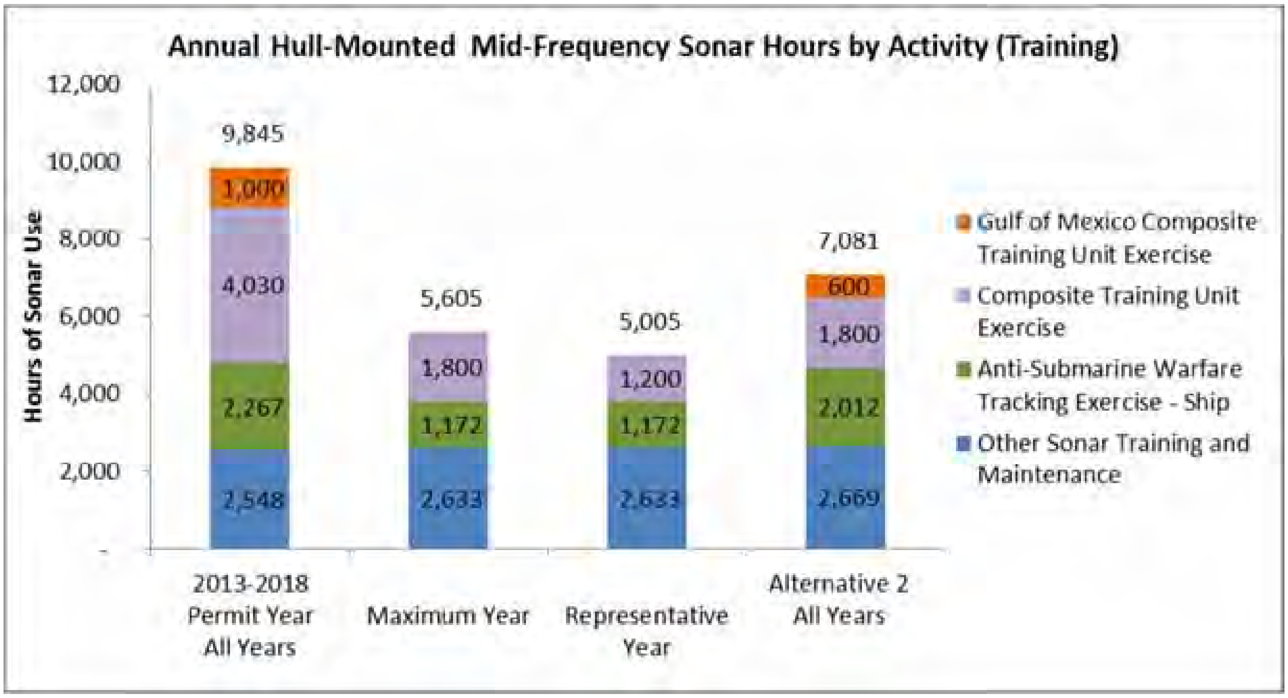


Figure 2.5-1: Proposed Maximum Year of Hull-Mounted Mid-Frequency Sonar Hour Use by Activity During Training Compared to the Number Authorized in the 2013–2018 Marine Mammal Protection Act Permit

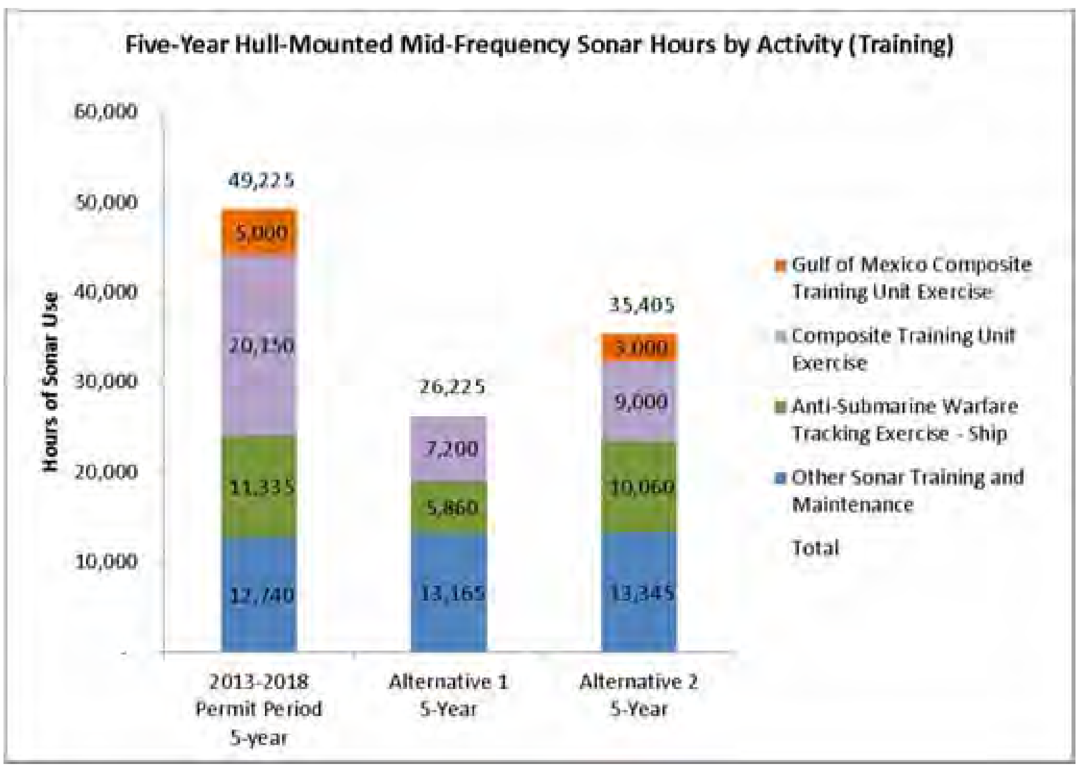


Figure 2.5-2: Proposed Five-Year Total Hull-Mounted Mid-Frequency Sonar Hour Use by Activity During Training Compared to the Number Authorized in the 2013–2018 Marine Mammal Protection Act Permit

After analyzing the level of explosive activities conducted during Phase II, the Navy identified that some explosive sources were incorrectly classed into bins with greater net explosive weights (see Appendix A, Navy Activity Descriptions, for a discussion of bins) than actually is present in the munition. For example, 20-millimeter rounds were considered in bin E1 during Phase II, but have less than 0.1 pounds of net explosive weight (defined as bin E0), and are therefore analyzed qualitatively (instead of quantitatively) for Phase III. Additionally in Phase II, munitions within the same category were all analyzed with the highest net explosive weight for all munitions in that category. For example, most bombs were analyzed as bin E12 (to account for the largest potential for environmental impact), whereas many fall within bins E9 and E10. For Phase III, munitions were divided into more appropriate bins based on current and anticipated weapon inventory. Due to the re-binning of multiple munitions, comparing the use of a single bin or type of explosive (similar to the comparison above for sonar) is not prudent. Figure 2.5-4 provides the change in explosive use per bin for all training activities between the 2013–2018 permitted level and the two action alternatives.

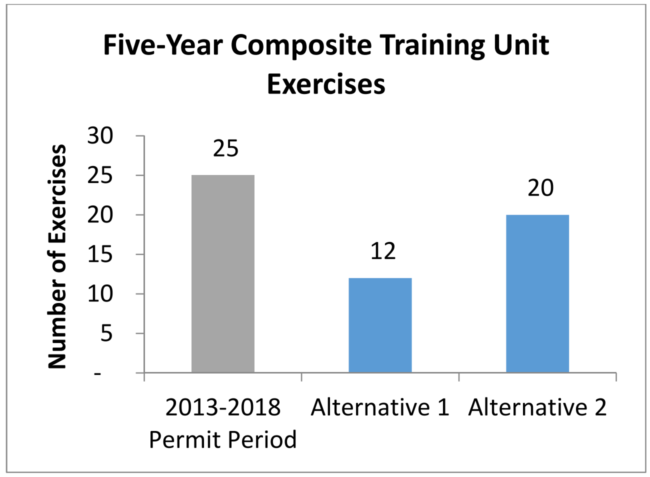
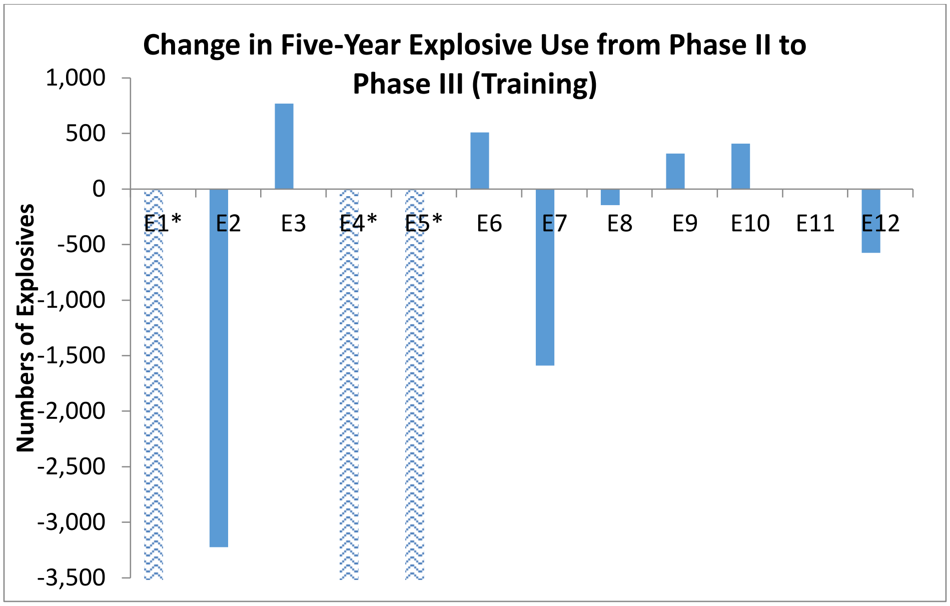


Figure 2.5-3: Proposed Number of Composite Training Unit Exercises over a Five-Year Period Compared to Number Authorized in the 2013–2018 Marine Mammal Protection Act Permit



* Bin E1 decreased by 571,060 explosives, bin E4 decreased by 10,303 explosives, and bin E5 decreased by 51,150 explosives. These bins cannot be represented in this graph without distorting the scale.

[1] Alternative 1 and Alternative 2 would use the same number of explosives in Phase III; bar graph depicts both alternatives.

[2] As the graph indicates the change in explosive use, the 2013–2018 permitted level is represented as the "0" line, to which the change for Phase III is compared, such that positive values are an increase in use of the bin, and negative values are a decrease in use of that bin.

Figure 2.5-4: Change in Explosive Use (for Both Action Alternatives) During Training Activities Compared to the 2013–2018 Marine Mammal Protection Act Permit[1, 2]

2.5.4.2 Testing

As described in Sections 1.4.3.2 (Methods of Testing), 2.5.2.2 (Testing) and 2.5.3.2 (Testing), the Navy's testing community faces a number of challenges in accurately defining future testing requirements. These challenges include varying funding availability, changes in Congressional and DoD/Navy priorities in responses to emerging threats in the world and the acquisition of new technologies that introduce increased uncertainties in the timeline, tempo or success of a system's testing schedule because the system is new and untested. As it does now, the Navy testing community took into account these same challenges in projecting requirements for the 2013–2018 (Phase II) testing timeframe. Although the best information available to the Navy has always been taken into account, as a result of the implementation of Phase II, the Navy testing community has improved its ability to obtain and define that information and, consequently, its ability to project future testing needs. It is expected that over time, the Navy's ability to project future testing requirements will continue to improve with increasing refinement of the process and more/better historical data. Nonetheless, the inherent challenges and uncertainties in testing, as described previously, will continue to make projection of future testing requirements challenging.

The majority of platforms, weapons, and systems that were proposed for testing during the Phase II timeframe are the same or very similar to those proposed to be tested in the future. However, the Navy projects that the need to test some platforms, weapons, and systems will increase, while others will decrease, as compared to the testing requirements that were proposed for the Phase II timeframe. Overall, the Navy is projecting a net increase in the need to test systems that use sonar and a net decrease for explosives use, as proposed under Alternative 1, and as compared to the proposed testing requirements of the Phase II timeframe. These future projections are based on improvements in the

Navy's understanding of requirements, the completion of test phases of certain projects since Phase II, the addition of test phases anticipated to start after December 2018, and the projected testing of new types of equipment since the 2013–2018 timeframe.

2.6 PROPOSED TRAINING AND TESTING ACTIVITIES FOR BOTH ALTERNATIVES

2.6.1 PROPOSED TRAINING ACTIVITIES

All proposed training activities are listed in Table 2.6-1. It should be noted that many of the activities listed occur the same number of time annually under both alternatives. These activities can be thought of as meeting individual training requirements. Although the number of some activities may be the same, the difference between the alternatives is manifest in how these activities are conducted. This difference is explained above in Section 2.5 (Alternatives Carried Forward) and represented in Figure 2.5-1 and Figure 2.5-2.

Table 2.6-1: Proposed Training Activities per Alternative

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Major Training Exercise – Large Integrated Anti-Submarine Warfare					
Composite Training Unit Exercise	2–3	3	12	15	VACAPES RC Navy Cherry Point RC JAX RC
	0	1	0	5	GOMEX
Major Training Exercise – Medium Integrated Anti-Submarine Warfare					
Fleet Exercise/Sustainment Exercise	4		20		VACAPES RC JAX RC
Integrated/Coordinated Training					
Small Integrated Anti-Submarine Training	6		30		JAX RC
	3		15		Navy Cherry Point RC
	3		15		VACAPES RC
Medium Coordinated Anti-Submarine Warfare Training	2		10		JAX RC
	1		5		Navy Cherry Point RC
	1		5		VACAPES RC
Small Coordinated Anti-Submarine Warfare Training	4		20		JAX RC
	5		25		Navy Cherry Point RC
	5		25		VACAPES RC
Air Warfare					
Air Combat Maneuver	1,270		6,350		JAX RC
	6,300		31,500		Key West RC
	1,155		5,775		Navy Cherry Point RC
	1,200		6,000		VACAPES RC
Air Defense Exercise	85		425		GOMEX RC
	5,157		25,785		JAX RC
	5,166		25,830		Navy Cherry Point RC
	3,425		17,125		VACAPES RC
Gunnery Exercise Air-to-Air Medium-Caliber	75		375		JAX RC
	70		350		Key West RC
	40		200		Navy Cherry Point RC
	120		600		VACAPES RC

Table 2.6-1: Proposed Training Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Gunnery Exercise Surface-to-Air Large Caliber	7		35		JAX RC
	25		125		VACAPES RC
Gunnery Exercise Surface-to-Air Medium Caliber	10		50		Other AFTT Areas
	31		155		JAX RC
	23		115		Navy Cherry Point RC
	59		295		VACAPES RC
Missile Exercise Air-to-Air	48		240		JAX RC
	8		40		Key West RC
	48		240		Navy Cherry Point RC
	40		200		VACAPES RC
Missile Exercise Surface-to-Air	2		10		GOMEX RC
	5		20		JAX RC
	2		10		Navy Cherry Point RC
	2		10		Northeast RC
	30		50		VACAPES RC
Missile Exercise – Man-Portable Air Defense System	5		25		Navy Cherry Point RC
Amphibious Warfare					
Amphibious Assault	5		25		Navy Cherry Point RC
Amphibious Marine Expeditionary Unit Integration Exercise	1		5		Navy Cherry Point RC
Amphibious Raid	20		100		JAX RC
	34		162		Navy Cherry Point RC
Amphibious Ready Group Marine Expeditionary Unit Exercise	1		5		Navy Cherry Point RC
Amphibious Vehicle Maneuvers	186		930		VACAPES RC
	2		10		JAX RC
Humanitarian Assistance Operations	1		5		Navy Cherry Point RC
Marine Expeditionary Unit Certification Exercise	5		25		Navy Cherry Point RC
Naval Surface Fire Support Exercise – At Sea	2		10		GOMEX
	6		30		JAX RC
	2		10		Navy Cherry Point RC
	19		95		VACAPES RC
Naval Surface Fire Support Exercise - Land–Based Target	7		35		Navy Cherry Point RC
Anti-Submarine Warfare					
Anti-Submarine Warfare Torpedo Exercise – Helicopter	14		70		JAX RC
	4		20		VACAPES RC
Anti-Submarine Warfare Torpedo Exercise – Maritime Patrol Aircraft	14		70		JAX RC
	4		20		VACAPES RC

Table 2.6-1: Proposed Training Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Anti-Submarine Warfare Torpedo Exercise –Ship	16		80		JAX RC
	5		25		VACAPES RC
Anti-Submarine Warfare Torpedo Exercise – Submarine	12		60		JAX RC
	6		30		Northeast RC
	2		10		VACAPES RC
Anti-Submarine Warfare Tracking Exercise – Helicopter	24		120		Other AFTT Areas
	370		1,850		JAX RC
	12		60		Navy Cherry Point RC
	8		40		VACAPES RC
Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft	90		450		Northeast RC
	176		880		VACAPES RC
	525		2,625		JAX RC
	46		230		Navy Cherry Point RC
Anti-Submarine Warfare Tracking Exercise – Ship	5*	5	25*	25	Northeast RC
	110*	110	550*	550	Other AFTT Areas
	5*	5	25*	25	GOMEX RC
	440*	440	2,200*	2,200	JAX RC
	55*	55	275*	275	Navy Cherry Point RC
	220*	220	1,100*	1,100	VACAPES RC
Anti-Submarine Warfare Tracking Exercise – Submarine	44		220		Other AFTT Areas
	13		65		JAX RC
	1		5		Navy Cherry Point RC
	18		90		Northeast RC
	6		30		VACAPES RC
Electronic Warfare					
Counter Targeting Chaff Exercise – Aircraft	18		90		GOMEX RC
	2,990		14,950		JAX RC
	3,000		15,000		Key West RC
	1,610		8,050		Navy Cherry Point RC
	130		650		VACAPES RC
Counter Targeting Chaff Exercise – Ship	5		25		GOMEX RC
	5		25		JAX RC
	5		25		Navy Cherry Point RC
	10		50		VACAPES RC
Counter Targeting Flare Exercise	92		460		GOMEX RC
	1,900		9,500		JAX RC
	1,550		7,750		Key West RC
	1,115		5,575		Navy Cherry Point RC
	50		250		VACAPES RC
Electronic Warfare Operations	181		905		JAX RC
	2,620		13,100		Navy Cherry Point RC
	302		1,510		VACAPES RC
High-Speed Anti-Radiation Missile Exercise	4		20		JAX RC
	10		50		Navy Cherry Point RC
	11		55		VACAPES RC

Table 2.6-1: Proposed Training Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Expeditionary Warfare					
Dive and Salvage Operations	16		80		GOMEX RC
	60		300		JAX RC
	8		40		Key West RC
	16		80		Navy Cherry Point RC
	30		150		VACAPES RC
Maritime Security Operations – Anti-Swimmer Grenades	2		10		GOMEX RC
	2		10		JAX RC
	2		10		Navy Cherry Point RC
	4		20		Northeast RC
	5		25		VACAPES RC
Personnel Insertion/ Extraction - Air	10		50		JAX RC
	10		50		Key West
	198		990		VACAPES RC
Personnel Insertion/ Extraction – Surface and Subsurface	2		10		Northeast RC
	5		25		GOMEX RC
	1		5		JAX RC
	360		1,800		VACAPES RC
Personnel Insertion/ Extraction – Swimmer/Diver	42		210		VACAPES RC
Underwater Construction Team Training	8		40		GOMEX RC
	4		20		JAX RC
	4		20		Key West RC
	8		40		VACAPES RC
Mine Warfare					
Airborne Mine Countermeasure - Mine Detection	66		330		GOMEX RC
	317		1,585		JAX RC
	371		1,855		Navy Cherry Point RC
	244		1,220		NSWC Panama City
	1,540		7,700		VACAPES RC
Airborne Mine Countermeasures – Towed Mine Neutralization	50		250		GOMEX RC
	100		500		JAX RC
	108		540		Navy Cherry Point RC
	510		2,550		VACAPES RC
Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercise	1		3		Beaumont, TX Boston, MA Corpus Christi, TX Delaware Bay, DE Earle, NJ GOMEX RC Hampton Roads, VA JAX RC Kings Bay, GA NS Mayport Morehead City, NC Port Canaveral, FL

Table 2.6-1: Proposed Training Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
					Savannah, GA Tampa, FL VACAPES RC Wilmington, DE
Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercise	2		10		GOMEX RC
	2		10		JAX RC
	2		10		Navy Cherry Point RC
	2		10		VACAPES RC
Mine Countermeasures – Mine Neutralization – Remotely Operated Vehicle	132		660		GOMEX RC
	71		355		JAX RC
	71		355		Navy Cherry Point RC
	630		3,150		VACAPES RC
Mine Countermeasures – Ship Sonar	22		110		GOMEX RC
	53		265		JAX RC
	53		265		VACAPES RC
Mine Laying	1		5		JAX RC
	2		10		Navy Cherry Point RC
	4		20		VACAPES RC
Mine Neutralization – Explosive Ordnance Disposal	6		30		Lower Chesapeake Bay
	16		80		GOMEX RC
	20		100		JAX RC
	17		85		Key West RC
	16		80		Navy Cherry Point RC
	524		2,620		VACAPES RC
Underwater Mine Countermeasures Raise, Tow, Beach, and Exploitation Operations	56		280		GOMEX RC
	78		390		JAX RC
	8		40		Key West RC
	24		120		Navy Cherry Point RC
	446		2,230		VACAPES RC
Surface Warfare					
Bombing Exercise Air-to-Surface	67		335		GOMEX RC
	437		2,185		JAX RC
	108		540		Navy Cherry Point RC
	359		1,795		VACAPES RC
Fast Attack Craft and Fast Inshore Attack Craft Exercise	25		125		JAX RC
	25		125		VACAPES RC
Gunnery Exercise Air-to-Surface Medium-Caliber	30		150		GOMEX RC
	495		2,475		JAX RC
	395		1,975		Navy Cherry Point RC
	720		3,600		VACAPES RC
Gunnery Exercise Air-to-Surface Small-Caliber	200		1,000		JAX RC
	130		650		Navy Cherry Point RC
	560		2,800		VACAPES RC
Gunnery Exercise Surface-to-Surface Boat	6		30		GOMEX RC
	26		130		JAX RC

Table 2.6-1: Proposed Training Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Medium-Caliber	128		640		Navy Cherry Point RC
	2		10		Northeast RC
	264		1,320		VACAPES RC
Gunnery Exercise Surface-to-Surface Boat Small-Caliber	67		335		GOMEX RC
	84		420		JAX RC
	92		460		Navy Cherry Point RC
	18		90		Northeast RC
	330		650		VACAPES RC
Gunnery Exercise Surface-to-Surface Ship Large-Caliber	10		5		Other AFTT Areas
	9		45		GOMEX RC
	47		235		JAX RC
	35		175		Navy Cherry Point RC
	71		355		VACAPES RC
Gunnery Exercise Surface-to-Surface Ship Medium-Caliber	42		210		Other AFTT Areas
	26		130		GOMEX RC
	119		595		JAX RC
	41		205		Navy Cherry Point RC
	245		1,225		VACAPES RC
Gunnery Exercise Surface-to-Surface Ship Small-Caliber	50		250		Other AFTT Areas
	10		50		GOMEX RC
	300		1,500		JAX RC
	20		100		Navy Cherry Point RC
	450		2,250		VACAPES RC
Integrated Live Fire Exercise	4		20		JAX RC
	4		20		VACAPES RC
Laser Targeting – Aircraft	315		1,575		JAX RC
	272		1,360		VACAPES RC
Laser Targeting – Ship	4		20		JAX RC
	4		20		VACAPES RC
Maritime Security Operations	59		245		GOMEX RC
	210		1,050		JAX RC
	75		375		Navy Cherry Point RC
	13		65		Northeast RC
	895		4,475		VACAPES RC
Missile Exercise Air-to-Surface	102		510		JAX RC
	52		260		Navy Cherry Point RC
	88		440		VACAPES RC
Missile Exercise Air-to-Surface – Rocket	10		50		GOMEX RC
	110		550		JAX RC
	10		50		Navy Cherry Point RC
	100		500		VACAPES RC
Missile Exercise Surface-to-Surface	15		75		JAX RC
	7		35		VACAPES RC
Sinking Exercise	1		5		SINKEX Box

Table 2.6-1: Proposed Training Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Other Training Activities					
Elevated Causeway System	1		5		Lower Chesapeake Bay
	1		5		Navy Cherry Point RC
Precision Anchoring	9		45		GOMEX RC
	231		1,155		JAX RC
	710		3,550		VACAPES RC
Search and Rescue	776		3,880		JAX RC
	1,176		5,880		VACAPES RC
Submarine Navigation	169		845		NSB New London
	3		15		NSB Kings Bay
	3		15		NS Mayport
	84		420		NS Norfolk
	23		115		Port Canaveral, FL
Submarine Sonar Maintenance	12		60		Other AFTT Areas
	66		330		NSB New London
	4		20		JAX RC
	2		10		NSB Kings Bay
	34		170		NS Norfolk
	66		330		Northeast RC
	2		10		Port Canaveral, FL
	34		170		VACAPES RC
Submarine Under Ice Certification	3		15		JAX RC
	3		15		Navy Cherry Point RC
	9		45		Northeast RC
	9		45		VACAPES RC
Surface Ship Object Detection	74		370		NS Mayport
	160		800		NS Norfolk
Surface Ship Sonar Maintenance	0	18	0	90	Other AFTT Areas
	50		250		JAX RC
	50		250		NS Mayport
	120		600		Navy Cherry Point RC
	235		1,175		NS Norfolk
	120		600		VACAPES RC

Table 2.6-1: Proposed Training Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Waterborne Training	42		210		GOMEX RC
	55		275		JAX RC
	141		705		Northeast RC
	110		550		VACAPES RC

[1] For activities where the maximum number of events varies between years, a range is provided to indicate the "representative–maximum" number of events. For activities where no variation is anticipated, only the maximum number of events within a single year is provided.

[2] Locations given are areas where activities typically occur. However, activities could be conducted in other locations within the Study Area. Where multiple locations are provided within a single cell, the number of activities could occur in any of the locations, not in each of the locations.

* For anti-submarine warfare tracking exercise – Ship, Alternative 1, 50 percent of requirements are met through synthetic training or other training exercises

AFTT: Atlantic Fleet Training and Testing; NS: Naval Station; NSB: Naval Submarine Base; NSWC: Naval Surface Warfare Center; GOMEX: Gulf of Mexico; JAX: Jacksonville; RC: Range Complex; SINKEX: sinking exercises; VACAPES: Virginia Capes

2.6.2 Proposed Testing Activities

All proposed testing activities are listed in Table 2.6-2 through Table 2.6-4.

Table 2.6-2: Naval Air Systems Command Proposed Testing Activities per Alternative

Activity Name	*Annual # of Activities*[1]		*5-Year # of Activities*		*Location*[2]
	Alt 1	*Alt 2*	*Alt 1*	*Alt 2*	
Air Warfare					
Air Combat Maneuver Test	550		2,750		VACAPES RC
Air Platform Weapons Integration Test	40		200		VACAPES RC
Air Platform-Vehicle Test	12		60		GOMEX RC
	9		45		JAX RC
	9		45		Key West RC
	9		45		Navy Cherry Point RC
	190		950		VACAPES RC
Air-to-Air Weapons System Test	10		50		GOMEX RC
Air-to-Air Gunnery Test – Medium-Caliber	55		275		VACAPES RC
Air-to-Air Missile Test	83		415		VACAPES RC
Intelligence, Surveillance, and Reconnaissance Test	7		35		JAX RC
	9		45		Navy Cherry Point RC
	406		2,030		VACAPES RC
Anti-Submarine Warfare					
Anti-Submarine Warfare Torpedo Test	20–43	43	146	215	JAX RC
	40–121	121	362	605	VACAPES RC
Anti-Submarine Warfare Tracking Test – Helicopter	4–6	6	24	30	GOMEX RC
	0–12	12	24	60	JAX RC
	3–27	27	39	135	Key West RC
	28–110	110	304	550	Northeast RC
	137–280	280	951	1,400	VACAPES RC
Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft	10–15	15	60	75	GOMEX RC
	19	24	95	120	JAX RC
	10–12	12	54	60	Key West RC
	14–15	16	72	80	Navy Cherry Point RC
	36–45	48	198	240	Northeast RC
	25	26	125	130	VACAPES RC
Kilo Dip	2–6	6	14	30	GOMEX RC
	0–6	6	6	30	JAX RC
	0–6	6	6	30	Key West RC
	0–4	4	8	20	Northeast RC
	20–40	40	140	200	VACAPES RC
Sonobuoy Lot Acceptance Test	160		800		Key West RC
Electronic Warfare					
Chaff Test	20		100		GOMEX RC
	4		20		JAX RC
	24		120		VACAPES RC

Table 2.6-2: Naval Air Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	Annual # of Activities[1] Alt 1	Annual # of Activities[1] Alt 2	5-Year # of Activities Alt 1	5-Year # of Activities Alt 2	Location[2]
Electronic Systems Evaluation	2		10		JAX RC
	61		305		VACAPES RC
Flare Test	10		50		GOMEX RC
	20		100		VACAPES RC
Mine Warfare					
Airborne Dipping Sonar Minehunting Test	16–32	32	96	160	NSWC Panama City
	6–18	18	42	90	VACAPES RC
Airborne Laser Based Mine Detection System Test	40		200		NSWC Panama City
	50		250		VACAPES RC
Airborne Mine Neutralization System Test	20–27	32	107	160	NSWC Panama City
	25–45	50	145	250	VACAPES RC
Airborne Sonobuoy Minehunting Test	52		260		NSWC Panama City
	24		120		VACAPES RC
Mine Laying Test	1		5		JAX RC
	2		10		VACAPES RC
Surface Warfare					
Air-to-Surface Bombing Test	20		100		VACAPES RC
Air-to-Surface Gunnery Test	25–55	55	215	275	JAX RC
	110–140	140	640	700	VACAPES RC
Air-to-Surface Missile Test	0–10	10	20	50	GOMEX RC
	29–38	38	167	190	JAX RC
	117–148	148	663	740	VACAPES RC
High Energy Laser Weapons Test	108		540		VACAPES RC
Laser Targeting Test	5		25		VACAPES RC
Rocket Test	15–19	19	87	95	JAX RC
	31–35	35	167	175	VACAPES RC
Other Testing Activities					
Undersea Range System Test	4–20		42		JAX RC
Acoustic and Oceanographic Research	1		5		GOMEX RC
	1		5		JAX RC
	1		5		Key West RC
	1		5		Northeast RC
	1		5		VACAPES RC
Air Platform Shipboard Integrate Test	126		630		VACAPES RC
Maritime Security	12		60		JAX RC
	12		60		Navy Cherry Point RC
	20		100		VACAPES RC

Table 2.6-2: Naval Air Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Shipboard Electronic Systems Evaluation	24		120		GOMEX RC
	24		120		JAX RC
	24		120		Key West RC
	26		130		VACAPES RC

[1] For activities where the maximum number of events varies between years, a range is provided to indicate the "representative–maximum" number of events. For activities where no variation is anticipated, only the maximum number of events within a single year is provided.

[2] Locations given are areas where activities typically occur. However, activities could be conducted in other locations within the Study Area.

GOMEX: Gulf of Mexico; JAX: Jacksonville; NSWC: Naval Surface Warfare Center; RC: Range Complex; VACAPES: Virginia Capes

Table 2.6-3: Naval Sea Systems Command Proposed Testing Activities per Alternative

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Anti-Submarine Warfare					
Anti-Submarine Warfare Mission Package Testing	42		210		JAX RC
	4		20		Newport, RI
	4		20		NUWC Newport
	26		130		VACAPES RC
At-Sea Sonar Testing	2		10		JAX RC Navy Cherry Point RC Northeast RC VACAPES RC
	1		5		JAX RC Navy Cherry Point RC VACAPES RC
	2		10		Offshore Fort Pierce, FL GOMEX RC JAX SFOMF Northeast RC VACAPES
	4		20		JAX RC
	2		10		Navy Cherry Point RC
	8		40		NUWC Newport
	12		60		VACAPES RC
Pierside Sonar Testing	1		5		NSB New London NS Norfolk Port Canaveral, FL
	11		55		Bath, ME
	5		25		NSB New London
	4		20		NSB Kings Bay
	8		40		Newport, RI

Table 2.6-3: Naval Sea Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	*Annual # of Activities*[1]		*5-Year # of Activities*		*Location*[2]
	Alt 1	*Alt 2*	*Alt 1*	*Alt 2*	
Pierside Sonar Testing (continued)	13		65		NS Norfolk
	2		10		Pascagoula, MS
	3		15		Port Canaveral, FL
	2		10		PNS
Submarine Sonar Testing/Maintenance	16		80		Norfolk, VA
	24		120		PNS
Surface Ship Sonar Testing/Maintenance	1		5		JAX RC
	1		5		NS Mayport
	3		15		NS Norfolk
	3		15		VACAPES RC
Torpedo (Explosive) Testing	4		20		GOMEX RC offshore Fort Pierce, FL Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
	2		10		GOMEX RC JAX RC Northeast RC VACAPES RC
Torpedo (Non-Explosive) Testing	8		40		GOMEX RC
	11		55		Offshore Fort Pierce, FL
	8		40		Navy Cherry Point RC
	8		40		Northeast RC
	30		150		NUWC Newport
	11		55		VACAPES RC
Countermeasure Testing	5		25		GOMEX RC Key West RC JAX RC NUWC Newport VACAPES RC
	2–4		14		GOMEX RC JAX RC Northeast RC VACAPES RC
Electronic Warfare					
Radar and Other System Testing	6–10		34		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC NSWC Panama City NUWC Newport SFOMF

Table 2.6-3: Naval Sea Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
					VACAPES RC
	4		20		NSB New London
	0–3		3		JEB LC-FS NS Norfolk
	2		10		NS Norfolk
	2		10		Northeast RC
	21–45		129		VACAPES RC
Mine Warfare					
Mine Countermeasure and Neutralization Testing	13		65		NSWC Panama City
	6		30		VACAPES RC
Mine Countermeasure Mission Package Testing	19		95		GOMEX RC
	10		50		JAX RC
	11		55		NSWC Panama City
	2		10		SFOMF
	5		25		VACAPES RC
Mine Detection and Classification Testing	6		30		GOMEX RC
	10		50		Navy Cherry Point RC
	47–52		250		NSWC Panama City
	7–12		43		Riviera Beach, FL
	4		20		SFOMF
	3		15		VACAPES RC
Surface Warfare					
Gun Testing – Large-Caliber	12		60		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
	1		5		GOMEX RC
	1		5		JAX RC
	1		5		Key West RC
	1		5		Navy Cherry Point RC
	1		5		Northeast RC
	33		165		NSWC Panama City
	5		25		VACAPES RC
Gun Testing – Medium-Caliber	12		60		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
	102		510		NSWC Panama City
	5		24		VACAPES RC

Table 2.6-3: Naval Sea Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Gun Testing – Small-Caliber	24		120		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
	13		65		GOMEX RC
	7		35		NSWC Panama City
	8		40		VACAPES RC
Kinetic Energy Weapon Testing	61		301		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
Missile and Rocket Testing	13		65		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
	1		5		GOMEX RC
	2		10		JAX RC
	5		25		Northeast RC
	22		110		VACAPES RC
Unmanned Systems					
Unmanned Aerial System Testing	15		75		Northeast RC
	17		85		NUWC Newport
	15		75		VACAPES RC
Unmanned Surface Vehicle System Testing	132		660		NUWC Newport
Unmanned Underwater Vehicle Testing	16		80		GOMEX RC JAX RC NUWC Newport
	41		205		GOMEX RC
	25		125		JAX RC
	145–146		727		NSWC Panama City
	308–309		1,541		NUWC Newport
	9		45		Riviera Beach, FL
	42		210		SFOMF
Vessel Evaluation					
Aircraft Carrier Sea Trials – Propulsion Testing	2		10		VACAPES RC

Table 2.6-3: Naval Sea Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Large Ship Shock Trial	1		1		GOMEX RC JAX RC VACAPES RC
In-Port Maintenance Testing	24		120		NS Mayport NS Norfolk
	2		10		NS Mayport
	5		25		NS Norfolk
Air Defense Testing	1		5		GOMEX RC
	2		10		JAX RC
	1		5		Northeast RC
	5		25		VACAPES RC
Propulsion Testing	34		170		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
	86		430		Gulf of Mexico
	2		10		JAX RC
	6		30		Navy Cherry Point RC
	5		25		Northeast RC
	7		35		VACAPES RC
Surface Warfare Testing	2		10		GOMEX RC
	13		65		JAX RC
	1		5		Key West RC
	10		50		Northeast RC
	9		45		VACAPES RC
Underwater Warfare Testing	2		10		JAX RC Northeast RC VACAPES RC
	0–2		4		JAX RC Navy Cherry Point RC Northeast RC SFOMF VACAPES RC
	2		10		GOMEX RC
	6		30		JAX RC
	3		15		Northeast RC
	2		10		VACAPES RC
Small Ship Shock Trial	0–3		3		JAX RC VACAPES RC
Submarine Sea Trials – Propulsion Testing	1		5		JAX RC
	1		5		Northeast RC
	1		5		VACAPES RC

Table 2.6-3: Naval Sea Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Submarine Sea Trials – Weapons System Testing	2		10		Offshore Fort Pierce, FL GOMEX RC JAX SFOMF Northeast VACAPES
	4		20		JAX RC
	4		20		Northeast RC
	4		20		VACAPES RC
Total Ship Survivability Trials	0–1		1		JAX RC VACAPES RC
Vessel Signature Evaluation	9		45		JAX RC VACAPES RC
	2		10		GOMEX RC
	16		80		JAX RC
	5		25		JEB LC-FS
	18		90		VACAPES RC
Hydrodynamic and Maneuverability Testing	2		10		GOMEX RC JAX RC Key West RC Navy Cherry Point RC Northeast RC VACAPES RC
Signature Analysis Operations	1		5		JAX RC
	59		295		SFOMF
Underwater Search, Deployment, and Recovery	33		165		SFOMF
Other Testing Activities					
Insertion/Extraction	4		20		Key West RC
	264		1,320		NSWC Panama City
Line Charge Testing	4		20		NSWC Panama City
Acoustic Component Testing	33		165		SFOMF
Chemical and Biological Simulant Testing	80		400		JAX RC
	80		400		Navy Cherry Point RC
	80		400		Northeast RC
	80		400		VACAPES RC
Non-Acoustic Component Testing	4		20		GOMEX RC
	4		20		VACAPES RC
Payload Deployer Testing	1		5		GOMEX RC
	1		5		Northeast RC
	39		195		NUWC Newport

Table 2.6-3: Naval Sea Systems Command Proposed Testing Activities per Alternative (continued)

Activity Name	Annual # of Activities[1]		5-Year # of Activities		Location[2]
	Alt 1	Alt 2	Alt 1	Alt 2	
Semi-Stationary Equipment Testing	4		20		Newport, RI
	11		55		NSWC Panama City
	190		950		NUWC Newport
Towed Equipment Testing	36		180		NUWC Newport

[1] For activities where the maximum number of events could vary between years, the information is presented as a "representative-maximum" number of events per year. For activities where no variation is anticipated, only the maximum number of events within a single year is provided.

[2] Locations given are areas where activities typically occur. However, activities could be conducted in other locations within the Study Area. Where multiple locations are provided within a single cell, the number of activities could occur in any of the locations, not in each of the locations.

Notes: JEB LC-FS: Joint Expeditionary Base Little Creek-Fort Story; GOMEX: Gulf of Mexico; JAX: Jacksonville; NS: Naval Station; NSB: Naval Submarine Base; NSWC: Naval Surface Warfare Center; NUWC: Naval Undersea Warfare Center; PNS: Portsmouth Naval Shipyard; RC: Range Complex; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes

Table 2.6-4: Office of Naval Research Proposed Testing Activities per Alternative

Activity Name	Annual # of Activities		5-Year # of Activities		Location
	Alt 1	Alt 2	Alt 1	Alt 2	
Acoustic and Oceanographic Science and Technology					
Acoustic and Oceanographic Research	4		20		GOMEX RC
	7		35		Northeast RC
	2		10		VACAPES RC
Emerging Mine Countermeasure Technology Research	1		5		JAX RC
	2		10		Northeast RC
	1		5		VACAPES RC
Large Displacement Unmanned Underwater Vehicle Testing	4		20		GOMEX RC
	12		60		JAX RC
	4		20		Navy Cherry Point RC
	16		80		Northeast RC
	8		40		VACAPES RC

Notes: GOMEX: Gulf of Mexico; JAX: Jacksonville, Florida; RC: Range Complex; VACAPES: Virginia Capes

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

TABLE OF CONTENTS

List of Figures

List of Tables

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3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.0 INTRODUCTION

This chapter describes existing environmental conditions in the Atlantic Fleet Training and Testing (AFTT) Study Area as well as the analysis of resources potentially impacted by the Proposed Action described in Chapter 2 (Description of Proposed Action and Alternatives). The Study Area is described in Section 2.1 (Description of the Atlantic Fleet Training and Testing Study Area) and depicted in Figure 2.1-1.

This section provides the ecological characterization of the Study Area and describes the resources evaluated in the analysis. The Overall Approach to Analysis section explains that each proposed military readiness activity was examined to determine which environmental stressors could potentially impact a resource.

Resources Analyzed:
Physical Resources:

- Air Quality
- Sediments and Water Quality

Biological Resources:

- Vegetation
- Invertebrates
- Habitats
- Fishes
- Marine Mammals
- Reptiles
- Birds

Human Resources:

- Cultural
- Socioeconomic
- Public Health and Safety

The sections following 3.0 (Introduction) provide analyses for each resource. The physical resources (air quality, and sediments and water quality) are presented first (Sections 3.1 and 3.2, respectively). Because impacts to air or water quality could affect all other marine resources, any potential impacts on air quality or sediments and water quality were considered as potential secondary stressors on the remaining resources to be described: vegetation, invertebrates, habitats, fishes, marine mammals, reptiles, and birds (Sections 3.3 through 3.9). Following the biological resource sections are human resource sections: cultural, socioeconomics, and public health and safety (Sections 3.10, 3.11, and 3.12).

3.0.1 NAVY COMPILED AND GENERATED DATA

While preparing this document, the Navy used the best available data, science, and information accepted by the appropriate regulatory and scientific communities to establish a baseline and perform environmental analyses for all resources in accordance with National Environmental Policy Act (NEPA), the Administrative Procedure Act (5 United States Code sections 551–596), and Executive Order 12114.

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

3.0.1.1 Marine Species Monitoring and Research Programs

The Navy has been conducting marine species monitoring for compliance with the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) since 2006, both in association with training and testing events and independently. In addition to monitoring activities associated with regulatory compliance, two other United States (U.S.) Department of the Navy (Navy) research programs provide extensive investments in basic and applied research: the Office of Naval Research Marine Mammals & Biology program, and the Living Marine Resources program. In fact, the U.S. Navy is one of the largest sources of funding for marine mammal research in the world. A survey of federally-funded marine mammal research and conservation conducted by the Marine Mammal Commission found that the U.S. Department of Navy was the second largest source of funding for marine mammal activities (direct project expenditures, as well as associated indirect or support costs) in the United States in 2014, second only to National Oceanic and Atmospheric Administration Fisheries (Purdy, 2016).

The monitoring program has historically focused on collecting baseline occurrence data that supports analysis of marine mammal occurrence, distribution, abundance, and habitat use preferences in and around ocean areas in the Atlantic and Pacific where the Navy conducts training and testing. More recently, the priority has begun to shift towards assessing the potential response of individual species to training and testing activities. Data collected through the monitoring program serves to inform the analysis of impacts on marine mammals with respect to species distribution, habitat use, and potential responses to training and testing activities. Monitoring is performed using various methods, including visual surveys from surface vessels and aircraft, passive acoustics, and tagging. Additional information on the program is available on the U.S. Navy Marine Species Monitoring Program website, which serves as a public online portal for information on the background, history, and progress of the program and also provides access to reports, documentation, data, and updates on current monitoring projects and initiatives.

The two other Navy programs previously mentioned invest in research on the potential effects of sound on marine species and develop scientific information and analytic tools that support preparation of environmental impact statements (EISs) and associated regulatory processes under the MMPA and ESA, as well as support development of improved monitoring and detection technology and advance overall knowledge about marine species. These programs support coordinated science, technology, research, and development focused on understanding the effects of sound on marine mammals, including physiological, behavioral, ecological, and population-level effects[1]. Additional information on these programs and other ocean resources-oriented initiatives can be found at the U.S. Navy Green Fleet – Energy, Environment, and Climate Change website.

3.0.1.2 Marine Species Density Database

A quantitative analysis of impacts on a species requires data on the occurrence, including abundance and concentration of the species population in the potentially impacted area. The most appropriate metric for this type of analysis is concentration of a species, known as density, which is the number of animals present per unit area. Estimating marine species density requires substantial surveys and effort to collect and analyze data to produce a usable estimate. The National Marine Fisheries Service is the primary agency responsible for estimating marine mammal and sea turtle density within the U.S. Exclusive Economic Zone. Other agencies and independent researchers often publish density data for species in specific areas of interest, including areas outside the U.S. Exclusive Economic Zone. In areas where surveys have not produced adequate data to allow robust density estimates, methods such as model extrapolation from surveyed areas, Relative Environmental Suitability models, or expert opinion are used to estimate occurrence. Modeled relationships rely on the location where the animals are

[1] A population-level impact is an impact on the population numbers (survival) or growth and reproductive rates (recruitment) of a particular marine mammal species or stock.

sighted, amount of survey effort, and the associated environmental variables (e.g., depth, sea surface temperature).

There is no single source of density data for every area of the world, species, and season because of the fiscal costs, resources, and effort involved in providing survey coverage to sufficiently estimate density. Therefore, to characterize marine species density for large areas, such as the AFTT Study Area, the Navy compiled data from multiple sources and developed a protocol to select the best available density estimates based on species, area, and time (i.e., season). When multiple data sources were available, the Navy ranked density estimates based on a hierarchal approach to ensure that the most accurate estimates were selected. The highest tier included peer-reviewed published studies of density estimates from spatial models since these provide spatially explicit density estimates with relatively low uncertainty. Other preferred sources included peer-reviewed published studies of density estimates derived from systematic line-transect survey data, the method typically used for the National Marine Fisheries Service (NMFS) marine mammal stock assessment reports. In the absence of survey data, information on species occurrence and known or inferred habitat associations have been used to predict densities using model-based approaches including Relative Environmental Suitability models. Because these estimates inherently include a high degree of uncertainty, they were considered the least preferred data source. In cases where a preferred data source was not available, density estimates were selected based on expert opinion from scientists. The resulting Geographic Information System database includes seasonal density values for every marine mammal and sea turtle species present within the Study Area (U.S. Department of the Navy, 2017c). These data are used as an input into the Navy Acoustic Effects Model. A detailed explanation of this analysis is provided in the technical report titled Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles (U.S. Department of the Navy, 2017b).

3.0.1.3 Developing Acoustic and Explosive Criteria and Thresholds

If proposed Navy activities introduce sound or explosive energy into the marine environment, an analysis of potential impacts on marine species is conducted. To do this, information about the numerical sound and energy levels that are likely to elicit certain types of physiological and behavioral reactions is needed. Revised Phase III criteria and thresholds for quantitative modeling of impacts use the best available existing data from scientific journals, technical reports, and monitoring reports to develop thresholds and functions for estimating impacts to marine species. Working with NMFS, the Navy has developed updated criteria for marine mammals and sea turtles. Criteria for estimating impacts to marine fishes are also used in this analysis, which largely follows the *Sound Exposure Guidelines for Fishes and Sea Turtles* (Popper et al., 2014).

Since the release of the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effect Analysis* in 2012 (Finneran & Jenkins, 2012), recent and emerging science has necessitated an update to these criteria and thresholds for assessing potential impacts to marine mammals and sea turtles. A detailed description of the Phase III acoustic and explosive criteria and threshold development is included in the supporting technical report *Criteria and Thresholds for U.S Navy Acoustic and Explosive Impact to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017a). A series of behavioral studies, largely funded by the Navy, has led to a new understanding of how some species of marine mammals react to military sonar. This resulted in developing new behavioral response functions for predicting alterations in behavior. Additional information on auditory weighting functions has also emerged (e.g.,(Mulsow et al., 2015)) leading to developing a new methodology to predict auditory weighting functions for each hearing group along with the accompanying hearing loss thresholds. These criteria for predicting hearing loss in marine mammals was largely adopted by NMFS for species within their purview (National Marine Fisheries Service, 2016).

The Navy also uses criteria for estimating effects to fish and the ranges to which those effects are likely to occur. A working group of experts generated a technical report that provides numerical criteria and relative likelihood of effects to fish within different hearing groups (i.e., fishes with no swimbladder versus fishes with swimbladder used in hearing) (Popper et al., 2014). Details on criteria used to estimate impacts to marine fishes are contained within the appropriate stressor section (e.g., sonar and other transducers, explosives). This panel of experts (Popper et al., 2014) also provided criteria for sea turtles, assigning “low”, “medium,” and “high” probability of specific categories of behavioral impacts due to exposure to sources located at “near,” “intermediate,” and “far” distances.

3.0.1.4 Aquatic Habitats Database

The AFTT and Hawaii-Southern California Training and Testing (HSTT) Aquatic Habitat Database was developed after the completion of the 2013 AFTT and HSTT EIS/Overseas Environmental Impact Statement (OEIS) in order to refine the regional scale and overlapping habitat data used in the analysis of military expended materials and bottom explosives. The database includes more numerous data sources ranging from regional-to-local scale. These data sources are subsequently combined to create a non-overlapping mosaic of habitat information that presents the highest quality data for a given location. The database primarily includes areas within the Study Area; however, there are also specific point locations for selected habitat types (e.g., artificial substrate). The current database is limited to abiotic (physical rather than biological) substrate types assessed in Section 3.5 (Habitats) for the current AFTT and HSTT EIS documents. A detailed description of the database is included as a supporting technical document with associated Geographic Information System and database deliverables (U.S. Department of the Navy, 2016).

3.0.2 Ecological Characterization of the Study Area

The Study Area includes the intertidal and subtidal marine waters within the boundaries shown in Figure 2.1-1 but does not extend above the mean high tide line. Navy activities in the marine environment predominately occur within established operating areas (OPAREAs), range complexes, testing ranges, ports, and pierside locations. These locations are determined by Navy requirements, not to interfere with existing civilian and commercial maritime and airspace boundaries. The Navy-defined boundaries are not consistent with ecological boundaries, such as ecosystems, that may be more appropriate when assessing potential impacts on marine resources. Therefore, for the purposes of this document, the Navy analyzed the marine resources in an ecological context to the extent possible to more comprehensively assess the potential impacts. The Navy used biogeographic classification systems to frame this ecological context.

Biogeographic classifications organize and describe the patterns and distributions of organisms and the biological and physical processes that influence this distribution. These biogeographic classification systems and areas are described in Section 3.0.2.1 (Biogeographic Classifications).

3.0.2.1 Biogeographic Classifications

For context, the Navy organized the resources within coastal waters by large marine ecosystems, where primary productivity is higher than open ocean areas (Bergmann et al., 2015). Primary productivity is the rate of the formation of organic material from inorganic carbon via photosynthesis (e.g., by marine vegetation) or chemical reactions. Resources within open ocean areas are characterized by main oceanographic features (currents, gyres).

The large marine ecosystem classification system originated in the mid-1980s as a spatial planning tool to address transboundary management issues such as fisheries and pollution (Duda & Sherman, 2002). Large marine ecosystems are "relatively large areas of ocean space of approximately 200,000 square kilometers (km^2) or greater, adjacent to the continents in coastal waters where primary productivity is generally higher than in open ocean areas" (Bergmann et al., 2015). The large marine ecosystem concept for ecosystem-based management includes a five-module approach: (1) productivity, (2) fish and fisheries, (3) pollution and ecosystem health, (4) socioeconomics, and (5) governance. This approach is being applied to 16 international projects in Africa, Asia, Latin America, and Eastern Europe (Duda & Sherman, 2002) as well as to the large marine ecosystems in the AFTT Study Area described in the sections below (Aquarone & Adams, 2009c).

The large marine ecosystem classification system was advocated by the Council on Environmental Quality's Interagency Ocean Policy Task Force (The White House Council on Environmental Quality, 2010) as a marine spatial framework for coordinating regional planning in the waters off of the United States. For this EIS/ OEIS, three main oceanographic features are used: the Labrador Current, the Gulf Stream, and the North Atlantic Gyre. The Study Area contains seven designated large marine ecosystems: the West Greenland Shelf, Newfoundland- Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea. The seven large marine ecosystems and three open ocean areas are shown in Figure 3.0-1 and outlined in Sections 3.0.2.1.1 (West Greenland Shelf Large Marine Ecosystem) through 3.0.2.1.10 (North Atlantic Gyre Open Ocean Area). Designated training and testing areas in relation to each of the large marine ecosystems and open ocean areas are presented in Figure 3.0-1.

3.0.2.1.1 West Greenland Shelf Large Marine Ecosystem

The West Greenland Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of 375,000 km^2 (Aquarone et al., 2009). No specifically designated training or testing areas fall within the West Greenland Shelf Large Marine Ecosystem; however, training may occasionally occur in this area during transit. See Chapter 2 (Description of Proposed Action and Alternatives) for locations of activities conducted outside of designated training and testing ranges, identified as "Other AFTT Areas." Examples of these activities include gunnery exercises and anti-submarine warfare tracking exercises. This large marine ecosystem extends off the west coast of Greenland adjacent to Baffin Bay and the Davis Strait. Most of this ecosystem extends outside the Study Area; only the southwestern portion occurs within the Study Area (Figure 3.0-1). Other oceanic influences on this area are the West Greenland Current Front and the East Greenland Current. Significant structural features of this ecosystem include the Fylass Bank and the Tasersuaq Estuary. Most of this large marine ecosystem is covered with ice during winter (Sherman & Hempel, 2009).

The West Greenland Shelf Large Marine Ecosystem provides resources for commercial fisheries (e.g., northern shrimp and flounder) and is an important feeding and migration area for the ESA-endangered Gulf of Maine Atlantic salmon (Fay et al., 2006). The average primary productivity within this large marine ecosystem is low: less than 150 grams (g) of carbon per square meter (m^2) per year (Aquarone et al., 2009). Low primary productivity is a result of low numbers of primary producers (e.g., algae) that are responsible for most of the primary production in the ocean and form the base of the marine food web.

Refer to U.S. Department of the Navy (2012b) for more information. Less than 1 percent of the Study Area is in the West Greenland Shelf Large Marine Ecosystem.

3.0.2.1.2 Newfoundland-Labrador Shelf Large Marine Ecosystem

The Newfoundland-Labrador Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 896,000 km^2 (Aquarone & Adams, 2009a).

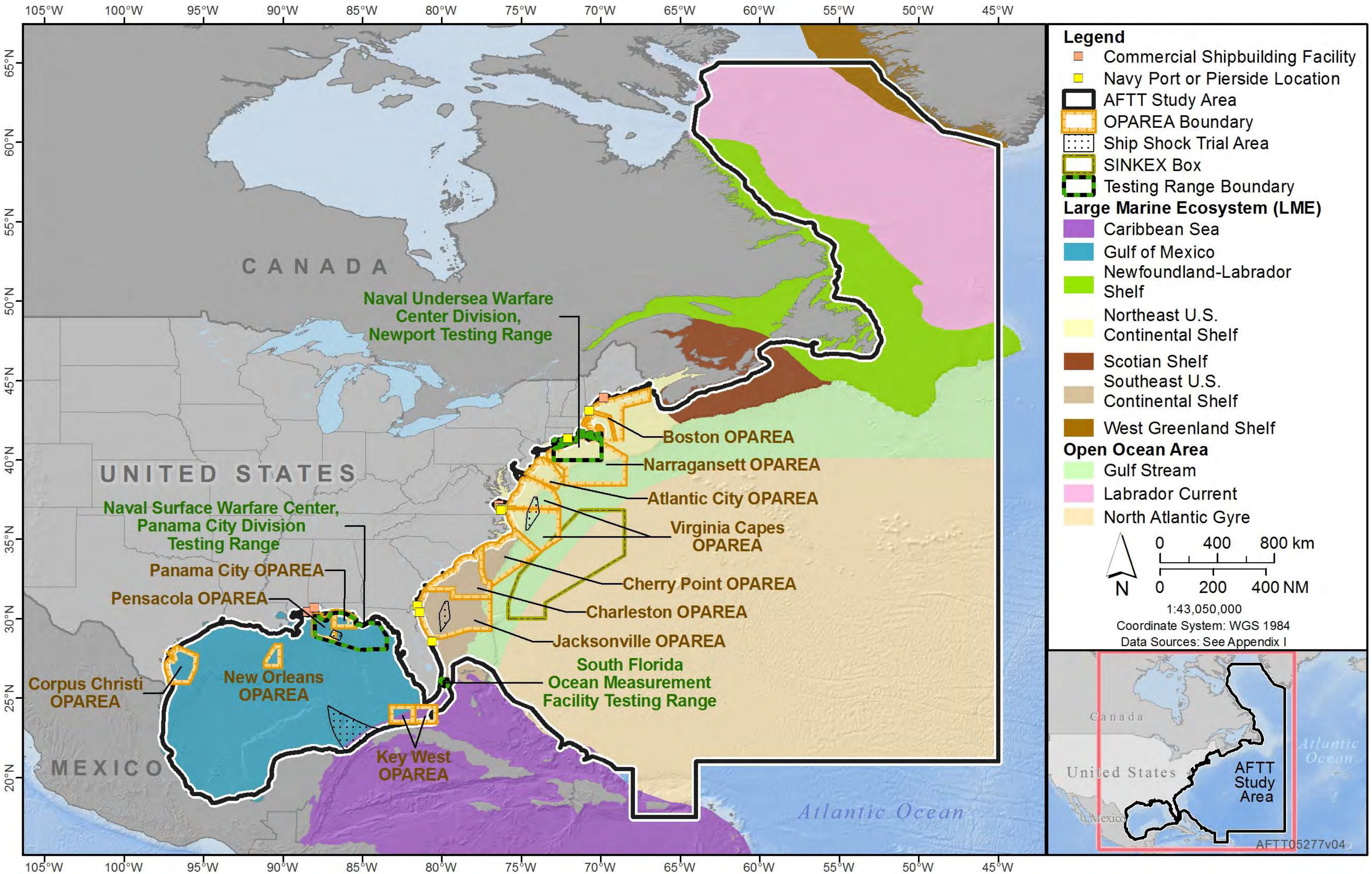
This large marine ecosystem extends off the east coast of Canada within the Labrador Current (Aquarone & Adams, 2009a). Other oceanic influences on this area are the Gulf Stream, Labrador Shelf-Slope Front, and Labrador Mid-Shelf Front. Important structural features of this ecosystem include a structurally complex seabed, 14 estuaries, and the Grand Banks, which is a rich fishing ground (Sherman & Hempel, 2009). The Newfoundland-Labrador Shelf Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., cod, haddock, and pollock). The average primary productivity within this large marine ecosystem is moderate: 150–300 g of carbon per m^2 per year (Aquarone & Adams, 2009a).

No specifically designated training or testing areas fall within the Newfoundland-Labrador Shelf Large Marine Ecosystem; however, training may occasionally occur in this area during transit. See Chapter 2 (Description of Proposed Action and Alternatives) for locations of activities conducted outside of designated training and testing ranges, identified as “Other AFTT Areas.” Examples of these activities include gunnery exercises and anti-submarine warfare tracking exercises. Approximately 5 percent of the Study Area is located in the Newfoundland-Labrador Shelf Large Marine Ecosystem.

3.0.2.1.3 Scotian Shelf Large Marine Ecosystem

The Scotian Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 283,000 km^2 (Aquarone & Adams, 2009b). This large marine ecosystem is located off the coast of the Canadian province of Nova Scotia and extends to the shelf break (Aquarone & Adams, 2009b). The Laurentian Channel in the north separates this large marine ecosystem from the Newfoundland-Labrador Shelf Large Marine Ecosystem. Oceanic influences in this area are the Gulf Stream, Nova Scotia Current, Cape North Front, Cabot Strait Front, Gully Front, and Shelf-Slope Front. Important structural features of this ecosystem include the St. Lawrence Estuary and the complex topography of the area, which includes deep, mid-shelf basins, and many off-shore shallow banks (Sherman & Hempel, 2009). The Scotian Shelf Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., cod, haddock, pollock, snow crab, northern shrimp, and short-finned squid). The average primary productivity within this large marine ecosystem is moderately high: 150–300 g of carbon per m^2 per year (Aquarone & Adams, 2009b).

No specifically designated training or testing areas fall within the Scotian Shelf Large Marine Ecosystem; however, training may occasionally occur in this area during transit. See Chapter 2 (Description of Proposed Action and Alternatives) for locations of activities conducted outside of designated training and testing ranges, identified as “Other AFTT Areas.” Examples of these activities include gunnery exercises and anti-submarine warfare tracking exercises. Approximately 1 percent of the Study Area is located in the Scotian Shelf Large Marine Ecosystem.



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area

Figure 3.0-1: The Study Area with Large Marine Ecosystems and Open Ocean Areas

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3.0.2.1.4 Northeast United States Continental Shelf Large Marine Ecosystem

The Northeast U.S. Continental Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 310,000 km^2 (Aquarone & Adams, 2009c). This large marine ecosystem extends from the Gulf of Maine to Cape Hatteras, North Carolina. This area includes the Gerry E. Studds Stellwagen Bank National Marine Sanctuary. For additional details on marine protected areas and national marine sanctuaries, see Section 6.1.2 (Marine Protected Areas).

Oceanic influences in this large marine ecosystem are the Gulf Stream, Cape North Front, Georges Bank Front, Maine Coastal Front, Mid-Shelf Front, Nantucket Shoals Front, and Shelf-Slope Front (Aquarone & Adams, 2009c). Important structural features of this ecosystem include 28 estuaries and river systems such as Penobscot Bay/River, Hudson River, Delaware Bay/River, and Chesapeake Bay (Sherman & Hempel, 2009). This large marine ecosystem also supplies an important ecosystem service by providing resources for commercial fisheries (e.g., cod, flounder, mackerel, lobster, sea scallops, and red crab). The Northeast U.S. Continental Shelf Large Marine Ecosystem is one of the most productive large marine ecosystems in the world, with a high average primary productivity of greater than 300 g of carbon per m^2 per year (Aquarone & Adams, 2009c).

A large proportion of Navy training and testing activities occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem. To determine which designated training and testing areas (or portions of these areas) occur within this large marine ecosystem, refer to Figure 3.0-1, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.3-1 through 2.3-5. Approximately 2 percent of the Study Area is located in the Northeast U.S. Continental Shelf Large Marine Ecosystem.

3.0.2.1.5 Southeast United States Continental Shelf Large Marine Ecosystem

The Southeast U.S. Continental Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 300,000 km^2 (Aquarone, 2009). This large marine ecosystem extends from Cape Hatteras, North Carolina, to the Straits of Florida (Aquarone, 2009). This area includes the Monitor and Gray's Reef National Marine Sanctuaries. For additional details on marine protected areas and national marine sanctuaries, see Section 6.1.2 (Marine Protected Areas).

Oceanic influences in this large marine ecosystem are the Gulf Stream, Inshore Gulf Stream Front, Mid-Shelf Front, and Offshore Gulf Stream Front. Important structural features of this ecosystem include many types of habitat such as coral reefs, estuaries, barrier islands, and coastal marshes (Sherman & Hempel, 2009). The calving grounds for the North Atlantic right whale are located in this large marine ecosystem, as discussed in Section 3.7 (Marine Mammals). The Southeast U.S. Continental Shelf Large Marine Ecosystem supplies important ecosystem services by providing resources for commercial fisheries (e.g., mackerel, swordfish, tuna, white shrimp, brown shrimp) and by supporting these fisheries with estuarine nurseries for these species. The Southeast U.S. Continental Shelf Large Marine Ecosystem includes important breeding areas for sea turtles. This large marine ecosystem is a moderately productive ecosystem, with an average primary productivity of 150–300 g of carbon per m^2 per year (Aquarone, 2009). This is comparable to productivity levels associated with the open ocean.

A large proportion of Navy training and testing activities occur in the Southeast U.S. Continental Shelf Large Marine Ecosystem. To determine which designated training and testing areas (or portions of these areas) occur within this large marine ecosystem, refer to Figure 3.0-1, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.3-1 through 2.3-5. Approximately 2 percent of the Study Area is located in the Southeast U.S. Continental Shelf Large Marine Ecosystem.

3.0.2.1.6 Gulf of Mexico Large Marine Ecosystem

The Gulf of Mexico Large Marine Ecosystem (Figure 3.0-1) encompasses an area of more than 1,500,000 km^2 (Heileman & Rabalais, 2008). This large marine ecosystem is a semi-enclosed sea that borders the United States, Mexico, and Cuba. This area includes the Florida Keys and Flower Garden Banks National Marine Sanctuaries. For additional details on marine protected areas and national marine sanctuaries, see Section 6.1.2 (Marine Protected Areas).

Oceanic influences in this large marine ecosystem are the Loop Current, Campeche Bank Coastal Front, Campeche Bank Shelf-Slope Front, Inner Shelf Front, Louisiana-Texas Shelf Front, and West Florida Shelf Front. Important structural features of this ecosystem include the extensive continental shelf, numerous estuaries, and a large amount of freshwater input from the Mississippi River (Sherman & Hempel, 2009). The Gulf of Mexico Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., Gulf menhaden, king mackerel, red grouper, brown shrimp, white shrimp, and pink shrimp). This large marine ecosystem has a moderately high average primary productivity of less than 300 g of carbon per m^2 per year (Heileman & Rabalais, 2008). Other human uses in this large marine ecosystem include off-shore oil and gas exploration.

A large number of Navy training and testing activities occur in the Gulf of Mexico Large Marine Ecosystem. To determine which designated training and testing areas (or portions of these areas) occur within this large marine ecosystem, refer to Figure 3.0-1, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.3-1 through 2.3-5. Approximately 13 percent of the Study Area is located in the Gulf of Mexico Large Marine Ecosystem.

3.0.2.1.7 Caribbean Sea Large Marine Ecosystem

The Caribbean Sea Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 3,300,000 km^2. This large marine ecosystem is bordered by the southern part of Florida, Central and South America, and the Antilles (Heileman & Mahon, 2008). Oceanic influences in this area are the Loop Current, North Equatorial Current, and Windward Passage Front. Important structural features of this ecosystem include coral reefs, sea mounts, and major input of freshwater from large rivers (Sherman & Hempel, 2009). The Caribbean Sea Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., king mackerel, Spanish mackerel, dolphinfish, spiny lobster, queen conch, and shrimp). The Caribbean Sea Large Marine Ecosystem includes important breeding areas for sea turtles, as discussed in Section 3.8 (Reptiles). This region has a moderate primary productivity of 150–300 g of carbon per m^2 per year (Heileman & Mahon, 2008).

To determine which designated training and testing areas (or portions of these areas) occur within the portion of the Caribbean Sea Large Marine Ecosystem that falls within the Study Area, refer to Figure 3.0-1, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.3-1 through 2.3-5. Approximately 1 percent of the Study Area is located in the Caribbean Sea Large Marine Ecosystem.

3.0.2.1.8 Labrador Current Open Ocean Area

The Labrador Current Open Ocean Area (Figure 3.0-1) lies between Labrador (Canada) and Greenland and is characterized by the cold water of the Labrador Current that flows north to south from the Arctic Ocean, down along the eastern coast of Canada (Reverdin et al., 2003). The Labrador Current then joins the Gulf Stream Current to form the North Atlantic Current (Gould, 1985; Reverdin et al., 2003). The Labrador Current has an average width of 26–50 nautical miles (NM), with typical velocities of 0.3–0.5

meters (m) per second, and flows to a maximum depth of 150 m (Halkin & Rossby, 1985; Reverdin et al., 2003; Tomczak & Godfrey, 2003).

The Arctic influence, combined with the southward-flowing current, results in an abundance of icebergs in this open ocean area, particularly during the spring and early summer months (Reverdin et al., 2003; Schmitz & McCartney, 1993; Tomczak & Godfrey, 2003). The cold-water Labrador Current influences the species assemblages found within this open ocean area (Valiela, 1995). However, farther south where this cold water current combines with the warm waters of the Gulf Stream (offshore of the Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems), the species assemblage reflects both warm- and cold-water organisms (Aquarone, 2009; Aquarone & Adams, 2009a; Valiela, 1995). The Labrador Current Open Ocean Area is an important feeding and migration area for the Gulf of Maine Atlantic salmon (Fay et al., 2006).

No specifically designated training or testing areas fall within the Labrador Current Open Ocean Area; however, training or testing may occasionally occur in this area during transit. See Chapter 2 (Description of Proposed Action and Alternatives) for locations of activities within and outside of designated training and testing ranges. Approximately 10 percent of the Study Area is located in the Labrador Current Open Ocean Area.

3.0.2.1.9 Gulf Stream Open Ocean Area

The major western boundary current of the North Atlantic, the Gulf Stream, characterizes the Gulf Stream Open Ocean Area (Figure 3.0-1). The Gulf Stream forms where the Loop Current in the Gulf of Mexico (Reverdin et al., 2003) and the Florida Current (Atkinson et al., 1984) combine in the Atlantic Ocean. The Gulf Stream begins where the Florida Current ceases to follow the continental shelf, flowing northeast along the southeastern United States from Cape Canaveral, Florida, to Cape Hatteras, North Carolina (Atkinson & Targett, 1983). As the Gulf Stream moves away from Cape Hatteras it flows northeast toward Europe (Garrison, 1998).

The Gulf Stream has a maximum width of 200 kilometers (km), with typical velocities exceeding 1.0 m per second, and flows to a maximum depth of 200 m (Halkin & Rossby, 1985; Reverdin et al., 2003; Tomczak & Godfrey, 2003). The Gulf Stream flows over the shelf break south of 32 degrees (°) North (N) at water depths less than 800 m (Atkinson et al., 1984; Halkin & Rossby, 1985). North of 32° N, the Gulf Stream is displaced 54 NM offshore, at which point it abruptly turns east near the Charleston Bump (a deep-water outcropping) (Reverdin et al., 2003). From there, the Gulf Stream continues northeast, joining the Labrador Current to form the Slope Jet Current at 41° N–42° N. This branch of the Gulf Stream, along with the Labrador and Slope Jet Current, continues northeast as the North Atlantic Current (Gould, 1985; Reverdin et al., 2003).

The Gulf Stream is an important migratory corridor for many different marine species, including marine mammals, sea turtles, and fishes. The influence of the warm waters of the Gulf Stream also provides passive dispersal of tropical species from southern portions of the Study Area into the northern portions of the Study Area.

A large proportion of Navy training and testing activities occur in this open ocean area. To determine which designated training and testing areas (or portions of these areas) occur within the Gulf Stream Open Ocean Area, refer to Figure 3.0-1, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.3-1 through 2.3-5. Approximately 11 percent of the Study Area is located in the Gulf Stream Open Ocean Area.

3.0.2.1.10 North Atlantic Gyre Open Ocean Area

North Atlantic Ocean circulation is driven by the anticyclonic (clockwise) motion of the North Atlantic Subtropical Gyre (Figure 3.0-1). The North Atlantic Gyre Open Ocean Area occurs from 10° N to 40° N and is delimited by the westward-flowing Canary Current, North Equatorial Current, the Caribbean Current, Loop Current in the Gulf of Mexico, Florida Current, Gulf Stream (Talwani et al., 1971), and the eastward-flowing North Atlantic Current (Schmitz & McCartney, 1993). The North Atlantic Subtropical Gyre is transected by the eastward-flowing Azores Current (Juliano & Alves, 2007). Only the northwestern portion of the North Atlantic Gyre is located in the Study Area. The North Atlantic Gyre, like all large subtropical gyres in the ocean, has extremely low rates of primary productivity (Valiela, 1995). The observed low productivity is caused by a persistent thermocline (a layer of water that separates warm water from cold deep water) that prevents the vertical mixing of water. This thermocline results in dilute (nutrient-poor) surface waters in the gyre, which limits the growth of phytoplankton throughout the year (Valiela, 1995). The Sargasso Sea is a unique feature contained within this gyre, and despite the nutrient limitations of the area, is characterized by dense mats of floating Sargassum, a type of marine vegetation (seaweed) that provides important cover habitat for a variety of marine organisms (see Section 3.3, Vegetation, for more details).

To determine which designated training and testing areas (or portions of these areas) occur within the North Atlantic Gyre Open Ocean Area, refer to Figure 3.0-1 and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.3-1 through 2.3-5. Although approximately 50 percent of the Study Area is located in the North Atlantic Gyre Open Ocean Area, the majority of Navy training and testing activities do not occur here.

3.0.2.2 Bathymetry

The discussion of bathymetry (water depth) includes a general overview of the Study Area followed by more detailed sections organized by biogeographic classification area. Bathymetry describes the surface features of the seafloor, and it is an important factor in understanding the potential impacts of Navy training and testing activities on the seafloor, the propagation of underwater sound, and species diversity.

The contour of the ocean floor as it descends from the shoreline has an important influence on the distribution of organisms, as well as the structure and function of marine ecosystems (Madden et al., 2009). The continental shelf and slope make up the continental margin of oceans. The typical zonation of oceans is shown in Figure 3.0-2.

The continental shelf gently slopes seaward hundreds of miles (mi.) from shore from the low tide line to a maximum depth of 200 m (Tomczak & Godfrey, 2003; United Nations Educational Scientific and Cultural Organization, 2009). The continental slope is steep; it begins seaward of the shelf break and extends to a depth of approximately 3,000 m. The continental rise extends from the continental slope to a depth of approximately 4,000 m. The abyssal zone, a relatively flat or gently sloping ocean floor, continues from the continental rise to depths of up to approximately 6,500 m. The abyssal zones of the Atlantic Ocean reach depths greater than 6,000 m. Bathymetry of the entire Study Area is shown in Figure 3.0-3 through Figure 3.0-6.

Bathymetric features associated with the continental margin and the deep seafloor of the Study Area include canyons, seamounts (underwater mountains), trenches, ridges, and plateaus. The continental shelf of the northwest Atlantic ranges in width from 5 to 17 NM at its narrowest point off the coast of

North Carolina to 215 NM at its widest point off the coast of Newfoundland (Blanton et al., 2003; Slatt, 1984).

Several bathymetric features are located in the Northeast U.S. Continental Shelf, the Scotian Shelf, and the Newfoundland-Labrador Shelf Large Marine Ecosystems. The Grand Banks are a group of shallow underwater plateaus on the eastern extent of the continental shelf in 25–100 m of water. South of the Grand Banks is the Newfoundland Rise, which at 41° N, 50° West (W) is the northernmost extent of the New England Seamount Chain (Reverdin et al., 2003). This chain includes more than 30 volcanic seamounts that extend south to Bermuda.

The Scotian Shelf is bordered by the Canadian province of Nova Scotia and extends offshore to the shelf break, more than 200 NM from the coast (Aquarone & Adams, 2009b). The continental shelf is relatively shallow, with an average depth of 90 m. However, in some areas it rapidly drops to depths greater than 3,000 m. Sable Island, located 160 NM southeast of Halifax, is surrounded by shallow banks (25–100 m).

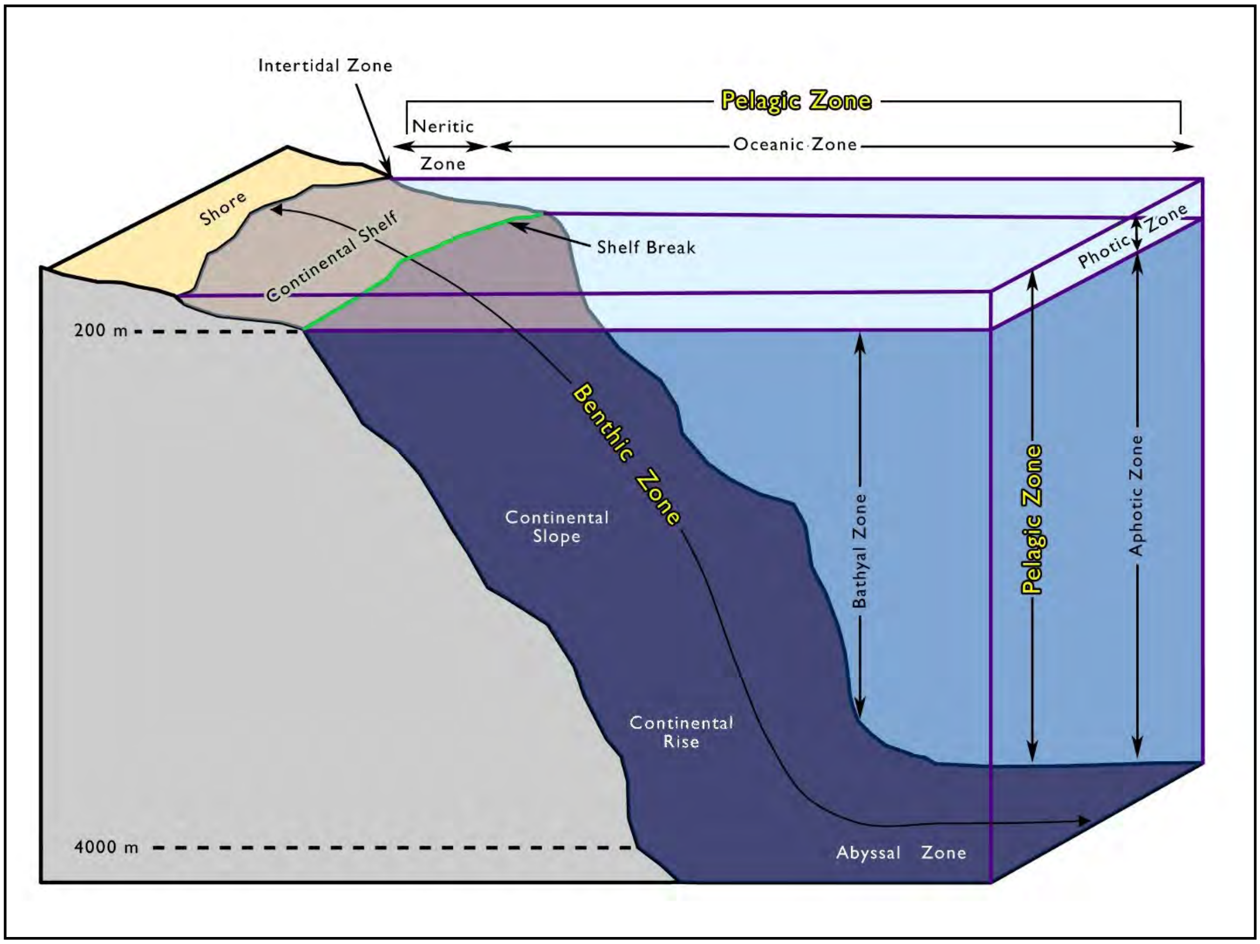


Figure 3.0-2: Three-Dimensional Representation of the Intertidal Zone (shoreline), Continental Margin, Abyssal Zone, and Water Column Zones

The Gulf of Maine is a semi-enclosed continental sea with an area of 89,000 km^2 and average depth of 150 m (Ballard & Uchupi, 1974). It is characterized by rocky shorelines of exposed bedrock from previous glacial scouring. Inland of the Gulf of Maine is the Bay of Fundy. It covers 16,500 km^2 with an average depth of 50 m (Wade et al., 1996). The Bay of Fundy and Gulf of Maine are known for having extreme tidal ranges as great as 15 m (Wade et al., 1996).

The Southeast U.S. Continental Shelf Large Marine Ecosystem includes the coastal area from southern Florida to Cape Hatteras, North Carolina (Shepard, 2005). It includes the topographic feature known as the Blake Plateau, which has water depths of 500–1,100 m (Popenoe & Manheim, 2001). The Blake Plateau is bounded by the continental shelf on the west, Cape Hatteras on the north, the Bahama Banks on the south, and the abyssal plain on the east (Gorsline, 1963; Popenoe & Manheim, 2001). The Charleston Bump, a rocky, high-relief outcrop, occurs on the Blake Plateau between latitude 31° N and 32° N, and between longitude 77.5° W and 79.5° W (Popenoe & Manheim, 2001). The continental shelf in this area has a smooth surface and a low gradient (3° or less), while the continental slope reaches depths of 1,400 m (Knebel, 1984). Portions of the continental slope in this area are associated with deep-water coral communities at depths of 70–1,000 m (Reed & Ross, 2005). At the boundary between the Northeast U.S. Continental Shelf and the Southeast U.S. Continental Shelf, the continental slope is divided by Hatteras Canyon, the most southerly canyon along the continental margin of the U.S. east coast. Offshore of Hatteras Canyon, the continental slope is steep and reaches 5,000 m (Rowe, 1971). Other notable features are large sand shoals that extend from the barrier islands off North Carolina (Hunt et al., 1977; Oertel, 1985).

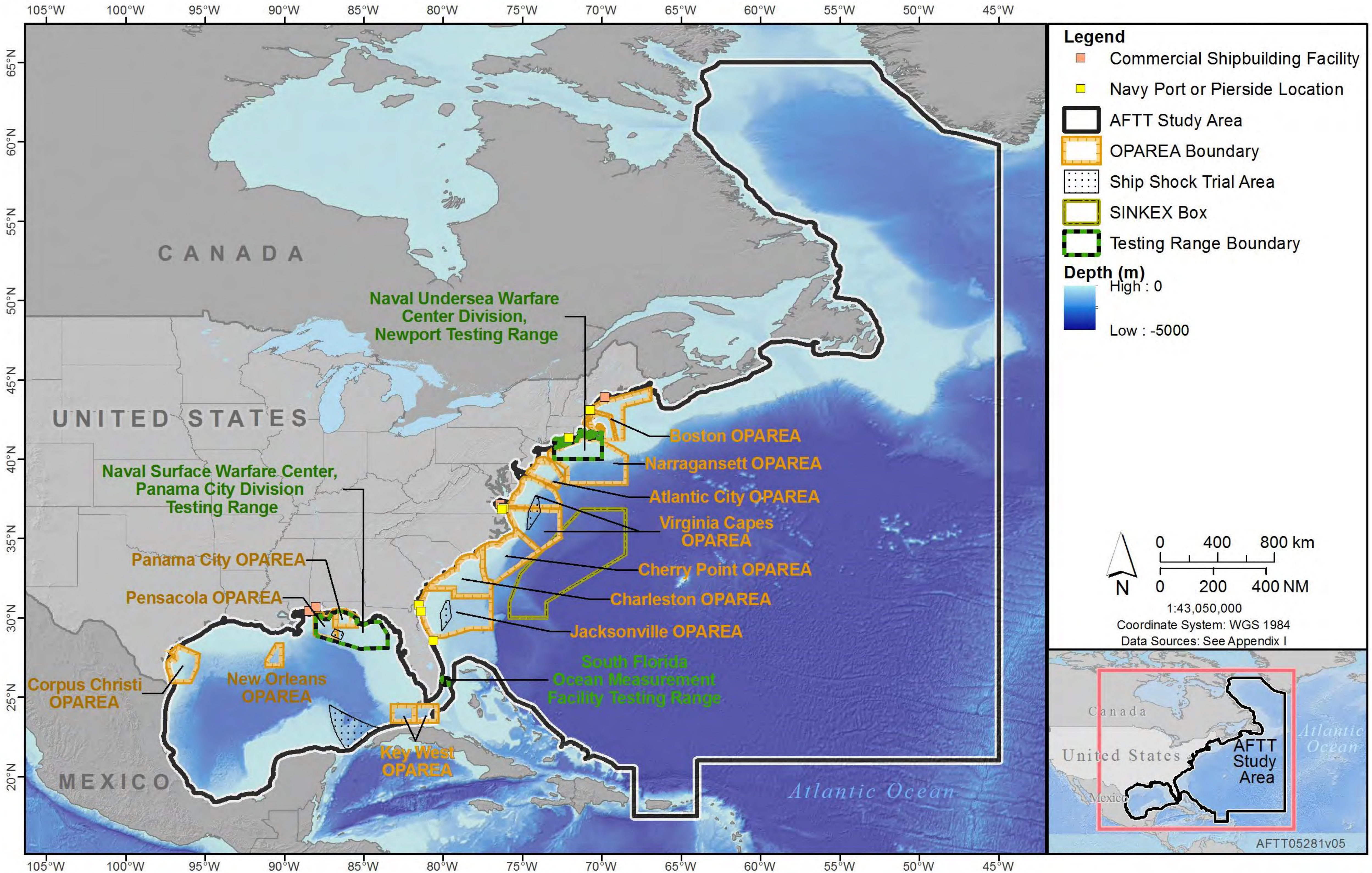
The average depth of the Gulf of Mexico is 1,615 m, with a maximum depth of 3,850 m (Pequegnat et al., 1990). Dominant features of the Gulf of Mexico include the Sigsbee Escarpment (steep slope) and the Alaminos and Keathley Canyons, which divide the escarpment into western and eastern portions (Roberts et al., 2005). The eastern Gulf of Mexico is dominated by the Florida Escarpment, which is divided by a series of submarine canyons and contains more than 90 basins (Rowe & Kennicutt, 2002). The western portion is underlain by the Louann Salt Formation, which creates faults and diapirs (salt domes) often associated with hydrocarbon seeps along the faults. Dominant features in the southern portion of the Gulf of Mexico are the Campeche Escarpment and the Mexican Ridge, which consists of a series of valleys and ridges (Escobar-Briones et al., 2008).

3.0.2.3 Currents, Circulation Patterns, and Water Masses

To analyze the impact of Navy training and testing activities on marine resources (e.g., vegetation and animals) it is important to know where the resources occur in the Study Area. Some of the major factors that influence the distribution of marine resources are currents, circulation patterns, and water masses.

Prevailing winds and the Coriolis effect (the deflection of objects caused by the rotation of the earth) cause surface waters to move in a gyre, or circular fashion, in ocean basins. In the North Atlantic Ocean, this gyre system is composed of the Gulf Stream, North Atlantic, Canary, and Equatorial Currents. In the Gulf of Mexico, the Florida Current is a strong, east-northeast-flowing current that connects the Loop Current to the Gulf Stream at the entrance to the Florida Straits (Figure 3.0-7).

Surface currents are horizontal movements of water primarily driven by the drag of the wind over the sea surface. Wind-driven circulation affects the upper 100 m of the water column and therefore drives the circulation over continental shelves (Hunter et al., 2007). Surface currents of the Atlantic Ocean have an annual average mean velocity of 0.5 m per second and include equatorial currents, circumpolar currents, eastern boundary currents, and western boundary currents (Juliano & Alves, 2007). Refer to Figure 3.0-7 and Table 3.0-1 for a depiction and description of the major surface currents in the Study Area.



Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.0-3: Bathymetry of the Entire Study Area

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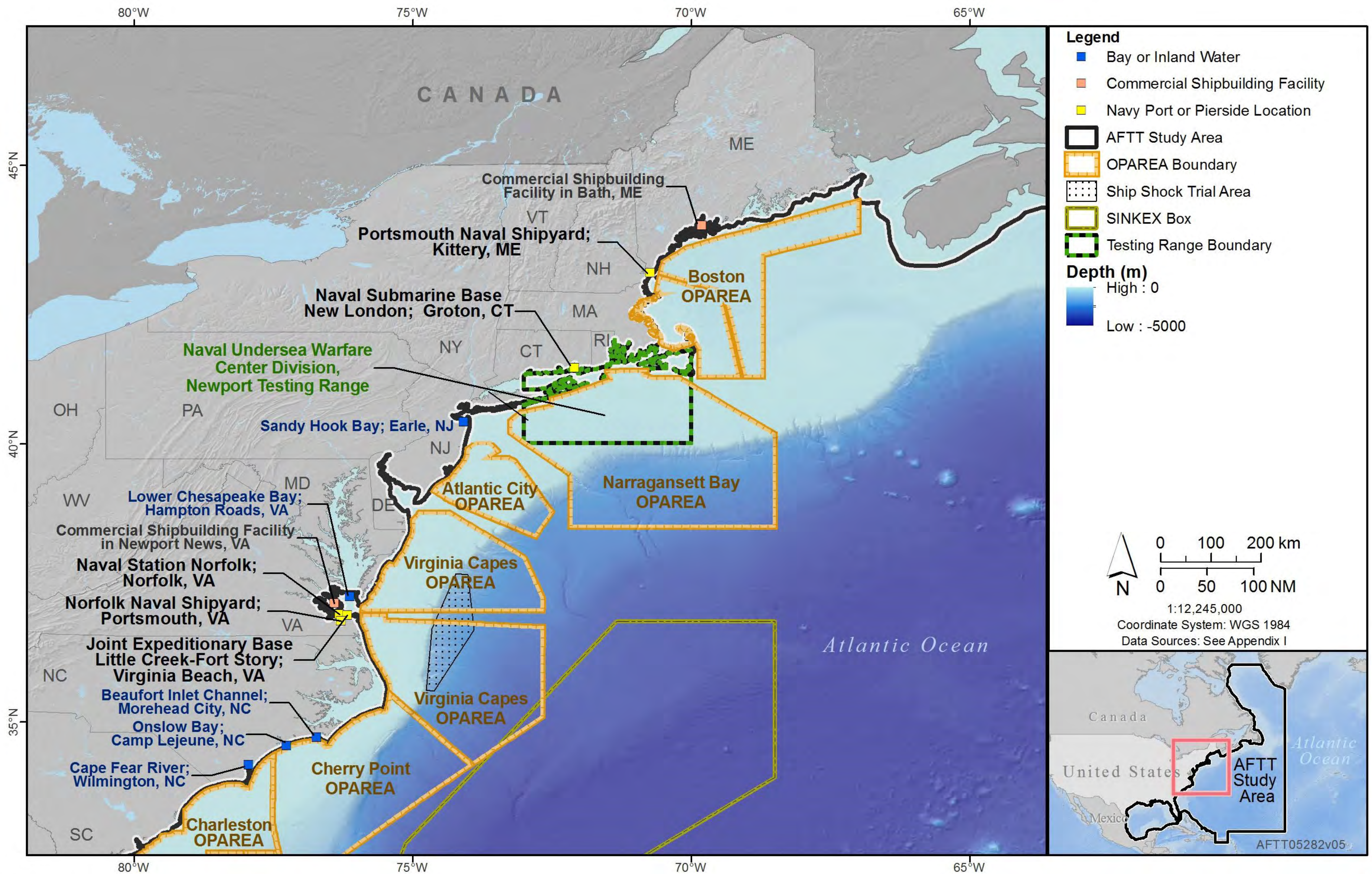

Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area, SINKEX = Sinking Exercise

Figure 3.0-4: Bathymetry of the Northeast Portion of the Study Area

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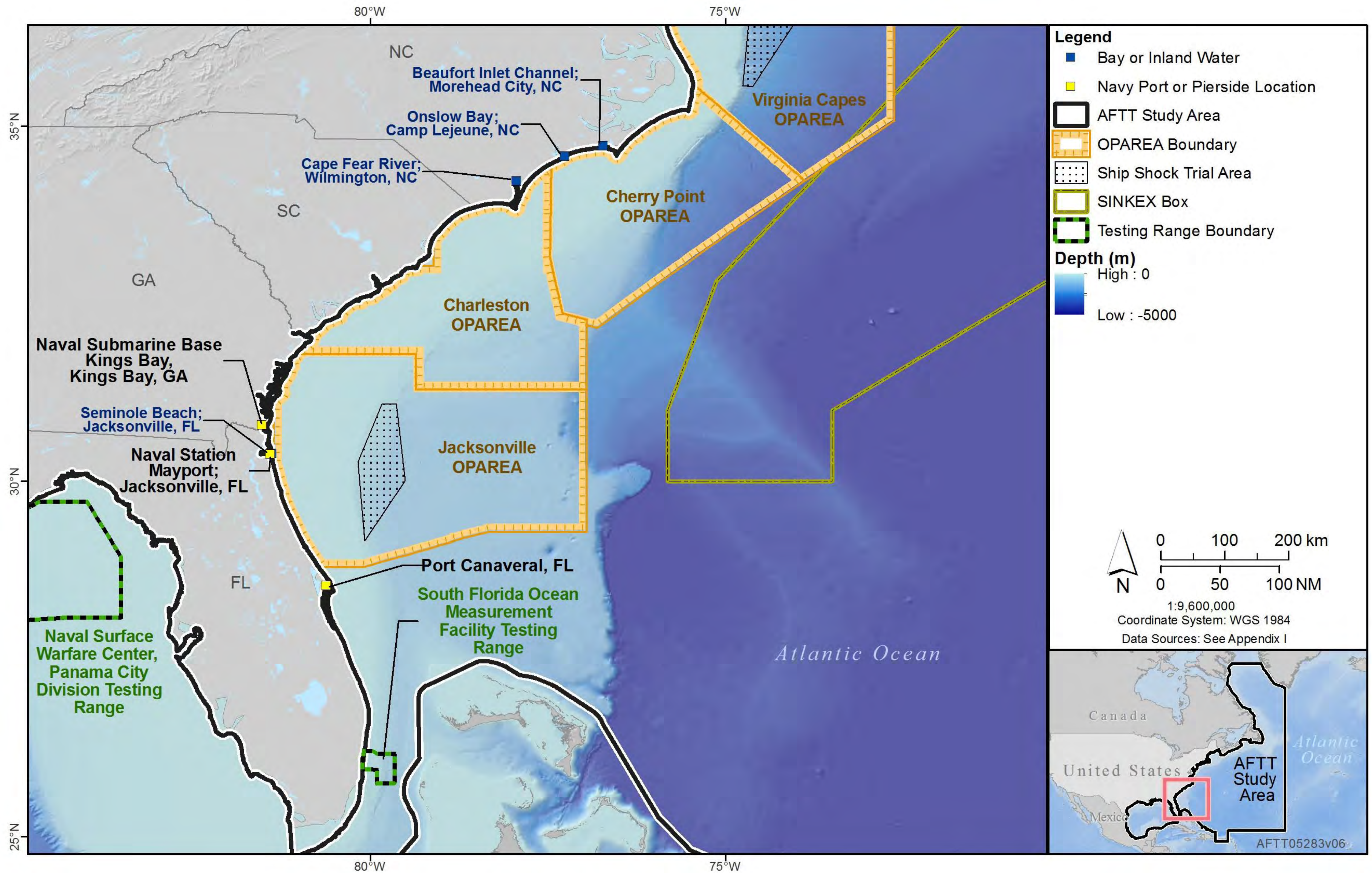

Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area, SINKEX = Sinking Exercise

Figure 3.0-5: Bathymetry of the Southeast and Caribbean Portions of the Study Area

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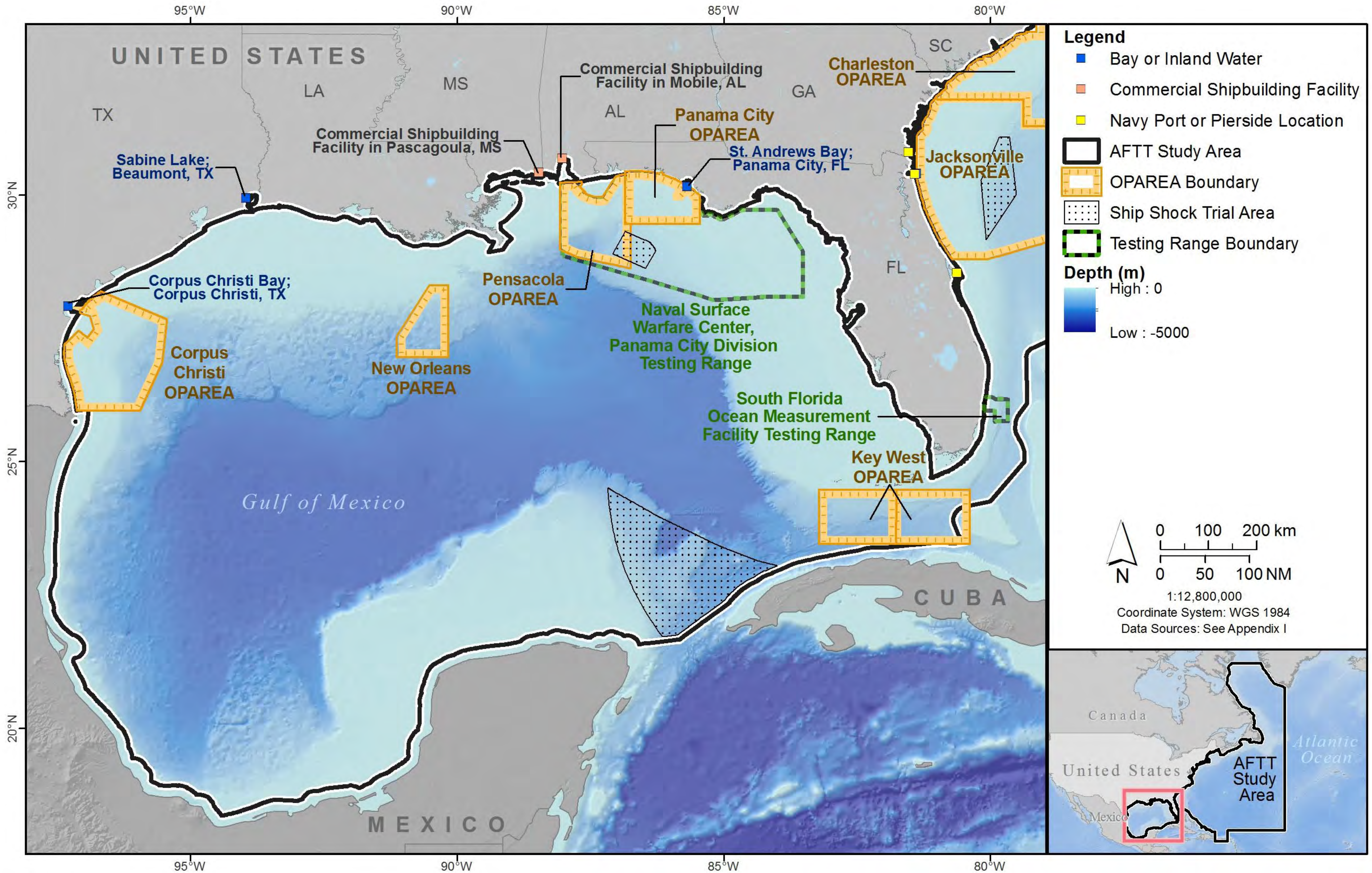

Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.0-6: Bathymetry of the Gulf of Mexico and Caribbean Sea Portions of the Study Area

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Eastern boundary currents are relatively shallow, broad, and slow-moving and travel toward the equator along the eastern boundaries of ocean basins. Western boundary currents are narrow, deep, and swift and are a result of the trade winds and the westerlies. In general, eastern boundary currents carry cold waters from higher latitudes to lower latitudes, and western boundary currents carry warm waters from lower latitudes to higher latitudes (Reverdin et al., 2003).

In the northern hemisphere, including the Study Area, the influence of the westerlies and the northeasterly trade winds on North Atlantic currents produce the eastward-flowing Subtropical Counter Current (Tomczak & Godfrey, 2003). Subpolar gyres are also present in the North Atlantic as a result of the polar easterlies and the westerlies. In the North Atlantic, subpolar gyres rotate counterclockwise (Tomczak & Godfrey, 2003).

The western continental margin of any ocean basin is the location of intense boundary currents; the Gulf Stream Current is the western boundary current found in the North Atlantic Ocean (Figure 3.0-7). The Gulf Stream Current is part of a larger current system called the Gulf Stream System that also includes the Loop Current in the Gulf of Mexico, the Florida Current in the Florida Straits, and the North Atlantic Current in the central North Atlantic Ocean. The Gulf Stream Current is a powerful surface current, carrying warm water into the cooler North Atlantic just south of the Northeast Range Complexes (Pickard & Emery, 1990; Verity et al., 1993). In general, the Gulf Stream flows roughly parallel to the coastline from the Florida Straits to Cape Hatteras, where it is deflected away from the North American continent and flows northeastward.

The temperature and salinity of water determines its density; density differences cause water masses to move both vertically and horizontally in relation to one another. Cold, salty, dense water at the surface will sink, and warm, less saline water will rise. Density differences also drive the horizontal circulation of deep-water masses throughout ocean basins.

Thermohaline circulation—also called the ocean conveyor belt or meridional overturning—is the continuous horizontal circulation of water masses throughout the ocean. This cycle begins when dense waters sink and deep-water masses form. Deep-water masses form in the North Atlantic and Southern oceans (Dickson & Brown, 1994). North Atlantic Deep Water is formed in the Norwegian Sea between Iceland and Greenland. North Atlantic Deep Water is carried by the Deep Western Boundary Current along the western continental slope to join Antarctic Bottom Water (Dengler et al., 2004; Pickart, 1992). At the surface, waters are heated and freshwater inputs result in lower salinity. As a result of density differences and higher sea levels in the Pacific Ocean and Indian Ocean, these surface water masses return to the Antarctic Ocean and North Atlantic Ocean. In the North Atlantic, these surface waters undergo evaporative cooling, which increases their densities, resulting in the sinking and formation of the North Atlantic Deep Water (Huang & Tiedemann, 1998).

Table 3.0-1: Summary of Current Patterns in Areas Located Outside the Range Complexes

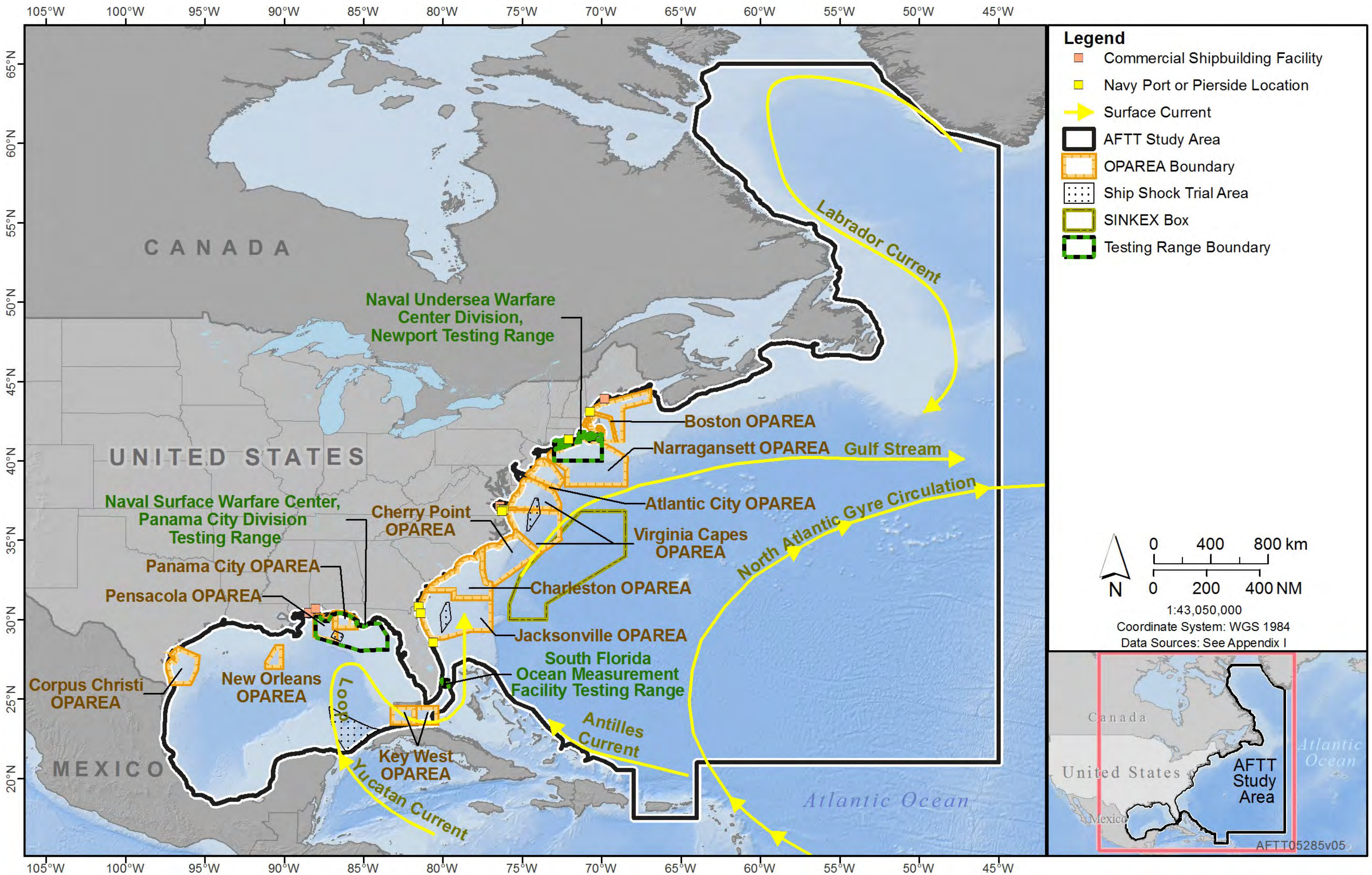
<table>
<tr><th>Component</th><th>Currents</th></tr>
<tr><td colspan="2">Northeast U.S. Continental Shelf Large Marine Ecosystem</td></tr>
<tr><td>Bath, ME</td><td rowspan="2">Riverine and tidal circulation patterns.</td></tr>
<tr><td>Portsmouth Naval Shipyard; Kittery, ME</td></tr>
<tr><td>Naval Undersea Warfare Center Division, Newport Testing Range</td><td>Shallow water coastal currents generated by tidal action and wind. Currents are affected by open-ocean conditions as well as by tidal exchange and wind-generated currents in the estuaries.</td></tr>
</table>

Table 3.0-1: Summary of Current Patterns in Areas Located Outside the Range Complexes (continued)

Component	*Currents*
Northeast U.S. Continental Shelf Large Marine Ecosystem (continued)	
Naval Submarine Base New London; Groton, CT	Riverine and tidal circulation patterns near mouth of estuary. Subject to the influence of larger open oceanic currents and circulation systems.
Newport News, VA	
Naval Station Norfolk; Norfolk, VA	
Joint Expeditionary Base Little Creek—Fort Story; Virginia Beach, VA	
Norfolk Naval Shipyard; Portsmouth, VA	
Southeast U.S. Continental Shelf Large Marine Ecosystem	
Naval Submarine Base Kings Bay; Kings Bay, GA	Riverine and tidal circulation patterns in middle part of estuary.
Naval Station Mayport, Jacksonville, FL	Riverine and tidal circulation patterns in the mouth of estuary inlet. Subject to the influence of larger open oceanic currents and circulation systems.
Port Canaveral, FL; South Florida Ocean Measurement Facility, FL	Tidal mixing within shallow dredged channel, plus wind driven circulation.
Gulf of Mexico Large Marine Ecosystem	
Pascagoula, MS; Naval Surface Warfare Center, Panama City Division, FL	Riverine and tidal circulation patterns in mouth of estuary/inlet. Offshore, near coastal areas subject to influence of larger open oceanic current/circulation.
Gulf of Mexico	The Louisiana coast current flows along the coast of the United States from the mouth of the Mississippi River to the western Gulf of Mexico. The Yucatan Current flows north, east, and west as it enters the Gulf of Mexico from the Caribbean Sea. The Loop Current originates as part of the Yucatan Current, and spins in a clockwise direction and connects with the Florida Current from west to east through the Florida Straits. Warm and cold core eddy rings develop in the western half of the Gulf of Mexico between the Loop Current and the Texas/Mexico coast. Cold-core eddy rings develop off the Florida Current in the eastern Gulf.
Caribbean Sea Large Marine Ecosystem	
Other AFTT Areas (Outside the Range Complexes)	The Antilles Current flows southeast to northwest along the northern edge of the Turks and Caicos Islands and Bahama Islands. The Labrador Current flows south from Labrador Bay.
Labrador Current Open Ocean Area	
Other AFTT Areas (Outside the Range Complexes)	Labrador surface current and West Greenland surface current move water in a counter clockwise direction around the outer edges of the Labrador Sea. West Labrador surface current also moves water farther to the north. Portions of the deep North Atlantic Current return cold, denser water back to the south, away from the Labrador Sea.

Source: Stewart, (2008)

Notes: AFTT = Atlantic Fleet Training and Testing, CT = Connecticut, FL = Florida, GA = Georgia, ME = Maine, MS = Mississippi, VA = Virginia



Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.0-7: Major Currents in the Study Area

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3.0.2.4 Ocean Fronts

Ocean fronts are characterized by increased productivity and biomass (e.g., marine vegetation and animals) (Bost et al., 2009). Fronts are the boundaries between two water masses with distinct temperatures or densities and are characterized by rapid changes in specific water properties over short distances.

The Study Area is influenced by the Mid-Atlantic Bight (a curve in the coastline) shelf break front, the Gulf Stream front, and the Loop Current and Florida Current. As the Gulf Stream Current moves east from Cape Hatteras, North Carolina, it carries warm equatorial waters into the cooler Atlantic Ocean. Cold water flowing north to south from coastal areas of the northeastern United States (as shown in Figure 3.0-7) converges with the warmer waters of the Gulf Stream off Cape Hatteras, creating a frontal system. These fronts can be depicted on maps that show the drastic changes in sea surface temperatures between water masses. Figure 3.0-8 shows the influence of ocean fronts on the sea surface temperatures of the Study Area.

The front formed at the intersection of the continental shelf and slope extends from the Mid-Atlantic Bight into New England waters. This front is biologically important and persists year-round. Phytoplankton (microscopic drifting plants) production is enhanced at this frontal boundary, often with twice the concentration of phytoplankton found in adjacent waters (Ryan et al., 1999).

North of Cape Hatteras, the Gulf Stream meanders in a wave-like fashion and becomes unstable. These instabilities in current flow lead to the pinching off of relatively warm or cool waters as either warm- or cold-core mesoscale eddies (Mann & Lazier, 1996). Mesoscale eddies are large (54–108 NM wide) rotating water currents that separate from the main current. They cause cold, deep waters to rise to the surface (upwelling) or conversely, warm, surface waters to sink (downwelling), and consequently influence primary production (Sangrà et al., 2009) and facilitate the transfer of energy to higher trophic levels (Rice et al., 2015; Thompson et al., 2012). Warm-core eddies rotate clockwise (anticyclonic) and bring warm water and associated plankton (drifting organisms), including ichthyoplankton (fish eggs and larvae), to the colder areas of the northeast shelf. Cold-core eddies rotate counterclockwise (cyclonic) and deliver cold, nutrient-rich waters and plankton to the surface of the ocean. These types of mesoscale eddies form around the Gulf Stream and influence the sea surface temperature.

Warm- and cold-core eddy rings develop in the western half of the Gulf of Mexico between the Loop Current and the Texas and Mexico coast. These eddies travel westward and southward in the Gulf (Elliot, 1982; Gallaway et al., 2001; Hamilton, 1990). The Loop Current and associated eddies are responsible for circulation in the deepest portions of the Gulf of Mexico (Hamilton, 1990). Frontal eddies occur along the East Florida Shelf (Fiechter & Mooers, 2003; Lee et al., 1992) when warm Florida Current front waters meander seaward beyond the shelf break, allowing colder slope waters to upwell onto the East Florida Shelf.

3.0.2.5 Abiotic Substrate

In the marine and estuarine environments of the AFTT Study Area there are a variety of types of surfaces, or substrates, on which organisms live. Nonliving (abiotic) substrates can be categorized based on the grain size of unconsolidated material: “Soft” (e.g., sand, mud), “Intermediate” (e.g., cobble, gravel), and “Hard” (e.g., bedrock, boulders, artificial structures).

3.0.3 Overall Approach to Analysis

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

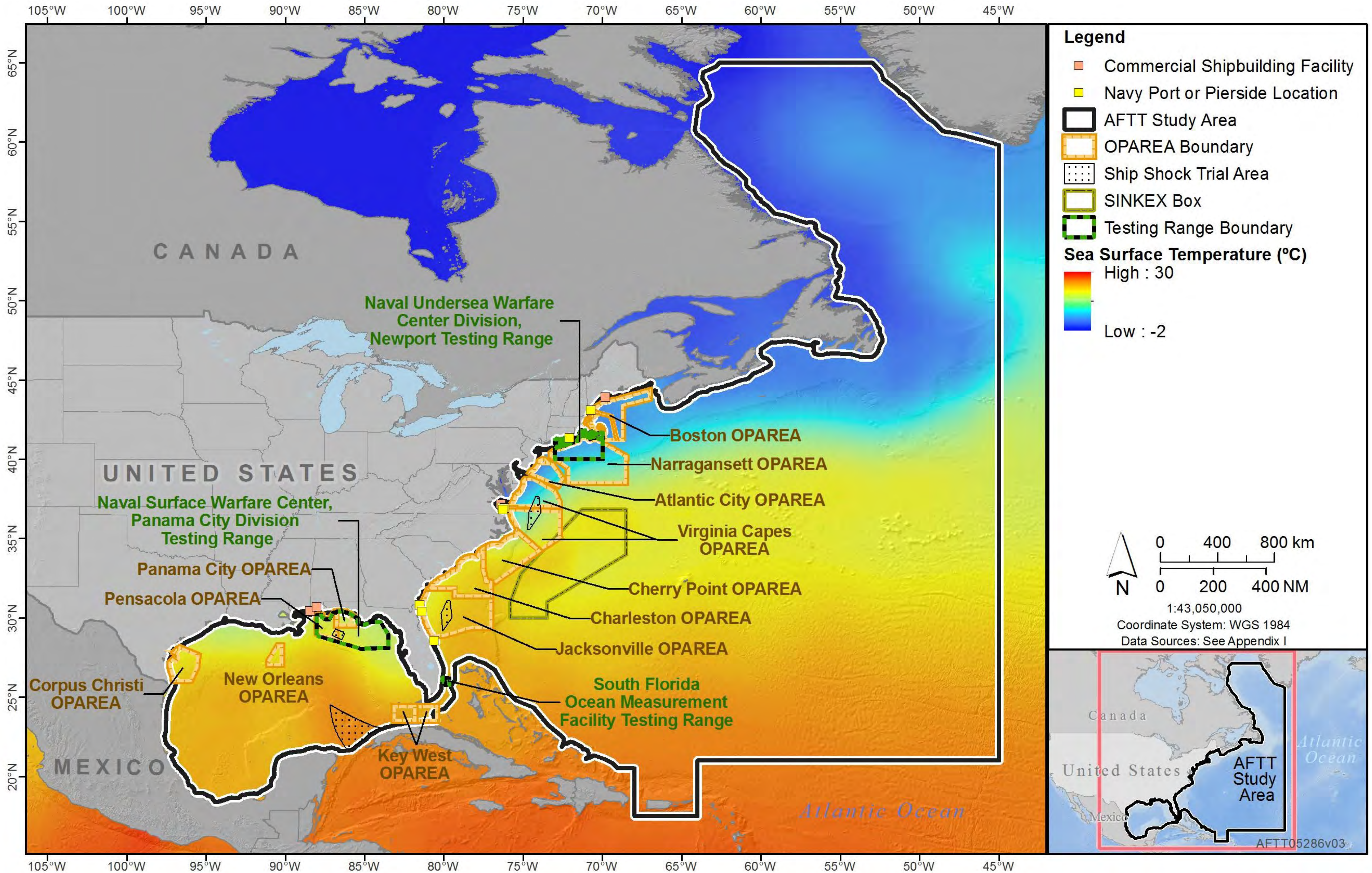
- identifying resources and stressors for analysis,
- analyzing resource-specific impacts for individual stressors,
- analyzing resource-specific impacts for multiple stressors,
- examining potential marine species population-level impacts,
- analyzing cumulative effects, and
- analyzing mitigations to reduce identified potential impacts.

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

Navy training and testing activities in the Proposed Action may produce one or more stimuli that cause stress on a resource. Each proposed Navy activity was examined to determine its potential stressors. The term stressor is broadly used in this document to refer to an agent, condition, or other stimulus that causes stress to an organism or alters physical, socioeconomic, or cultural resources. Not all stressors affect every resource, nor do all proposed Navy activities produce all stressors. Since the activities proposed in this EIS/OEIS are similar to current activities analyzed previously, the stressors considered are also similar.

The potential direct, indirect, and cumulative impacts of the Proposed Action were analyzed based on these potential stressors being present with the resource. Direct impacts are caused by the action and occur at the same time and place. Indirect impacts result when a direct impact on one resource induces an impact on another resource (referred to as a secondary stressor). Indirect impacts would be reasonably foreseeable because of a functional relationship between the directly impacted resource and the secondarily impacted resource. For example, a significant change in water quality could secondarily impact those resources that rely on water quality, such as marine animals and public health and safety. Cumulative effects or impacts are the incremental impacts of the action added to other past, present, and reasonably foreseeable future actions.

First, a preliminary analysis was conducted to determine the environmental resources potentially impacted and associated stressors. Secondly, each resource was analyzed for potential impacts of individual stressors, followed by an analysis of the combined impacts of all stressors related to the Proposed Action. A cumulative impact analysis was conducted to evaluate the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions (Chapter 4, Cumulative Impacts). Mitigation measures are discussed in detail in Chapter 5 (Mitigation), and regulatory considerations are discussed in Chapter 6 (Regulatory Considerations).



Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.0-8: Average Sea Surface Temperature in the Study Area (2011–2015)

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

3.0.3.1 Resources and Issues Evaluated

Physical resources evaluated include air quality, sediments, and water quality. Biological resources (including threatened and endangered species) evaluated include vegetation, invertebrates, habitats, fishes, marine mammals, reptiles, and birds. Human resources evaluated include cultural resources, socioeconomics, and public health and safety.

3.0.3.2 Resources and Issues Eliminated from Further Consideration

This AFTT EIS/OEIS analyzes only in-water activities and activities occurring over water. Therefore, some resource areas are not analyzed. Resources and issues considered but not carriesd forward for further consideration include land use, demographics, environmental justice, and children’s health and safety. Land use was eliminated from further consideration because the offshore activities in the Proposed Action are not connected to land use issues and no new actions are being proposed that would include relevant land use. Demographics were eliminated from further consideration because implementing the Proposed Action would result in activities that occur at sea away from human populations, and would not result in a change in the demographics within the Study Area or within the counties of the coastal states that abut the Study Area. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, was eliminated as an issue for further consideration because all of the proposed activities occur in the ocean and in harbors and bays, where there are no human residences present. Also, the proposed activities do not impact access to food sources. Therefore, there are no disproportionately high and adverse human health or environmental impacts from the Proposed Action on minority populations or low-income populations. Similarly, Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, was eliminated as an issue for further consideration because all of the proposed activities occur in the ocean, where there are no child populations present. Therefore, the Proposed Action would not lead to disproportionate risks to children that result from environmental health risks or safety risks.

3.0.3.3 Identifying Stressors for Analysis

The proposed training and testing activities were evaluated to identify specific components that could act as stressors by having direct or indirect impacts on the environment. This analysis includes identifying the spatial variation of the identified stressors. Matrices were prepared to identify associations between stressors, resources, and the spatial relationships of those stressors, resources, and activities within the Study Area under the Proposed Action. Each stressor includes a description of activities that may generate the stressor. Additional information on these activities and resources is also provided in Appendix B (Activity Stressor Matrices). Stressors for physical resources (air quality, sediments and water quality) and human resources (cultural resources, socioeconomics, and public health and safety) are described in their respective sections of Chapter 3 (Affected Environment and Environmental Consequences).

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

In subsequent sections, tables are provided in which the annual number of activities that could involve a particular stressor are totaled by alternative and by location, within the categories of training and testing. For example, see Table 3.0-13 (Annual Activities Including Electromagnetic Devices). It is important to note that the various tables are not exclusive of each other, and that the stressors from a single named activity from Chapter 2 (Description of Proposed Action and Alternatives) could show up on several tables. For example, the activity Anti-Submarine Warfare Tracking Exercise – Helicopter could include acoustic stressors that would appear on Table 3.0-2, physical disturbance stressors (Table 3.0-31), strike stressors (Table 3.0-36), entanglement stressors (Table 3.0-38, and ingestion stressors (Table 3.0-31). Also, activities are not always conducted independently of each other. For example, there are instances where a training activity could occur on a vessel while another training activity or a testing activity is being conducted on the same vessel simultaneously. Finally, note that some of the tables that follow in this section count individual items expended (see Table 3.0-23) while others count the annual number of activities in which that stressor could occur at least once during the conduct of that activity (see Table 3.0-13).

3.0.3.3.1 Acoustic Stressors

This section describes the characteristics of sounds produced during naval training and testing and the relative magnitude and location of these sound-producing activities. This provides the basis for analysis of acoustic impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences). Explanations of the terminology and metrics used when describing sound in this EIS/OEIS are in Appendix D (Acoustic and Explosive Concepts).

Acoustic stressors include acoustic signals emitted into the water for a specific purpose (e.g., by active sonars and air guns), as well as incidental sources of broadband sound produced as a byproduct of vessel movement; aircraft transits; pile driving and removal; and use of weapons or other deployed objects. Explosives also produce broadband sound but are characterized separately from other acoustic sources due to their unique hazardous characteristics (see Section 3.0.3.3.2, Explosive Stressors). Characteristics of each of these sound sources are described in the following sections.

In order to better organize and facilitate the analysis of approximately 300 individual sources of underwater sound deliberately employed by the Navy including sonars, other transducers (devices that convert energy from one form to another—in this case, to sound waves), air guns, and explosives, a series of source classifications, or source bins, were developed. The source classification bins do not include the broadband sounds produced incidental to pile driving; vessel and aircraft transits; and weapons firing.

The use of source classification bins provides the following benefits:

- provides the ability for new sensors or munitions to be covered under existing authorizations, as long as those sources fall within the parameters of a “bin”;
- improves efficiency of source utilization data collection and reporting requirements anticipated under the MMPA authorizations;
- ensures a conservative approach to all impact estimates, as all sources within a given class are modeled as the most impactful source (highest source level, longest duty cycle, or largest net explosive weight) within that bin;

- allows analyses to be conducted in a more efficient manner, without any compromise of analytical results; and
- provides a framework to support the reallocation of source usage (hours/explosives) between different source bins, as long as the total numbers of takes remain within the overall analyzed and authorized limits. This flexibility is required to support evolving Navy training and testing requirements, which are linked to real world events.

3.0.3.3.1.1 Sonar and Other Transducers

Active sonar and other transducers emit non-impulsive sound waves into the water to detect objects, safely navigate, and communicate. Passive sonars differ from active sound sources in that they do not emit acoustic signals; rather, they only receive acoustic information about the environment, or listen. In this EIS/OEIS, the terms sonar and other transducers will be used to indicate active sound sources unless otherwise specified.

The Navy employs a variety of sonars and other transducers to obtain and transmit information about the undersea environment. Some examples are mid-frequency hull-mounted sonars used to find and track enemy submarines; high-frequency small object detection sonars used to detect mines; high-frequency underwater modems used to transfer data over short ranges; and extremely high-frequency (> 200 kilohertz [kHz]) Doppler sonars used for navigation, like those used on commercial and private vessels. The characteristics of these sonars and other transducers, such as source level, beam width, directivity, and frequency, depend on the purpose of the source. Higher frequencies can carry more information or provide more information about objects off which they reflect, but attenuate more rapidly. Lower frequencies attenuate less rapidly, so may detect objects over a longer distance, but with less detail.

Propagation of sound produced underwater is highly dependent on environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity. The sound received at a particular location will be different than near the source due to the interaction of many factors, including propagation loss; how the sound is reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher-frequency sounds propagate. The effects of these factors are explained in Appendix D (Acoustic and Explosive Concepts). Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the Study Area.

The sound sources and platforms typically used in naval activities analyzed in the EIS/OEIS are described in Appendix A (Navy Activity Descriptions). Sonars and other transducers used to obtain and transmit information underwater during Navy training and testing activities generally fall into several categories of use described below.

<u>**Anti-Submarine Warfare**</u>

Sonar used during anti-submarine warfare would impart the greatest amount of acoustic energy of any category of sonar and other transducers analyzed in this EIS/OEIS. Types of sonars used to detect enemy vessels include hull-mounted, towed, line array, sonobuoy, helicopter dipping, and torpedo sonars. In addition, acoustic targets and decoys (countermeasures) may be deployed to emulate the sound signatures of vessels or repeat received signals.

Most anti-submarine warfare sonars are mid-frequency (1–10 kHz) because mid-frequency sound balances sufficient resolution to identify targets with distance over which threats can be identified. However, some sources may use higher or lower frequencies. Duty cycles can vary widely, from rarely used to continuously active. For example, a submarine‘s mission revolves around its stealth; therefore, submarine sonar is used infrequently because its use would also reveal a submarine’s location. Anti-submarine warfare sonars can be wide-angle in a search mode or highly directional in a track mode.

Most anti-submarine warfare activities involving submarines or submarine targets would occur in waters greater than 600 feet (ft.) deep due to safety concerns about running aground at shallower depths. Sonars used for anti-submarine warfare activities would typically be used beyond 12 NM from shore. Exceptions include use of dipping sonar by helicopters, maintenance of systems while in port, and system checks while transiting to or from port.

Mine Warfare, Small Object Detection, and Imaging

Sonars used to locate mines and other small objects, as well those used in imaging (e.g., for hull inspections or imaging of the seafloor), are typically high frequency or very high frequency. Higher frequencies allow for greater resolution and, due to their greater attenuation, are most effective over shorter distances. Mine detection sonar can be deployed (towed or vessel hull-mounted) at variable depths on moving platforms (ships, helicopters, or unmanned vehicles) to sweep a suspected mined area. Hull-mounted anti-submarine sonars can also be used in an object detection mode known as “Kingfisher” mode. Sonars used for imaging are usually used in close proximity to the area of interest, such as pointing downward near the seafloor.

Mine detection sonar use would be concentrated in areas where practice mines are deployed, typically in water depths less than 200 ft. and at established training minefields or temporary minefields close to strategic ports and harbors. Kingfisher mode on vessels is most likely to be used when transiting to and from port. Sound sources used for imaging could be used throughout the Study Area.

Navigation and Safety

Similar to commercial and private vessels, Navy vessels employ navigational acoustic devices including speed logs, Doppler sonars for ship positioning, and fathometers. These may be in use at any time for safe vessel operation. These sources are typically highly directional to obtain specific navigational data.

Communication

Sound sources used to transmit data (such as underwater modems), provide location (pingers), or send a single brief release signal to bottom-mounted devices (acoustic release) may be used throughout the Study Area. These sources typically have low duty cycles and are usually only used when it is desirable to send a detectable acoustic message.

Classification of Sonar and Other Transducers

Sonars and other transducers are grouped into classes that share an attribute, such as frequency range or purpose of use. Classes are further sorted by bins based on the frequency or bandwidth; source level; and, when warranted, the application in which the source would be used, as follows:

- frequency of the non-impulsive acoustic source
  - low-frequency sources operate below 1 kHz
  - mid-frequency sources operate at and above 1 kHz, up to and including 10 kHz
  - high-frequency sources operate above 10 kHz, up to and including 100 kHz

   - very high-frequency sources operate above 100 kHz but below 200 kHz
- sound pressure level
   - greater than 160 dB re 1 µPa, but less than 180 dB re 1 µPa
   - equal to 180 dB re 1 µPa and up to 200 dB re 1 µPa
   - greater than 200 dB re 1 µPa
- application in which the source would be used.
   - sources with similar functions that have similar characteristics, such as pulse length (duration of each pulse), beam pattern, and duty cycle

The bins used for classifying active sonars and transducers that are quantitatively analyzed in the Study Area are shown in Table 3.0-2. While general parameters or source characteristics are shown in the table, actual source parameters are classified.

Table 3.0-2 shows the bin use that could occur in any year under each action alternative for training and testing activities. A range of annual bin use indicates that use of that bin is anticipated to vary annually, consistent with the variation in the number of annual activities described in Chapter 2 (Description of Proposed Action and Alternatives). The five-year total for both action alternatives takes that variability into account.

Table 3.0-2: Sonar and Transducer Sources Quantitatively Analyzed

Source Class Category	*Bin*	*Description*	*Unit[1]*	*Training*				*Testing*			
				Alternative 1		*Alternative 2*		*Alternative 1*		*Alternative 2*	
				Annual[2]	*5-year Total*	*Annual[2]*	*5-year Total*	*Annual[2]*	*5-year Total*	*1-year*	*5-year Total*
Low-Frequency (LF): Sources that produce signals less than 1 kHz	LF3	LF sources greater than 200 dB	H	0	0	0	0	1,188	5,940	1,188	5,940
	LF4	LF sources equal to 180 dB and up to 200 dB	H	0	0	0	0	641	3,205	641	3,205
			C	0	0	0	0	20	100	20	100
	LF5	LF sources less than 180 dB	H	0	0	0	0	1,632	8,160	1,632	8,160
	LF6	LF sources greater than 200 dB with long pulse lengths	H	145–175	784	204	1,020	40	200	40	200
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1 and 10 kHz	MF1	Hull-mounted surface ship sonars (e.g., AN/SQS-53C and AN/SQS-61)	H	5,005–5,605	26,224	7,081	35,404	3,417	17,084	3,417	17,084
	MF1K	Kingfisher mode associated with MF1 sonars	H	58	290	58	290	152	760	152	760
	MF3	Hull-mounted submarine sonars (e.g., AN/BQQ-10)	C	49,188–49,227	246,017	49,265	246,321	20,681	103,405	20,681	103,405
	MF4	Helicopter-deployed dipping sonars (e.g., AN/AQS-22)	H	591–611	2,994	630	3,150	412–803	2,792	803	4,015
	MF5	Active acoustic sonobuoys (e.g., DICASS)	C	6,708–6,836	33,796	6,964	34,820	5,070–6,182	27,412	6,382	31,908

Table 3.0-2: Sonar and Transducer Sources Quantitatively Analyzed (continued)

Source Class Category	Bin	Description	Unit	Training				Testing			
				Alternative 1		Alternative 2		Alternative 1		Alternative 2	
				Annual	5-year Total	Annual	5-year Total	Annual	5-year Total	Annual	5-year Total
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1 and 10 kHz (continued)	MF6	Active underwater sound signal devices (e.g., MK 84)	C	0	0	0	0	1,256–1,341	6,450	1,391	6,955
	MF8	Active sources (greater than 200 dB) not otherwise binned	H	0	0	0	0	228	1,140	228	1,140
	MF9	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned	H	0	0	0	0	9,765–9,932	49,023	9,765–9,932	49,023
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	0	0	0	0	6,530	32,651	6,530	32,651
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%	H	873–1,001	4,621	1,399	6,995	1,424	7,120	1,424	7,120
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%	H	367–397	1,894	596	2,980	1,388	6,940	1,388	6,940
	MF14	Oceanographic MF sonar	H	0	0	0	0	1,440	7,200	1,440	7,200

Table 3.0-2: Sonar and Transducer Sources Quantitatively Analyzed (continued)

Source Class Category	Bin	Description	Unit	Training				Testing			
				Alternative 1		Alternative 2		Alternative 1		Alternative 2	
				Annual	5-year Total	Annual	5-year Total	Annual	5-year Total	Annual	5-year Total
High-Frequency (HF): Tactical and non-tactical sources that produce signals between 10 and 100 kHz	HF1	Hull-mounted submarine sonars (e.g., AN/BQQ-10)	H	1,928–1,932	9,646	1,935	9,672	582	2,908	582	2,908
	HF3	Other hull-mounted submarine sonars (classified)	H	0	0	0	0	31	154	31	154
	HF4	Mine detection, classification, and neutralization sonar (e.g., AN/SQS-20)	H	5,411–6,371	29,935	6,371	31,855	30,772–30,828	117,916	30,828	118,140
	HF5	Active sources (greater than 200 dB) not otherwise binned	H	0	0	0	0	2,824	14,120	2,824	14,120
			C	0	0	0	0	40	200	40	200
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned	H	0	0	0	0	2,193	10,964	2,193	10,964
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	0	0	0	0	1,224	6,120	1,224	6,120
	HF8	Hull-mounted surface ship sonars (e.g., AN/SQS-61)	H	18	90	18	90	2,084	10,419	2,084	10,419

Table 3.0-2: Sonar and Transducer Sources Quantitatively Analyzed (continued)

Source Class Category	*Bin*	*Description*	*Unit*	*Training*				*Testing*			
				Alternative 1		*Alternative 2*		*Alternative 1*		*Alternative 2*	
				Annual	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*
Very High Frequency Sonars (VHF): Non-tactical sources that produce signals between 100 and 200 kHz	VHF1	Very high frequency sources greater than 200 dB	H	0	0	0	0	12	60	12	60
Anti-Submarine Warfare (ASW): Tactical sources (e.g., active sonobuoys and acoustic countermeasures systems) used during ASW training and testing activities	ASW1	MF systems operating above 200 dB	H	582–641	3,208	1,040	5,200	820	4,100	820	4,100
	ASW2	MF Multistatic Active Coherent sonobuoy (e.g., AN/SSQ-125)	C	1,476–1,556	7,540	1,636	8,180	4,636–5,486	24,880	5,986	29,930
	ASW3	MF towed active acoustic countermeasure systems (e.g., AN/SLQ-25)	H	4,485–5,445	24,345	6,690	34,800	4,941	24,704	4,941	24,704
	ASW4	MF expendable active acoustic device countermeasures (e.g., MK 3)	C	426–432	2,138	438	2,186	3,723	18,615	3,723	18,615
	ASW5[3]	MF sonobuoys with high duty cycles	H	572–652	3,020	732	3,660	608–628	3,080	708	3,540

Table 3.0-2: Sonar and Transducer Sources Quantitatively Analyzed (continued)

Source Class Category	*Bin*	*Description*	*Unit*	*Training*				*Testing*			
				Alternative 1		*Alternative 2*		*Alternative 1*		*Alternative 2*	
				Annual	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes	TORP1	Lightweight torpedo (e.g., MK-46, MK-54, or Anti-Torpedo Torpedo)	C	57	285	57	285	1,228–1,352	6,448	1,332	6,660
	TORP2	Heavyweight torpedo (e.g., MK-48)	C	80	400	80	400	934	4,670	934	4,670
Forward Looking Sonar (FLS): Forward or upward looking object avoidance sonars used for ship navigation and safety	FLS2	HF sources with short pulse lengths, narrow beam widths, and focused beam patterns	H	0	0	0	0	1,224	6,120	1,224	6,120
	FLS3	VHF sources with short pulse lengths, narrow beam widths, and focused beam patterns	H	0	0	0	0	0	0	0	0
Acoustic Modems (M): Systems used to transmit data through the water	M3	MF acoustic modems (greater than 190 dB)	H	0	0	0	0	1,269	6,344	1,269	6,344

Table 3.0-2: Sonar and Transducer Sources Quantitatively Analyzed (continued)

Source Class Category	*Bin*	*Description*	*Unit*	*Training*				*Testing*			
				Alternative 1		*Alternative 2*		*Alternative 1*		*Alternative 2*	
				Annual	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*
Swimmer Detection Sonars (SD): Systems used to detect divers and submerged swimmers	SD1–SD2	HF and VHF sources with short pulse lengths, used for the detection of swimmers and other objects for the purpose of port security	H	0	0	0	0	176	880	176	880
Synthetic Aperture Sonars (SAS): Sonars in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS1	MF SAS systems	H	0	0	0	0	960	4,800	960	4,800
	SAS2	HF SAS systems	H	0–8,400	25,200	8,400	42,000	3,512	17,560	3,512	17,560
	SAS3	VHF SAS systems	H	0	0	0	0	960	4,800	960	4,800
	SAS4	MF to HF broadband mine countermeasure sonar	H	0	0	0	0	960	4,800	960	4,800
Broadband Sound Sources (BB): Sonar systems with large frequency spectra, used for various purposes	BB1	MF to HF mine countermeasure sonar	H	0	0	0	0	960	4,800	960	4,800
	BB2	HF to VHF mine countermeasure sonar	H	0	0	0	0	960	4,800	960	4,800
	BB4	LF to MF oceanographic source	H	0	0	0	0	516–2,892	4,956	516–2,892	4,956

Table 3.0-2: Sonar and Transducer Sources Quantitatively Analyzed (continued)

Source Class Category	*Bin*	*Description*	*Unit*	*Training*				*Testing*			
				Alternative 1		*Alternative 2*		*Alternative 1*		*Alternative 2*	
				Annual	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*
Broadband Sound Sources (BB) (continued): Sonar systems with large frequency spectra, used for various purposes	BB5	LF to MF oceanographic source	H	0	0	0	0	672	3,360	672	3,360
	BB6	HF oceanographic source	H	0	0	0	0	672	3,360	672	3,360
	BB7	LF oceanographic source	C	0	0	0	0	120	600	120	600

[1]H = hours; C = count (e.g., number of individual pings or individual sonobuoys).
[2]Expected annual use may vary per bin because the number of events may vary from year to year, as described in Chapter 2, Description of Proposed Action and Alternatives.
[3]Formerly ASW2 (H) in Phase II.

There are in-water active acoustic sources with narrow beam widths, downward directed transmissions, short pulse lengths, frequencies above known hearing ranges, low source levels, or combinations of these factors, which are not anticipated to result in takes of protected species. These sources are categorized as *de minimis* sources and are qualitatively analyzed to determine the appropriate determinations under NEPA in the appropriate resource impact analyses, as well as under the MMPA and the ESA. When used during routine training and testing activities, and in a typical environment, *de minimis* sources fall into one or more of the following categories:

- Transmit primarily above 200 kHz: Sources above 200 kHz are above the hearing range of the most sensitive marine mammals and far above the hearing range of any other animals in the Study Area.
- Source levels of 160 dB re 1 µPa or less: Low-powered sources with source levels less than 160 dB re 1 µPa are typically hand-held sonars, range pingers, transponders, and acoustic communication devices. Assuming spherical spreading for a 160 dB re 1 µPa source, the sound will attenuate to less than 140 dB within 10 m and less than 120 dB within 100 m of the source. Ranges would be even shorter for a source less than 160 dB re 1 µPa source level.
- Acoustic source classes listed in Table 3.0-3: Sources with operational characteristics, such as short pulse length, narrow beam width, downward-directed beam, and low energy release, or manner of system operation, which exclude the possibility of any significant impact to a protected species (actual source parameters listed in the classified bin list). Even if there is a possibility that some species may be exposed to and detect some of these sources, any response is expected to be short-term and inconsequential.

3.0.3.3.1.2 Air Guns

Air guns are essentially stainless steel tubes charged with high-pressure air via a compressor. An impulsive sound is generated when the air is almost instantaneously released into the surrounding water. Small air guns with capacities up to 60 cubic inches would be used during testing activities in various offshore areas in the AFTT Study Area, as well as near shore at Newport, RI. Table 3.0-3 shows the number of air guns shots proposed in the AFTT Study Area.

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

Table 3.0-3: Training and Testing Air Gun Sources Quantitatively Analyzed in the Study Area

Source Class Category	*Bin*	*Unit*[1]	*Training*				*Testing*			
			Alternative 1		*Alternative 2*		*Alternative 1*		*Alternative 2*	
			Annual	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*	*Annual*	*5-year Total*
Air Guns (AG): Small underwater air guns	AG	C	0	0	0	0	604	3,020	604	3,020

[1] C = count. One count (C) of AG is equivalent to 100 air gun firings.

Table 3.0-4: Sonar and Transducers Qualitatively Analyzed

Source Class Category	*Bin*	*Characteristics*
Broadband Sound Sources (BB): Sources with wide frequency spectra	BB3	• Very high frequency • Very short pulse length
	BB8	• Small imploding source (lightbulb)
Doppler Sonar/Speed Logs (DS): High-frequency/very high-frequency navigation transducers	DS2–DS4	*Required for safe navigation.* • downward focused • narrow beam width • very short pulse lengths
Fathometers (FA): High-frequency sources used to determine water depth	FA1–FA4	*Required for safe navigation*. • downward focused directly below the vessel • narrow beam width (typically much less than 30º) • short pulse lengths (less than 10 milliseconds)
Hand-Held Sonar (HHS): High-frequency sonar devices used by Navy divers for object location	HHS1	• very high frequency sound at low power levels • narrow beam width • short pulse lengths • under positive control of the diver (power and direction)
Imaging Sonar (IMS): Sonars with high or very high frequencies used obtain images of objects underwater	IMS1-IMS3	• High-frequency or very high-frequency • downward directed • narrow beam width • very short pulse lengths (typically 20 milliseconds)
High-Frequency Acoustic Modems (M): Systems that send data underwater **Tracking Pingers (P):** Devices that send a ping to identify an object location	M2 P1-P4	• low duty cycles (single pings in some cases) • short pulse lengths (typically 20 milliseconds) • low source levels
Acoustic Releases (R): Systems that ping to release a bottom-mounted object from its housing in order to retrieve the device at the surface	R1-R3	• typically emit only several pings to send release order
Side-Scan Sonars (SSS): Sonars that use active acoustic signals to produce high-resolution images of the seafloor	SSS1-SSS2	• downward-directed beam • short pulse lengths (less than 20 milliseconds)

Notes: ° = degree(s), kHz = kilohertz, lb. = pound(s)

3.0.3.3.1.3 Pile Driving

Impact pile driving and vibratory pile removal would occur during construction of an Elevated Causeway System, a temporary pier that allows the offloading of ships in areas without a permanent port. Construction of the elevated causeway could occur in sandy shallow water coastal areas at Joint

Expeditionary Base Little Creek-Fort Story in the Virginia Capes Range Complex or Marine Corps Base Camp Lejeune in the Navy Cherry Point Range Complex.

Installing piles for elevated causeways would involve the use of an impact hammer mechanism with both it and the pile held in place by a crane. The hammer rests on the pile, and the assemblage is then placed in position vertically on the beach or, when offshore, positioned with the pile in the water and resting on the seafloor. When the pile driving starts, the hammer part of the mechanism is raised up and allowed to fall, transferring energy to the top of the pile. The pile is thereby driven into the sediment by a repeated series of these hammer blows. Each blow results in an impulsive sound emanating from the length of the pile into the water column as well as from the bottom of the pile through the sediment. Because the impact wave travels through the steel pile at speeds faster than the speed of sound in water, a steep-fronted acoustic shock wave is formed in the water (Reinhall & Dahl, 2011) (note this shock wave has very low peak pressure compared to a shock wave from an explosive). An impact pile driver generally operates in the range of 36–50 blows per minute.

Pile removal involves the use of vibratory extraction, during which the vibratory hammer is suspended from the crane and attached to the top of a pile. The pile is then vibrated by hydraulic motors rotating eccentric weights in the mechanism, causing a rapid up and down vibration in the pile. This vibration causes the sediment particles in contact with the pile to lose frictional grip on the pile. The crane slowly lifts up on the vibratory driver and pile until the pile is free of the sediment. Vibratory removal creates continuous non-impulsive noise at low source levels for a short duration.

The source levels of the noise produced by impact pile driving and vibratory pile removal from an actual elevated causeway pile driving and removal are shown in Table 3.0-5.

Table 3.0-5: Elevated Causeway System Pile Driving and Removal Underwater Sound Levels

Pile Size &Type	*Method*	*Average Sound Levels at 10 m (SEL per individual pile)*
24-in. Steel Pipe Pile	Impact[1]	192 dB re 1 µPa SPL peak 182 dB re 1 µPa^{2}s SEL (single strike)
24-in. Steel Pipe Pile	Vibratory[2]	146 dB re 1 µPa SPL rms 145 dB re 1 µPa^{2}s SEL (per second of duration)

[1] Illingworth and Rodkin (2016), [2] Illingworth and Rodkin (2015)
Notes: in. = inch, SEL = Sound Exposure Level, SPL = Sound Pressure Level, rms = root mean squared, dB re 1 µPa = decibels referenced to 1 micropascal

In addition to underwater noise, the installation and removal of piles also results in airborne noise in the environment. Impact pile driving creates in-air impulsive sound about 100 dBA re 20 µPa at a range of 15 m (Illingworth and Rodkin, 2016). During vibratory extraction, the three aspects that generate airborne noise are the crane, the power plant, and the vibratory extractor. The average sound level recorded in air during vibratory extraction was about 85 dBA re 20 µPa (94 dB re 20 µPa) within a range of 10-15 m (Illingworth and Rodkin, 2015).

The length of the pier, and therefore the number of piles required, would be determined by the distance from shore to the appropriate water depth for ship off-loading. Construction of the Elevated Causeway System would involve intermittent impact pile driving over approximately 20 days. Crews work 24 hours a day and would drive approximately six piles in that period. Each pile takes about 10 minutes to drive with time taken between piles to reposition the driver. When training events that use the Elevated Causeway System are complete, the structure would be removed using vibratory methods over approximately 10 days. Crews would remove about 12 piles per 24-hour period, each taking about three minutes to remove. Table 3.0-6 summarizes the pile driving and pile removal activities that would occur during a 24-hour period.

Table 3.0-6: Summary of Pile Driving and Removal Activities per 24-Hour Period

Method	*Piles Per 24-Hour Period*	*Time Per Pile*	*Total Estimated Time of Noise Per 24-Hour Period*
Pile Driving (Impact)	6	10 minutes	60 minutes
Pile Removal (Vibratory)	12	3 minutes	36 minutes

Pile driving for elevated causeway system training would occur in shallower water, and sound could be transmitted on direct paths through the water, be reflected at the water surface or bottom, or travel through bottom substrate. Soft substrates such as sand bottom at the proposed elevated causeway system locations would absorb or attenuate the sound more readily than hard substrates (rock), which may reflect the acoustic wave. Most acoustic energy would be concentrated below 1,000 hertz (Hz) (Hildebrand, 2009).

3.0.3.3.1.4 Vessel Noise

Vessel noise, in particular commercial shipping, is a major contributor to noise in the ocean and intensively used inland waters. Frisk (2012) reported that between 1950 and 2007 ocean noise in the 25–50 Hz frequency range has increased 3.3 dB per decade, resulting in a cumulative increase of approximately 19 dB over a baseline of 52 dB. The increase in noise is associated with an increase in commercial shipping, which correlates with global economic growth (Frisk, 2012).

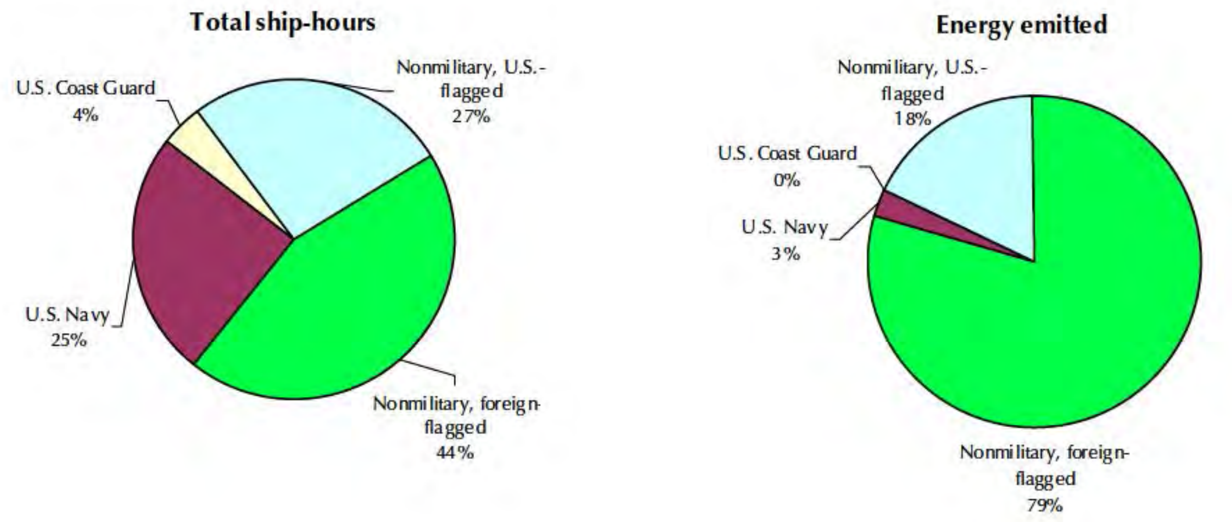
Naval vessels (including ships and small craft) would produce low-frequency, broadband underwater sound, though the exact level of noise produced varies by vessel type. Navy vessels represent a small amount of overall vessel traffic and an even smaller amount of overall vessel traffic noise. As shown in Table 3.0-7, Navy ships make up roughly 1 percent of the vessel presence in the AFTT Study Area. Navy ship traffic is more concentrated around the homeports of Norfolk, VA and Jacksonville, FL. The Navy contributes 1 percent of radiated broadband noise in the Virginia Capes and Jacksonville Range Complexes (Mintz & Filadelfo, 2011). However, since Navy ships are quieter (Mintz, 2012a; Mintz & Filadelfo, 2011), they are most likely contributing less than 1 percent of the overall total vessel broadband noise in the entire AFTT study area.

Table 3.0-7: Estimated Vessel Presence (Hours) in Study Area

Ship Category	*AFTT*
Non-military	9,970,244
Military	72,094

Notes: Ship-hours were calculated from representative data to assess the relative contribution. The totals given represent a relative fraction of actual vessel presence (Mintz, 2012a).

Figure 3.0-9 shows a comparison of ship hours to energy emitted during a Composite Training Unit Exercise, a major training exercise, an event during which Navy vessel traffic would be higher than usual in the Study Area (Mintz & Filadelfo, 2011). Although this data was gathered for a Composite Training Unit Exercise conducted in the Southern California Range Complex, it shows how the Navy contribution to overall vessel noise changes during a major training exercise. Even during this period of greater than typical Navy vessel use, the Navy contribution to overall vessel noise in the Study Area is low.



Source: Mintz & Filadelfo, 2011

Figure 3.0-9: Traffic and Broadband Radiated Noise During a Composite Training Unit Exercise in the Southern California Range Complex

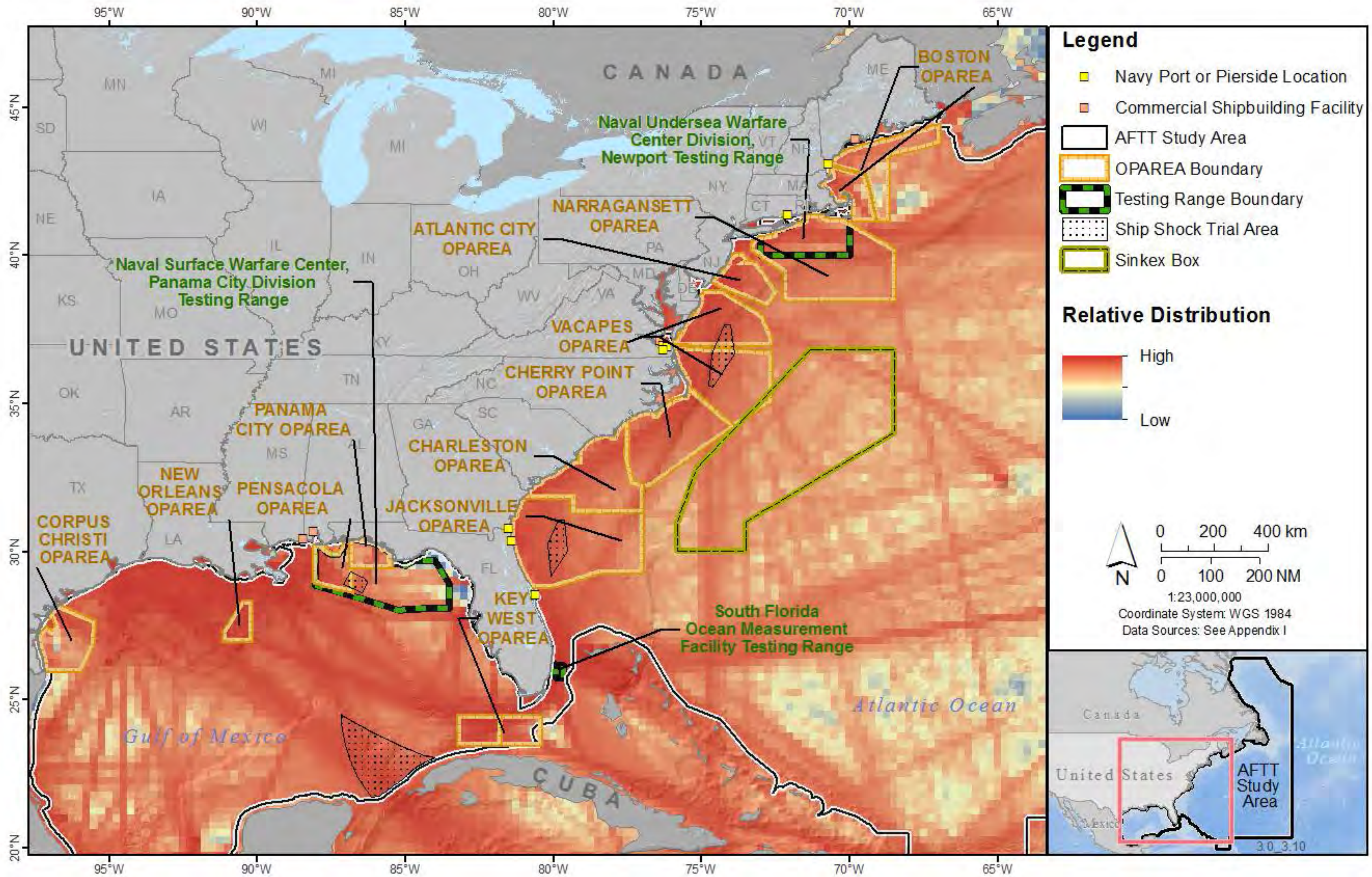
Studies to determine traffic patterns of Navy and non-Navy vessels in the Study Area were conducted by the Center for Naval Analysis (Mintz, 2012a; Mintz & Filadelfo, 2011; Mintz & Parker, 2006). SeaLink data from 2009 for U.S. Navy and non-military vessels was used, which included Navy surface vessels, cargo vessels, bulk carriers, commercial fishing vessels, oil tankers, passenger vessels, tugs, and research vessels. SeaLink data includes only vessels over 65 ft. in length so smaller navy vessels and pleasure craft are not included, and vessel position records in SeaLink are much more frequent for Navy vessels than for commercial vessels. Therefore, the Navy is likely overrepresented in the data and the reported fraction of total energy is likely the upper limit of its contribution (Mintz, 2012a; Mintz & Filadelfo, 2011).

Exposure to vessel noise would be greatest in the areas of highest vessel traffic. Within the Study Area, commercial traffic is heaviest along the U. S. East Coast and the northern coast of the Gulf of Mexico and follows distinct overseas routes and across the Gulf of Mexico. Navy traffic in the Study Area is concentrated along the U.S. East Coast between the mouth of the Chesapeake Bay and Jacksonville, FL (Mintz, 2012a), although vessels would be used during many training and testing activities proposed throughout the Study Area. Noise exposure due to naval vessels would be greatest near naval port facilities, especially around and between the ports of Norfolk, VA, and Jacksonville, FL (Mintz & Parker, 2006).

Radiated noise from ships varies depending on the nature, size, and speed of the ship. Due to the large number of variables that determine the sound level radiated from vessels, this source will be analyzed qualitatively. The quietest Navy warships radiate much less broadband noise than a typical fishing vessel, while the loudest Navy ships during travel are almost on par with large oil tankers (Mintz & Filadelfo, 2011). For comparison, McKenna et al. (2012) determined that container ships produced broadband source levels around 188 dB re 1 µPa and a typical fishing vessel radiates noise at a source level of about 158 dB re 1 µPa (Mintz & Filadelfo, 2011; Richardson et al., 1995; Urick, 1983). The average acoustic signature for a Navy vessel is 163 dB re 1 µPa, while the average acoustic signature for a commercial vessel is 175 dB re 1 µPa (Mintz & Filadelfo, 2011). Typical large vessel ship-radiated noise is dominated by tonals related to blade and shaft sources at frequencies below about 50 Hz and by broadband components related to cavitation and flow noise at higher frequencies (approximately around the one-third octave band centered at 100 Hz) (Mintz & Filadelfo, 2011; Richardson et al., 1995; Urick, 1983). Ship types also have unique acoustic signatures characterized by differences in dominant frequencies. Bulk carrier noise is predominantly near 100 Hz while container ship and tanker noise is predominantly below 40 Hz (McKenna et al., 2012). Small craft types will emit higher-frequency noise (between 1 kHz and 50 kHz) than larger ships (below 1 kHz). Sound produced by vessels will typically increase with speed. During training, speeds of most large naval vessels (greater than 60 ft.) generally range from 10 to 15 knots for fuel consumption; however, ships will, on occasion, operate at higher speeds within their specific operational capabilities.

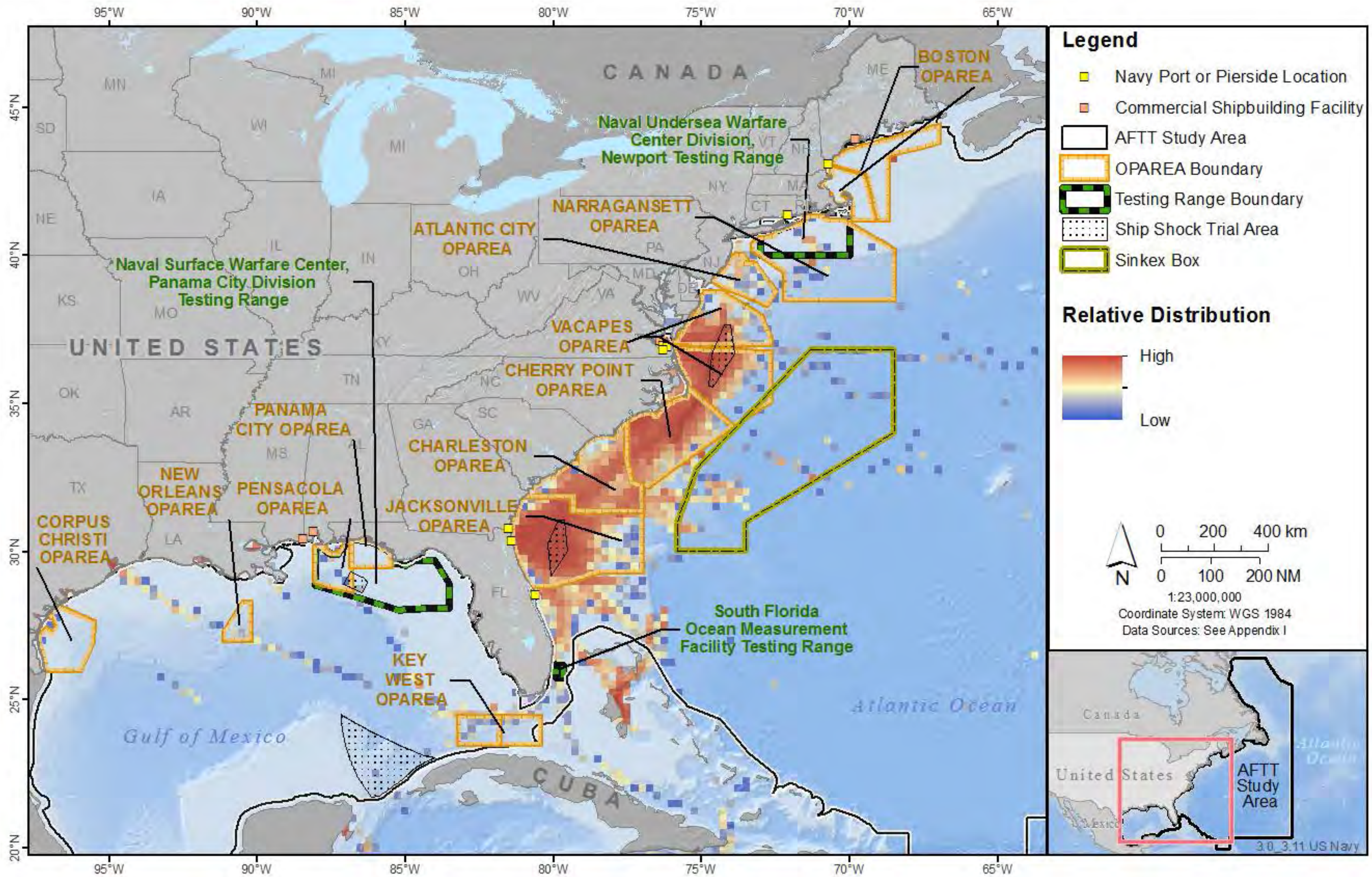
Anti-submarine warfare platforms (such as guided missile destroyers and cruisers) and submarines make up a large part of Navy traffic but contribute little noise to the overall sound budget of the oceans as these vessels are designed to be quiet to minimize detection. These platforms are much quieter than Navy oil tankers, for example, which have a smaller presence but contribute substantially more broadband noise than anti-submarine warfare platforms (Mintz & Filadelfo, 2011). A variety of smaller craft that vary in size and speed, such as service vessels for routine operations and opposition forces used during training events, would be operating within the Study Area.

While commercial traffic (and, therefore, broadband noise generated by it) is relatively steady throughout the year, Navy traffic is episodic in the ocean. Vessels engaged in training and testing may consist of a single vessel involved in unit-level activity for a few hours or multiple vessels involved in a major training exercise that could last a few weeks within a given area. Activities involving vessel movements occur intermittently and are variable in duration. Navy vessels do contribute to the overall increased ambient noise in inland waters near Navy ports, although their contribution to the overall noise in these environments is a small percentage compared to the large amounts of commercial and recreational vessel traffic in these areas (Mintz & Filadelfo, 2011), as shown in the hours of vessel presence (Table 3.0-7) and the relative distribution of vessel traffic (Figure 3.0-10 and Figure 3.0-11).



Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.0-10: Relative Distribution of Commercial Vessel Traffic in Atlantic Fleet Training and Testing Study Areas



Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.0-11: Relative Distribution of U.S. Navy Vessel Traffic in Atlantic Fleet Training and Testing Study Areas

3.0.3.3.1.5 Aircraft Overflight Noise

Fixed-wing, tiltrotor, and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area, contributing both airborne and underwater sound to the ocean environment. Sounds in air are often measured using A-weighting, which adjusts received sound levels based on human hearing abilities (see Appendix D, Acoustic and Explosive Concepts]. Aircraft used in training and testing generally have turboprop or jet engines. Motors, propellers, and rotors produce the most noise, with some noise contributed by aerodynamic turbulence. Aircraft sounds have more energy at lower frequencies. Aircraft may transit to or from vessels at sea throughout the Study Area from established airfields on land. Most aircraft noise would be produced around air stations outside the Study Area. Military activities involving aircraft generally are dispersed over large expanses of open ocean but can be highly concentrated in time and location. Table 3.0-8 provides source levels for some typical aircraft used during training and testing in the Study Area and depicts comparable airborne source levels for the F-35A, EA-18G, and F/A-18C/D during takeoff.

Table 3.0-8: Representative Aircraft Sound Characteristics

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

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

<u>**Underwater Transmission of Aircraft Noise**</u>

Sound generated in air is transmitted to water primarily in a narrow area directly below the source (Appendix D, Acoustic and Explosive Concepts). A sound wave propagating from any source must enter the water at an angle of incidence of about 13° or less from the vertical for the wave to continue propagating under the water's surface. At greater angles of incidence, the water surface acts as an effective reflector of the sound wave and allows very little penetration of the wave below the water (Urick, 1983). Water depth and bottom conditions strongly influence how the sound from airborne sources propagates underwater. At lower altitudes, sound levels reaching the water surface would be higher, but the transmission area would be smaller. As the sound source gains altitude, sound reaching the water surface diminishes, but the possible transmission area increases. Estimates of underwater sound pressure level are provided for representative aircraft in Table 3.0-8.

Noise generated by fixed-wing aircraft is transient in nature and extremely variable in intensity. Most fixed-wing aircraft sorties (a flight mission made by an individual aircraft) would occur above 3,000 ft. Air combat maneuver altitudes generally range from 5,000 to 30,000 ft., and typical airspeeds range from very low (less than 100 knots) to high subsonic (less than 600 knots). Sound exposure levels at the sea surface from most air combat maneuver overflights are expected to be less than 85 A-weighted decibels (based on an F/A-18 aircraft flying at an altitude of 5,000 ft. and at a subsonic airspeed [400 knots] (U.S. Department of the Navy, 2009b). Exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead.

Helicopters

Noise generated from helicopters is transient in nature and extremely variable in intensity. In general, helicopters produce lower-frequency sounds and vibration at a higher intensity than fixed-wing aircraft (Richardson et al., 1995). Helicopter sounds contain dominant tones from the rotors that are generally below 500 Hz. Helicopters often radiate more sound forward than backward. The underwater noise produced is generally brief when compared with the duration of audibility in the air and is estimated to be 125 dB re 1 µPa at 1 m below water surface for a UH-60 hovering at 82 ft. (25 m) altitude (Bousman & Kufeld, 2005).

Helicopter unit level training typically entails single-aircraft sorties over water that start and end at an air station, although flights may occur from ships at sea. Individual flights typically last about two to four hours. Some events require low-altitude flights over a defined area, such as mine countermeasure activities deploying towed systems. Most helicopter sorties associated with mine countermeasures would occur at altitudes as low as 75-100 ft. Likewise, in some anti-submarine warfare events, a dipping sonar is deployed from a line suspended from a helicopter hovering at low altitudes over the water.

Sonic Booms

An intense but infrequent type of aircraft noise is the sonic boom, produced when an aircraft exceeds the speed of sound. Supersonic aircraft flights are not intentionally generated below 30,000 ft. unless over water and more than 30 NM from inhabited coastal areas or islands. Although deviation from these guidelines may be authorized for tactical missions that require supersonic flight, phases of formal training requiring supersonic speeds, research and test flights that require supersonic speeds, and for flight demonstration purposes when authorized by the Chief of Naval Operations (U.S. Department of the Navy, 2009a). A supersonic test track parallel to the Eastern Shore of the Delmarva Peninsula has historically been used by the U.S. Navy and is regularly used for F/A-18 and F-35 sorties. Due to the proximity of the supersonic test track to the Eastern Shore of the Delmarva Peninsula, sonic booms may occur closer to shore within the test track.

Several factors that influence sonic booms include weight, size, and shape of aircraft or vehicle; altitude; flight paths; and atmospheric conditions. A larger and heavier aircraft must displace more air and create more lift to sustain flight, compared with small, light aircraft. Therefore, larger aircraft create sonic booms that are stronger than those of smaller, lighter aircraft. Consequently, the larger and heavier the aircraft, the stronger the shock waves (U.S. Department of the Navy & Department of Defense, 2007). Aircraft maneuvers that result in changes to acceleration, flight path angle, or heading can also affect the strength of a boom. In general, an increase in flight path angle (lifting the aircraft's noise) will diffuse a boom while a decrease (lowering the aircraft's nose) will focus it. In addition, acceleration will focus a boom while deceleration will weaken it. Any change in horizontal direction will focus a boom, causing two or more wave fronts that originated from the aircraft at different times to coincide exactly (U.S. Department of the Navy, 2001). Atmospheric conditions such as wind speed and direction, and air temperature and pressure can also influence the sound propagation of a sonic boom.

Of all the factors influencing sonic booms, increasing altitude is the most effective method of reducing sonic boom intensity. The width of the boom "carpet" or area exposed to sonic boom beneath an aircraft is about 1 mi. for each 1,000 ft. of altitude. For example, an aircraft flying supersonic, straight, and level at 50,000 ft. can produce a sonic boom carpet about 50 mi. wide. The sonic boom, however, would not be uniform, and its intensity at the water surface would decrease with greater aircraft altitude. Maximum intensity is directly beneath the aircraft and decreases as the lateral distance from the flight path increases until shock waves refract away from the ground or water surface and the sonic boom attenuates. The lateral spreading of the sonic boom depends only on altitude, speed, and the atmosphere and is independent of the vehicle's shape, size, and weight. The ratio of the aircraft length to maximum cross-sectional area also influences the intensity of the sonic boom. The longer and more slender the aircraft, the weaker the shock waves. The wider and more blunt the aircraft, the stronger the shock waves can be (U.S. Department of the Navy & Department of Defense, 2007).

In air, the energy from a sonic boom is concentrated in the frequency range from 0.1 to 100 Hz. The underwater sound field due to transmitted sonic boom waveforms is primarily composed of low-frequency components (Sparrow, 2002), and frequencies greater than 20 Hz have been found to be difficult to observe at depths greater than 33 ft. (10 m) (Sohn et al., 2000). F/A-18 Hornet supersonic flight was modeled to obtain peak sound pressure levels and energy flux density at the water surface and at depth (Laney & Cavanagh, 2000). These results are shown in Table 3.0-9.

Table 3.0-9: Sonic Boom Underwater Sound Levels Modeled for F/A-18 Hornet Supersonic Flight

*Mach Number **	*Aircraft Altitude (km)*	*Peak SPL (dB re 1 µPa)*			*Energy Flux Density (dB re 1 µPa²-s)[1]*		
		At surface	*50 m Depth*	*100 m Depth*	*At surface*	*50 m Depth*	*100 m Depth*
1.2	1	176	138	126	160	131	122
	5	164	132	121	150	126	117
	10	158	130	119	144	124	115
2	1	178	146	134	161	137	128
	5	166	139	128	150	131	122
	10	159	135	124	144	127	119

[1] Equivalent to SEL for a plane wave.
* Mach number equals aircraft speed divided by the speed of sound.
Notes: SPL = sound pressure level, dB re 1 µPa = decibel(s) referenced to 1 micropascal, dB re 1 µPa²-s = decibel(s) referenced to 1 micropascal squared seconds, m = meter(s)

3.0.3.3.1.6 Weapon Noise

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

Noise associated with large caliber weapons firing and the impact of non-explosive practice munitions or kinetic weapons would typically occur at locations greater than 12 NM from shore for safety reasons. Small- and medium-caliber weapons firing could occur throughout the Study Area.

Examples of some types of weapons noise are shown in Table 3.0-10. Examples of launch noise are provided in the table. Noise produced by other weapons and devices are described further below.

Table 3.0-10: Examples of Weapons Noise

Noise Source	*Sound Level*
In-Water Noise Level	
Naval Gunfire Muzzle Blast (5-inch)	Approximately 200 dB re 1 µPa peak directly under gun muzzle at 1.5 m below the water surface[1]
Airborne Noise Level	
Naval Gunfire Muzzle Blast (5-inch)	178 dB re 20 µPa peak directly below the gun muzzle above the water surface[1]
Hellfire Missile Launch from Aircraft	149 dB re 20 µPa at 4.5 m[2]
Advanced Gun System Missile (115-millimeter)	133-143 dBA re 20 µPa between 12 and 22 m from the launcher on shore[3]
RIM 116 Surface-to-Air Missile	122-135 dBA re 20 µPa between 2 and 4 m from the launcher on shore[3]
Tactical Tomahawk Cruise Missile	92 dBA re 20 µPa 529 m from the launcher on shore[3]

Sources: [1]Yagla and Stiegler (2003); [2]U.S. Department of the Army (1999); [3]U.S. Department of the Navy (2013).
Notes: dB re 1 µPa = decibel(s) referenced to 1 micropascal, dB re 20 µPa = decibel(s) referenced to 20 micropascals, dBA re 20 µPa = A-weighted decibel(s) referenced to 20 micropascals, m = meter(s)

Muzzle Blast from Naval Gunfire

Firing a gun produces a muzzle blast in air that propagates away from the gun with strongest directivity in the direction of fire. Because the muzzle blast is generated at the gun, the noise decays with distance from the gun. The muzzle blast has been measured for the largest gun analyzed in the EIS/OEIS, the 5 inch (in.) large-caliber naval gun. At a distance of 3,700 ft. from the gun, which was fired at 10° elevation angle, and at 10° off the firing line, the in-air received level was 124 dB re 20 µPa SPL peak for the atmospheric conditions of the test (Pater, 1981). Measurements were obtained for additional distances and angles off the firing line but were specific to the atmospheric conditions present during the testing.

As the pressure from the muzzle blast from a ship-mounted large caliber gun propagates in air toward the water surface, the pressure can be both reflected from the water surface and transmitted into the water. As explained in Appendix D (Acoustic and Explosive Concepts), most sound enters the water in a narrow cone beneath the sound source (within about 13–14° of vertical), with most sound outside of this cone being totally reflected from the water surface. In-water sound levels were measured during the muzzle blast of a 5 in. large caliber naval gun. The highest possible sound level in the water (average peak SPL of 200 dB re 1 µPa, measured 5 ft. below the surface) was obtained when the gun was fired at the lowest angle, placing the blast closest to the water surface (Yagla & Stiegler, 2003). The unweighted sound exposure level would be expected to be 15–20 dB lower than the peak pressure, making the highest possible sound exposure level in the water about 180–185 dB re 1 µPa^2-s directly below the muzzle blast. Other gunfire arrangements, such as with smaller-caliber weapons or greater angles of fire, would result in less sound entering the water. The sound entering the water would have the strongest directivity directly downward beneath the gun blast, with lower sound pressures at increasing angles of incidence until the angle of incidence is reached where no sound enters the water.

Source: (Yagla & Stiegler, 2003)

Figure 3.0-12: Gun Blast and Projectile from a 5-in./54 Navy Gun

Large-caliber gunfire also sends energy through the ship structure and into the water. This effect was investigated in conjunction with the measurement of 5 in. gun firing described above. The energy transmitted through the ship to the water for a typical round was about 6 percent of that from the muzzle blast impinging on the water (U.S. Department of the Navy, 2000). Therefore, sound transmitted from the gun through the hull into the water is a minimal component of overall weapons firing noise.

Supersonic Projectile Bow Shock Wave

Supersonic projectiles, such as a fired gun shell or kinetic energy weapon, create a bow shock wave along the line of fire. A bow shock wave is an impulsive sound caused by a projectile exceeding the speed of sound (for more explanation, see Appendix D, Acoustic and Explosive Concepts). The bow shock wave itself travels at the speed of sound in air. The projectile bow shock wave created in air by a shell in flight at supersonic speeds propagates in a cone (generally about 65°) behind the projectile in the direction of fire (Pater, 1981). Exposure to the bow shock wave is very brief.

Projectiles from a 5 in./54 gun would travel at approximately 2,600 ft./sec, and the associated bow shock wave is subjectively described as a "crack" noise (Pater, 1981). Measurements of a 5 in. projectile shock wave ranged from 140 to 147 dB re 20 µPa SPL peak taken at the ground surface at 0.59 NM distance from the firing location and 10° off the line of fire for safety (approximately 190 m from the shell's trajectory) (Pater, 1981).

Hyperkinetic projectiles may travel up to and exceed approximately six times the speed of sound in air, or about 6,500 ft./second (U.S. Department of the Navy, 2014). For a hyperkinetic projectile sized similar to the 5-in. shell, peak pressures would be expected to be several dB higher than those described for the 5-in. projectile above, following the model in Pater (1981).

Like sound from the gun muzzle blast, sound waves from a projectile in flight could only enter the water in a narrow cone beneath the sound source, with in-air sound being totally reflected from the water surface outside of the cone. The region of underwater sound influence from a single traveling shell would be relatively narrow, and the duration of sound influence would be brief at any location.

Launch Noise

Missiles can be rocket or jet propelled. Sound due to missile and target launches is typically at a maximum at initiation of the booster rocket. It rapidly fades as the missile or target reaches optimal thrust conditions and the missile or target reaches a downrange distance where the booster burns out and the sustainer engine continues. Examples of launch noise sound levels are shown in Table 3.0-10.

Impact Noise (non-explosive)

Any object dropped in the water would create a noise upon impact, depending on the object's size, mass, and speed. Sounds of this type are produced by the kinetic energy transfer of the object with the target surface and are highly localized to the area of disturbance. A significant portion of an object's kinetic energy would be lost to splash, any deformation of the object, and other forms of non-mechanical energy (McLennan, 1997). The remaining energy could contribute to sound generation. Most objects would be only momentarily detectable, if at all, but some large objects traveling at high speeds could generate a broadband impulsive sound upon impact with the water surface. Sound associated with impact events is typically of low frequency (less than 250 Hz) and of short duration.

Long Range Acoustic Device

Although not a weapon, the Long Range Acoustic Device (and other hailing and deterrent sources) is considered along with in-air sounds produced by Navy sources. The Long Range Acoustic Device is a communication device that can be used to warn vessels from continuing towards a high value asset by emitting loud sounds in air. The system would typically be used in training activities near shore, and use would be intermittent during these activities. Source levels at 1 m range between 137 dBA re 1 µPa for small portable systems and 153 dBA re 1 µPa for large systems. Sound would be directed within a 30–60 degree wide zone and would be directed over open water.

3.0.3.3.2 Explosive Stressors

This section describes the characteristics of explosions during naval training and testing. The activities analyzed in the EIS/OEIS that use explosives are described in Appendix A (Navy Activity Descriptions). This section provides the basis for analysis of explosive impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences). Explanations of the terminology and metrics used when describing explosives in this EIS/OEIS are in Appendix D (Acoustic and Explosive Concepts).

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

3.0.3.3.2.1 Explosions in Water

Explosive detonations during training and testing activities are associated with high-explosive munitions, including, but not limited to, bombs, missiles, rockets, naval gun shells, torpedoes, mines, demolition charges, and explosive sonobuoys. Explosive detonations during training and testing involving the use of high-explosive munitions, including bombs, missiles, and naval gun shells, could occur in the air or near the water's surface. Explosive detonations associated with torpedoes and explosive sonobuoys would occur in the water column; mines and demolition charges could be detonated in the water column or on the ocean bottom. Most detonations would occur in waters greater than 200 ft. in depth, and greater than 3 NM from shore, although mine warfare, demolition, and some testing detonations would occur in shallow water close to shore.

In order to better organize and facilitate the analysis of explosives used by the Navy during training and testing that could detonate in water or at the water surface, explosive classification bins were developed. The use of explosive classification bins provides the same benefits as described for acoustic source classification bins in Section 3.0.3.3.1 (Acoustic Stressors).

Explosives detonated in water are binned by net explosive weight. The bins of explosives that are proposed for use in the Study Area are shown in Table 3.0-11. This table shows the number of in-water explosive items that could be used in any year under each action alternative for training and testing activities. A range of annual bin use indicates that use of that bin is anticipated to vary annually, consistent with the variation in the number of annual activities described in Chapter 2 (Description of Proposed Action and Alternatives). The five-year total for both action alternatives takes any annual variability into account.

In addition to the explosives quantitatively analyzed for impacts to protected species shown in Table 3.0-11, the Navy uses some very small impulsive sources (<0.1 pound [lb.] net explosive weight), categorized in bin E0, that are not anticipated to result in takes of protected species. Quantitative modeling in multiple locations has validated that these sources have a very small zone of influence. These E0 charges, therefore, are categorized as *de minimis* sources and are qualitatively analyzed to determine the appropriate determinations under NEPA in the appropriate resource impact analyses, as well as under the MMPA and the ESA.

Propagation of explosive pressure waves in water is highly dependent on environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity, which affect how the pressure waves are reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher frequency components of explosive broadband noise can propagate. Appendix D (Acoustic and Explosive Concepts) explains the characteristics of explosive detonations and how the above factors affect the propagation of explosive energy in the water. Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the Study Area.

Table 3.0-11: Explosive Sources Quantitatively Analyzed that Could Be Used Underwater or at the Water Surface

Bin	Net Explosive Weight[1] (lb.)	Example Explosive Source	Training				Testing			
			Alternative 1		Alternative 2		Alternative 1		Alternative 2	
			Annual[2]	5-year Total	Annual[2]	5-year Total	Annual[2]	5-year Total	Annual[2]	5-year Total
E1	0.1–0.25	Medium-caliber projectile	10,340	51,700	10,340	51,700	17,840–26,840	116,200	26,840	134,200
E2	> 0.25–0.5	Medium-caliber projectile	210–214	1,062	214	1,070	0	0	0	0
E3	> 0.5–2.5	Large-caliber projectile	3,286	16,430	3,286	16,430	2,814–3,182	15,006	3,182	15,910
E4	> 2.5–5	Mine neutralization charge	127–133	653	133	665	746–800	3,784	810	4,050
E5	> 5–10	5 in. projectile	4,140	20,700	4,140	20,700	1,325	6,625	1,325	6,625
E6	> 10–20	Hellfire missile	602	3,010	602	3,010	28–48	200	48	240
E7	> 20–60	Demo block/ shaped charge	4	20	4	20	0	0	0	0
E8	> 60–100	Lightweight torpedo	48	240	48	240	33	165	33	165
E9	> 100–250	500 lb. bomb	66	330	66	330	4	20	4	20
E10	> 250–500	Harpoon missile	90	450	90	450	68–98	400	98	490
E11	> 500–650	650 lb. mine	1	5	1	5	10	50	20	100
E12	> 650–1,000	2,000 lb. bomb	18	90	18	90	0	0	0	0
E14[3]	> 1,741–3,625	Line charge	0	0	0	0	4	20	4	20
E16[4]	> 7,250–14,500	Littoral Combat Ship full ship shock trial	0	0	0	0	0–12	12	0–12	12
E17[4]	> 14,500–58,000	Aircraft carrier full ship shock trial	0	0	0	0	0–4	4	0–4	4

[1] Net Explosive Weight refers to the equivalent amount of trinitrotoluene (TNT) the actual weight of a munition may be larger due to other components.
[2] Expected annual use may vary per bin because the number of events may vary from year to year, as described in Chapter 2, Description of Proposed Action and Alternatives.
[3] E14 is not modeled for protected species impacts in water because most energy is lost into the air or to the bottom substrate due to detonation in very shallow water.
[4] Shock trials consist of four explosions each. In any given year there could be 0-3 small ship shock trials (E16) and 0-1 large ship shock trials (E17). Over a 5-year period, there could be three small ship shock trials (E16) and one large ship shock trial (E17).

3.0.3.3.2.2 Explosions in Air

Explosions in air include detonations of projectiles and missiles during surface-to-air gunnery and air-to-air missile exercises conducted during air warfare. These explosions typically occur far above the water surface. Some typical types of explosive munitions that would be detonated in air during Navy activities are shown in Table 3.0-12. Various missiles, rockets, and medium and large projectiles may be explosive or non-explosive, depending on the objective of the training or testing activity in which they are used. Quantities of explosive and non-explosive missiles, rockets, and projectiles proposed for use during Navy training and testing are provided in Appendix F (Military Expended Material and Direct Strike Impact Analyses).

Table 3.0-12: Typical Air Explosive Munitions During Navy Activities

Weapon Type[1]	*Net Explosive Weight (lb.)*	*Typical Altitude of Detonation (ft.)*
Surface-to-Air Missile		
RIM-66 SM-2 Standard Missile	80	> 15,000
RIM-116 Rolling Airframe Missile	39	< 3,000
RIM-7 Sea Sparrow	36	> 15,000 (can be used on low targets)
FIM-92 Stinger	7	< 3,000
Air-to-Air Missile		
AIM-9 Sidewinder	38	> 15,000
AIM-7 Sparrow	36	> 15,000
AIM-120 AMRAAM	17	> 15,000
Air-to-Surface Missile		
AGM-88 HARM	45	< 100
Projectile - Large Caliber[2]		
5"54 HE-ET	7	< 100
5"54 Other	8	< 3,000

[1] Mission Design Series and popular name shown for missiles. [2] Most medium and large caliber projectiles used during Navy training and testing activities do not contain high explosives.
AMRAAM = Advanced Medium-Range Air-to-Air Missile; HARM = High-Speed Anti-Radiation; HE-ET = High Explosive- Electronic Time

Bombs and projectiles that detonate at or near the water surface, which are considered for underwater impacts (see Table 3.0-11), would also release some explosive energy into the air. Appendix A (Navy Activity Descriptions) describes where activities with these stressors typically occur.

The explosive energy released by detonations in air has been well-studied (see Appendix D, Acoustic and Explosive Concepts), and basic methods are available to estimate the explosive energy exposure with distance from the detonation [e.g., Swisdak (1975)]. In air, the propagation of impulsive noise from an explosion is highly influenced by atmospheric conditions, including temperature and wind. While basic estimation methods do not consider the unique environmental conditions that may be present on a given day, they allow for approximation of explosive energy propagation under neutral atmospheric conditions. Explosions that occur during air warfare would typically be a sufficient altitude that a large portion of the sound refracts upward due to cooling temperatures with increased altitude.

Missiles, rockets, projectiles, and other cased weapons will produce casing fragments upon detonation. These fragments may be of variable size and are ejected at supersonic speed from the detonation. The casing fragments will be ejected at velocities much greater than debris from any target due to the proximity of the casing to the explosive material. Unlike detonations on land targets, in-air detonations during Navy training and testing would not result in other propelled materials such as crater debris.

3.0.3.3.3 Energy Stressors

This section describes the characteristics of energy introduced through naval training and testing activities and the relative magnitude and location of these activities to provide the basis for analysis of potential impacts on resources from in-water electromagnetic devices, in-air electromagnetic devices, and lasers .

3.0.3.3.3.1 In-Water Electromagnetic Devices

Electromagnetic energy emitted into the water from magnetic influence mine neutralization systems is considered in this document. Table 3.0-13 shows the number and location of proposed activities, primarily mine sweeping, that include the use of in-water electromagnetic devices.

Table 3.0-13: Number and Location of Activities Including In-Water Electromagnetic Devices

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Virginia Capes Range Complex	890	890	4,450	4,450
Navy Cherry Point Range Complex	193	193	965	965
Jacksonville Range Complex	165	165	825	825
Gulf of Mexico Range Complex	104	104	520	520
Inland Waters (Table 3.0-14)	68	68	204	340
Total	**1,420**	**1,420**	**6,964**	**7,100**
Testing				
Virginia Capes Range Complex	184	184	920	920
Navy Cherry Point Range Complex	12	12	60	60
Jacksonville Range Complex	102	102	510	510
Gulf of Mexico Range Complex	40	40	200	200
NUWC Newport Testing Range	660	660	3,300	3,300
SFOMF	3	3	15	15
NSWC Panama City Testing Range	3	3	15	15
Inland Waters (Table 3.0-14)	100	100	500	500
Total	**1,104**	**1,104**	**5,520**	**5,520**

Notes: NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center

Table 3.0-14 shows where within the inland waters the activities would occur.

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

Table 3.0-14: Number and Location of Activities in Inland Waters Including In-Water Electromagnetic Devices

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Boston, MA	4	4	12	20
Earle, NJ	4	4	12	20
Wilmington, DE	4	4	12	20
Delaware Bay, DE	4	4	12	20
Hampton Roads, VA	8	8	24	40
Morehead City, NC	8	8	24	40
Savannah, GA	4	4	12	20
Kings Bay, GA	4	4	12	20
Mayport, FL	4	4	12	20
Port Canaveral, FL	8	8	24	40
Tampa, FL	4	4	12	20
Beaumont, TX	8	8	24	40
Corpus Christi, TX	4	4	12	20
Total	**68**	**68**	**204**	**340**
Testing				
Little Creek, VA	100	100	500	500
Total	**100**	**100**	**500**	**500**

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

The static magnetic field generated by the mine neutralization devices is of relatively minute strength. Typically, the maximum magnetic field generated would be approximately 2,300 microteslas[2]. This level of electromagnetic density is very low compared to magnetic fields generated by other everyday items. The magnetic field generated is between the levels of a refrigerator magnet (15,000–20,000 microteslas) and a standard household can opener (up to 400 microteslas at 4 in.). The strength of the electromagnetic field decreases quickly away from the cable. The magnetic field generated is very weak, comparable to the earth's natural field (U.S. Department of the Navy, 2005).

The kinetic energy weapon (commonly referred to as the rail gun) will be tested and eventually used in training events aboard surface vessels, firing non-explosive projectiles at land- or sea-based targets. The system uses stored electrical energy to accelerate the projectiles, which are fired at supersonic speeds over great distances. The system charges for two minutes, and fires in less than one second; therefore, the release of any electromagnetic energy would occur over a very short period. Also, the system is shielded so as not to affect shipboard controls and systems. The amount of electromagnetic energy

[2] The microtesla is a unit of measurement of magnetic flux density, or "magnetic induction."

released from this system is low and contained on the surface vessel. Therefore, this device is not expected to result in any electromagnetic impacts and will not be further analyzed for biological resources in this document.

3.0.3.3.3.2 In-Air Electromagnetic Devices

Sources of electromagnetic energy in the air include kinetic energy weapons, communications transmitters, radars, and electronic countermeasures transmitters. Electromagnetic devices on Navy platforms operate across a wide range of frequencies and power. On a single ship the source frequencies may range from 2 megahertz (MHz) to 14,500 MHz, and transmitter maximum average power may range from 0.25 watts to 1,280,00 watts.

The term radar was originally coined by the Navy to refer to Radio Detection And Ranging. A radar system is an electromagnetic device that emits radio waves to detect and locate objects. In most cases, basic radar systems operate by generating pulses of radio frequency energy and transmitting these pulses via directional antennae into space (Courbis & Timmel, 2008). Some of this energy is reflected by the target back to the antenna, and the signal is processed to provide useful information to the operator.

Radars come in a variety of sizes and power, ranging from wide-band milliwatt systems to very high-power systems that are used primarily for long-range search and surveillance (Courbis & Timmel, 2008). In general, radars operate at radio frequencies that range between 300 MHz and 300 gigahertz, and are often classified according to their frequency range. Navy vessels commonly operate radar systems which include S-band and X-band electronically steered radar. S-band radar serves as the primary search and acquisition sensor capable of tracking and collecting data on a large number of objects while X-band radar can provide high resolution data on particular objects of interest and discrimination for weapons systems. Both systems employ a variety of waveforms and bandwidths to provide high quality data collection and operational flexibility (Baird et al., 2016).

It is assumed that most Navy platforms associated with the Proposed Action will be transmitting from a variety of in-air electromagnetic devices at all times that they are underway, with very limited exceptions. Most of these transmissions (e.g., for routine surveillance, communications, and navigation) will be at low power. High-power settings are used for a small number of activities including ballistic missile defense training, missile and rocket testing, radar and other system testing, and signature analysis operations. The number of Navy vessels or aircraft in the Study Area at any given time varies and is dependent on local training or testing requirements. Therefore, in-air electromagnetic energy as part of the Proposed Action would be widely dispersed throughout the Study Area, but more concentrated in portions of the Study Area near ports, naval installations, and range complexes. Table 3.0-17 and Table 3.0-36 show the annual number and location of activities involving vessels and aircraft, which provide a proxy for level of in-air electromagnetic device use for the purposes of this EIS/OEIS.

3.0.3.3.3.3 Lasers

The devices discussed here include lasers that can be organized into two categories: (1) low-energy lasers and (2) high-energy lasers. Low-energy lasers are used to illuminate or designate targets, to measure the distance to a target, to guide weapons, to aid in communication, and to detect or classify mines. High-energy lasers are used as weapons to create critical failures on air and surface targets.

Low-Energy Lasers

Within the category of low-energy lasers, the highest potential level of exposure would be from an underwater laser or an airborne laser beam directed at the ocean's surface. An assessment on the use of low-energy lasers by the Navy determined that low-energy lasers, including those involved in the training and testing activities in this EIS/OEIS, have an extremely low potential to impact marine biological resources (Swope, 2010). The assessment determined that the maximum potential for laser exposure is at the ocean's surface, where laser intensity is greatest (Swope, 2010). As the laser penetrates the water, 96 percent of a laser beam is absorbed, scattered, or otherwise lost (Ulrich, 2004). Based on the parameters of the low-energy lasers and the behavior and life history of major biological groups, it was determined the greatest potential for impact would be to the eye of a marine species. However, an animal's eye would have to be exposed to a direct laser beam for at least ten seconds or longer to sustain damage. Swope (2010) assessed the potential for damage based on species specific eye/vision parameters and the anticipated output from low-energy lasers, and determined that no animals were predicted to incur damage. Therefore, low-energy lasers are not further analyzed in this document for biological resources.

High-Energy Lasers

High-energy laser weapons training and testing involves the use of up to 30 kilowatts of directed energy as a weapon against small surface vessels and airborne targets. High-energy lasers would be employed from surface ships and are designed to create small but critical failures in potential targets. The high-energy laser is expected to be used at short ranges. Table 3.0-15 shows the number and location of proposed activities that include the use of high-energy lasers. Marine life at or near the ocean surface and birds could be susceptible to injury by high-energy lasers.

3.0.3.3.4 Physical Disturbance and Strike Stressors

This section describes the characteristics of physical disturbance and strike stressors from Navy training and testing activities. It also describes the magnitude and location of these activities to provide the basis for analyzing the potential physical disturbance and strike impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences).

3.0.3.3.4.1 Vessels and In-Water Devices

Vessels

Vessels used as part of the Proposed Action include ships (e.g., aircraft carriers, surface combatants), support craft, and submarines ranging in size from 15 ft. to over 1,000 ft. Table 3.0-16 provides examples of the types of vessels, length, and speeds used in both testing and training activities. The U.S. Navy Fact Files, available on the Internet, provide the latest information on the quantity and specifications of the vessels operated by the Navy.

Table 3.0-15: Activities Including High-Energy Lasers

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Virginia Capes Range Complex	4	4	20	20
Jacksonville Range Complex	4	4	20	20
Total	**8**	**8**	**40**	**40**
Testing				
Northeast Range Complexes	8	8	40	40
Virginia Capes Range Complex	116	116	580	580
Navy Cherry Point Range Complex	8	8	40	40
Jacksonville Range Complex	8	8	40	40
Key West Range Complex	8	8	40	40
Gulf of Mexico Range Complex	8	8	40	40
NUWC Newport Testing Range	8	8	40	40
SFOMF	8	8	40	40
NSWC Panama City Testing Range	8	8	40	40
Total	**180**	**180**	**900**	**900**

Notes: NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center

Navy ships transit at speeds that are optimal for fuel conservation or to meet operational requirements. Large Navy ships (greater than 18 m in length) generally operate at average speeds of between 10 and 15 knots, and submarines generally operate at speeds in the range of 8–13 knots. Small craft (for purposes of this discussion, less than 50 ft. in length), which are all support craft, have much more variable speeds (0–50+ knots, dependent on the mission). While these speeds are considered averages and representative of most events, some vessels need to operate outside of these parameters during certain situations. For example, to produce the required relative wind speed over the flight deck for take-off and landings, an aircraft carrier vessel group engaged in flight operations must adjust its speed through the water accordingly. Also, there are other instances such as launch and recovery of a small rigid hull inflatable boat; vessel boarding, search, and seizure training events; or retrieval of a target when vessels would be idling or moving slowly ahead to maintain steerage. There are a few specific offshore events, including high-speed tests of newly constructed vessels, where vessels would operate at higher speeds. High speed movements of smaller craft during inshore operations could occur more frequently.

The number of Navy vessels in the Study Area at any given time varies and is dependent on local training or testing requirements. Activities range from involving one or two vessels to several vessels operating over various time frames and locations. For the purposes of this analysis, vessel movements are discussed in two categories; (1) those activities that occur in the offshore component of the Study Area and (2) those activities that occur in inland waters.

Table 3.0-16: Representative Vessel Types, Lengths, and Speeds

Type	*Example(s)*	*Length*	*Typical Operating Speed*
Aircraft Carrier	Aircraft Carrier (CVN)	>1000 ft.	10–15 knots
Surface Combatant	Cruisers (CG), Destroyers (DDG), Frigates (FF), Littoral Combat Ships (LCS)	300–700 ft.	10–15 knots
Amphibious Warfare Ship	Amphibious Assault Ship (LHA, LHD), Amphibious Transport Dock (LPD), Dock Landing Ship (LSD)	300–900 ft.	10–15 knots
Combat Logistics Force Ships	Fast Combat Support Ship (T-AOE), Dry Cargo/Ammunition Ship (T-AKE), Fleet Replenishment Oilers (T-AO)	600–750 ft.	8–12 knots
Support Craft/Other	Amphibious Assault Vehicle (AAV); Combat Rubber Raiding Craft (CRRC); Landing Craft, Mechanized (LCM); Landing Craft, Utility (LCU); Submarine Tenders (AS); Yard Patrol Craft (YP)	15–140 ft.	0–20 knots
Support Craft/Other—Specialized High Speed	High Speed Ferry/Catamaran; Patrol Combatants (PC); Rigid Hull Inflatable Boat (RHIB); Expeditionary Fast Transport (EPF); Landing Craft, Air Cushion (LCAC)	33–320 ft.	0–50+ knots
Submarines	Fleet Ballistic Missile Submarines (SSBN), Attack Submarines (SSN), Guided Missile Submarines (SSGN)	300–600 ft.	8–13 knots

Notes: > = greater than, m = meters

Activities that occur in the offshore component of the Study Area may last from a few hours to a few weeks. Vessels associated with those activities would be widely dispersed in the offshore waters, but more concentrated in portions of the Study Area in close proximity to ports, naval installations, range complexes, and testing ranges. In contrast, activities that occur in inland waters can last from a few hours to up to 12 hours of daily movement per vessel per activity, and can involve speeds greater than 10 knots. The vessels operating within the inland waters are generally smaller than those in the offshore waters and are considered small craft (less than 50 ft.).

In an attempt to determine traffic patterns for Navy and non-Navy vessels, the Center for Naval Analysis (Mintz & Parker, 2006) conducted a review of historic data for commercial vessels, coastal shipping patterns, and Navy vessels. Commercial and non-Navy traffic, which included cargo vessels, bulk carriers, passenger vessels, and oil tankers (all over 20 m in length), was heaviest near the major shipping ports from the Gulf of Maine to southern Florida, as well as in specific international shipping lanes. Compared to coastal vessel activity, there was relatively little concentration of vessels in the other portions of the Study Area (Mintz & Parker, 2006). Navy traffic was heaviest just offshore of Norfolk, Virginia, and Jacksonville, Florida, as well as along the coastal waters between the two ports.

Data collected for 2009 vessel traffic were analyzed by Mintz (2012b) and Mintz and Filadelfo (2011) and indicated that within the AFTT Study Area, large Navy vessels accounted for less than 1 percent of the total large vessel traffic (from estimated vessel hours using positional data) in that area. In the Virginia Capes and Jacksonville Range Complexes where Navy vessel activity is concentrated, the Navy vessels accounted for 7 and 9 percent (respectively) of the total large vessel traffic. Barco et al. (2009) found that large military vessels (at least 65 ft. in length) were approximately 18 percent of the total large vessels transiting (inbound and outbound) the Chesapeake Bay channel, an area of highly concentrated

Navy activity because of the proximity of Naval Station Norfolk. Based on the large number of commercial and recreational boats in the Hampton Roads area, military vessels would probably comprise an even smaller proportion of total vessels, if smaller vessels (less than 65 ft. in length) were factored into these analyses.

Table 3.0-17 shows the number and location of proposed activities that include the use of vessels in the Study Area. Each activity included in Table 3.0-17 could involve one or more vessels. As described above in Section 3.0.3.3 (Identifying Stressors for Analysis), activities are not always conducted independently of each other, as there are instances when a training activity could occur on a vessel while another training activity or a testing activity is being conducted on the same vessel simultaneously. The location and hours of Navy vessel usage for testing and training activities are most dependent upon the locations of Navy ports, piers, and established at-sea testing and training areas. Table 3.0-18 shows the number and location of proposed activities that include the use of vessels in the inland waters of the Study Area. Each activity included in Table 3.0-18 could involve one or more vessels. With the exception of the establishment of the Undersea Warfare Training Range in the offshore waters off the coast of Florida, these established training and testing areas have not appreciably changed in several decades and are not expected to change in the foreseeable future.

Table 3.0-17: Number and Location of Activities Including Vessels

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Northeast Range Complexes	373	375	1,153	1,165
Virginia Capes Range Complex	10,821	10,931	50,753	51,315
Navy Cherry Point Range Complex	6,590	6,617	32,919	33,080
Jacksonville Range Complex	8,956	9,176	44,038	45,180
Key West Range Complex	141	141	705	705
Gulf of Mexico Range Complex	642	658	3,208	3,290
Other AFTT Areas	503	521	2,515	2,605
Inland Waters (see Table 3.0-18)	3,189	3,189	16,505	15,537
Total	**31,215**	**31,608**	**151,796**	**152,986**
Testing				
Northeast Range Complexes	945	948	4,449	4,737
Virginia Capes Range Complex	1,345	1,346	5,915	6,612
Navy Cherry Point Range Complex	755	756	3,768	3,776
Jacksonville Range Complex	1,060	1,065	5,109	5,239
Key West Range Complex	351	351	1,646	1,748
Gulf of Mexico Range Complex	426	426	2,089	2,110
NUWC Newport Testing Range	697	697	3,479	3,479
SFOMF	149	149	742	742
NSWC Panama City Testing Range	404	404	1,992	1,992
Inland Waters (see Table 3.0-18)	166	166	828	728
Total	**6,298**	**6,308**	**30,017**	**31,163**

Table 3.0-18: Number and Location of Activities in Inland Waters Including Vessels

Activity Area	Maximum Annual # of Activities		5-Year # of Activities	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Training				
Boston, MA	1	1	3	5
Groton, CT	235	235	1,175	1,175
Narragansett, RI	198	198	990	990
Earle, NJ	1	1	3	5
Wilmington, DE	1	1	3	5
Delaware Bay, DE	1	1	3	5
James Rivers & Tributaries, VA	705	705	3,525	3,525
York River, VA	125	125	625	625
Lower Chesapeake Bay, VA	1,017	1,017	5,085	5,085
Hampton Roads, VA	2	2	6	10
Norfolk, VA	406	406	2,620	2,620
Morehead City, NC	1	1	3	5
Cooper River, SC	60	60	300	300
Savannah, GA	1	1	3	5
Kings Bay, GA	6	6	28	30
Mayport, FL	327	327	1,633	1,635
St. Johns River, FL	2	2	10	10
Port Canaveral, FL	46	46	228	230
Tampa, FL	1	1	3	5
St. Andrew's Bay, FL	50	50	250	252
Beaumont, TX	2	2	6	10
Corpus Christi, TX	1	1	3	5
Total	**3,189**	**3,189**	**16,505**	**16,537**
Testing				
Bath, ME	11	11	55	55
Portsmouth, NH	26	26	130	130
Newport, RI	4	4	20	20
Groton, CT	9	9	47	47
Little Creek, VA	11	11	51	51
Norfolk, VA	64	64	318	318
Kings Bay, GA	4	4	20	20
Mayport, FL	27	27	135	135
Port Canaveral, FL	3	3	17	17
Pascagoula, MS	7	7	35	35
Total	**166**	**166**	**828**	**828**

As stated earlier, activities that include vessel movements in the inland waters of the Study Area occur on a more regular basis than the offshore activities, and often involve the vessels traveling at speeds greater than 10 knots, and generally in more confined waterways than activities occurring in the offshore waters. In order to analyze this stressor appropriately, the number of hours of high speed vessel movement for small crafts are provided in Table 3.0-19.

Table 3.0-19: Number of High Speed Vessel Hours for Small Crafts Associated with Training Activities in Inland Waters of the Study Area

Activity Area	***Maximum Annual # of Hours***		***5-Year # of Hours***	
	Alternative 1	***Alternative 2***	***Alternative 1***	***Alternative 2***
Narragansett, RI	9,502	9,502	47,510	47,510
James Rivers & Tributaries	18,108	18,108	90,540	90,540
York River	6,590	6,590	32,950	32,950
Lower Chesapeake Bay	39,325	39,325	196,625	196,625
Cooper River, SC	12,651	12,651	63,255	63,255
Mayport, FL	510	510	2,550	2,550
St. Johns River	482	482	2,410	2,410
Port Canaveral, FL	4,352	4,352	21,760	21,760
St. Andrew's Bay	56	56	280	280
Total	**91,576**	**91,576**	**457,880**	**457,880**

While the estimates provided in the above tables represent the average distribution of events, actual locations and hours of Navy vessel usage are dependent upon requirements, deployment schedules, annual budgets, and other unpredictable factors. Consequently, vessel use can be highly variable. Multiple activities usually occur from the same vessel, particularly in offshore waters, so increases in the number of activities do not necessarily result in increases in vessel use or transit. The manner in which the Navy uses vessels to accomplish its training and testing activities is likely to remain consistent with the range of variability observed over the last decade. Consequently, even with the addition of Undersea Warfare Training Range off the coast of Florida, the Navy is not proposing appreciable changes in the levels, frequency, or locations where vessels have been used over the last decade.

In-Water Devices

In-water devices as discussed in this analysis include unmanned vehicles, such as remotely operated vehicles, unmanned surface vehicles, unmanned underwater vehicles, motorized autonomous targets, and towed devices. These devices are self-propelled and unmanned or towed through the water from a variety of platforms, including helicopters, unmanned underwater vehicles, and surface ships. In-water devices are generally smaller than most Navy vessels, ranging from several inches to about 50 ft. See Table 3.0-20 for a range of in-water devices used. These devices can operate anywhere from the water surface to the benthic zone. Most devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most unmanned underwater vehicles) or are closely monitored by observers manning the towing platform who ensure the towed in-water device does not run into objects in the water. Because of their size and potential operating speed, unmanned surface vehicles are the in-water devices that operate in a manner with the most potential to strike living marine resources. Table 3.0-21 shows the number and location of proposed activities that include the use of in-water devices. For a list of activities by name that include the use of in-water devices, see Appendix B (Activity Stressor Matrices).

Table 3.0-20: Representative Types, Sizes, and Speeds of In-Water Devices

Type	*Example(s)*	*Length*	*Typical Operating Speed*
Towed Device	Minehunting Sonar Systems; Improved Surface Tow Target; Towed Sonar System; MK-103, MK-104 and MK-105 Minesweeping Systems; Organic Airborne and Surface Influence Sweep	< 33 ft.	10–40 knots
Unmanned Surface Vehicle	MK-33 Seaborne Power Target Drone Boat, QST-35A Seaborne Powered Target, Ship Deployable Seaborne Target, Small Waterplane Area Twin Hull, Unmanned Influence Sweep System	< 50 ft.	Variable, up to 50+ knots
Unmanned Underwater Vehicle	Acoustic Mine Targeting System, Airborne Mine Neutralization System, AN/AQS Systems, Archerfish Common Neutralizer, Crawlers, CURV 21, Deep Drone 8000, Deep Submergence Rescue Vehicle, Gliders, Expendable Mobile Anti-Submarine Warfare Training Targets, Magnum Remotely Operated Vehicle, Manned Portables, MK 30 Anti-Submarine Warfare Targets, Remote Multi-Mission Vehicle, Remote Minehunting System, Large Displacement Unmanned Underwater Vehicle	< 60 ft.	1–15 knots
Torpedoes	Light-weight and Heavy-weight Torpedoes	< 33 ft.	20–30 knots

Table 3.0-21: Number and Location of Activities Including In-Water Devices

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Northeast Range Complexes	9	11	43	55
Virginia Capes Range Complex	3,809	3,939	19,009	19,695
Navy Cherry Point Range Complex	819	856	4,021	4,280
Jacksonville Range Complex	1,357	1,717	6,677	8,585
Gulf of Mexico Range Complex	385	423	1,923	2,115
NSWC Panama City Testing Range	328	328	1,640	1,640
Other AFTT Areas	110	110	550	550
Inland Waters (see Table 3.0-22)	777	777	3,615	3,886
Total	**6,894**	**7,461**	**37,478**	**40,806**
Testing				
Northeast Range Complexes	185	185	928	928
Virginia Capes Range Complex	316	316	1,337	1,580
Navy Cherry Point Range Complex	48	48	237	237
Jacksonville Range Complex	549	549	2,612	2,612
Key West Range Complex	1	1	8	8
Gulf of Mexico Range Complex	318	318	1,588	1,588
NUWC Newport Testing Range	1,771	1,771	8,825	8,825

Table 3.0-21: Number and Location of Activities Including In-Water Devices (continued)

Activity Area	***Maximum Annual # of Activities***		***5-Year # of Activities***	
	Alternative 1	***Alternative 2***	***Alternative 1***	***Alternative 2***
Testing				
SFOMF	619	619	3,455	3,455
NSWC Panama City Testing Range	1,563	1,563	7,704	7,704
Total	**5,370**	**5,370**	**26,694**	**26,937**

Notes: NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility;
NSWC = Naval Surface Warfare Center

Table 3.0-22: Number and Location of Activities in Inland Waters Including In-Water Devices

Activity Area	***Maximum Annual # of Activities***		***5-Year # of Activities***	
	Alternative 1	***Alternative 2***	***Alternative 1***	***Alternative 2***
Training				
Boston, MA	9	9	27	45
Earle, NJ	9	9	27	45
Wilmington, DE	9	9	27	45
Delaware Bay, DE	9	9	27	45
Lower Chesapeake Bay	426	426	2,130	2,130
Hampton Roads, VA	18	18	54	90
James River and Tributaries	90	90	450	450
York River	19	19	95	95
Morehead City, NC	9	9	27	45
Savannah, GA	9	9	27	45
Kings Bay, GA	31	31	137	156
Mayport, FL	44	44	202	220
Port Canaveral, FL	9	9	27	45
Tampa, FL	9	9	27	45
St. Andrew's Bay	50	50	250	250
Beaumont, TX	18	18	54	90
Corpus Christi, TX	9	9	27	45
Total	**777**	**777**	**3,615**	**3,886**

3.0.3.3.4.2 Military Expended Materials

Military expended materials that may cause physical disturbance or strike include: (1) all sizes of non-explosive practice munitions (Table 3.0-23, Table 3.0-24 and Table 3.0-25), (2) fragments from high-explosive munitions (Table 3.0-26 and Table 3.0-27), (3) expendable targets (Table 3.0-28, Table 3.0-29, and Table 3.0-30), and (4) expended materials other than munitions, such as sonobuoys or torpedo accessories (Table 3.0-31 and

Table 3.0-32). See Appendix F (Military Expended Materials and Direct Strike Calculations) for more information on the type and quantities of military expended materials proposed to be used.

For living marine resources in the water column, the discussion of military expended material strikes focuses on the potential of a strike at the surface of the water. The effect of materials settling on the bottom will be discussed as an alteration of the bottom substrate and associated organisms (e.g., invertebrates and vegetation).

Table 3.0-23: Number and Location of Non-Explosive Practice Munitions Expended During Training Activities

Activity Area	*Maximum Annual # of Munitions*		*5-Year # of Munitions*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Torpedoes [1]				
Northeast Range Complexes	24	24	120	120
Virginia Capes Range Complex	21	21	105	105
Jacksonville Range Complex	92	92	460	460
Total	**137**	**137**	**685**	**685**
Bombs				
Virginia Capes Range Complex	2,248	2,248	11,240	11,240
Navy Cherry Point Range Complex	596	596	2,980	2,980
Jacksonville Range Complex	1,366	1,366	6,830	6,830
Gulf of Mexico Range Complex	270	270	1,350	1,350
Total	**4,480**	**4,480**	**22,400**	**22,400**
Rockets				
Virginia Capes Range Complex	2,708	2,708	13,538	13,538
Navy Cherry Point Range Complex	289	289	1,444	1,444
Jacksonville Range Complex	2,997	2,997	14,982	14,982
Gulf of Mexico Range Complex	289	289	1,444	1,444
Total	**6,283**	**6,283**	**31,408**	**31,408**
Rockets (Flechette)				
Virginia Capes Range Complex	143	143	712	712
Navy Cherry Point Range Complex	15	15	76	76
Jacksonville Range Complex	157	157	788	788
Gulf of Mexico Range Complex	15	15	76	76
Total	**330**	**330**	**1,652**	**1,652**
Large Caliber Projectiles				
Virginia Capes Range Complex	3,802	3,802	19,010	19,010
Navy Cherry Point Range Complex	1,134	1,134	5,670	5,670
Jacksonville Range Complex	1,388	1,388	6,940	6,940
Gulf of Mexico Range Complex	638	638	3,190	3,190
Other AFTT Areas	196	196	980	980
Total	**7,158**	**7,158**	**35,790**	**35,790**
Large Caliber – Casings Only				
Navy Cherry Point Range Complex	960	960	4,800	4,800
Total	**960**	**960**	**4,800**	**4,800**

Table 3.0-23: Number and Location of Non-Explosive Practice Munitions Expended During Training Activities (continued)

Activity Area	*Maximum Annual # of Munitions*		*5-Year # of Munitions*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Medium Caliber Projectiles				
Northeast Range Complexes	1,000	1,000	5,000	5,000
Virginia Capes Range Complex	800,769	800,769	4,003,845	4,003,845
Navy Cherry Point Range Complex	358,574	358,574	1,792,870	1,792,870
Jacksonville Range Complex	439,234	439,234	2,196,170	2,196,170
Key West Range Complex	56,000	56,000	280,000	280,000
Gulf of Mexico Range Complex	32,000	32,000	160,000	160,000
Other AFTT Areas	21,251	21,251	106,250	106,250
Total	**1,708,828**	**1,708,828**	**8,544,135**	**8,544,135**
Small Caliber Projectiles				
Northeast Range Complexes	36,600	36,600	135,000	135,000
Virginia Capes Range Complex	3,806,350	3,806,350	19,031,750	19,031,750
Navy Cherry Point Range Complex	833,675	833,675	4,168,375	4,168,375
Jacksonville Range Complex	1,436,275	1,436,275	7,181,375	7,181,375
Gulf of Mexico Range Complex	237,500	237,500	1,187,500	1,187,500
Other AFTT Areas	200,000	200,000	1,000,000	1,000,000
Total	**6,550,400**	**6,550,400**	**32,704,000**	**32,704,000**
Small Caliber – Casings Only				
Virginia Capes Range Complex	3,400	3,400	17,000	17,000
Jacksonville Range Complex	1,000	1,000	5,000	5,000
Inland Waters (see Table 3.0-24)	157,020	157,020	781,100	781,100
Total	**161,420**	**161,420**	**803,100**	**803,100**

[1] Non-explosive torpedoes are recovered after use.
Notes: AFTT = Atlantic Fleet Training and Testing

Table 3.0-24: Number and Location of Non-Explosive Practice Munitions Expended During Training Activities in Inland Waters

Activity Area	*Maximum Annual # of Munitions*		*5-Year # of Munitions*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Narragansett, RI	8,320	8,320	41,600	41,600
James Rivers & Tributaries	102,000	102,000	510,000	510,000
Lower Chesapeake Bay	28,800	28,800	140,000	140,000
Cooper River, SC	5,100	5,100	25,500	25,500
Port Canaveral, FL	12,800	12,800	64,000	64,000
Total	**157,020**	**157,020**	**781,100**	**781,100**

Table 3.0-25: Number and Location of Non-Explosive Practice Munitions Expended During Testing Activities

Activity Area	*Maximum Annual # of Munitions*		*5-Year # of Munitions*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Airborne Mine Neutralization System Neutralizer				
Virginia Capes Range Complex	180	195	740	975
Jacksonville Range Complex	50	50	250	250
Gulf of Mexico Range Complex	100	100	500	500
NSWC Panama City Testing Range	84	99	364	495
Total	**414**	**444**	**1,854**	**2,220**
Torpedoes [1]				
Northeast Range Complexes	240	240	1,192	1,192
Virginia Capes Range Complex	465	465	2,074	2,317
Navy Cherry Point Range Complex	128	128	642	642
Jacksonville Range Complex	571	571	2,778	2,847
Key West Range Complex	4	4	12	12
Gulf of Mexico Range Complex	236	236	1,172	1,172
NUWC Newport Testing Range	120	120	600	600
SFOMF	34	34	170	170
NSWC Panama City Testing Range	240	240	1,200	1,200
Total	**2,038**	**2,038**	**9,840**	**10,152**
Bombs				
Virginia Capes Range Complex	964	964	4,820	4,820
Jacksonville Range Complex	12	12	60	60
Total	**976**	**976**	**4,880**	**4,880**
Rockets				
Virginia Capes Range Complex	746	746	3,644	3,728
Jacksonville Range Complex	406	406	1,945	2,029
Total	**1,152**	**1,152**	**5,589**	**5,757**
Rockets (Flechette)				
Virginia Capes Range Complex	248	248	1,215	1,243
Jacksonville Range Complex	135	135	648	676
Total	**383**	**383**	**1,863**	**1,919**
Missiles				
Northeast Range Complexes	24	24	120	120
Virginia Capes Range Complex	899	899	4,463	4,495
Navy Cherry Point Range Complex	24	24	120	120
Jacksonville Range Complex	136	136	672	680
Key West Range Complex	31	31	155	155
Gulf of Mexico Range Complex	24	24	120	120
Total	**1,138**	**1,138**	**5,650**	**5,690**

Table 3.0-25: Number and Location of Non-Explosive Practice Munitions Expended During Testing Activities (continued)

Activity Area	*Maximum Annual # of Munitions*		*5-Year # of Munitions*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Kinetic Energy Rounds				
Northeast Range Complexes	35,003	35,003	175,017	175,017
Virginia Capes Range Complex	35,003	35,003	175,017	175,017
Navy Cherry Point Range Complex	35,003	35,003	175,017	175,017
Jacksonville Range Complex	35,003	35,003	175,017	175,017
Key West Range Complex	35,003	35,003	175,017	175,017
Gulf of Mexico Range Complex	35,003	35,003	175,017	175,017
NUWC Newport Testing Range	4	4	17	17
SFOMF	4	4	17	17
NSWC Panama City Testing Range	4	4	17	17
Total	**210,030**	**210,030**	**1,050,153**	**1,050,153**
Large Caliber Projectiles				
Northeast Range Complexes	1,761	1,761	8,805	8,805
Virginia Capes Range Complex	8,147	8,147	40,735	40,735
Navy Cherry Point Range Complex	1,440	1,440	7,200	7,200
Jacksonville Range Complex	14,524	14,524	72,620	72,620
Key West Range Complex	3,190	3,190	15,950	15,950
Gulf of Mexico Range Complex	2,774	2,774	13,870	13,870
NSWC Panama City Testing Range	280	280	1,400	1,400
Total	**32,116**	**32,116**	**160,580**	**160,580**
Medium Caliber Projectiles				
Northeast Range Complexes	9,060	9,060	45,300	45,300
Virginia Capes Range Complex	239,660	239,660	1,180,300	1,198,300
Navy Cherry Point Range Complex	8,160	8,160	40,800	40,800
Jacksonville Range Complex	237,360	237,360	1,150,800	1,186,800
Key West Range Complex	32,660	32,660	163,300	163,300
Gulf of Mexico Range Complex	22,860	22,860	114,300	114,300
NSWC Panama City Testing Range	5,100	5,100	25,500	25,500
Total	**554,860**	**554,860**	**2,720,300**	**2,774,300**

Table 3.0-25: Number and Location of Non-Explosive Practice Munitions Expended During Testing Activities (continued)

Activity Area	Maximum Annual # of Munitions		5-Year # of Munitions	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Kinetic Energy Rounds				
Small Caliber Projectiles				
Northeast Range Complexes	4,800	4,800	24,000	24,000
Virginia Capes Range Complex	77,800	77,800	389,000	389,000
Navy Cherry Point Range Complex	4,800	4,800	24,000	24,000
Jacksonville Range Complex	4,800	4,800	24,000	24,000
Key West Range Complex	4,800	4,800	24,000	24,000
Gulf of Mexico Range Complex	17,800	17,800	89,000	89,000
NSWC Panama City Testing Range	7,000	7,000	35,000	35,000
Total	**121,800**	**121,800**	**609,000**	**609,000**

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

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center

Table 3.0-26: Number and Location of Explosives that May Result in Fragments Used During Training Activities

Activity Area	Maximum Annual # of Munitions		5-Year # of Munitions	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Torpedoes				
SINKEX Area	1	1	5	5
Total	**1**	**1**	**5**	**5**
Neutralizers				
Virginia Capes Range Complex	62	62	306	310
Navy Cherry Point Range Complex	1	1	5	5
Jacksonville Range Complex	2	2	6	10
Gulf of Mexico Range Complex	22	22	106	110
Total	**87**	**87**	**423**	**435**
Grenades				
Northeast Range Complexes	56	56	280	280
Virginia Capes Range Complex	70	70	350	350
Navy Cherry Point Range Complex	28	28	140	140
Jacksonville Range Complex	28	28	140	140
Gulf of Mexico Range Complex	28	28	140	140
Total	**210**	**210**	**1,050**	**1,050**
Bombs				
Virginia Capes Range Complex	76	76	380	380
Jacksonville Range Complex	50	50	250	250
Gulf of Mexico Range Complex	4	4	20	20

Table 3.0-26: Number and Location of Explosives that May Result in Fragments Used During Training Activities (continued)

Activity Area	*Maximum Annual # of Munitions*		*5-Year # of Munitions*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
SINKEX Area	12	12	60	60
Total	**142**	**142**	**710**	**710**
Rockets				
Virginia Capes Range Complex	1,254	1,254	6,270	6,270
Navy Cherry Point Range Complex	76	76	380	380
Jacksonville Range Complex	1,330	1,330	6,650	6,650
Gulf of Mexico Range Complex	76	76	380	380
Total	**2,736**	**2,736**	**13,680**	**13,680**
Missiles				
Northeast Range Complexes	4	4	20	20
Virginia Capes Range Complex	155	155	775	775
Navy Cherry Point Range Complex	106	106	530	530
Jacksonville Range Complex	136	136	680	680
Key West Range Complex	8	8	40	40
Gulf of Mexico Range Complex	8	8	40	40
SINKEX Area	4	4	20	20
Total	**421**	**421**	**2,105**	**2,105**
Large Caliber Projectiles				
Virginia Capes Range Complex	2,998	2,998	14,990	14,990
Navy Cherry Point Range Complex	756	756	3,780	3,780
Jacksonville Range Complex	1,160	1,160	5,800	5,800
Gulf of Mexico Range Complex	260	260	1,300	1,300
Other AFTT Areas	96	96	480	480
SINKEX Area	200	200	1,000	1,000
Total	**5,470**	**5,470**	**27,350**	**27,350**
Medium Caliber Projectiles				
Virginia Capes Range Complex	65,312	65,312	326,560	326,560
Navy Cherry Point Range Complex	23,200	23,200	116,000	116,000
Jacksonville Range Complex	58,952	58,952	294,760	294,760
Gulf of Mexico Range Complex	6,250	6,250	31,250	31,250
Other AFTT Areas	1,350	1,350	6,750	6,750
Total	**155,064**	**155,064**	**775,320**	**775,320**

Notes: AFTT = Atlantic Fleet Training and Testing; SINKEX = Sinking Exercise

Table 3.0-27: Number and Location of Explosives that May Result in Fragments Used During Testing Activities

Activity Area	*Maximum Annual # of Munitions*		*5-Year # of Munitions*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Torpedoes				
Northeast Range Complexes	7	7	29	29
Virginia Capes Range Complex	7	7	29	29
Navy Cherry Point Range Complex	3	3	9	9
Jacksonville Range Complex	7	7	29	29
Key West Range Complex	3	3	9	9
Gulf of Mexico Range Complex	3	3	29	29
NSWC Panama City Testing Range	12	12	60	60
Total	**42**	**42**	**194**	**194**
Explosive Sonobuoys				
Key West Range Complex	72	72	360	360
Total	**72**	**72**	**360**	**360**
Neutralizers				
Virginia Capes Range Complex	250	255	1,090	1,275
Jacksonville Range Complex	50	50	250	250
Gulf of Mexico Range Complex	100	100	500	500
NSWC Panama City Testing Range	328	333	1,584	1,665
Total	**728**	**738**	**3,424**	**3,690**
Bombs				
Virginia Capes Range Complex	2	2	10	10
Total	**2**	**2**	**10**	**10**
Rockets				
Virginia Capes Range Complex	206	206	830	1,030
Jacksonville Range Complex	200	200	800	1,000
Total	**406**	**406**	**1,630**	**2,030**
Missiles				
Northeast Range Complexes	10	10	50	50
Virginia Capes Range Complex	176	176	830	880
Jacksonville Range Complex	70	70	327	350
Gulf of Mexico Range Complex	12	12	30	60
Total	**268**	**268**	**1,237**	**1,340**
Buoys				
Northeast Range Complexes	710	725	3,268	3,622
Virginia Capes Range Complex	576	581	2,517	2,902
Navy Cherry Point Range Complex	337	342	1,667	1,707
Jacksonville Range Complex	399	424	1,992	2,117
Key West Range Complex	706	706	3,497	3,527
Gulf of Mexico Range Complex	352	352	1,682	1,757
Total	**3,080**	**3,130**	**14,623**	**15,632**

Table 3.0-27: Number and Location of Explosives that May Result in Fragments Used During Testing Activities (continued)

Activity Area	***Maximum Annual # of Munitions***		***5-Year # of Munitions***	
	Alternative 1	***Alternative 2***	***Alternative 1***	***Alternative 2***
Anti-Torpedo Countermeasures				
Northeast Range Complexes	142	142	710	710
Virginia Capes Range Complex	160	160	800	800
Navy Cherry Point Range Complex	42	42	210	210
Jacksonville Range Complex	156	156	780	780
Gulf of Mexico Range Complex	142	142	710	710
Total	**642**	**642**	**3,210**	**3,210**
Mines				
Virginia Capes Range Complex	10	15	50	75
Jacksonville Range Complex	8	8	40	40
Gulf of Mexico Range Complex	16	16	80	80
NSWC Panama City Testing Range	4	9	20	45
Total	**38**	**48**	**190**	**240**
Large Caliber Projectiles				
Northeast Range Complexes	132	132	660	660
Virginia Capes Range Complex	3,263	3,263	16,315	16,315
Navy Cherry Point Range Complex	132	132	660	660
Jacksonville Range Complex	6,376	6,376	31,880	31,880
Key West Range Complex	832	832	4,160	4,160
Gulf of Mexico Range Complex	923	923	4,615	4,615
NSWC Panama City Testing Range	100	100	500	500
Total	**11,758**	**11,758**	**58,790**	**58,790**
Medium Caliber Projectiles				
Northeast Range Complexes	3,860	3,860	19,300	19,300
Virginia Capes Range Complex	17,270	17,270	80,350	86,350
Navy Cherry Point Range Complex	3,360	3,360	16,800	16,800
Jacksonville Range Complex	14,860	14,860	62,300	74,300
Key West Range Complex	3,360	3,360	16,800	16,800
Gulf of Mexico Range Complex	3,360	3,360	16,800	16,800
Total	**46,070**	**46,070**	**212,350**	**230,350**

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center

Table 3.0-28: Number and Location of Targets Used or Expended During Training Activities

Activity Area	*Maximum Annual # of Targets*		*5-Year # of Targets*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Air Targets				
Northeast Range Complexes	4	4	20	20
Virginia Capes Range Complex	78	78	390	390
Navy Cherry Point Range Complex	85	85	425	425
Jacksonville Range Complex	65	65	325	325
Key West Range Complex	8	8	40	40
Gulf of Mexico Range Complex	8	8	40	40
Total	**248**	**248**	**1,240**	**1,240**
Surface Targets [1]				
Northeast Range Complexes	2	2	10	10
Virginia Capes Range Complex	1,215	1,215	6,075	6,075
Navy Cherry Point Range Complex	598	598	2,990	2,990
Jacksonville Range Complex	775	775	3,875	3,875
Gulf of Mexico Range Complex	51	51	255	255
Other AFTT Areas	3	3	15	15
Total	**2,644**	**2,644**	**13,220**	**13,220**
Surface Targets (Stationary)				
Virginia Capes Range Complex	4	4	20	20
Total	**4**	**4**	**20**	**20**
Subsurface Targets (Mobile)[1]				
Northeast Range Complexes	100	102	498	510
Virginia Capes Range Complex	291	401	1,455	2,005
Navy Cherry Point Range Complex	81	108	403	540
Jacksonville Range Complex	1,108	1,328	5,540	6,640
Gulf of Mexico Range Complex	3	5	13	25
Other AFTT Areas	179	179	891	891
Total	**1,762**	**2,123**	**8,800**	**10,611**
Mine Shapes [1]				
Virginia Capes Range Complex	292	292	1,456	1,460
Navy Cherry Point Range Complex	24	24	120	120
Jacksonville Range Complex	60	60	292	300
Key West Range Complex	8	8	40	40
Gulf of Mexico Range Complex	60	60	292	300
Inland Waters (see Table 3.0-29)	68	68	204	340
Total	**504**	**504**	**2,404**	**2,560**
Ship Hulks				
SINKEX Area	1	1	5	5
Total	**1**	**1**	**5**	**5**

[1] Many of these items are recovered after use.

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center; SINKEX = Sinking Exercise

Table 3.0-29: Number and Location of Targets Used or Expended During Training Activities in Inland Waters

Activity Area	*Maximum Annual # of Targets*		*5-Year # of Targets*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Mine Shapes				
Boston, MA	4	4	12	20
Earle, NJ	4	4	12	20
Delaware Bay, DE	4	4	12	20
Hampton Roads, VA	8	8	24	40
Morehead City, NC	8	8	24	40
Wilmington, NC	4	4	12	20
Savannah, GA	4	4	12	20
Kings Bay, GA	4	4	12	20
Mayport, FL	4	4	12	20
Port Canaveral, FL	8	8	24	40
Tampa, FL	4	4	12	20
Beaumont, TX	8	8	24	40
Corpus Christi, TX	4	4	12	20
Total	**68**	**68**	**204**	**340**

Table 3.0-30: Number and Location of Targets Used or Expended During Testing Activities

Activity Area	*Maximum Annual # of Targets*		*5-Year # of Targets*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Aerial Drones[1]				
Northeast Range Complexes	6	6	28	28
Virginia Capes Range Complex	480	480	2,397	2,398
Navy Cherry Point Range Complex	6	6	28	28
Jacksonville Range Complex	174	174	868	868
Key West Range Complex	6	6	28	28
Gulf of Mexico Range Complex	6	6	28	28
NUWC Newport Testing Range	6	6	28	28
SFOMF	6	6	28	28
NSWC Panama City Testing Range	6	6	28	28
Total	**696**	**696**	**3,461**	**3,462**
Air Target [1]				
Northeast Range Complexes	60	60	300	300
Virginia Capes Range Complex	60	60	300	300
Navy Cherry Point Range Complex	60	60	300	300
Jacksonville Range Complex	60	60	300	300
Key West Range Complex	60	60	300	300
Gulf of Mexico Range Complex	70	70	350	350
Total	**370**	**370**	**1,850**	**1,850**

Table 3.0-30: Number and Location of Targets Used or Expended During Testing Activities (continued)

Activity Area	Maximum Annual # of Targets		5-Year # of Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Surface Targets [1]				
Northeast Range Complexes	111	111	552	552
Virginia Capes Range Complex	400	400	1,904	1,907
Navy Cherry Point Range Complex	111	111	552	552
Jacksonville Range Complex	228	228	1,038	1,137
Key West Range Complex	111	111	552	552
Gulf of Mexico Range Complex	121	121	572	602
NUWC Newport Testing Range	13	13	62	62
SFOMF	13	13	62	62
NSWC Panama City Testing Range	13	13	62	62
Total	**1,121**	**1,121**	**5,356**	**5,578**
Surface Targets (Mobile)[1]				
Northeast Range Complexes	1	1	4	4
Virginia Capes Range Complex	1	1	4	4
Navy Cherry Point Range Complex	1	1	4	4
Jacksonville Range Complex	1	1	4	4
Key West Range Complex	1	1	4	4
Gulf of Mexico Range Complex	1	1	4	4
Total	**6**	**6**	**24**	**24**
Surface Targets (Stationary) [1]				
Northeast Range Complexes	61	61	305	305
Virginia Capes Range Complex	61	61	305	305
Navy Cherry Point Range Complex	61	61	305	305
Jacksonville Range Complex	61	61	305	305
Key West Range Complex	61	61	305	305
Gulf of Mexico Range Complex	61	61	305	305
Total	**366**	**366**	**1,830**	**1,830**
Sub-Surface Targets (Mobile)[1]				
Northeast Range Complexes	100	100	500	500
Virginia Capes Range Complex	105	105	525	525
Jacksonville Range Complex	265	265	1,325	1,325
Gulf of Mexico Range Complex	100	100	500	500
NUWC Newport Testing Range	240	240	1,200	1,200
Total	**810**	**810**	**4,050**	**4,050**

Table 3.0-30: Number and Location of Targets Used or Expended During Testing Activities (continued)

Activity Area	Maximum Annual # of Targets		5-Year # of Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Mine Shapes [1]				
Northeast Range Complexes	5,600	5,600	28,000	28,000
Virginia Capes Range Complex	3,172	3,172	12,860	12,860
Jacksonville Range Complex	1,595	1,595	7,975	7,975
Gulf of Mexico Range Complex	2,755	2,755	13,772	13,772
NUWC Newport Testing Range	342	342	1,710	1,710
SFOMF	885	885	4,423	4,423
NSWC Panama City Testing Range	4,309	4,309	21,545	21,545
Total	**18,658**	**18,658**	**90,285**	**90,285**

[1] Most of these items are recovered after use.

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center; SINKEX = Sinking Exercise

Table 3.0-31: Number and Location of Other Military Materials Used or Expended During Training Activities

Activity Area	Maximum Annual # of Materials		5-Year # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Acoustic Countermeasures				
Northeast Range Complexes	84	84	420	420
Virginia Capes Range Complex	41	41	205	205
Navy Cherry Point Range Complex	14	14	70	70
Jacksonville Range Complex	164	164	802	820
Gulf of Mexico Range Complex	0	6	0	30
Other AFTT Areas	89	89	441	441
Total	**392**	**398**	**1,938**	**1,986**
Concrete Slugs				
Virginia Capes Range Complex	14	14	70	70
Navy Cherry Point Range Complex	1	1	5	5
Jacksonville Range Complex	1	1	5	5
Key West Range Complex	6	6	30	30
Gulf of Mexico Range Complex	1	1	5	5
Inland Waters (see Table 3.0-32)	6	6	30	30
Total	**29**	**29**	**145**	**145**

Table 3.0-31: Number and Location of Other Military Materials Used or Expended During Training Activities (continued)

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Compression Pad/Piston				
Virginia Capes Range Complex	1,000	1,000	5,000	5,000
Navy Cherry Point Range Complex	22,300	22,300	111,500	111,500
Jacksonville Range Complex	38,000	38,000	190,000	190,000
Key West Range Complex	31,000	31,000	155,000	155,000
Gulf of Mexico Range Complex	1,840	1,840	9,200	9,200
Total	**94,140**	**94,140**	**470,700**	**470,700**
Chaff – Air Cartridge				
Virginia Capes Range Complex	2,080	2,080	10,400	10,400
Navy Cherry Point Range Complex	25,760	25,760	128,800	128,800
Jacksonville Range Complex	47,840	47,840	239,200	239,200
Key West Range Complex	4,800	4,800	240,000	240,000
Gulf of Mexico Range Complex	288	288	1,440	1,440
Total	**80,768**	**80,768**	**619,840**	**619,840**
Chaff – Ship Cartridge				
Virginia Capes Range Complex	264	264	1,320	1,320
Navy Cherry Point Range Complex	480	480	2,400	2,400
Jacksonville Range Complex	516	516	2,580	2,580
Gulf of Mexico Range Complex	120	120	600	600
Total	**1,380**	**1,380**	**6,900**	**6,900**
Endcaps – Chaff & Flare				
Virginia Capes Range Complex	3,120	3,120	15,600	15,600
Navy Cherry Point Range Complex	48,108	48,108	240,540	240,540
Jacksonville Range Complex	85,888	85,888	429,440	429,440
Key West Range Complex	79,008	79,008	395,040	395,040
Gulf of Mexico Range Complex	2,128	2,128	10,640	10,640
Total	**218,252**	**218,252**	**1,091,260**	**1,091,260**
Flares				
Virginia Capes Range Complex	1,040	1,040	5,200	5,200
Navy Cherry Point Range Complex	22,348	22,348	111,740	111,740
Jacksonville Range Complex	38,048	38,048	190,240	190,240
Key West Range Complex	31,008	31,008	155,040	155,040
Gulf of Mexico Range Complex	1,840	1,840	9,200	9,200
Inland Waters (see Table 3.0-32)	20,400	20,400	102,000	102,000
Total	**114,684**	**114,684**	**573,420**	**573,420**

Table 3.0-31: Number and Location of Other Military Materials Used or Expended During Training Activities (continued)

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Flare O-Rings				
Virginia Capes Range Complex	1,040	1,040	5,200	5,200
Navy Cherry Point Range Complex	22,348	22,348	111,740	111,740
Jacksonville Range Complex	38,048	38,048	190,240	190,240
Key West Range Complex	31,008	31,008	155,040	155,040
Gulf of Mexico Range Complex	1,840	1,840	9,200	9,200
Inland Waters (see Table 3.0-32)	20,400	20,400	102,000	102,000
Total	**114,684**	**114,684**	**573,420**	**573,420**
Fiber Optic Canister				
Virginia Capes Range Complex	62	62	306	210
Navy Cherry Point Range Complex	1	1	5	5
Jacksonville Range Complex	2	2	6	10
Gulf of Mexico Range Complex	22	22	106	110
Total	**87**	**87**	**423**	**335**
Expendable Bathythermographs				
Northeast Range Complexes	139	142	695	708
Virginia Capes Range Complex	329	439	1,640	2,193
Navy Cherry Point Range Complex	85	113	422	563
Jacksonville Range Complex	1,171	1,391	5,490	6,953
Gulf of Mexico Range Complex	3	128	13	640
Other AFTT Areas	154	154	771	771
Total	**1,880**	**2,365**	**9,031**	**11,828**
Heavyweight Torpedo Accessories				
Northeast Range Complexes	24	24	120	120
Virginia Capes Range Complex	8	8	40	40
Jacksonville Range Complex	48	48	240	240
Total	**81**	**81**	**405**	**405**
Lightweight Torpedo Accessories				
Virginia Capes Range Complex	13	13	65	65
Jacksonville Range Complex	44	44	220	220
Total	**57**	**57**	**285**	**285**
Marine Markers				
Northeast Range Complexes	192	192	960	960
Virginia Capes Range Complex	10,196	10,196	50,980	50,980
Navy Cherry Point Range Complex	332	332	1,660	1,660
Jacksonville Range Complex	1,263	1,263	6,315	6,315
Gulf of Mexico Range Complex	303	303	1,515	1,515

Table 3.0-31: Number and Location of Other Military Materials Used or Expended During Training Activities (continued)

Activity Area	Maximum Annual # of Materials		5-Year # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Other AFTT Areas	24	24	120	120
Inland Waters (see Table 3.0-32)	805	805	4,025	4,025
Total	**13,115**	**13,115**	**65,575**	**65,575**
Non-Explosive Buoy				
Virginia Capes Range Complex	24	34	114	170
Navy Cherry Point Range Complex	17	22	73	110
Jacksonville Range Complex	116	186	550	930
Gulf of Mexico Range Complex	0	16	0	80
Total	**157**	**258**	**737**	**1,290**
Non-Explosive Sonobuoy				
Northeast Range Complexes	3,132	3,132	15,660	15,660
Virginia Capes Range Complex	8,394	8,394	41,787	41,970
Navy Cherry Point Range Complex	2,987	2,987	14,542	14,935
Jacksonville Range Complex	30,504	30,504	150,741	152,520
Gulf of Mexico Range Complex	0	785	0	3,925
Other AFTT Areas	496	496	2,480	2,480
Total	**45,513**	**46,298**	**225,210**	**231,490**
Decelerators/Parachutes - Small				
Northeast Range Complexes	3,128	3,128	15,640	15,640
Virginia Capes Range Complex	8,218	8,218	40,907	41,090
Navy Cherry Point Range Complex	2,959	2,959	14,402	14,795
Jacksonville Range Complex	30,328	30,328	149,861	151,640
Gulf of Mexico Range Complex	0	785	0	3,925
Other AFTT Areas	480	480	2,400	2,400
Total	**45,113**	**45,898**	**223,210**	**229,490**
Decelerators/Parachutes - Medium				
Virginia Capes Range Complex	8	8	40	40
Jacksonville Range Complex	28	28	140	140
Total	**36**	**36**	**180**	**180**
Parachutes - Large				
Virginia Capes Range Complex	40	40	200	200
Navy Cherry Point Range Complex	48	48	240	240
Jacksonville Range Complex	48	48	240	240
Key West Range Complex	8	8	40	40
Total	**144**	**144**	**720**	**720**

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center; SINKEX = Sinking Exercise

Table 3.0-32: Number and Location of Other Military Materials Used or Expended During Training Activities in Inland Waters

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Concrete Slugs				
Lower Chesapeake Bay	6	6	30	30
Total	**6**	**6**	**30**	**30**
Flares				
James River & Tributaries	20,400	20,400	102,000	102,000
Total	**20,400**	**20,400**	**102,000**	**102,000**
Marine Markers				
Narragansett, RI	65	65	325	325
James River & Tributaries	660	660	3,300	3,300
York River	20	20	100	100
Port Canaveral, FL	60	60	300	300
Total	**805**	**805**	**4,025**	**4,025**

Table 3.0-33: Number and Location of Other Military Materials Used or Expended During Testing Activities

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Acoustic Countermeasures				
Northeast Range Complexes	842	842	4,210	4,210
Virginia Capes Range Complex	1,038	1,038	5,190	5,190
Navy Cherry Point Range Complex	764	764	3,820	3,820
Jacksonville Range Complex	1,331	1,331	6,651	6,651
Gulf of Mexico Range Complex	836	836	4,180	4,180
NUWC Newport Testing Range	64	64	320	320
SFOMF	100	100	500	500
Total	**4,975**	**4,975**	**24,871**	**24,871**
Anchors				
Northeast Range Complexes	3,600	3,600	18,000	18,000
Virginia Capes Range Complex	1,800	1,800	9,000	9,000
Jacksonville Range Complex	101	101	501	501
Gulf of Mexico Range Complex	1,923	1,923	9,614	9,614
NUWC Newport Testing Range	206	206	1,026	1,026
SFOMF	87	87	433	433
Total	**7,717**	**7,717**	**38,574**	**38,574**

Table 3.0-33: Number and Location of Other Military Materials Used or Expended During Testing Activities (continued)

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Concrete Slugs				
Northeast Range Complexes	38	38	190	190
Gulf of Mexico Range Complex	38	38	190	190
Total	**76**	**76**	**380**	**380**
Compression Pad/Piston				
Virginia Capes Range Complex	20,195	20,195	100,975	100,975
Gulf of Mexico Range Complex	600	600	3,000	3,000
Total	**20,795**	**20,795**	**103,975**	**103,975**
Chaff – Air Cartridge				
Virginia Capes Range Complex	20,595	20,595	102,975	102,975
Jacksonville Range Complex	400	400	2,000	2,000
Gulf of Mexico Range Complex	1,200	1,200	6,000	6,000
Total	**22,195**	**22,195**	**110,975**	**110,975**
Chaff – Ship Cartridge				
Northeast Range Complexes	144	144	720	720
Virginia Capes Range Complex	1,019	1,019	5,095	5,095
Navy Cherry Point Range Complex	144	144	720	720
Jacksonville Range Complex	480	480	2,400	2,400
Key West Range Complex	144	144	720	720
Gulf of Mexico Range Complex	144	144	720	720
Total	**2,075**	**2,075**	**10,375**	**10,375**
Endcaps – Chaff & Flare				
Virginia Capes Range Complex	40,790	40,790	203,950	203,950
Jacksonville Range Complex	400	400	2,000	2,000
Gulf of Mexico Range Complex	1,800	1,800	9,000	9,000
Total	**42,990**	**42,990**	**214,950**	**214,950**
Endcaps and Pistons (Non Chaff & Flare)				
NUWC Newport Testing Range	379	379	1,895	1,895
Total	**379**	**379**	**1,895**	**1,895**
Flares				
Virginia Capes Range Complex	20,195	20,195	100,975	100,975
Gulf of Mexico Range Complex	600	600	3,000	3,000
Total	**20,795**	**20,795**	**103,975**	**103,975**
Flare O-Rings				
Virginia Capes Range Complex	20,195	20,195	100,975	100,975
Gulf of Mexico Range Complex	600	600	3,000	3,000
Total	**20,795**	**20,795**	**103,975**	**103,975**

Table 3.0-33: Number and Location of Other Military Materials Used or Expended During Testing Activities (continued)

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Fiber Optic Canister				
Virginia Capes Range Complex	430	430	1,830	2,250
Jacksonville Range Complex	100	100	500	500
Gulf of Mexico Range Complex	200	200	1,000	1,000
NSWC Panama City Testing Range	412	432	1,948	2,160
Total	**1,142**	**1,162**	**5,278**	**5,910**
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Expendable Bathythermographs				
Northeast Range Complexes	1,835	1,835	7,171	7,171
Virginia Capes Range Complex	1,019	1,019	5,065	5,095
Navy Cherry Point Range Complex	315	315	1,575	1,575
Jacksonville Range Complex	637	637	3,155	3,185
Key West Range Complex	10	10	50	50
Gulf of Mexico Range Complex	978	978	4,890	4,890
SFOMF	4	4	20	20
Total	**4,798**	**4,798**	**23,926**	**23,986**
Heavyweight Torpedo Accessories				
Northeast Range Complexes	190	190	950	950
Virginia Capes Range Complex	220	220	1,100	1,100
Navy Cherry Point Range Complex	52	52	260	260
Jacksonville Range Complex	234	234	1,170	1,170
Key West Range Complex	2	2	10	10
Gulf of Mexico Range Complex	186	186	930	930
NUWC Newport Testing Range	60	60	300	300
SFOMF	34	34	170	170
Total	**978**	**978**	**4,890**	**4,890**
Lightweight Torpedo Accessories				
Northeast Range Complexes	196	196	977	977
Virginia Capes Range Complex	409	409	1,799	2,042
Navy Cherry Point Range Complex	120	120	597	597
Jacksonville Range Complex	497	497	2,413	2,482
Key West Range Complex	2	2	7	7
Gulf of Mexico Range Complex	196	196	977	977
NUWC Newport Testing Range	60	60	300	300
NSWC Panama City Testing Range	252	252	1,260	1,260
Total	**1,732**	**1,732**	**8,330**	**8,330**
Non-Explosive Sonobuoy				
Northeast Range Complexes	9,190	9,410	42,949	47,049

Table 3.0-33: Number and Location of Other Military Materials Used or Expended During Testing Activities (continued)

Activity Area	Maximum Annual # of Materials		5-Year # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Virginia Capes Range Complex	8,678	8,758	39,659	40,039
Navy Cherry Point Range Complex	2,558	2,638	12,579	13,189
Jacksonville Range Complex	6,344	6,744	30,669	33,719
Key West Range Complex	3,906	3,906	19,109	19,529
Gulf of Mexico Range Complex	4,646	4,646	22,149	23,229
NUWC Newport Testing Range	1,200	1,200	6,000	6,000
SFOMF	32	32	160	160
NSWC Panama City Testing Range	192	192	960	960
Total	**36,746**	**37,526**	**174,234**	**187,624**
Decelerators/Parachutes – Small				
Northeast Range Complexes	9,190	9,410	42,949	47,049
Virginia Capes Range Complex	8,678	8,758	39,659	40,039
Navy Cherry Point Range Complex	2,558	2,638	12,579	13,189
Jacksonville Range Complex	6,344	6,744	30,669	33,719
Key West Range Complex	3,978	3,978	19,469	19,889
Gulf of Mexico Range Complex	4,646	4,646	22,149	23,229
NUWC Newport Testing Range	1,200	1,200	6,000	6,000
SFOMF	32	32	160	160
NSWC Panama City Testing Range	192	192	960	960
Total	**36,818**	**37,598**	**174,594**	**187,984**
Decelerators/Parachutes - Medium				
Northeast Range Complexes	33	33	165	165
Virginia Capes Range Complex	196	196	737	980
Navy Cherry Point Range Complex	33	33	165	165
Jacksonville Range Complex	224	224	1,051	1,120
Key West Range Complex	1	1	5	5
Gulf of Mexico Range Complex	33	33	165	165
Total	**520**	**520**	**2,288**	**2,288**
Sabots				
Northeast Range Complexes	35,003	35,003	175,017	175,017
Virginia Capes Range Complex	35,003	35,003	175,017	175,017
Navy Cherry Point Range Complex	35,003	35,003	175,017	175,017
Jacksonville Range Complex	35,003	35,003	175,017	175,017
Key West Range Complex	35,003	35,003	175,017	175,017
Gulf of Mexico Range Complex	35,003	35,003	175,017	175,017
NUWC Newport Testing Range	383	383	1,912	1,912
Total	**210,409**	**210,409**	**1,052,048**	**1,052,048**

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center; SINKEX = Sinking Exercise

3.0.3.3.4.3 Seafloor Devices

Seafloor devices represent items used during training or testing activities that are deployed onto the seafloor and recovered. These items include moored mine shapes, recoverable anchors, bottom-placed instruments, and robotic vehicles referred to as "crawlers." Seafloor devices are either stationary or move very slowly along the bottom and do not pose a threat to highly mobile organisms when in place, however during the deployment process, they may pose a physical disturbance or strike risk. The effect of devices on the bottom will be discussed as an alteration of the bottom substrate and associated living resources (e.g., invertebrates and vegetation).

Table 3.0-34 shows the number and location of proposed activities that include the use of seafloor devices.

Table 3.0-34: Number and Location of Activities Including Seafloor Devices

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Virginia Capes Range Complex	7,052	7,052	35,256	35,256
Navy Cherry Point Range Complex	1,365	1,365	6,825	6,825
Jacksonville Range Complex	1,374	1,374	6,860	6,870
Key West Range Complex	37	37	185	185
Gulf of Mexico Range Complex	759	759	3,785	3,795
NSWC Panama City Testing Range	488	488	2,440	2,440
Inland Waters (see Table 3.0-35)	1,052	1,052	5,200	5,260
Total	**12,127**	**12,127**	**60,551**	**60,631**
Testing				
Northeast Range Complexes	28	28	138	138
Virginia Capes Range Complex	312	317	1,338	1,571
Navy Cherry Point Range Complex	29	29	143	143
Jacksonville Range Complex	83	83	383	383
Key West Range Complex	1	1	3	3
Gulf of Mexico Range Complex	75	75	376	376
NUWC Newport Testing Range	590	590	2,942	2,942
SFOMF	213	213	1,063	1,063
NSWC Panama City Testing Range	534	539	2,499	2,644
Other AFTT Areas	2	2	10	10
Inland Waters (see Table 3.0-35)	2	2	10	10
Total	**1,869**	**1,879**	**8,905**	**9,283**

Notes: NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center

Table 3.0-35: Number and Location of Activities in Inland Waters Including Seafloor Devices

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Boston, MA	2	2	6	10
Narragansett, RI	185	185	925	925
Earle, NJ	2	2	6	10
Wilmington, DE	2	2	6	10
Delaware Bay, DE	2	2	6	10
Hampton Roads, VA	4	4	12	20
Lower Chesapeake Bay	490	490	2,450	2,450
James Rivers & Tributaries	198	198	990	990
York River	45	45	225	225
Morehead City, NC	2	2	6	10
Cooper River, SC	60	60	300	300
Savannah, GA	2	2	6	10
Kings Bay, GA	2	2	6	10
Mayport, FL	46	46	226	230
Port Canaveral, FL	2	2	6	10
Tampa, FL	2	2	6	10
Beaumont, TX	4	4	12	20
Corpus Christi, TX	2	2	6	10
Total	**1,052**	**1,052**	**5,200**	**5,260**
Testing				
Little Creek, VA	1	1	5	5
Norfolk, VA	1	1	5	5
Total	**2**	**2**	**10**	**10**

3.0.3.3.4.4 Aircraft

Aircraft involved in Navy training and testing activities are separated into three categories: (1) fixed-wing aircraft, (2) rotary-wing aircraft, (3) tilt-rotor aircraft, and (4) unmanned aerial systems. Fixed-wing aircraft include, but are not limited to, planes such as F-35, P-8, F/A-18, and E/A-18G. Rotary-wing aircraft are also referred to as helicopters (e.g., MH-60), and tilt-rotor aircraft include the MV-22. Unmanned aerial systems include a variety of platforms, including but not limited to, the Small Tactical Unmanned Aerial System – Tier II, Triton unmanned aerial system, Fire Scout Vertical Take-off and Landing Unmanned Aerial System, and the Unmanned Combat Air System. Aircraft strikes are only applicable to birds. Table 3.0-36 shows the number and location of proposed activities that include the use of aircraft.

Table 3.0-36: Number and Location of Activities Including Aircraft

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Northeast Range Complexes	92	92	460	460
Virginia Capes Range Complex	16,586	16,583	80,957	80,965
Navy Cherry Point Range Complex	17,008	17,008	85,023	85,035
Jacksonville Range Complex	19,115	19,115	95,555	95,575
Key West Range Complex	29,908	29,908	149,540	149,540
Gulf of Mexico Range Complex	752	758	3,758	3,790
NSWC Panama City Testing Range	244	244	1,220	1,220
Other AFTT Areas	24	24	120	120
Inland Waters (see Table 3.0-37)	1,501	1,501	7,485	7,515
Total	**85,230**	**85,233**	**424,118**	**424,220**
Testing				
Northeast Range Complexes	738	741	3,403	3,703
Virginia Capes Range Complex	3,343	3,349	15,568	16,623
Navy Cherry Point Range Complex	608	609	3,035	3,043
Jacksonville Range Complex	871	876	4,069	4,314
Key West Range Complex	240	240	1,072	1,198
Gulf of Mexico Range Complex	139	139	610	677
NUWC Newport Testing Range	18	18	86	86
SFOMF	34	34	170	170
NSWC Panama City Testing Range	227	232	1,041	1,158
Inland Waters (see Table 3.0-37)	4	4	16	16
Total	**5,995**	**6,010**	**28,029**	**29,830**

Notes: NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center

Table 3.0-37: Number and Location of Activities in Inland Waters Including Aircraft

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Training				
Boston, MA	1	1	3	5
Earle, NJ	1	1	3	5
Wilmington, DE	1	1	3	5
Delaware Bay, DE	1	1	3	5
Hampton Roads, VA	2	2	6	10
Lower Chesapeake Bay	68	68	340	340
James Rivers & Tributaries	720	720	3,660	3,660
York River	4	4	20	20

Table 3.0-37: Number and Location of Activities in Inland Waters Including Aircraft (continued)

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Morehead City, NC	1	1	3	5
Savannah, GA	1	1	3	5
Kings Bay, GA	481	481	2,403	2,405
Mayport, FL	165	165	773	775
Port Canaveral, FL	1	1	3	5
Tampa, FL	1	1	3	5
St. Andrews Bay, FL	50	50	250	250
Beaumont, TX	2	2	6	10
Corpus Christi, TX	1	1	3	5
Total	**1,501**	**1,501**	**7,485**	**7,515**
Testing				
Little Creek, VA	2	2	8	8
Norfolk, VA	2	2	8	8
Total	**4**	**4**	**16**	**16**

3.0.3.3.5 Entanglement Stressors

This section describes the entanglement stressors introduced into the water through naval training and testing, the relative magnitude and location of these activities, and provides the basis for analysis of potential impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences). To assess the entanglement risk of materials expended during training and testing, the Navy examined the characteristics of these items (e.g., size and rigidity) for their potential to entangle marine animals. For a constituent of military expended materials to entangle a marine animal. The item must be flexible enough to wrap around the animal or appendages, or trapped in the jaw, baleen, etc. This analysis includes the potential impacts from three types of military expended materials: (1) wires and cables, (2) decelerators/parachutes, and (3) biodegradable polymer. Unlike typical fishing nets and lines, the Navy's equipment, other than biodegradable polymer, is not designed for trapping or entanglement purposes. The Navy deploys equipment designed for military purposes and strives to reduce the risk of accidental entanglement posed by any item it releases into the sea.

3.0.3.3.5.1 Wires and Cables

<u>**Fiber Optic Cables**</u>

Fiber optic cables are expended during Navy training and testing associated with remotely operated mine neutralization activities. The length of the cable varies (up to about 3,000 m). The physical properties of the fiber optic cable would not allow the cable to loop before it breaks. Fiber optic cables are somewhat flexible, durable, and abrasion or chemical-resistant. The physical characteristics of the fiber optic material render the cable easily broken when kinked, twisted, or bent sharply. The cables are often designed with controlled buoyancy to minimize the cable's effect on vehicle movement. The fiber optic cable would be suspended within the water column during the activity, and then be expended to sink to the seafloor.

Guidance Wires

Guidance wires are used during heavy-weight torpedo firings to help the firing platform control and steer the torpedo. They trail behind the torpedo as it moves through the water. Finally, the guidance wire is released from both the firing platform and the torpedo and sinks to the ocean floor.

The torpedo guidance wire is a single-strand, thin gauge, coated copper alloy. The tensile breaking strength of the wire is a maximum of 42 lb. and can be broken by hand (Environmental Sciences Group, 2005) which minimizes the potential for entanglement of marine animals (National Marine Fisheries Service, 2008), contrasting with the rope or lines associated with commercial fishing towed gear (trawls), stationary gear (traps), or entanglement gear (gillnets) that use lines with substantially higher (up to 500–2,000 lb.) breaking strength as their "weak links." The relatively low breaking strength and resistance to looping and coiling suggest that torpedo guidance wire does not have a high entanglement potential compared to other entanglement hazards (Swope & McDonald, 2013). Torpedo guidance wire sinks at a rate of 0.24 m per second (Swope & McDonald, 2013).

Sonobuoy Wire

Sonobuoys consist of a surface antenna and float unit and a subsurface hydrophone assembly unit. The two units are attached through a thin-gauge, dual-conductor, and hard-draw copper strand wire, which is then wrapped by a hollow rubber tubing or bungee in a spiral configuration. The tensile breaking strength of the wire and rubber tubing is no more than 40 lb. The length of the wire is housed in a plastic canister dispenser, which remains attached upon deployment. The length of wire that extends out is no more than 1,500 ft. and is dependent on the water depth and type of sonobuoy. Attached to the wire is a kite-drogue and damper disk stabilizing system made of non-woven nylon fabric. The nylon fabric is very thin and can be broken by hand. The wire runs through the stabilizing system and leads to the hydrophone components. The hydrophone components may be covered by thin plastic netting depending on type of sonobuoy, but pose no entanglement risk. Each sonobuoy has a saltwater-activated polyurethane float that inflates when the sonobuoy is submerged and keeps the sonobuoy components floating vertically in the water column below it. Sonobuoys remain suspended in the water column for no more than 30 hours, after which they sink to the seafloor.

Bathythermographs are similar to sonobuoys in that they consist of an antenna, a float unit, and a subsurface unit (to measure temperature of the water column in the case of the bathythermograph) that is connected to the float unit by a wire. The bathythermograph wire is similar to the sonobuoy wire described above.

Table 3.0-38 and Table 3.0-39 show the number and location of wires and cables expended during proposed training and testing activities.

Table 3.0-38: Number and Location of Wires and Cables Expended During Training Activities

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Fiber Optic Cables				
Virginia Capes Range Complex	762	762	3,806	3,810
Navy Cherry Point Range Complex	88	88	440	440
Jacksonville Range Complex	165	165	821	825
Gulf of Mexico Range Complex	154	154	766	770
Total	**1,169**	**1,169**	**5,833**	**5,845**

Table 3.0-38: Number and Location of Wires and Cables Expended During Training Activities (continued)

Activity Area	Maximum Annual # of Materials		5-Year # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Guidance Wires				
Northeast Range Complexes	24	24	120	120
Virginia Capes Range Complex	8	8	40	40
Jacksonville Range Complex	48	48	240	240
SINKEX Area	1	1	5	5
Total	**81**	**81**	**405**	**405**
Sonobuoy Wires				
Northeast Range Complexes	3,128	3,128	15,640	15,640
Virginia Capes Range Complex	8,218	8,218	40,907	41,090
Navy Cherry Point Range Complex	2,959	2,959	14,402	14,795
Jacksonville Range Complex	30,328	30,328	149,861	151,640
Gulf of Mexico Range Complex	0	785	0	3,925
SINKEX Area	480	480	2,400	2,400
Total	**45,113**	**45,898**	**223,210**	**229,490**
Expendable Bathythermograph Wires				
Northeast Range Complexes	139	142	695	708
Virginia Capes Range Complex	329	439	1,640	2,193
Navy Cherry Point Range Complex	85	113	422	563
Jacksonville Range Complex	1,171	1,391	5,490	6,953
Gulf of Mexico Range Complex	3	128	13	640
Other AFTT Areas	155	155	771	771
Total	**1,882**	**2,368**	**9,031**	**11,828**

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center; SINKEX = Sinking Exercise

Table 3.0-39: Number and Location of Wires and Cables Expended During Testing Activities

Activity Area	Maximum Annual # of Materials		5-Year # of Materials	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Fiber Optic Cables				
Virginia Capes Range Complex	430	450	1,830	2,250
Jacksonville Range Complex	100	100	500	500
Key West Range Complex	200	200	1,000	1,000
NSWC Panama City Testing Range	412	432	1,948	2,160
Total	**1,142**	**1,182**	**5,278**	**5,910**

Table 3.0-39: Number and Location of Wires and Cables Expended During Testing Activities (continued)

Activity Area	*Maximum Annual # of Materials*		*5-Year # of Materials*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Guidance Wires				
Northeast Range Complexes	190	190	950	950
Virginia Capes Range Complex	220	220	1,100	1,100
Navy Cherry Point Range Complex	52	52	260	260
Jacksonville Range Complex	234	234	1,170	1,170
Key West Range Complex	2	2	10	10
Gulf of Mexico Range Complex	186	186	930	930
NUWC Newport Testing Range	60	60	300	300
SFOMF	34	34	170	170
Total	**978**	**978**	**4,890**	**4,890**
Sonobuoy Wires				
Northeast Range Complexes	9,290	9,410	42,949	47,049
Virginia Capes Range Complex	8,678	8,758	39,659	43,789
Navy Cherry Point Range Complex	2,558	2,638	12,579	13,189
Jacksonville Range Complex	6,344	6,744	30,669	33,719
Key West Range Complex	3,978	3,978	19,469	19,889
Gulf of Mexico Range Complex	4,646	4,646	22,149	23,229
NUWC Newport Testing Range	1,200	1,200	6,000	6,000
SFOMF	32	32	160	160
NSWC Panama City Testing Range	192	192	960	960
Total	**36,918**	**37,598**	**174,594**	**187,984**
Expendable Bathythermograph Wires				
Northeast Range Complexes	1,835	1,835	9,171	9,171
Virginia Capes Range Complex	1,019	1,019	5,065	5,095
Navy Cherry Point Range Complex	315	315	1,575	1,575
Jacksonville Range Complex	637	637	3,155	3,185
Key West Range Complex	10	10	50	50
Gulf of Mexico Range Complex	978	978	4,890	4,890
SFOMF	4	4	20	20
Total	**4,798**	**4,798**	**23,926**	**23,986**

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center; SINKEX = Sinking Exercise

3.0.3.3.5.2 Decelerators/Parachutes

Aircraft-launched sonobuoys and lightweight torpedoes (such as the MK 46 and MK 54) use nylon decelerators/parachutes ranging in size from 18 in. (small) to 48 in. (medium) in diameter. The majority are relatively small (18 in.) cruciform shape decelerators/parachutes associated with sonobuoys (Figure 3.0-13). Illumination flares and targets use large decelerators/parachutes, up to approximately 19 ft. in diameter. Decelerators/parachutes are made of cloth and nylon, many with weights attached to their short attachment lines to speed their sinking. At water impact, the decelerator/parachute assembly is expended and sinks away from the unit. The decelerator/parachute assembly may remain at the surface for 5–15 seconds before the decelerator/parachute and its housing sink to the seafloor, where it becomes flattened (Environmental Sciences Group, 2005). Once settled on the bottom the canopy may temporarily billow if bottom currents are present. Table 3.0-31 and Table 3.0-32.

Table 3.0-33 show the number and location of decelerator/parachutes expended during proposed training and testing activities.

Figure 3.0-13: Sonobuoy Launch Depicting the Relative Size of a Parachute

3.0.3.3.5.3 Biodegradable Polymer

Marine Vessel Stopping payloads are systems designed to deliver the appropriate measure(s) to affect a vessel's propulsion and associated control surfaces to significantly slow and potentially stop the advance of the vessel. Marine Vessel Stopping proposed activities include the use of biodegradable polymers designed to entangle the propellers of in-water vessels. A biodegradable polymer is a high molecular weight polymer that degrades to smaller compounds as a result of microorganisms and enzymes. The rate of biodegradation could vary from hours to years and the type of small molecules formed during degradation can range from complex to simple products, depending on whether the polymers are natural or synthetic (Karlsson & Albertsson, 1998). Based on the constituents of the biodegradable polymer the Navy proposes to use, it is anticipated that the material will breakdown into small pieces within a few days to weeks. This will breakdown further and dissolve into the water column within weeks to a few months. The final products which are all environmentally benign will be dispersed quickly to undetectable concentrations. Degradation and dispersal timelines are influenced by water temperature, currents, and other oceanographic features. Overall, the longer the polymer remains in the water, the weaker it becomes making it more brittle and likely to break.

Biodegradable polymers will be used only during proposed testing activities, not during training activities. Table 3.0-40 shows the number and location of proposed testing activities that use biodegradable polymer.

Table 3.0-40: Activities Including Biodegradable Polymers During Testing Activities

Activity Area	*Maximum Annual # of Activities*		*5-Year # of Activities*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Biodegradable Polymer				
Virginia Capes Range Complex	30	30	150	150
Jacksonville Range Complex	30	30	150	150
Key West Range Complex	30	30	150	150
Gulf of Mexico Range Complex	30	30	150	150
NUWC Newport Testing Range	30	30	150	150
Total	**150**	**150**	**750**	**750**

Notes: NUWC = Naval Undersea Warfare Center

3.0.3.3.6 Ingestion Stressors

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

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

3.0.3.3.6.1 Non-Explosive Practice Munitions

Only small- or medium-caliber projectiles and flechettes (small metal darts) from some non-explosive rockets would be small enough for marine animals to ingest. This would vary depending on the resource and will be discussed in more detail within each resource section. Small- and medium-caliber projectiles include all sizes up to and including those that are 2.25 in. in diameter. Flechettes from some non-explosive rockets are approximately 2 in. in length. Each non-explosive flechette rocket contains approximately 1,180 individual flechettes that are released. These solid metal materials would quickly move through the water column and settle to the seafloor. Table 3.0-23 and Table 3.0-25 show the number and location of non-explosive practice munitions used during proposed training and testing activities.

3.0.3.3.6.2 Fragments from High-Explosive Munitions

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

Types of high-explosive munitions that can result in fragments include torpedoes, neutralizers, grenades, projectiles, missiles, rockets, buoys, sonobuoys, anti-torpedo countermeasures, mines, and bombs. Fragments would result from fractures in the munitions casing and would vary in size depending on the size of the net explosive weight and munition type; typical sizes of fragments are unknown. These solid metal materials would quickly sink through the water column and settle to the seafloor. Table 3.0-26 and Table 3.0-27 show the number and location of explosives used during training and testing activities that may result in fragments.

3.0.3.3.6.3 Military Expended Materials Other Than Munitions

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

Target-Related Materials

At-sea targets are usually remotely-operated airborne, surface, or subsurface traveling units, many of which are designed to be recovered for reuse. However, if they are used during activities that use high-explosives then they may result in fragments and ultimate loss of the target. Expendable targets that may result in fragments would include air-launched decoys, surface targets (e.g., marine markers, cardboard boxes, and 10 ft. diameter red balloons), and mine shapes. Most target fragments would sink quickly to the seafloor. Floating material, such as Styrofoam, may be lost from target boats and remain at the surface for some time. Only targets that may result in smaller fragments are included in the analyses of ingestion potential.

There are additional types of targets discussed previously, but only surface targets, air targets, ship hulks, and mine shapes would be expected to result in fragments when high-explosive munitions are used. Table 3.0-41 and Table 3.0-42 show the number and location of targets used during proposed training and testing activities that may result in fragments.

Table 3.0-41: Number and Location of Targets Expended During Training Activities That May Result in Fragments

Activity Area	*Maximum Annual # of Targets*		*5-Year # of Targets*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Air Targets				
Northeast Range Complexes	4	4	20	20
Virginia Capes Range Complex	78	78	390	390
Navy Cherry Point Range Complex	85	85	425	425
Jacksonville Range Complex	65	65	325	325
Key West Range Complex	8	8	40	40
Gulf of Mexico Range Complex	8	8	40	40
Total	**248**	**248**	**1,240**	**1,240**
Surface Targets				
Northeast Range Complexes	2	2	10	10

Table 3.0-41: Number and Location of Targets Expended During Training Activities That May Result in Fragments (continued)

Activity Area	Maximum Annual # of Targets		5-Year # of Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Virginia Capes Range Complex	3,876	3,876	6,095	6,095
Navy Cherry Point Range Complex	598	598	2,990	2,990
Jacksonville Range Complex	775	775	3,875	3,875
Gulf of Mexico Range Complex	51	51	255	255
Other AFTT Areas	3	3	15	15
Total	**5,305**	**5,305**	**13,240**	**13,240**
Subsurface Targets				
Northeast Range Complexes	100	102	498	510
Virginia Capes Range Complex	291	401	1,455	2,055
Navy Cherry Point Range Complex	81	108	403	540
Jacksonville Range Complex	1,108	1,328	5,540	6,640
Gulf of Mexico Range Complex	3	5	12	25
Other AFTT Areas	178	178	891	891
Total	**1,761**	**2,122**	**8,799**	**10,661**
Mine Shapes				
Virginia Capes Range Complex	292	292	1,456	1,460
Navy Cherry Point Range Complex	24	24	120	120
Jacksonville Range Complex	60	60	292	300
Key West Range Complex	8	8	40	40
Gulf of Mexico Range Complex	60	60	292	300
Inland Waters (see Table 3.0-42)	60	60	204	340
Total	**504**	**504**	**2,584**	**2,860**

Notes: AFTT = Atlantic Fleet Training and Testing

Table 3.0-42: Number and Location of Targets Expended During Training Activities in Inland Waters That May Result in Fragments

Activity Area	Maximum Annual # of Targets		5-Year # of Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Mine Shapes				
Boston, MA	4	4	12	20
Earle, NJ	4	4	12	20
Delaware Bay, DE	4	4	12	20
Hampton Roads, VA	8	8	24	40
Morehead City, NC	8	8	24	40
Wilmington, NC	4	4	12	20
Savannah, GA	4	4	12	20
Kings Bay, GA	4	4	12	20

Table 3.0-42: Number and Location of Targets Expended During Training Activities in Inland Waters That May Result in Fragments (continued)

Activity Area	*Maximum Annual # of Targets*		*5-Year # of Targets*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Mayport, FL	4	4	12	20
Port Canaveral, FL	8	8	24	40
Tampa, FL	4	4	12	20
Beaumont, TX	8	8	24	40
Corpus Christi, TX	4	4	12	20
Total	**68**	**68**	**204**	**340**

Table 3.0-43: Number and Location of Targets Expended During Testing Activities That May Result in Fragments

Activity Area	*Maximum Annual # of Targets*		*5-Year # of Targets*	
	Alternative 1	*Alternative 2*	*Alternative 1*	*Alternative 2*
Air Targets				
Northeast Range Complexes	60	60	300	300
Virginia Capes Range Complex	60	60	300	300
Navy Cherry Point Range Complex	60	60	300	300
Jacksonville Range Complex	60	60	300	300
Key West Range Complex	60	60	300	300
Gulf of Mexico Range Complex	70	70	350	350
Total	**370**	**370**	**1,850**	**1,850**
Air Targets – Drones				
Northeast Range Complexes	6	6	28	28
Virginia Capes Range Complex	480	480	2,398	2,398
Navy Cherry Point Range Complex	6	6	28	28
Jacksonville Range Complex	174	174	868	868
Key West Range Complex	6	6	28	28
Gulf of Mexico Range Complex	6	6	28	28
NUWC Newport Testing Range	6	6	28	28
SFOMF	6	6	28	28
NSWC Panama City Testing Range	6	6	28	28
Total	**696**	**696**	**3,462**	**3,462**
Surface Targets				
Northeast Range Complexes	174	174	861	861
Virginia Capes Range Complex	462	462	2,213	2,306
Navy Cherry Point Range Complex	171	171	861	861
Jacksonville Range Complex	290	290	1,317	1,445
Key West Range Complex	173	173	861	861
Gulf of Mexico Range Complex	121	121	881	911

Table 3.0-43: Number and Location of Targets Expended During Testing Activities That May Result in Fragments (continued)

Activity Area	Maximum Annual # of Targets		5-Year # of Targets	
	Alternative 1	Alternative 2	Alternative 1	Alternative 2
NUWC Newport Testing Range	253	253	62	62
SFOMF	13	13	62	62
NSWC Panama City Testing Range	13	13	62	62
Total	**1,670**	**1,670**	**7,180**	**7,431**
Subsurface Targets				
Northeast Range Complexes	100	100	500	500
Virginia Capes Range Complex	105	105	525	525
Jacksonville Range Complex	265	265	1,325	1,325
Gulf of Mexico Range Complex	100	100	500	500
NUWC Newport Testing Range	240	240	1,200	1,200
Total	**810**	**810**	**4,050**	**4,050**
Mine Shapes				
Northeast Range Complexes	5,600	5,600	28,000	28,000
Virginia Capes Range Complex	3,172	3,172	15,860	15,860
Jacksonville Range Complex	1,595	1,595	7,975	7,975
Gulf of Mexico Range Complex	2,755	2,755	13,772	13,772
NUWC Newport Testing Range	342	342	1,710	1,710
SFOMF	885	885	4,423	4,423
NSWC Panama City Testing Range	4,309	4,309	21,545	21,545
Total	**18,658**	**18,658**	**93,285**	**93,285**

Notes: AFTT = Atlantic Fleet Training and Testing; NUWC = Naval Undersea Warfare Center; SFOMF = South Florida Ocean Measurement Facility; NSWC = Naval Surface Warfare Center; SINKEX = Sinking Exercise

Chaff

Chaff consists of reflective, aluminum-coated glass fibers used to obscure ships and aircraft from radar-guided systems. Chaff, which is stored in canisters, is either dispensed from aircraft or fired into the air from the decks of surface ships when an attack is imminent. The glass fibers create a radar cloud that mask the position of the ship or aircraft. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide (U.S. Department of the Air Force, 1997). Chaff is released or dispensed in cartridges or projectiles that contain millions of fibers. When deployed, a diffuse cloud of fibers is formed that is undetectable to the human eye. Chaff is a very light material, similar to fine human hair. It can remain suspended in air anywhere from 10 minutes to 10 hours and can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten et al., 2002; U.S. Department of the Air Force, 1997). Doppler radar has tracked chaff plumes containing approximately 900 g of chaff drifting 200 mi. from the point of release, with the plume covering greater than 400 mi.^{3} (Arfsten et al., 2002).

The chaff concentrations that marine animals could be exposed to following the release of multiple cartridges (e.g., following a single day of training) is difficult to accurately estimate because it depends on several variable factors. First, specific release points are not recorded and tend to be random, and chaff dispersion in air depends on prevailing atmospheric conditions. After falling from the air, chaff fibers would be expected to float on the sea surface for some period, depending on wave and wind action. The fibers would be dispersed farther by sea currents as they float and slowly sink toward the bottom. Chaff concentrations in benthic habitats following the release of a single cartridge would be lower than the values noted in this section, based on dispersion by currents and the dilution capacity of the ocean.

Several literature reviews and controlled experiments indicate that chaff poses little risk to organisms, except at concentrations substantially higher than those that could reasonably occur from military training (Arfsten et al., 2002; Hullar et al., 1999; U.S. Department of the Air Force, 1997). Nonetheless, some marine animal species within the Study Area could be exposed to chaff through direct body contact, inhalation, and ingestion. Chemical alteration of water and sediment from decomposing chaff fibers is not expected to occur. Based on the dispersion characteristics of chaff, it is likely that marine animals would occasionally come in direct contact with chaff fibers while either at the water's surface or while submerged, but such contact would be inconsequential. Because of the flexibility and softness of chaff, external contact would not be expected to impact most wildlife (U.S. Department of the Air Force, 1997) and the fibers would quickly wash off shortly after contact. Given the properties of chaff, skin irritation is not expected to be a problem (U.S. Department of the Air Force, 1997). The potential exists for marine animals to inhale chaff fibers if they are at the surface while chaff is airborne. Arfsten et al. (2002), Hullar et al. (1999), and U.S. Department of the Air Force (1997) reviewed the potential impacts of chaff inhalation on humans, livestock, and other animals and concluded that the fibers are too large to be inhaled into the lungs. The fibers were predicted to be deposited in the nose, mouth, or trachea and either swallowed or expelled.

In laboratory studies conducted by the University of Delaware (Hullar et al., 1999), blue crabs and killifish were fed a food-chaff mixture daily for several weeks, and no significant mortality was observed at the highest exposure treatment. Similar results were found when chaff was added directly to exposure chambers containing filter-feeding menhaden. Histological examination indicated no damage from chaff exposures. A study on cow calves that were fed chaff found no evidence of digestive disturbance or other clinical symptoms (U.S. Department of the Air Force, 1997).

Chaff cartridge plastic end caps and pistons would also be released into the marine environment, where they would persist for long periods and could be ingested by marine animals. Chaff end caps and pistons sink in saltwater (Spargo, 2007).

Table 3.0-31 and Table 3.0-33 show the number and location of chaff cartridges, chaff canisters, and chaff components used during training and testing activities.

Flares

Flares are pyrotechnic devices used to defend against heat-seeking missiles, where the missile seeks out the heat signature from the flare rather than the aircraft's engines. Similar to chaff, flares are also dispensed from aircraft. The flare device consists of a cylindrical cartridge approximately 1.4 in. in diameter and 5.8 in. in length. Flares are designed to burn completely. The only material that would enter the water would be a small, round, plastic compression pad or piston (0.45 to 4.1 g depending on flare type). The flare pads and pistons float in sea water.

An extensive literature review and controlled experiments conducted by the U.S. Air Force revealed that self-protection flare use poses little risk to the environment or animals (U.S. Department of the Air Force, 1997).

Table 3.0-31 and Table 3.0-33 show the number and location of flares and flare components expended during training and testing activities.

Decelerators/Parachutes

Decelerators/parachutes are expended with the use of sonobuoys, lightweight torpedoes, and illumination flares. Only the small- and medium-size decelerators/parachutes expended with sonobuoys and lightweight torpedoes pose an ingestion risk to marine life. See Section 3.0.3.3.5.2 (Decelerators/Parachutes) above for a complete description.

Table 3.0-31 and Table 3.0-33 show the number and location of small- and medium-size decelerators/parachutes expended during proposed training and testing activities.

3.0.3.4 Resource-Specific Impacts Analysis for Individual Stressors

The direct and indirect impacts of each stressor are analyzed in each resource section for which there may be an impact. Quantitative methods were used to the extent possible, but data limitations required the use of qualitative methods for most stressor/resource interactions. Resource-specific methods are described in sections of Chapter 3 (Affected Environment and Environmental Consequences), where applicable. While specific methods used to analyze the impacts of individual stressors varied by resource, the following generalized approach was used for all stressor/resource interactions:

- The frequency, duration, and spatial extent of exposure to stressors were analyzed for each resource. The frequency of exposure to stressors or frequency of a proposed activity was characterized as intermittent or continuous, and was quantified in terms of number per unit of time when possible. Duration of exposure was expressed as short or long term and was quantified in units of time (e.g., seconds, minutes, and hours) when possible. The spatial extent of exposure was generally characterized as widespread or localized, and the stressor footprint or area (e.g., square feet, square nautical miles) was quantified when possible.
- An analysis was conducted to determine whether and how resources are likely to respond to stressor exposure or be altered by stressor exposure based upon available scientific knowledge. This step included reviewing available scientific literature and empirical data. For many stressor/resource interactions, a range of likely responses or endpoints was identified. For example, exposure of an organism to sound produced by an underwater explosion could result in no response, a physiological response such as increased heart rate, a behavioral response such as being startled, or injury.
- The information obtained was used to analyze the likely impacts of individual stressors on a resource and to characterize the type, duration, and intensity (severity) of impacts. The type of impact was generally defined as beneficial or adverse and was further defined as a specific endpoint (e.g., change in behavior, mortality, change in concentration, loss of habitat, loss of fishing time). When possible, the endpoint was quantified. The duration of an impact was generally characterized as short term (e.g., minutes, days, weeks, months, depending on the resource), long-term (e.g., months, years, decades, depending on the resource), or permanent. The intensity of an impact was then determined. For biological resources, the analysis started with individual organisms and their habitats, and then addressed populations, species, communities, and representative ecosystem characteristics, as appropriate.

3.0.3.5 Resource-Specific Impacts Analysis for Multiple Stressors

The stressors associated with the proposed training and testing activities could affect the environment individually or in combination. The impacts of multiple stressors may be different when considered collectively rather than individually. Therefore, following the resource-specific impacts analysis for individual stressors, the combined impacts of all stressors were analyzed for that resource. This step determines the overall impacts of the alternatives on each resource, and it considers the potential for impacts that are additive (where the combined impacts on the resource are equal to the sum of the individual impacts), synergistic (where impacts combine in such a way as to amplify the effect on the resource), and antagonistic (where impacts will cancel each other out or reduce a portion of the effect on the resource). In some ways, this analysis is similar to the cumulative impacts analysis described below, but it only considers the activities in the alternatives and not other past, present, and reasonably foreseeable future actions. This step helps inform the cumulative impacts analysis and make overall impact conclusions for each resource.

Evaluating the combined impacts of multiple stressors can be complex, especially when the impacts associated with a stressor are hard to measure. Therefore, some general assumptions were used to help determine the potential for individual stressors to contribute to combined impacts. For this analysis, combined impacts were considered more likely to occur in the following situations:

- Stressors co-occur in time and space, causing a resource to be simultaneously affected by more than one stressor.
- A resource is repeatedly affected by multiple stressors or is re-exposed before fully recovering from a previous exposure.
- The impacts of individual stressors are permanent or long term (years or decades) versus short term (minutes, days, or months).
- The intensity of the impacts from individual stressors contributes to a combined overall adverse impact.

The resource-specific impacts analysis for multiple stressors included the following steps:

- Information obtained from the analysis of individual stressors was used to develop a conceptual model to predict the combined impacts of all stressors on each resource. This conceptual model incorporated factors such as the co-occurrence of stressors in space and time; the impacts or assessment endpoints of individual stressors (e.g., mortality, injury, changes in animal behavior or physiology, habitat alteration, or changes in human use); and the duration and intensity of the impacts of individual stressors.
- To the extent possible, additive impacts on a given resource were considered by summing the impacts of individual stressors. This summation was only possible for stressors with identical and quantifiable assessment endpoints. For example, if one stressor disturbed 0.25 square nautical miles (NM^2) of benthic habitat, a second stressor disturbed 0.5 NM^2, and all other stressors did not disturb benthic habitat, then the total benthic habitat disturbed would be 0.75 NM^2. For stressors with identical but not quantifiable assessment endpoints, available scientific knowledge, best professional judgment, and the general assumptions outlined above were used to evaluate potential additive impacts.

- For stressors with differing impacts and assessment endpoints, the potential for additive, synergistic, and antagonistic effects were evaluated based on available scientific knowledge, professional judgment, and the general assumptions outlined above.

A cumulative impact is the impact on the environment that results when the incremental impact of an action is added to other past, present, and reasonably foreseeable future actions. The cumulative impacts analysis (Chapter 4, Cumulative Impacts) considers other actions regardless of what agency (federal or nonfederal) or person undertakes the actions. Cumulative impacts result when individual actions combine with similar actions taking place over a period of time to produce conditions that frequently alter the historical baseline (40 Code of Federal Regulations section 1508.7). The goal of the analysis is to provide the decision makers with information relevant to reasonably foresee potentially significant impacts. See Chapter 4 (Cumulative Impacts) for the specific approach used for determining cumulative impacts.

3.0.3.6 Biological Resource Methods

The analysis of impacts on biological resources focused on the likelihood of encountering the stressor, the primary stimulus, response, and recovery of individual organisms. Where appropriate, the potential of a biological resource to overlap with a stressor was analyzed with consideration given to the specific geographic area (large marine ecosystems, open ocean areas, range complexes, OPAREAs, and other training and testing areas) in which the overlap could occur. Additionally, the differential impacts of training versus testing activities that introduce stressors to the resource were considered.

For each of the non-biological resources considered in this EIS/OEIS, the methods are unique to each specific resource and are therefore described in each resource section. For Air Quality see Section 3.1.1.1 (Methods), for Sediments and Water Quality see Section 3.2.1.2 (Methods), for Cultural Resources see Section 3.10.1.3 (Methods), for Socioeconomics see Section 3.11.1 (Introduction and Methods), and for Public Health and Safety see the Methods discussion under 3.12.1 (Introduction).

3.0.3.6.1 Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities

This conceptual framework describes the potential effects from exposure to acoustic and explosive activities and the accompanying short-term costs to the animal (e.g., expended energy or missed feeding opportunity). It then outlines the conditions that may lead to long-term consequences for the individual if the animal cannot fully recover from the short-term costs and how these in turn may affect the population. Within each biological resource section (e.g., marine mammals, birds, and fishes) the detailed methods to predict effects on specific taxa are derived from this conceptual framework.

An animal is considered “exposed” to a sound if the received sound level at the animal’s location is above the background ambient noise level within a similar frequency band. A variety of effects may result from exposure to acoustic and explosive activities.

The categories of potential effects are:

- ***Injury*** *and other non-auditory injury- Injury to organs or tissues of an animal.*
- ***Hearing loss –*** *A noise-induced decrease in hearing sensitivity which can be either temporary or permanent and may be limited to a narrow frequency range of hearing.*
- ***Masking*** *– When the perception of a biologically important sound (i.e., signal) is interfered with by a second sound (i.e., noise).*
- ***Physiological stress*** *– An adaptive process that helps an animal cope with changing conditions; although, too much stress can result in physiological problems.*
- ***Behavioral response*** *– A reaction ranging from very minor and brief changes in attentional focus, changes in biologically important behaviors, and avoidance of a sound source or area, to aggression or prolonged flight.*

Figure 3.0-14 is a flowchart that diagrams the process used to evaluate the potential effects to marine animals exposed to sound-producing activities. The shape and color of each box on the flowchart represent either a decision point in the analysis (green diamonds); specific processes such as responses, costs, or recovery (blue rectangles); external factors to consider (purple parallelograms); and final outcomes for the individual or population (orange ovals and rectangles). Each box is labeled for reference throughout the following sections. For simplicity, sound is used here to include not only sound waves but also blast waves generated from explosive sources. Box A1, the Sound-Producing Activity, is the source of this stimuli and therefore the starting point in the analysis.

The first step in predicting whether an activity is capable of affecting a marine animal is to define the Stimuli experienced by the animal. The Stimuli include the overall level of activity, the surrounding acoustical environment, and characteristics of the sound when it reaches the animal.

Sounds emitted from a sound-producing activity (Box A1) travel through the environment to create a spatially variable sound field. The received sound at the animal (Box A2) determines the range of possible effects. The received sound can be evaluated in several ways, including number of times the sound is experienced (repetitive exposures), total received energy, or highest sound pressure level experienced. Sounds that are higher than the ambient noise level and within an animal’s hearing sensitivity range (Box A3) have the potential to cause effects. There can be any number of individual sound sources in a given activity, each with its own unique characteristics. For example, a Navy training exercise may involve several ships and aircraft using several types of sonar. Environmental factors such as temperature and bottom type impact how sound spreads and attenuates through the environment. Additionally, independent of the sounds, the overall level of activity and the number and movement of sound sources are important to help predict the probable reactions.

The magnitude of the responses are predicted based on the characteristics of the acoustic stimuli and the characteristics of the animal (species, susceptibility, life history stage, size, and past experiences). Very high exposure levels close to explosives have the potential to cause injury. High-level, long-duration, or repetitive exposures may potentially cause some hearing loss. All perceived sounds may lead to behavioral responses, physiological stress, and masking. Many sounds, including sounds that are not detectable by the animal, could have no effect (Box A4).

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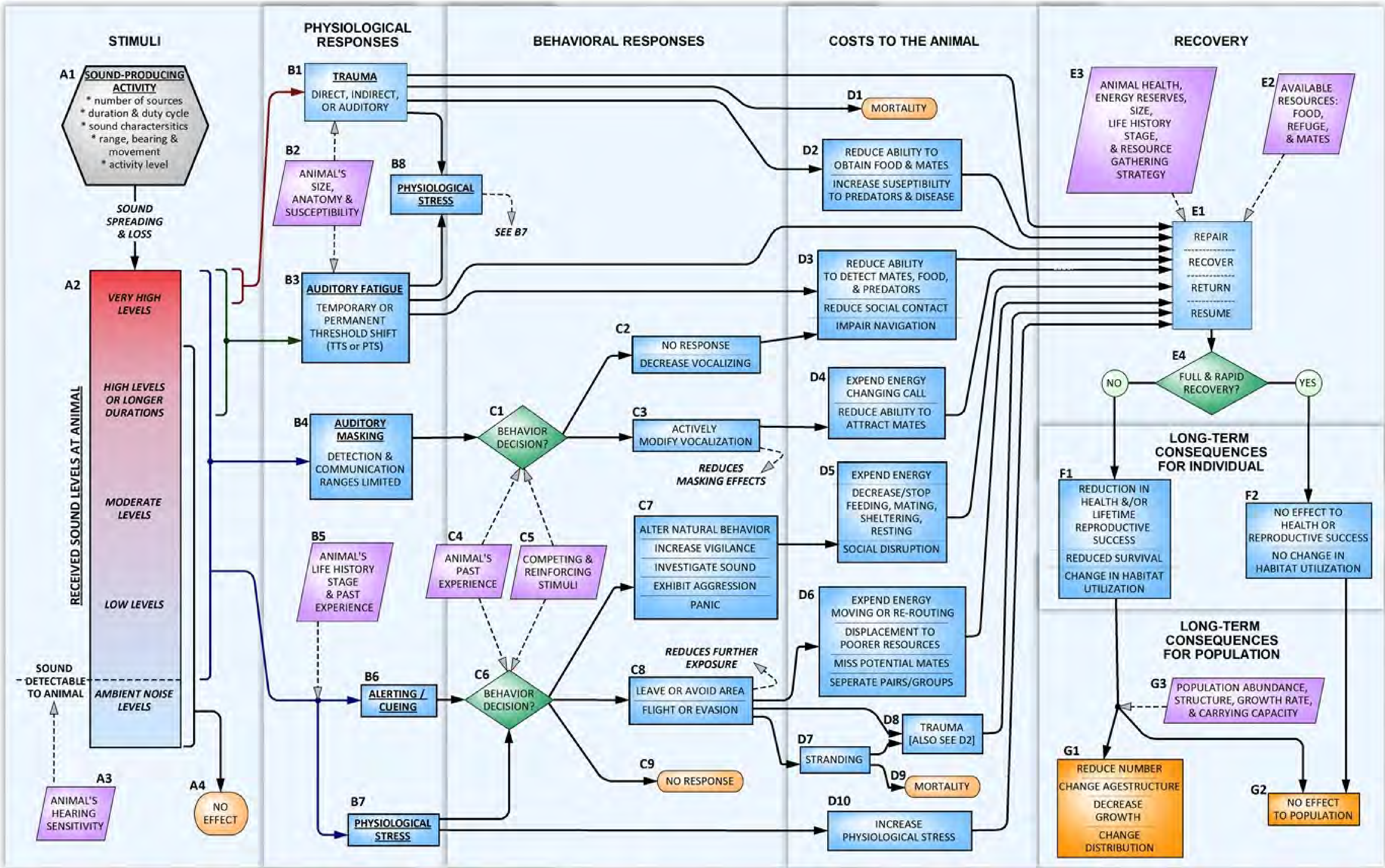

Figure 3.0-14: Flow Chart of the Evaluation Process of Sound-Producing Activities

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3.0.3.6.1.1 Injury

Injury (Box B1) refers to the direct injury of tissues and organs by shock or pressure waves impinging upon or traveling through an animal's body. Marine animals are well adapted to large, but relatively slow, hydrostatic pressures changes that occur with changing depth. However, injury may result from exposure to rapid pressure changes, such that the tissues do not have time to adequately adjust.

Therefore, injury is normally limited to relatively close ranges from explosions. Injury can be mild and fully recoverable or, in some cases, lead to mortality.

Injury includes both auditory and non-auditory injury. Auditory injury is the direct mechanical injury to hearing-related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and injury to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory injury differs from auditory fatigue in that the latter involves the overstimulation of the auditory system at levels below those capable of causing direct mechanical damage. Auditory injury is always injurious but can be temporary. One of the most common consequences of auditory injury is hearing loss.

Non-auditory injury can include hemorrhaging of small blood vessels and the rupture of gas-containing tissues such as the lung, swim bladder, or gastrointestinal tract. After the ear (or other sound-sensing organs), these are usually the organs and tissues most sensitive to explosive injury. An animal’s size and anatomy are important in determining its susceptibility to non-auditory injury (Box B2). Larger size indicates more tissue to protect vital organs. Therefore, larger animals should be less susceptible to injury than smaller animals. In some cases, acoustic resonance of a structure may enhance the vibrations resulting from noise exposure and result in an increased susceptibility to injury. The size, geometry, and material composition of a structure determine the frequency at which the object will resonate. Because most biological tissues are heavily damped, the increase in susceptibility from resonance is limited.

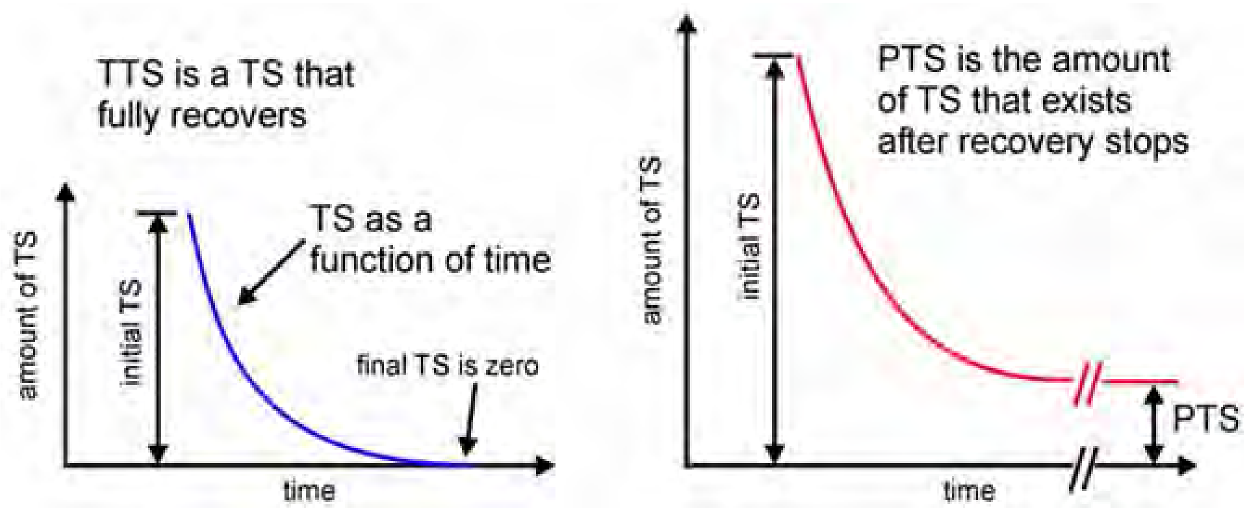
Vascular and tissue bubble formation resulting from sound exposure is a hypothesized mechanism of injury to breath-holding marine animals. Bubble formation and growth due to direct sound exposure have been hypothesized (Crum et al., 2005; Crum & Mao, 1996); however, the experimental laboratory conditions under which these phenomena were observed would not be replicated in the wild. Certain dive behaviors by breath-holding animals are predicted to result in conditions of blood nitrogen super-saturation, potentially putting an animal at risk for decompression sickness (Fahlman et al., 2014), although this phenomena has not been observed (Houser et al., 2009). In addition, animals that spend long periods of time at great depths are predicted to have super-saturated tissues that may slowly release nitrogen if the animal then spends a long time at the surface (i.e., stranding) (Houser et al., 2009).

Injury could increase the animal’s physiological stress (Box B8), which feeds into the stress response (Box B7) and also increases the likelihood or severity of a behavioral response. Injury may reduce an animal’s ability to secure food by reducing its mobility or the efficiency of its sensory systems, making the injured individual less attractive to potential mates, increasing an individual’s chances of contracting diseases or falling prey to a predator (Box D2), or increasing an animal's overall physiological stress level (Box D10). Severe injury can lead to the death of the individual (Box D1).

Damaged tissues from mild to moderate injury may heal over time. The predicted recovery of direct injury is based on the severity of the injury, availability of resources, and characteristics of the animal. The animal may also need to recover from any potential costs due to a decrease in resource gathering efficiency and any secondary effects from predators or disease. Severe injuries can lead to reduced survivorship (longevity), elevated stress levels, and prolonged alterations in behavior that can reduce an animal's lifetime reproductive success. An animal with decreased energy stores or a lingering injury may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring produced over its lifetime.

3.0.3.6.1.2 Hearing Loss

Hearing loss, also called a noise-induced threshold shift, is possibly the best studied type of effect from sound exposures to animals. Hearing loss manifests itself as loss in hearing sensitivity across part of an animal's hearing range, which is dependent upon the specifics of the noise exposure. Hearing loss may be either permanent threshold shift (PTS), or temporary threshold shift (TTS). If the threshold shift eventually returns to zero (the animal's hearing returns to pre-exposure value), the threshold shift is a TTS. If the threshold shift does not return to zero but leaves some finite amount of threshold shift, then that remaining threshold shift is a PTS. Figure 3.0-15shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.



Notes: PTS = Permanent Threshold Shift, TS = Threshold Shift, TTS = Temporary Threshold Shift

Figure 3.0-15: Two Hypothetical Threshold Shifts

The characteristics of the received sound stimuli are used and compared to the animal's hearing sensitivity and susceptibility to noise (Box A3) to determine the potential for hearing loss. The amplitude, frequency, duration, and temporal pattern of the sound exposure are important parameters for predicting the potential for hearing loss over a specific portion of an animal's hearing range. Duration is particularly important because hearing loss increases with prolonged exposure time. Longer exposures with lower sound levels can cause more threshold shift than a shorter exposure using the same amount of energy overall. The frequency of the sound also plays an important role. Experiments show that animals are most susceptible to hearing loss (Box B3) within their most sensitive hearing range. Sounds outside of an animal's audible frequency range do not cause hearing loss.

The mechanisms responsible for hearing loss may consist of a variety of mechanical and biochemical processes in the inner ear, including physical damage or distortion of the tympanic membrane (not including tympanic membrane rupture which is considered auditory injury), physical damage or distortion of the cochlear hair cells, hair cell death, changes in cochlear blood flow, and swelling of cochlear nerve terminals (Henderson et al., 2006; Kujawa & Liberman, 2009). Although the outer hair cells are the most prominent target for fatigue effects, severe noise exposures may also result in inner hair cell death and loss of auditory nerve fibers (Henderson et al., 2006).

The relationship between TTS and PTS is complicated and poorly understood, even in humans and terrestrial mammals, where numerous studies failed to delineate a clear relationship between the two. Relatively small amounts of TTS (e.g., less than 40–50 dB measured two minutes after exposure) will recover with no apparent permanent effects; however, terrestrial mammal studies revealed that larger amounts of threshold shift can result in permanent neural degeneration, despite the hearing thresholds returning to normal (Kujawa & Liberman, 2009). The amounts of threshold shift induced by Kujawa and Liberman (2009) were described as being "at the limits of reversibility." It is unknown whether smaller amounts of threshold shift can result in similar neural degeneration, or if effects would translate to other species such as marine animals.

Hearing loss can increase an animal's physiological stress (Box B8), which feeds into the stress response (Box B7). Hearing loss increase the likelihood or severity of a behavioral response and increase an animal's overall physiological stress level (Box D10). Hearing loss reduces the distance over which animals can communicate and detect other biologically important sounds (Box D3). Hearing loss could also be inconsequential for an animal if the frequency range affected is not critical for that animal to hear within, or the hearing loss is of such short duration (e.g., a few minutes) that there are no costs to the individual.

Small to moderate amounts of hearing loss may recover over a period of minutes to days, depending on the amount of initial threshold shift. Severe noise-induced hearing loss may not fully recover, resulting in some amount of PTS. An animal whose hearing does not recover quickly and fully could suffer a reduction in lifetime reproductive success. An animal with PTS may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring it can produce over its lifetime.

3.0.3.6.1.3 Masking

Masking occurs if the noise from an activity interferes with an animal's ability to detect, understand, or recognize biologically relevant sounds of interest (Box B4). In this context noise refers to unwanted or unimportant sounds that mask an animal's ability to hear sounds of interest. Sounds of interest include those from conspecifics such as offspring, mates, and competitors; echolocation clicks; sounds from predators; natural, abiotic sounds that may aid in navigation; and reverberation, which can give an animal information about its location and orientation within the ocean. The probability of masking increases as the noise and sound of interest increase in similarity and the masking noise increases in level. The frequency, received level, and duty cycle of the noise determines the potential degree of auditory masking. Masking only occurs during the sound exposure.

A behavior decision (either conscious or instinctive) is made by the animal when the animal detects increased background noise, or possibly, when the animal recognizes that biologically relevant sounds are being masked (Box C1). An animal's past experiences can be important in determining the behavioral response when dealing with masking (Box C4). For example, an animal may modify its vocalizations to reduce the effects of masking noise. Other stimuli present in the environment can influence an animal's behavior decision (Box C5) such as the presence of predators, prey, or potential mates.

An animal may exhibit a passive behavioral response when coping with masking (Box C2). It may simply not respond and keep conducting its current natural behavior. An animal may also stop calling until the background noise decreases. These passive responses do not present a direct energetic cost to the animal; however, masking will continue, depending on the acoustic stimuli.

An animal may actively compensate for masking (Box C3). An animal can vocalize more loudly to make its signal heard over the masking noise. An animal may also shift the frequency of its vocalizations away from the frequency of the masking noise. This shift can actually reduce the masking effect for the animal and other animals that are listening in the area.

If masking impairs an animal's ability to hear biologically important sounds (Box D3) it could reduce an animal's ability to communicate with conspecifics or reduce opportunities to detect or attract more distant mates, gain information about their physical environment, or navigate. An animal that modifies its vocalization in response to masking could also incur a cost (Box D4). Modifying vocalizations may cost the animal energy, interfere with the behavioral function of a call, or reduce a signaler's apparent quality as a mating partner. For example, songbirds that shift their calls up an octave to compensate for increased background noise attract fewer or less-desirable mates, and many terrestrial species advertise body size and quality with low-frequency vocalizations (Slabbekoorn & Ripmeester, 2007). Masking may also lead to no measurable costs for an animal. Masking could be of short duration or intermittent such that biologically important sounds that are continuous or repeated are received by the animal between masking noise.

Masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity. Masking could have long-term consequences for individuals if the activity was continuous or occurred frequently enough.

3.0.3.6.1.4 Physiological Stress

Marine animals naturally experience physiological stress as part of their normal life histories. The physiological response to a stressor, often termed the stress response, is an adaptive process that helps an animal cope with changing external and internal environmental conditions. Sound-producing activities have the potential to cause additional stress. However, too much of a stress response can be harmful to an animal, resulting in physiological dysfunction.

If a sound is detected (i.e., heard or sensed) by an animal, a stress response can occur (Box B7). The severity of the stress response depends on the received sound level at the animal (Box A2), the details of the sound-producing activity (Box A1), and the animal's life history stage (e.g., juvenile or adult, breeding or feeding season), and past experience with the stimuli (Box B5). An animal's life history stage is an important factor to consider when predicting whether a stress response is likely (Box B5). An animal's life history stage includes its level of physical maturity (i.e., larva, infant, juvenile, sexually mature adult) and the primary activity in which it is engaged such as mating, feeding, or rearing/caring for young. Prior experience with a stressor may be of particular importance because repeated experience with a stressor may dull the stress response via acclimation (St. Aubin & Dierauf, 2001) or increase the response via sensitization. Additionally, if an animal suffers injury or hearing loss, a physiological stress response will occur (Box B8).

The generalized stress response is characterized by a release of hormones (Reeder & Kramer, 2005) and other chemicals (e.g., stress markers) such as reactive oxidative compounds associated with noise-induced hearing loss (Henderson et al., 2006). Stress hormones include norepinephrine and epinephrine (i.e., the catecholamines), which produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipid for energy. Other stress hormones are the glucocorticoid steroid hormones cortisol and aldosterone, which are classically used as an indicator of a stress response and to characterize the magnitude of the stress response (Hennessy et al., 1979).

An acute stress response is traditionally considered part of the startle response and is hormonally characterized by the release of the catecholamines. Annoyance type reactions may be characterized by the release of either or both catecholamines and glucocorticoid hormones. Regardless of the physiological changes that make up the stress response, the stress response may contribute to an animal's decision to alter its behavior.

Elevated stress levels may occur whether or not an animal exhibits a behavioral response (Box D10). Even while undergoing a stress response, competing stimuli (e.g., food or mating opportunities) may overcome any behavioral response. Regardless of whether the animal displays a behavioral response, this tolerated stress could incur a cost to the animal. Reactive oxygen compounds produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can lead to damage of lipids, proteins, and nucleic acids at the cellular level (Berlett & Stadtman, 1997; Sies, 1997; Touyz, 2004).

Frequent physiological stress responses may accumulate over time increasing an animal's chronic stress level. Each component of the stress response is variable in time, and stress hormones return to baseline levels at different rates. Elevated chronic stress levels are usually a result of a prolonged or repeated disturbance. Chronic elevations in the stress levels (e.g., cortisol levels) may produce long-term health consequences that can reduce lifetime reproductive success.

3.0.3.6.1.5 Behavioral Reactions

Behavioral responses fall into two major categories: alterations in natural behavior patterns and avoidance. These types of reactions are not mutually exclusive, and many overall reactions may be combinations of behaviors or a sequence of behaviors. Severity of behavioral reactions can vary drastically between minor and brief reorientations of the animal to investigate the sound, to severe reactions such as aggression or prolonged flight. The type and severity of the behavioral response will determine the cost to the animal. The total number of vehicles and platforms involved, the size of the activity area, the distance between the animal and activity, and the duration of the activity are important considerations when predicting the initial behavioral responses.

A physiological stress response (Box B7) such as an annoyance or startle reaction, or cueing or alerting (Box B6) may cause an animal to make a behavior decision (Box C6). Any exposure that produces an injury or hearing loss is also assumed to produce a stress response (Box B7) and increase the severity or likelihood of a behavioral reaction. Both an animal's experience (Box C4) and competing and reinforcing stimuli (Box C5) can affect an animal's behavior decision. The decision can result in three general types of behavioral reactions: no response (Box C9), area avoidance (Box C8), or alteration of a natural behavior (Box C7).

An animal's past experiences can be important in determining what behavior decision it may make when dealing with a stress response (Box C4). Habituation is the process by which an animal learns to ignore or tolerate stimuli over some period and return to a normal behavior pattern, perhaps after being exposed to the stimuli with no negative consequences. Sensitization is when an animal becomes more sensitive to a set of stimuli over time, perhaps as a result of a past, negative experience that could result in a stronger behavioral response.

Other stimuli (Box C5) present in the environment can influence an animal's behavioral response. These stimuli may be conspecifics or predators in the area or the drive to engage in a natural behavior. Other stimuli can also reinforce the behavioral response caused by acoustic stimuli. For example, the awareness of a predator in the area coupled with the sound-producing activity may elicit a stronger reaction than the activity alone would have.

An animal may reorient, become more vigilant, or investigate if it detects a sound-producing activity (Box C7). These behaviors all require the animal to divert attention and resources, therefore slowing or stopping their presumably beneficial natural behavior. This can be a very brief diversion, or an animal may not resume its natural behaviors until after the activity has concluded. An animal may choose to leave or avoid an area where a sound-producing activity is taking place (Box C8). A more severe form of this comes in the form of flight or evasion. Avoidance of an area can help the animal avoid further effects by avoiding or reducing further exposure. An animal may also choose not to respond to a sound-producing activity (Box C9).

An animal that alters its natural behavior in response to stress or an auditory cue may slow or cease its natural behavior and instead expend energy reacting to the sound-producing activity (Box D5). Natural behaviors include feeding, breeding, sheltering, and migrating. The cost of feeding disruptions depends on the energetic requirements of individuals and the potential amount of food missed during the disruption. Alteration in breeding behavior can result in delaying reproduction. The costs of a brief interruption to migrating or sheltering are less clear.

An animal that avoids a sound-producing activity may expend additional energy moving around the area, be displaced to poorer resources, miss potential mates, or have social interactions affected (Box D6). The amount of energy expended depends on the severity of the behavioral response. Missing potential mates can result in delaying reproduction. Groups could be separated during a severe behavioral response such as flight and offspring that depend on their parents may die if they are permanently separated. Splitting up an animal group can result in a reduced group size, which can have secondary effects on individual foraging success and susceptibility to predators.

Some severe behavioral reactions can lead to stranding (Box D7) or secondary injury (Box D8). Animals that take prolonged flight, a severe avoidance reaction, may injure themselves or strand in an environment for which they are not adapted. Some injury is likely to occur to an animal that strands (Box D8). Trauma can reduce the animal's ability to secure food and mates, and increase the animal's susceptibility to predation and disease (Box D2). An animal that strands and does not return to a hospitable environment may die (Box D9).

3.0.3.6.1.6 Long-Term Consequences

The potential long-term consequences from behavioral responses are difficult to discern. Animals displaced from their normal habitat due to an avoidance reaction may return over time and resume their natural behaviors. This is likely to depend upon the severity of the reaction and how often the activity is repeated in the area. In areas of repeated and frequent acoustic disturbance, some animals may habituate to the new baseline; conversely, species that are more sensitive may not return, or return but not resume use of the habitat in the same manner. For example, an animal may return to an area to feed but no longer rest in that area. Long-term abandonment or a change in the utilization of an area by enough individuals can change the distribution of the population. Frequent disruptions to natural behavior patterns may not allow an animal to recover between exposures, which increase the probability of causing long-term consequences to individuals.

The magnitude and type of effect and the speed and completeness of recovery (i.e., return to baseline conditions) must be considered in predicting long-term consequences to the individual animal (Box E4). The predicted recovery of the animal (Box E1) is based on the cost to the animal from any reactions, behavioral or physiological. Available resources fluctuate by season, location, and year and can play a major role in an animal's rate of recovery (Box E2). Recovery can occur more quickly if plentiful food resources, many potential mates, or refuge or shelter is available. An animal's health, energy reserves, size, life history stage, and resource gathering strategy affect its speed and completeness of recovery (Box E3). Animals that are in good health and have abundant energy reserves before an effect takes place will likely recover more quickly.

Animals that recover quickly and completely are unlikely to suffer reductions in their health or reproductive success, or experience changes in habitat utilization (Box F2). No population-level effects would be expected if individual animals do not suffer reductions in their lifetime reproductive success or change their habitat utilization (Box G2). Animals that do not recover quickly and fully could suffer reductions in their health and lifetime reproductive success; they could be permanently displaced or change how they use the environment; or they could die (Box F1). These long-term consequences to the individual can lead to consequences for the population (Box G1); although, population dynamics and abundance play a role in determining how many individuals would need to suffer long-term consequences before there was an effect on the population.

Long-term consequences to individuals can translate into consequences for populations dependent upon population abundance, structure, growth rate, and carry capacity. Carrying capacity describes the theoretical maximum number of animals of a particular species that the environment can support. When a population nears its carrying capacity, its growth is naturally limited by available resources and predator pressure. If one, or a few animals, in a population are removed or gather fewer resources, then other animals in the population can take advantage of the freed resources and potentially increase their health and lifetime reproductive success. Abundant populations that are near their carrying capacity (theoretical maximum abundance) that suffer consequences on a few individuals may not be affected overall. Populations that exist well below their carrying capacity may suffer greater consequences from any lasting consequences to even a few individuals. Population-level consequences can include a change in the population dynamics, a decrease in the growth rate, or a change in geographic distribution.

3.0.3.6.2 Conceptual Framework for Assessing Effects from Energy-Producing Activities

3.0.3.6.2.1 Stimuli

<u>Magnitude of the Energy Stressor</u>

Regulations do not provide threshold criteria to determine the significance of the potential effects from activities that involve the use of varying electromagnetic frequencies or lasers. Many organisms, primarily marine vertebrates, have been studied to determine their thresholds for detecting electromagnetic fields, as reviewed by Normandeau et al. (2011); however, there are no data on predictable responses to exposure above or below detection thresholds. The types of electromagnetic fields discussed are those from mine neutralization activities (magnetic influence minesweeping). High-energy and low-energy lasers were considered for analysis. Low-energy lasers (e.g., targeting systems, detection systems, laser light detection and ranging) do not pose a risk to organisms (Swope, 2010) and therefore will not be discussed further. Radar was also considered for analysis, and also was determined not to pose a risk to biological resources.

Location of the Energy Stressor

Evaluation of potential energy exposure risks considered the spatial overlap of the resource occurrence and electromagnetic field and high-energy laser use. Wherever appropriate, specific geographic areas of potential impact were identified and the relative location of the resource with respect to the source was considered. For example, the greatest potential electromagnetic energy exposure is at the source, where intensity is greatest and the greatest potential for high energy laser exposure is at the ocean's surface, where high-energy laser intensity is greatest. All light energy, including laser light, entering the ocean becomes absorbed and scattered at a rate that is dependent on the frequency of the light. For most laser applications, the energy is rapidly reduced as the light penetrates the ocean.

Behavior of the Organism

Evaluation of potential energy exposure risk considered the behavior of the organism, especially where the organism lives and feeds (e.g., surface, water column, seafloor). The analysis for electromagnetic devices considered those species with the ability to perceive or detect electromagnetic signals. The analysis for high-energy lasers and radar particularly considered those species known to occur at or above the surface of the ocean.

3.0.3.6.2.2 Immediate Response and Costs to the Individual

Many different types of organisms (e.g., some invertebrates, fishes, sea turtles, birds, mammals) are sensitive to electromagnetic fields (Normandeau et al., 2011). An organism that encounters a disturbance in an electromagnetic field could respond by moving toward the source, moving away from it, or not responding at all. The types of electromagnetic devices used in the Proposed Action simulate the electromagnetic signature of a vessel passing through the water column, so the expected response would be similar to that of vessel movement. However, since there would be no actual strike potential, a physiological response would be unlikely in most cases. Recovery of an individual from encountering electromagnetic fields would be variable, but since the physiological response would likely be minimal, as reviewed by Normandeau et al. (2011), any recovery time would also be minimal.

Very little data are available to analyze potential impacts on organisms from exposure to high energy lasers. For all but the highest energy lasers, the greatest laser-related concern for marine species is damage to an organism's ability to see.

3.0.3.6.2.3 Long-Term Consequences to the Individual and Population

Long-term consequences are considered in terms of a resource's existing population level, growth and mortality rates, other stressors on the resource from the Proposed Action, cumulative impacts on the resource, and the ability of the population to recover from or adapt to impacts. Impacts of multiple or repeated stressors on individuals are cumulative.

3.0.3.6.3 Conceptual Framework for Assessing Effects from Physical Disturbance or Strike

3.0.3.6.3.1 Stimuli

Size and Weight of the Objects

To determine the likelihood of a strike and the potential impacts on an organism or habitat that would result from a physical strike, the size and weight of the striking object relative to the organism or habitat must be considered. For example, most small organisms and early life stages would simply be displaced by the movement generated by a large object moving through, or falling into, the water, whereas a larger organism could potentially be struck by an object since it may not be displaced by the movement of the water. The weight of the object is also a factor that would determine the severity of a strike. A strike by a heavy object would be more severe than a strike by a low-weight object (e.g., a decelerator/parachute, flare end cap, or chaff canister).

Location and Speed of the Objects

Evaluation of potential physical disturbance or strike risk considered the spatial overlap of the resource occurrence and potential striking objects. Analysis of impacts from physical disturbance or strike stressors focuses on proposed activities that may cause an organism or habitat to be struck by an object moving through the air (e.g., aircraft), water (e.g., vessels, in-water devices, towed devices), or dropped into the water (e.g., non-explosive practice munitions and seafloor devices). The area of operation, vertical distribution, and density of these items also play central roles in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact are identified. Analysis of potential physical disturbance or strike risk also considered the speed of vessels as a measure of intensity. Some vessels move slowly, while others are capable of high speeds.

Buoyancy of the Objects

Evaluation of potential physical disturbance or strike risk in the ocean considered the buoyancy of targets or expended materials during operation, which will determine whether the object will be encountered at the surface, within the water column, or on the seafloor.

Behavior of the Organism

Evaluation of potential physical disturbance or strike risk considered where organisms occur and if they occur in the same geographic area and vertical distribution as those objects that pose strike risks.

3.0.3.6.3.2 Immediate Response and Costs to the Individual

Before being struck, some organisms would sense a pressure wave through the water and respond by remaining in place, moving away from the object, or moving toward it. An organism displaced a small distance by movements from an object falling into the water nearby would likely continue on with no response. However, others could be disturbed and may exhibit a generalized stress response. If the object actually hit the organism, direct injury in addition to stress may result. The function of the stress response in vertebrates is to rapidly raise the blood sugar level to prepare the organism to flee or fight. This generally adaptive physiological response can become a liability if the stressor persists and the organism cannot return to its baseline physiological state.

Most organisms would respond to sudden physical approach or contact by darting quickly away from the stimulus. Other species may respond by freezing in place or seeking refuge. In any case, the individual must stop whatever it was doing and divert its physiological and cognitive attention to responding to the stressor. The energy costs of reacting to a stressor depend on the specific situation, but in all cases the caloric requirements of stress reactions reduce the amount of energy available to the individual for other functions such as predator avoidance, reproduction, growth, and metabolism.

The ability of an organism to return to what it was doing following a physical strike (or near miss resulting in a stress response) is a function of fitness, genetic, and environmental factors. Some organisms are more tolerant of environmental or human-caused stressors than others and become acclimated more easily. Within a species, the rate at which an individual recovers from a physical disturbance or strike may be influenced by its age, sex, reproductive state, and general condition. An organism that has reacted to a sudden disturbance by swimming at burst speed would tire after some time; its blood hormone and sugar levels may not return to normal for 24 hours. During the recovery period, the organism may not be able to attain burst speeds and could be more vulnerable to predators. If the individual were not able to regain a steady state following exposure to a physical stressor, it may suffer depressed immune function and even death.

3.0.3.6.3.3 Long-Term Consequences to the Population

Long-term consequences are considered in terms of a resource's existing population level, growth and mortality rates, other stressors on the resource from the Proposed Action, cumulative impacts on the resource, and the ability of the population to recover from or adapt to impacts. Impacts of multiple or repeated stressors on individuals are cumulative.

3.0.3.6.4 Conceptual Framework for Assessing Effects from Entanglement

3.0.3.6.4.1 Stimuli

Physical Properties of the Objects

For an organism to become entangled in military expended materials, the materials must have certain properties, such as the ability to form loops and a high breaking strength. Some items could have a relatively low breaking strength on their own, but that breaking strength could be increased if multiple loops were wrapped around an entangled organism.

Physical Features of the Resource

The physical makeup of the organism itself is also considered when evaluating the risk of entanglement. Some species, by their size or physical features, are more susceptible to entanglement than others. For example, more rigid bodies with protruding snouts (e.g., hammerhead shark) or large, rigid fins (e.g., humpback whale) would have an increased risk of entanglement when compared to species with smoother, streamlined bodies such as lamprey or eels.

Location of the Objects

Evaluation of potential entanglement risk considered the spatial overlap of the resource occurrence and military expended materials. Distribution and density of expended items play a central role in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact are identified.

Buoyancy of Objects

Evaluation of potential entanglement risk considered the buoyancy of military expended materials to determine whether the object will be encountered within the water column (including the surface) or on the seafloor. Less buoyant materials, such as torpedo guidance wires, sink rapidly to the seafloor. More buoyant materials include less dense items (e.g., decelerators/parachutes) that are weighted and would sink slowly to the seafloor and could be entrained in currents.

Behavior of the Organism

Evaluation of potential entanglement risk considered the general behavior of the organism, including where the organism typically occurs (e.g., surface, water column, seafloor). The analysis particularly considered those species known to become entangled in nonmilitary expended materials (e.g., "marine debris") such as fishing lines, nets, rope, and other derelict fishing gear that often entangle marine organisms.

3.0.3.6.4.2 Immediate Response and Costs to the Individual

The potential impacts of entanglement on a given organism depend on the species and size of the organism. Species that have protruding snouts, fins, or appendages are more likely to become entangled than smooth-bodied organisms. Also, items could get entangled by an organism's mouth, if caught on teeth or baleen, with the rest of the item trailing alongside the organism. Materials similar to fishing gear, which is designed to entangle an organism, would be expected to have a greater entanglement potential than other materials. An entangled organism would likely try to free itself of the entangling object and in the process may become even more entangled, possibly leading to a stress response. The net result of being entangled by an object could be disruption of the normal behavior, injury due to lacerations, and other sublethal or lethal impacts.

3.0.3.6.4.3 Long-Term Consequences to the Individual and Population

Consequences of entanglement could range from an organism successfully freeing itself from the object or remaining entangled indefinitely, possibly resulting in lacerations and other sublethal or lethal impacts. Stress responses or infection from lacerations could lead to latent mortality. The analysis will focus on reasonably foreseeable long-term consequences of the direct impact, particularly those that could impact the fitness of an individual. Changes in an individual’s growth, survival, annual reproductive success, or lifetime reproductive success could have population-level impacts if enough individuals are impacted. This population-level impact would vary among species and taxonomic groups.

3.0.3.6.5 Conceptual Framework for Assessing Effects from Ingestion

3.0.3.6.5.1 Stimuli

Size of the Objects

To assess the ingestion risk from military expended materials, this analysis considered the size of the object relative to the animal’s ability to swallow it. Some items are too large to be ingested (e.g., non-explosive practice bombs and most targets) and impacts from these items are not discussed further. However, these items may potentially break down into smaller ingestible pieces over time. Items that are of ingestible size when they are introduced into the environment and when they break down are carried forward for analysis within each resource section where applicable.

Location of the Objects

Evaluation of potential ingestion risk considered the spatial overlap of the resource occurrence and military expended materials. The distribution and density of expended items play a central role in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact were identified.

Buoyancy of the Objects

Evaluation of potential ingestion risk considered the buoyancy of military expended materials to determine whether the object will be encountered within the water column (including the surface) or on the seafloor. Less buoyant materials, such as solid metal materials (e.g., projectiles or munitions fragments), sink rapidly to the seafloor. More buoyant materials include less dense items (e.g., target fragments and decelerators/parachutes) that may be caught in currents and gyres or entangled in floating *Sargassum*. These materials can remain in the water column for an indefinite period of time before sinking. However, decelerators/parachutes are weighted and would generally sink, unless that sinking is suspended, in the scenario described here.

Feeding Behavior

Evaluation of potential ingestion risk considered the feeding behavior of the organism, including where (e.g., surface, water column, seafloor) and how (e.g., filter feeding) the organism feeds and what it feeds on. The analysis particularly considered those species known to ingest nonfood items (e.g., plastic or metal items).

3.0.3.6.5.2 Immediate Response and Costs to the Individual

Potential impacts of ingesting foreign objects on a given organism depend on the species and size of the organism. Species that normally eat spiny hard-bodied invertebrates would be expected to have tougher mouths and guts than those that normally feed on softer prey. Materials similar in size and shape to the normal diet of an organism may be more likely to be ingested without causing harm to the animal; however, some general assumptions were made. Relatively small objects with smooth edges, such as shells or small-caliber projectiles, might pass through the digestive tract without causing harm. A small sharp-edged item may cause the individual immediate physical distress by tearing or cutting the mouth, throat, or stomach. If the object is rigid and large (relative to the individual's mouth and throat), it may block the throat or obstruct digestive processes. An object may even be enclosed by a cyst in the gut lining. The net result of ingesting large foreign objects is disruption of the normal feeding behavior, which could be sublethal or lethal.

3.0.3.6.5.3 Long-Term Consequences to the Individual and Population

The consequences of ingesting nonfood items could be nutrient deficiency, bioaccumulation, uptake of toxic chemicals, compaction, and mortality. The analysis focused on reasonably foreseeable long-term consequences of the direct impact, particularly those that could impact the fitness of an individual. Changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success could have population-level impacts if enough individuals were impacted. This population-level impact would vary among species and taxonomic groups.

3.0.3.6.6 Conceptual Framework for Assessing Effects from Secondary Stressors

This conceptual framework describes the potential effects to marine species exposed to stressors indirectly through impacts on habitat and prey availability (e.g., sediment or water quality, and physical disturbance). Stressors from Navy training and testing activities could pose indirect impacts to marine biological resources via indirect effects to habitat or to prey. These include indirect impacts from (1) explosives, explosion byproducts and unexploded munitions, (2) metals, (3) chemicals, and (4) transmission of disease and parasites. The methods used to determine secondary stressors on marine resources are presented below. Once a category of primary stressor has been analyzed to determine how a marine biological resource is impacted, an analysis follows of how a secondary stressor is potentially impacting a marine resource. After the secondary stressors are identified, a determination on the significance of the secondary impact is made. The same criteria to determine the level of significance for primary impacts are used for secondary stressors. In addition, it is possible for a significant primary impact to produce a beneficial indirect impact. For example, sinking exercises could generate a significant impact to the seafloor and surrounding habitats, while causing a potential beneficial secondary impact by creating hard-bottom habitat for invertebrates, producing a food source for fishes, and creating structural refuges for other biological resources.

3.0.3.6.6.1 Secondary Stressors

Impacts on Habitat

Primary impacts defined in each marine resource section were used to develop a conceptual model to predict the potential secondary stressors on each habitat or resource. This conceptual model incorporated factors such as the co-occurrence of stressors in space and time, the impacts or assessment endpoints of individual stressors (e.g., habitat alteration, changes in animal behavior or physiology, injury, mortality, or changes in human use), and the duration and intensity of the impacts of individual stressors. For example, a secondary stressor from a munitions strike could be habitat degradation. The primary impact or stressor is the actual strike on the habitat such as the seafloor, with the introduction of military expended materials, munitions, and fragments inducing further habitat degradation.

Secondary stressors can also induce additive impacts on habitats. These types of impacts are also determined by summing the individual stressors with identical and quantifiable assessment endpoints. For example, if one stressor disturbed 0.25 NM^2 of benthic habitat, a second stressor disturbed 0.5 NM^2, and all other stressors did not disturb benthic habitat, then the total benthic habitat disturbed would be 0.75 NM^2. For stressors with identical but not quantifiable assessment endpoints, potential additive impacts were qualitatively evaluated using available scientific knowledge and best professional judgment. Other habitat impacts such as underwater detonations were assessed by size of charge (net explosive weight), charge radius, height above the seafloor, substrate types in the area, and equations linking all these factors. The analysis also considered that impacts of underwater explosions vary with the bottom substrate type and that the secondary impacts would also be variable among substrate types.

Impacts on Prey Availability

Assessing the impacts of secondary stressors on prey availability falls into two main areas over different temporal scales: the cost to an individual over a relatively short amount of time (short-term) and the cost to an individual or population over a longer period of time (long-term).

3.0.3.6.6.2 Immediate Response and Costs to the Individual

After a primary impact was identified, an analysis of secondary stressors on that resource was initiated. This analysis examined whether indirect impacts would occur after the initial (primary) impact and at what temporal scale that secondary stressor would affect the resource (short-term or long-term). An assessment was then made as to whether the secondary stressor would impact an individual or a population. For example, an underwater explosion could impact a single resource such as a fish or multiple other species in the food web (e.g., prey species such as plankton). The analysis also took into consideration whether the primary impact affected more than an individual or single species. For example, a prey species that would be directly injured or killed by an explosive blast could draw in predators or scavengers from the surrounding waters that would feed on those organisms, and in turn could be more directly susceptible to being injured or killed by subsequent explosions. For purposes of this analysis, indirect impacts on a resource did not require trophic transfer (e.g., bioaccumulation) in order to be observed. It is important to note that the terms “indirect” and “secondary” describe how the impact may occur in an organism or its ecosystem and does not imply reduced severity of environmental consequences.

3.0.3.6.6.3 Long-Term Consequences to the Individual and Population

Long-term consequences of secondary stressors on an individual or population are often difficult to determine. Once a primary impact is identified, the severity of that impact helps to determine the temporal scale at which the secondary stressor can be measured. For most marine resources, the abundance of prey species near a detonation point would be diminished for a short period (weeks to months) before being repopulated by animals from adjacent waters. In some extreme cases, recovery of the habitat or prey resources could occur over a relatively long time frame (months to years). It is important to note that indirect impacts often differ among resources, spatial, and temporal scales.

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

TABLE OF CONTENTS

List of Figures

List of Tables

3.1 Air Quality

AIR QUALITY SYNOPSIS

The United States Department of the Navy considered all potential stressors that air quality could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the Preferred Alternative:

- Criteria Air Pollutants: The emission of criteria pollutants resulting from activities in the Study Area would not cause a violation or contribute to an ongoing violation of the National Ambient Air Quality Standards.

3.1.1 Introduction

Air pollution is a threat to human health and also damages the environment (U.S. Environmental Protection Agency, 2007). Air pollution damages trees, crops, other plants, lakes, and animals. In addition to damaging the natural environment, air pollution damages the exteriors of buildings, monuments, and statues. It creates haze or smog that reduces visibility in national parks and cities and interferes with aviation. To improve air quality and reduce air pollution, Congress passed the Clean Air Act and its amendments in 1970 and 1990, which set regulatory limits on air pollutants and help to ensure basic health and environmental protection from air pollution.

Air quality is defined by ambient concentrations of specific air pollutants – pollutants the U.S. Environmental Protection Agency (USEPA) determined may affect the health or welfare of the public. The six major pollutants of concern are called “criteria pollutants”: carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, particulate matter (dust particles less than or equal to 10 microns in diameter and fine particulate matter less than or equal to 2.5 microns in diameter), and lead. The Clean Air Act required that the USEPA establish National Ambient Air Quality Standards for these criteria pollutants. These standards set specific concentration limits for criteria pollutants in the outdoor air. The concentration limits were developed because the criteria pollutants are common in outdoor air, considered harmful to public health and the environment, and come from numerous and diverse sources. The concentration limits are designed to aid in protecting public health and the environment. Areas with air pollution problems typically have one or more criteria pollutants consistently present at levels that exceed the National Ambient Air Quality Standards. These areas are designated as nonattainment for the standards.

Criteria air pollutants are classified as either primary or secondary pollutants based on how they are formed in the atmosphere. Primary air pollutants are emitted directly into the atmosphere from the source of the pollutant and retain their chemical form. Examples of primary pollutants are the smoke produced by burning wood and volatile organic compounds emitted by industrial solvents. Secondary air pollutants are those formed through atmospheric chemical reactions that usually involve primary air pollutants (or pollutant precursors) and normal constituents of the atmosphere. Ozone, a major component of photochemical smog, is a secondary air pollutant. Ozone precursors fall into two broad groups of chemicals: nitrogen oxides and volatile organic compounds. Nitrogen oxides consists of nitric oxide and nitrogen dioxide.

Finally, some criteria air pollutants are a combination of primary and secondary pollutants. Particulate matter less than or equal to 10 microns in diameter and particulate matter less than or equal to 2.5 microns in diameter are generated as primary pollutants by various mechanical processes (e.g., abrasion, erosion, mixing, or atomization) or combustion processes. They are generated as secondary pollutants through chemical reactions or through the condensation of gaseous pollutants into fine aerosols.

In addition to the six criteria pollutants, the USEPA currently designates 187 substances as hazardous air pollutants under the federal Clean Air Act. Hazardous air pollutants are air pollutants known or suspected to cause cancer or other serious health effects, or adverse environmental and ecological effects (U.S. Environmental Protection Agency, 2016a) National Ambient Air Quality Standards are not established for these pollutants; however, the USEPA developed rules that limit emissions of hazardous air pollutants from specific industrial sources. These emissions control standards are known as "maximum achievable control technologies" and "generally achievable control technologies." They are intended to achieve the maximum degree of reduction in emissions of the hazardous air pollutants, taking into consideration the cost of emissions control, non-air quality health and environmental impacts, and energy requirements. These emissions are typically one or more orders of magnitude smaller than concurrent emissions of criteria air pollutants, and only become a concern when large amounts of fuel, explosives, or other materials are consumed during a single activity or in one location. Hazardous air pollutants are analyzed qualitatively in relation to the prevalence of the sources emitting these pollutants during training and testing activities. Mobile sources operating as a result of the Proposed Action would be functioning intermittently over a large area and would produce negligible ambient hazardous air pollutants in a localized area not located near any publicly accessible areas. For these reasons, hazardous air pollutants are not further evaluated in the analysis. Air pollutant emissions are reported as the rate (by weight or volume) at which specific compounds are emitted into the atmosphere by a source. Most air pollutant emissions are expressed as a rate (e.g., pounds per hour, pounds per day, or tons per year). Typical units for emission factors for a source or source activity are pounds per thousand gallons of fuel burned, pounds per ton of material processed, and grams per vehicle-mile of travel.

Ambient air quality is reported as the atmospheric concentrations of specific air pollutants at a particular time and location. The units of measurement are expressed as a mass per unit volume (e.g., micrograms per cubic meter [$\mu g/m^3$] of air) or as a volume fraction (e.g., parts per million [ppm] by volume).The ambient air pollutant concentrations measured at a particular location are determined by the pollutant emissions rate, local meteorology, and atmospheric chemistry. Wind speed and direction, the vertical temperature gradient of the atmosphere, and precipitation patterns affect the dispersal, dilution, and removal of air pollutant emissions from the atmosphere.

3.1.1.1 Air Quality Standards

National Ambient Air Quality Standards for criteria pollutants are set forth in Table 3.1-1. Areas that exceed a standard are designated as "nonattainment" for that pollutant, while areas that are in compliance with a standard are in "attainment" for that pollutant. An area may be nonattainment for some pollutants and attainment for others simultaneously.

Table 3.1-1: National Ambient Air Quality Standards

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon monoxide		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead		primary and secondary	Rolling 3-month period	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen dioxide		primary	1 hour	100 parts per billion (ppb)	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual mean
Ozone		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle pollution (particulate matter)	particulate matter less than or equal to 2.5 microns in diameter	primary	1 year	12.0 µg/m^3	Annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	Annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	particulate matter less than or equal to 10 microns in diameter	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years

Table 3.1-1: National Ambient Air Quality Standards (continued)

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Sulfur dioxide	primary	1 hour	75 ppb[4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the lead standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

(2)The level of the annual nitrogen dioxide standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3)Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) ozone standards additionally remain in effect in some areas. Revocation of the previous (2008) ozone standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4)The previous sulfur dioxide standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous sulfur dioxide standards or is not meeting the requirements of a State Implementation Plan call under the previous sulfur dioxide standards (40 Code of Federal Regulations [CFR] 50.4(3)). A State Implementation Plan call is a USEPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the require National Ambient Air Quality Standards.

Source: (U.S. Environmental Protection Agency, 2016b), last updated January 7, 2016.

Notes: µg/m3 = micrograms per cubic meter; ppb = parts per billion; ppm = parts per million

States, through their air quality management agencies, are required to prepare and implement State Implementation Plans for nonattainment areas, which demonstrate how the area will meet the National Ambient Air Quality Standards. Areas classified as attainment, after being designated as nonattainment, may be reclassified as maintenance areas subject to maintenance plans showing how the area will continue to meet federal air quality standards. Nonattainment areas for some criteria pollutants are further classified, depending on the severity of their air quality problem, to facilitate their management:

- ozone – marginal, moderate, serious, severe, and extreme
- carbon monoxide – moderate and serious
- particulate matter – moderate and serious

The USEPA delegates the regulation of air quality to the state once the state has an approved State Implementation Plan. If the state fails to develop an adequate plan to achieve and maintain the National Ambient Air Quality Standards or a State Implementation Plan revision is not approved by EPA, federal agencies must comply with the Federal Implementation Plan. States may also choose to adopt the Federal Implementation Plan as an alternative to developing their own State Implementation Plan. States may establish air quality standards more stringent than the National Ambient Air Quality Standards, however they are prohibited from imposing more stringent conformity requirements unless the requirements apply equally to non-Federal activities.

The Atlantic Fleet Training and Testing (AFTT) Study Area is offshore of a number of states, and some elements of the Proposed Action occur within or over state waters. State waters extend from the shoreline to 3 NM from Maine to the east coast of Florida, Alabama, Mississippi, Louisiana, and to 9 NM for the west coast of Florida and Texas. A coastal state exercises sovereignty over its territorial sea, the air space above it, and the seabed and subsoil beneath it. Some activities occur in state waters and primarily involve the use of small boats as is the case with inland training on state waters. These activities occur in a variety of locations such as Narragansett Bay, the lower Chesapeake Bay, the James and York Rivers, Kings Bay, Cooper River, St. Johns River, and St. Andrew Bay. However, most of the Study Area is substantially offshore, beyond state boundaries where attainment status is unclassified and Clean Air Act National Ambient Air Quality Standards do not apply. There may be seasonal or other temporal fluctuations in wind direction, and during these periods, air quality in adjacent onshore areas may be affected by releases of air pollutants from mobile sources within the Study Area. Impacts at a scale that would produce demonstrable air quality impacts would typically be the result of heavy marine traffic in areas such as large ports but military activity could incrementally impact these areas. Therefore, National Ambient Air Quality Standards attainment status of adjacent onshore areas is considered in determining whether appropriate controls for air pollution sources in the adjacent offshore state waters is warranted.

3.1.1.2 General Conformity Evaluation

Federal actions are required to conform with the approved State Implementation Plan for those areas of the United States designated as nonattainment or maintenance areas for any criteria air pollutant under the Clean Air Act (40 CFR parts 51 and 93). The purpose of the General Conformity Rule is to ensure that applicable Federal actions, such as the Proposed Action evaluated in this EIS/OEIS, would not cause or contribute to a violation of an air quality standard and that the Proposed Action would not adversely affect the attainment and maintenance of National Ambient Air Quality Standards. A conformity evaluation must be completed for every applicable Navy action that generates emissions to determine and document whether a proposed action complies with the General Conformity Rule. If a federal action is not an emergency response action, presumed to conform under the Rule, does not meet the approved facility emissions budget, is not a listed exempt activity, and is not covered by the Transportation Conformity Rule, then a conformity demonstration evaluating total direct and indirect emissions must be made. In determining the total direct and indirect emissions caused by the action, agencies must project the future emissions in the area with the action versus the future emissions without the action, what the National Environmental Policy Act (NEPA) entitles “the no build option.” The total direct and indirect emissions considers all emission increases and decreases and must be reasonably foreseeable at the time that the conformity evaluation is conducted and are possibly controllable through agency's continuing program responsibility to affect emissions.

The first step in the demonstration is a Conformity Applicability Analysis and involves calculating the non-exempt direct and indirect emissions associated with the action. The emissions thresholds that trigger the conformity requirements are called *de minimis* levels. The total emissions calculated for the direct and indirect emissions are then compared to the air emissions that for direct and indirect emissions do not exceed the *de minimis* levels, then a General Conformity Determination is not required. If the net change emissions equal or exceed the *de minimis* conformity applicability threshold values, a formal Conformity Determination must be prepared to demonstrate conformity with the approved State Implementation Plan.

The Navy Guidance for Compliance with the Clean Air Act General Conformity Rule section 4.1, states that a Record of Non-Applicability must be prepared if the proposed action is subject to the Conformity Rule, but is exempt because it fits within one of the exemption categories listed under 40 CFR 93B, because the action's projected emissions are below the *de minimis* conformity applicability threshold values, or is presumed to conform (U.S. Department of the Navy, 2013).

Compliance is presumed if the net change in emissions resulting from a proposed federal action would be less than the relevant *de minimis* threshold. If the net change in emissions exceeds the *de minimis* thresholds, then a formal conformity determination must be prepared. *De minimis* levels are shown in Table 3.1-2. Note that *de minimis* levels for ozone precursors may be lower where nonattainment is a serious issue in the ozone transport region. This region includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, and the Washington, D.C. Metropolitan Statistical Area, including the northern Virginia suburbs (Ozone Transport Commission, 2017). The Ozone Transport Region is an area subjected to poor air quality in the warm summer months resulting from ozone pollution. Contributing to the problem are local sources of air pollution as well as air pollution transported hundreds of miles from distant sources in and outside of the Ozone Transport Region. Transport most frequently originates in the Midwest and the Ohio River Valley.

Table 3.1-2: *De Minimis* Thresholds for Conformity Determinations

Pollutant	*Nonattainment or Maintenance Area Type*	*de Minimis Threshold (TPY)*
Ozone (VOC or NO_X)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NO_X)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
CO, SO_2 and NO_2	All nonattainment and maintenance	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$	All nonattainment and maintenance	100
Lead	All nonattainment and maintenance	25

Source: (U.S. Environmental Protection Agency, 2010a)

Notes: CO: carbon monoxide; NOX: nitrogen oxides; NO_2: nitrogen dioxide; PM_{10}: particulate matter ≤ 10 microns in diameter; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; SO_2: sulfur dioxide; SO_X: sulfur oxides; TPY: tons per year; VOC: volatile organic compound

3.1.1.2.1 Conformity Analysis in Nonattainment and Maintenance Areas

Certain Navy training and testing activities take place within nonattainment and maintenance areas. These nonattainment and maintenance areas are identified by their air quality designated areas (an area designated by the federal government where communities share a common air pollution problem). Several designated areas were identified as relevant to AFTT Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) training or testing activities and are further discussed in Section 3.1.2.3, Existing Air Quality.

3.1.1.3 Approach to Analysis

Boundaries of Analysis

The air quality impact evaluation requires two separate analyses. Impacts of air pollutants emitted by Navy training and testing in the Atlantic Ocean, state waters, bays and inland locations are assessed under NEPA. Impacts of air pollutants emitted by Navy training and testing activities outside state waters are evaluated as required under Executive Order 12114.

Air pollutants emitted more than 3,000 feet (ft.) above ground level are considered to be above the atmospheric inversion layer and, therefore, do not affect ground-level air quality (U.S. Environmental Protection Agency, 2007, 2008, 2009). These emissions thus do not affect the concentrations of criteria air pollutants in the lower atmosphere, which are measured at ground-level monitoring stations, and upon which federal, state, and local regulatory decisions are based. For the analysis of the effects on global climate change, however, all emissions of greenhouse gases from aircraft and vessels participating in training and testing activities, as well as targets and munitions expended, are applicable regardless of altitude (Chapter 4, Cumulative Impacts). However, because activities above 3,000 ft. for individual aircraft activities are not specifically documented, it would be impossible to analyze with any accuracy the GHGs associated with testing and training activity flights above 3,000 ft. For this reason, the GHG emissions that are assessed should be understood to represent only a portion of the total emissions from aircraft flight activities.

Analysis of health-based air quality impacts under NEPA and Executive Order 12114 includes estimates of criteria air pollutants for all training and testing activities where aircraft, missiles, or targets operate at or below the aforementioned inversion layer or that involve vessels in U.S. territorial seas. The analysis of health-based air quality impacts under Executive Order 12114 includes emissions estimates of only those training and testing activities in which aircraft, missiles, or targets operate at or below 3,000 ft. above ground level, or that involve vessels outside of U.S. territorial seas.

Emission Sources

Criteria air pollutants are generated by the combustion of fuel by surface vessels and by fixed-wing and rotary-wing aircraft. They also are generated by the combustion of explosives and propellants in various types of munitions. Propellants used to fire small-, medium-, and large-caliber projectiles generate criteria pollutants when detonated. Non-explosive practice munitions contain spotting charges and propellants that generate criteria air pollutants when they function. Powered targets require fuel, generating criteria air pollutants during their operation, and towed targets generate criteria air pollutants secondarily because another aircraft or vessel is required to provide power. Stationary targets may generate criteria air pollutants if all or portions of the item burn in a high-order detonation. Chaff cartridges used by ships and aircraft are launched by an explosive charge that generates small quantities of criteria air pollutants. Countermeasure flares, parachute flares, and smoke floats are designed to burn for a prescribed period, emitting criteria pollutants in the process.

The primary emissions from many munition types are carbon dioxide, carbon monoxide, and particulate matter; hazardous air pollutants are emitted at low levels (U.S. Environmental Protection Agency, 2007, 2008, 2009).

Electronic warfare countermeasures generate emissions of chaff, a form of particulate not regulated under the federal Clean Air Act as a criteria air pollutant. Virtually all radio frequency chaff is 10 to 100 times larger than particulate matter under particle matter less than or equal to 10 microns in diameter and particulate matter less than or equal to 2.5 microns in diameter (Spargo et al., 1999). The types of training and testing that produce these other emissions may take place throughout the Study Area, but occur primarily within special use airspace. Chaff emissions during training and testing primarily occur 3 NM or more from shore and at altitudes over 3,000 ft. (above the mixing layer). Chaff released over the ocean would disperse in the atmosphere and then settle onto the ocean surface.

A study at Naval Air Station Fallon found that the release of 50,000 cartridges of chaff per year over 10,000 square miles (m^2) would result in an annual average concentration of 0.018 $\mu g/m^3$for regulated particulate matter. This is far below the National Ambient Air Quality Standards. Similar predictions were made for St. Mary's County, Maryland (on the Chesapeake Bay), where chaff releases contribute no more than 0.008 percent of total particulate matter emissions (Arfsten et al., 2001). Therefore, chaff is not further evaluated as an air quality stressor in this EIS/OEIS.

3.1.1.3.1 Analysis Framework

Emissions sources and the approach used to estimate emissions under Alternative 1 and Alternative 2 for the air quality analysis are based, wherever possible, on information from Navy subject matter experts and established training and testing requirements. These data were used to estimate the numbers and types of aircraft, surface ships and vessels, submarines, and munitions (i.e., potential sources of air emissions) that would be involved in training and testing activities under each alternative. Emissions were assessed to identify any possibility for the magnitude of Proposed Action emissions to result in a violation of one or more National Ambient Air Quality Standards.

The NEPA analysis includes a Clean Air Act General Conformity Applicability Analysis to support a determination pursuant to the General Conformity Rule (40 CFR part 93B). This analysis focuses on training and testing activities that could impact nonattainment or maintenance areas within the region of influence. As noted above, the Study Area lies partly within or adjacent to some air quality designated areas. To evaluate whether or not the General Conformity Rule applies, air pollutant emissions associated with the Proposed Action within the applicable designated nonattainment or maintenance areas are estimated, based on the distribution of mobile source activity in state waters and mobile source activity beyond state waters. The proposed training and testing activities within this portion of the Study Area are then compared to the General Conformity Rule *de minimis* thresholds.

3.1.1.4 Emission Estimates

3.1.1.4.1 Aircraft Activities

To estimate aircraft emissions, the operating modes, number of hours of operation, and type of engine for each type of aircraft were evaluated.

Emissions associated with airfield or air station operations ashore are analyzed within the home-basing environmental planning process (e.g., environmental impact statements or environmental assessments for (1) *Introduction of F/A-18 E/F (Super Hornet) Aircraft to the East Coast of the United States* (U.S. Department of the Navy, 2003); (2) Supplemental Environmental Impact Statement for the introduction of the P-8A Multi-Mission Aircraft into the U.S. Navy Fleet (U.S. Department of the Navy, 2014); (3) *Transition of E-2C Hawkeye to E-2D Advanced Hawkeye at Naval Station Norfolk, Virginia, Naval Base Ventura County Point Mugu, California* (U.S. Department of the Navy, 2009), and (4) *F-35B East Coast Basing Environmental Impact Statement* (U.S. Department of the Navy, 2010). All fixed-wing aircraft are assumed to travel to and from training and testing ranges at or above 3,000 ft. above mean sea level and, therefore, their transits to and from the ranges do not affect surface air quality. Air combat maneuvers and air-to-air missile exercises are primarily conducted at altitudes well in excess of 3,000 ft.

above mean sea level and, therefore, are not included in the estimated emissions of criteria air pollutants. Activities or portions of those training or testing activities occurring below 3,000 ft. are included in emissions estimates. Examples of activities typically occurring below 3,000 ft. include those involving helicopter platforms such as mine warfare, surface warfare, and anti-submarine warfare training and testing activities. The number of all training and testing activities and the estimated time spent above or below 3,000 ft. for calculation purposes is included in the air quality emissions estimates presented in Appendix C (Air Quality Example Emissions Calculations).

The types of aircraft identified include the typical aircraft platforms that conduct a particular training or testing exercise (or the closest surrogate when information is not available), including range support aircraft (e.g., non-Navy commercial air services). Estimates of future aircraft sorties are based on evolutionary changes in the Navy's force structure and mission assignments. Where there are no major changes in types of aircraft, future activity levels are estimated from the distribution of baseline activities. The types of aircraft used in each training or testing activity along with hours operated in the mission activity, as well as data on landings and take-offs from ships, and numbers of sorties flown by such aircraft are presented in Appendix C (Air Quality Emissions Calculations).

Several testing activities are similar to training activities, and therefore similar assumptions were made for such activities in terms of aircraft type, altitude, and flight duration. Table 2.3-4 lists Naval Air Systems Command testing activities similar to certain training activities. Where aircraft testing activities were dissimilar to training activities, Assumptions for time on ranges, and landing and takeoff information were derived by Navy subject matter experts.

Air pollutant emissions from aircraft were primarily estimated based on the training and testing hours provided by subject matter experts, as well as emission indices published in the Navy's Aircraft Environmental Support Office Memorandum Reports for individual aircraft categories. When Aircraft Environmental Support Office emission factor data were not available, emission factors were obtained from other published sources.

The emissions calculations performed for each alternative conservatively assume that each aircraft training and testing activity listed in Tables 2.3-1 to 2.3-4 is separately conducted. In practice, a testing activity may be conducted during a training flight. It is also probable that two or more training activities may be conducted during one flight (e.g., chaff or flare exercises may occur during electronic warfare activities; or air-to-surface gunnery and air-to-surface bombing activities may occur during a single flight operation). Conservative assumptions may produce elevated aircraft emissions calculations but account for the possibility, however remote, that each aircraft training and testing activity is separately conducted.

3.1.1.4.2 Military Vessel Activities

Military vessel traffic in the Study Area includes military ships and smaller boats providing services for military training and testing activities. The methods for estimating military ship emissions involve evaluating the type of activity, generating the average steaming hours for ships in each operational area, both within state waters and beyond state waters. This was done to create annual averages for the years 2010 through 2015. The average annual hours were used for Alternative 1. For Alternative 2, the year with the highest number of operational hours (2011) was selected as the year to represent maximum operations. For both alternatives, the hourly data was used with data from the Naval Sea Systems Command Navy and Military Sealift Command Marine Engine Fuel Consumption and Emission Calculator to calculate the emissions from the propulsion and onboard generation systems. Data from the calculator included emission factors for each type of propulsion and type of onboard generator by ship type, as well as the fuel used. The types of ships and numbers of activities for Alternatives 1 and 2 are derived from range records and Navy subject matter experts regarding ship participant data. Estimates of future ship activities are based on anticipated evolutionary changes in the Navy's force structure and mission assignments. Where there are no major changes in types of ships, estimates of future activities are based on the historical distribution of ship activities. Emission factors for military ships were obtained from the Naval Sea Systems Command database, Navy and Military Sea Lift Marine Engine Fuel Consumption and Emissions Calculator. Emission factors were provided for each marine vessel type and the applicable power levels. The resulting calculations provided information on the time spent at each power level in each part of the Study Area, emission factors for that power level (in pounds of pollutant per hour), and total emissions for each marine vessel for each operational type and mode.

Boat emissions were estimated based on activity data provided by the Navy, which included the type and number of boats, locations, and total number of hours running. Emissions factor data came from the Navy or from USEPA documentation on nonroad engines (U.S. Environmental Protection Agency, 2010b).The pollutants for which calculations are made include exhaust total hydrocarbons, carbon monoxide, nitrogen oxides, particulate matter, carbon dioxide, and sulfur dioxide. For non-road engines, 100 percent of all of the particulate matter less than or equal to 10 microns in diameter from gasoline and diesel-fueled engines is assumed to be particulate matter less than or equal to 2.5 microns in diameter (U.S. Environmental Protection Agency, 2010b). For gaseous-fueled engines (liquefied petroleum gas/compressed natural gas), 100 percent of the particulate matter emissions are assumed to be particulate matter less than or equal to 2.5 microns in diameter (U.S. Environmental Protection Agency, 2010b).

The emissions calculations performed for each alternative conservatively assume that each vessel training and testing activity listed in Chapter 2, Tables 2.3-1 to 2.3-4, is separately conducted and separately produces vessel emissions. In practice, one or more testing activities may take advantage of an opportunity to travel at sea and test aboard a vessel conducting a related or unrelated training activity. It is also probable that two or more training activities may be conducted during one training vessel movement (e.g., a ship may conduct large-, medium-, and small-caliber surface-to-surface gunnery exercises during one vessel movement). Furthermore, multiple unit-level training activities may be conducted during a larger composite training unit exercise. Conservative assumptions may produce elevated vessel emissions calculations but account for the possibility, however remote, that each training and testing activity is separately conducted.

3.1.1.4.3 Submarine Activities

No U.S. submarines burn fossil fuel under normal operating conditions. Therefore, no air pollutants are emitted during submarine training or testing activities.

3.1.1.4.4 Naval Gunfire, Missiles, Bombs, Other Munitions, and Military Expended Material

Naval gunfire, missiles, bombs, and other types of munitions used in training and testing activities emit air pollutants. To estimate the amounts of air pollutants emitted by munitions during its use, the numbers and types of munitions used during training or testing activities are first totaled. Then generally accepted emissions factors (U.S. Environmental Protection Agency, 2007, 2008, 2009) for criteria air pollutants are applied to the total amounts. Finally, the total amounts of air pollutants emitted by each munition type are summed to produce total amounts of each criteria air pollutant under each alternative.

3.1.1.5 Climate Change

Greenhouse gases are compounds that contribute to the greenhouse effect—a natural phenomenon in which gases trap heat within the lowest portion of the earth's atmosphere (surface-troposphere system), causing heating (radiative forcing) at the surface of the earth. The primary long-lived greenhouse gases directly emitted by human activities are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride, and sulfur hexafluoride. Carbon dioxide, methane, and nitrous oxide occur naturally in the atmosphere. These gases influence the global climate by trapping heat in the atmosphere that would otherwise escape to space. The heating effect from these gases is considered the probable cause of the global warming observed over the last 50 years (U.S. Environmental Protection Agency, 2009a). Global warming and climate change affect many aspects of the environment. Not all effects of greenhouse gases are related to climate. For example, elevated concentrations of carbon dioxide can lead to ocean acidification and stimulate terrestrial plant growth, and methane emissions can contribute to higher ozone levels.

The administrator of the USEPA determined that six greenhouse gases in combination endanger both the public health and the public welfare of current and future generations. The USEPA specifically identified carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride as greenhouse gases (U.S. Environmental Protection Agency, 2009b).

To estimate global warming potential, which is the heat trapping capacity of a gas, the United States quantifies greenhouse gas emissions using the 100-year timeframe values established in the Intergovernmental Panel on Climate Change Fourth Assessment Report (Intergovernmental Panel on Climate Change, 2007), in accordance with United Nations Framework Convention on Climate Change (United Nations Framework Convention on Climate Change, 2013) reporting procedures. All global warming potentials are expressed relative to a reference gas, carbon dioxide, which is assigned a global warming potential equal to 1. Six other primary greenhouse gases have global warming potentials: 25 for methane, 298 for nitrous oxide, 124 to 14,800 for hydrofluorocarbons, 7,390 to greater than 17,340 for perfluorocarbons, 17,200 for nitrogen trifluoride, and up to 22,800 for sulfur hexafluoride. To estimate the carbon dioxide equivalency of a non-carbon dioxide greenhouse gas, the appropriate global warming potential of that gas is multiplied by the amount of the gas emitted. All seven greenhouse gases are multiplied by their global warming potential and the results are added to calculate the total equivalent emissions of carbon dioxide. The dominant greenhouse gas emitted is carbon dioxide, mostly from fossil fuel combustion (85.4 percent) (U.S. Environmental Protection Agency, 2016c). Weighted by global warming potential, methane is the second largest component of emissions, followed by nitrous oxide. Global warming potential-weighted emissions are presented in terms of equivalent emissions of carbon dioxide, using units of metric tonnes. The Proposed Action is anticipated to release greenhouse gases to the atmosphere. These emissions are quantified (primarily using methods elaborated upon in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2014)for the proposed Navy training and testing in the Study Area, and estimates are presented in Chapter 4 (Cumulative Impacts) (U.S. Environmental Protection Agency, 2016c).

The potential effects of proposed greenhouse gas emissions are by nature global and may result in cumulative impacts because most individual sources of greenhouse gas emissions are not large enough to have any noticeable effect on climate change. Therefore, the impact of proposed greenhouse gas emissions to climate change is discussed in the context of cumulative impacts.

3.1.1.6 Other Compliance Considerations, Requirements, and Practices

Executive Order 13693, *Planning for Federal Sustainability in the Next Decade,* issued on March 19, 2015, establishes policy for federal agencies to maintain federal leadership in sustainability and greenhouse gas emission reductions. As noted in the Order, through a combination of more efficient federal operations, agency direct greenhouse gas emissions can be reduced by at least 40 percent over the next decade while fostering innovation, reducing spending, and strengthening the communities in which federal facilities operate.

In June 2014, Department of Defense (DoD) released the 2014 Climate Change Adaptation Roadmap to document DoD's efforts to plan for the changes that are occurring or expected to occur as a result of climate change. The Roadmap provides an overview and specific details on how DoD's adaptation will occur and describes ongoing efforts (U.S. Department of Defense, 2014).

3.1.1.6.1 Current Requirements and Practices

The Navy is committed to improving energy security and environmental stewardship by reducing reliance on fossil fuels. The Navy is actively developing and participating in energy, environmental, and climate change initiatives that will increase use of alternative energy and reduce emissions of greenhouse gases. The Navy has adopted energy, environmental, and climate change goals. These goals include increasing alternative energy use Navy-wide to 50 percent by 2020; reducing non-tactical petroleum use; ensuring environmentally sound acquisition practices; ensuring environmentally compliant operations for ships, submarines, aircraft, and facilities operated by the Navy; and implementing applicable elements of the Climate Change Adaptation Roadmap.

Equipment used by military units in the Study Area, including ships and other marine vessels, aircraft, and other equipment, are properly maintained and fueled in accordance with applicable Navy requirements. Operating equipment meets federal and state emission standards, where applicable.

3.1.2 Affected Environment

3.1.2.1 General Background

3.1.2.1.1 Region of Influence

The region of influence for air quality is a function of the type of pollutant, emission rates of the pollutant source, proximity to other emission sources, and local and regional meteorology. Figure 3.1-1 through Figure 3.1-4 present maps of the nonattainment and maintenance areas in the vicinity of the Study Area. For inert pollutants (all pollutants other than ozone and its precursors), the region of influence is generally limited to a few miles downwind from the source. For a photochemical pollutant such as ozone, however, the region of influence may extend much farther downwind. Ozone is a secondary pollutant formed in the atmosphere by photochemical reactions of previously emitted pollutants, or precursors (volatile organic compounds and nitrogen oxides). The maximum impacts of precursors on ozone levels tend to occur several hours after the time of emission during periods of high solar load, and may occur many miles from the source. Ozone and ozone precursors transported from other regions can also combine with local emissions to produce high local ozone concentrations. Therefore, the region of influence for air quality includes the Study Area as well as adjoining land areas several miles inland, which may from time to time be downwind from emission sources associated with the Proposed Action.

3.1.2.2 Sensitive Receptors

Identification of sensitive receptors is part of describing the existing air quality environment. Sensitive receptors are individuals in residential areas, schools, parks, hospitals, or other sites for which there is a reasonable expectation of continuous human exposure during the timeframe coinciding with peak pollution concentrations. On the oceanic portions of the Study Area, crews of commercial vessels and recreational users of the northern Atlantic Ocean and Gulf of Mexico could encounter the air pollutants generated by the Proposed Action. Few such individuals are expected to be present and the duration of substantial exposure to these pollutants is limited because the areas are cleared of nonparticipants before event commencement. These potential receptors are not considered sensitive.

3.1.2.2.1 Climate of the Study Area

The climatic conditions in the Study Area provide background on factors influencing air quality. Climate zones within the Study Area vary with latitude or region. For air quality, the Study Area can be divided into four areas: the North Atlantic Region (Arctic region to Nova Scotia), the Mid-Atlantic Region (Maine to Virginia), the Southeast Atlantic Region (North Carolina to southern Florida) and the Gulf of Mexico Region (southern Florida to Texas).

The climate is arctic near the 65-degree north latitude line and tropical at the 20-degree north latitude line, but most activities and their potential effects would occur in the northern temperate to subtropical climate zones between Maine, Florida, and the Gulf Coast.

The climate of the offshore Atlantic Ocean and adjacent land areas is influenced by the temperatures of the surface waters and water currents as well as by wind blowing across the water. Offshore climates are moderate and seldom have extreme seasonal variations because the ocean is slow to change temperature. Ocean currents of the Atlantic Ocean (i.e., Labrador, Gulf Stream, North Atlantic Drift, Canary, and North Equatorial) influence climate by moving warm and cold water between regions. Adjacent land areas are affected by wind that is cooled or warmed when blowing over these currents. In addition to its influence on temperature, the wind moves evaporated moisture from the ocean to adjacent land areas and is a major source of rainfall.

With the advent of human induced climate change, spatial and temporal variations in weather patterns have emerged or have become more pronounced. Very heavy precipitation events have increased across the eastern half of the United States, with the most pronounced increase involving the mid-Atlantic and New England states (Melillo et al., 2014). Other changes apparent along the eastern seaboard include the rising incidence of heat waves and their extended duration and coastal flooding due to sea level rise and storm surge. In the South and along the Gulf Coast, the incidence of extreme storms, such as hurricanes, continues to rise. These changes to weather patterns have long term consequences for regional climates and the flora and fauna of the regions.

3.1.2.2.1.1 Newfoundland-Labrador Shelf and Scotian Shelf

The Newfoundland-Labrador Shelf and Scotian Shelf are not connected to the continental United States and do not include state waters, but do fall within the AFTT Study Area. This area does not fall under the purview of the Clean Air Act and, therefore, is not included in the air quality analysis. In the North Atlantic (Newfoundland-Labrador Shelf and Scotian Shelf) winter begins (when daily temperatures average 32° Fahrenheit [° F]) as early as mid-August in the Labrador Sea or as late as October 1 off the coast of the island of Newfoundland (Canadian Coast Guard, 2010). Winter ends in this region in mid-June. Sea ice begins to grow shortly after the onset of winter as average sea temperatures reach 29° to

35° F. Polar lows usually occur during the fall, winter, and early spring. Northeast United States Continental Shelf

Along the coasts of Maine to New Jersey, the most frequent wind directions measured by buoys are from the west or west-northwest, but wind can come from any direction (National Oceanic and Atmospheric Administration, 2017). The average wind speeds are between 12.4 and 16.2 miles per hour (mph). Wind speeds are typically lowest in July at 9.0 to 12.1 miles per hour (mph), and highest in January at 15.7 to 20.0 mph.

Annual average air temperature ranges from 47° to 60° F along the coast of Maine to New Jersey (National Oceanic and Atmospheric Administration, 2017). Seasonal variations in temperature are greatest during the winter months. In January and February, the ambient temperature averages 28° F along the coast of Maine to New Jersey. During the warmer months, there is little daily variation in temperature. In August, the average temperature is 75° F along the coast of this region.

Along the coasts of Maine to New Jersey, precipitation is frequent and abundant but occurs evenly throughout the year (Minerals Management Service, 2007). Average annual rainfall along the Atlantic Coast ranges from about 42 inches (in.) in Block Island, Rhode Island, to 58 in. in Miami, Florida. Rainfall in the warmer months is usually associated with cloud systems that produce showers and thunderstorms. Winter rains are associated with the passage of frontal systems through the eastern seaboard. Precipitation also falls as snow along the coasts of Maine to New Jersey. The highest snowfall among coastal U.S. areas within the Study Area occurs in Portland, Maine, with a maximum yearly average of 62.4 in.

3.1.2.2.1.2 Southeast United States Continental Shelf

Off the coast of North Carolina, the prevailing winds are from south to southwest, with average wind speeds between 13 to 16 mph. Off the coasts of South Carolina and Georgia, the prevailing wind direction is from south to southwest, and from southeast to east-southeast off of Florida. Average wind speeds range from 12 to 14 mph and wind speeds exhibit smaller monthly variations than northern coastal states.

Annual average air temperatures range from 70° to 75°F along the coast of the Southeast U.S. Continental Shelf (National Oceanic and Atmospheric Administration, 2017). In January and February, ambient temperatures average 55°F along the coast of the Southeast U.S. Continental Shelf. During the warmer months, there is little daily variation in temperature. In August, average temperatures are 83° F along the coast of this region. Air temperatures over the southern coast and offshore Atlantic Ocean have smaller daily and seasonal ranges than temperatures over inland areas because the ocean, which is slow to change temperature, has a stabilizing influence on ocean and coastal atmospheric temperatures.

At various locations along the Atlantic coast, fog occurs occasionally in the cooler months as a result of warm, moist air from the Gulf of Mexico blowing over cool land or water surfaces. The poorest visibility occurs from November through April. During periods of air stagnation, industrial pollution and agricultural burning also can affect visibility.

In the Southeast U.S. Continental Shelf coastal areas (generally from North Carolina to Florida), precipitation is frequent and abundant throughout the year, but tends to peak in the summer months.

Hurricanes develop in the southern part of the Atlantic Ocean. Hurricane season in the Atlantic Ocean runs from June to November, with a peak in mid-September. Most storms form in warm waters several hundred miles north of the equator. Once a tropical system forms, it usually travels west and slightly north while strengthening. Many storms curve to the northeast near the Florida peninsula. The Atlantic basin averages about 10 storms of tropical storm strength or greater per year; about half reach hurricane level (National Oceanic and Atmospheric Administration, 2005). Storms weaken as they encounter cooler water, land, or vertical wind shear, sometimes slowing to an extra-tropical storm, mostly affecting northern Atlantic coastal areas.

3.1.2.2.1.3 Gulf of Mexico

The climate of the Gulf of Mexico is influenced mainly by the clockwise circulation around the semi-permanent area of high barometric pressure commonly known as the Bermuda High (Minerals Management Service, 2002). The Gulf of Mexico is southwest of this center of circulation. This high-pressure system results in a predominantly southeasterly wind flow in the Gulf of Mexico. Two important classes of storms occasionally occur with this circulation pattern. During the winter months, cold fronts associated with cold air masses from land influence the northern coast of the Gulf of Mexico. Behind the fronts, strong north winds bring drier air into the region. Secondly, hurricanes may develop in or migrate into the Gulf of Mexico during the warmer months. These storms may affect any area of the Gulf of Mexico and substantially change the local wind circulation around them. In coastal areas, the sea breeze may become the primary circulation feature during the summer months. Conversely, land breezes (particularly at night) transport air pollutants from land to offshore areas. Locally, the land breeze diminishes as more heat is retained within large, growing coastal cities (National Science Foundation, 2011). In general, however, the subtropical maritime climate is the dominant feature driving all aspects of the weather in this region. As a result, the climate shows very little daily or seasonal variation (Minerals Management Service, 2002).

Average air temperatures at Gulf of Mexico coastal locations (Texas to Florida) vary with latitude and exposure. Air temperatures range from highs in the summer of 88° to 96° F to lows in the winter of 37° to 59° F (Minerals Management Service, 2002). Temperatures depend on the frequency and intensity of polar air masses from the north. Air temperatures over the open waters of the Gulf of Mexico are more moderate and have smaller daily and seasonal temperature ranges than land temperatures because the Gulf of Mexico is slow to change temperature (Minerals Management Service, 2006). The average temperature over the center of the Gulf of Mexico is about 84° F in the summer and between 63° to 73° F in the winter(Minerals Management Service, 2006).

In the Gulf of Mexico portion of the Study Area, precipitation is frequent and abundant throughout the year (Minerals Management Service, 2002). Stations along the entire Gulf Coast record the highest precipitation values during the warmer months of the year. The warmer months usually have cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have hail (Minerals Management Service, 2002). The month of maximum rainfall for most locations in the Gulf of Mexico is July. Winter rains often come with frontal systems passing through the area. Rainfall is generally light, steady, and relatively continuous, often lasting several days. Snowfall is rare, and when snow or sleet does occur, it usually melts on contact with the ground. The chance for snow or sleet decreases with distance from shore, rapidly reaching zero.

Hurricanes affecting the Gulf of Mexico form near the equator in the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico (Minerals Management Service, 2002). Data from 1886 to 1986 show that almost half (44.5 percent) of these hurricanes, or 3.7 storms per year, will affect the Gulf of Mexico (Minerals Management Service, 2002).

3.1.2.3 Existing Air Quality

As a whole, the air quality of the Study Area is very good. As shown in Figure 3.1-1 through Figure 3.1-3, most nonattainment and maintenance areas in the eastern half of the continental United States are in the northeastern states. They are also located in inland, urban, industrialized areas. This limited geographical extent with regard to potential air pollution results from the relatively low number of air pollutant sources, size, and topography of the Study Area, and prevailing meteorological conditions. In general, the coastal counties of the lower-middle and southern Atlantic as well as the Gulf of Mexico , including the Hampton Roads Intrastate area (in the vicinity of Naval Station Norfolk on **Figure** 3.1-2), are in attainment of the National Ambient Air Quality Standards. Being in attainment means that the areas maintain air quality better than the National Ambient Air Quality Standards.

Some other coastal areas, however, are either in nonattainment or are a designated maintenance area for one or more of the criteria pollutants. These designations are based on air quality data collected from monitors at locations in urban and rural setting, as well as modeling. Based on available information the USEPA designates an area as attainment, maintenance, nonattainment, or if there is a lack of available monitoring data for the area, it may be designated unclassifiable. Nonattainment and maintenance designations range from as small as a single location to large multi-state regions. Table 3.1-3 identifies the nonattainment and maintenance areas that are adjacent to the Study Area.

Table 3.1-3: Nonattainment and Maintenance Areas Adjacent to Study Area

Area Name	***Coastal Locations Included***	***Designation***
EPA Regions 1 & 2		
Central New Hampshire, NH	Rockingham County (p), Hillsborough County (p)	2010 SO2 (n)
Greater Connecticut	New London County	Ozone (n-moderate)
Hartford –New Britain-Middletown, CT	Middlesex County CT (p)	CO (m)
New Haven-Meriden-Waterbury, CT	New Haven County CT	CO (m)
New York-Northern New Jersey-Long Island, NY-NJ-CT	Fairfield, New Haven & Middlesex Counties (CT); Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, & Westchester Counties (NY); Bergen, Essex, Hudson, Union, Middlesex & Monmouth Counties (NJ)	Ozone (n-moderate)
	Fairfield & New Haven Counties (CT); Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, & Westchester Counties (NY); Bergen, Essex, Hudson, Union, Middlesex & Monmouth Counties (NJ)	1997 PM2.5 (m) and 2006 PM2.5 (m)
	New Haven County CT (p) New York County NY	PM10 (m) PM10 (n)
	Fairfield County CT (p)	CO (m)
Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE	Atlantic, Cape May & Ocean Counties	Ozone (n-marginal)
EPA Region 3		
Seaford, DE	Sussex County	Ozone (n-marginal

Table 3.1-3: Nonattainment and Maintenance Areas Adjacent to Study Area (continued)

Area Name	Coastal Locations Included	Designation
EPA Region 4		
Nassau County, FL	Nassau County, FL (p)	2010 SO2 (n)
Hillsborough County, FL	Hillsborough County, FL (p)	2010 SO2 (n)
	Tampa, FL (p)	2008 Lead
EPA Region 6		
Saint Bernard Par LA	Saint Bernard Parish, LA	2010 SO2 (n)
Houston-Galveston-Brazoria, TX	Brazoria, Chambers, Galveston Counties, TX	Ozone (n-moderate)

Source: (U.S. Environmental Protection Agency, 2017)
Notes: (p) means partial; (n) means nonattainment; (m) means maintenance
CO: carbon monoxide; PM_{10}: particulate matter ≤ 10 microns in diameter; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; SO_2: sulfur dioxide

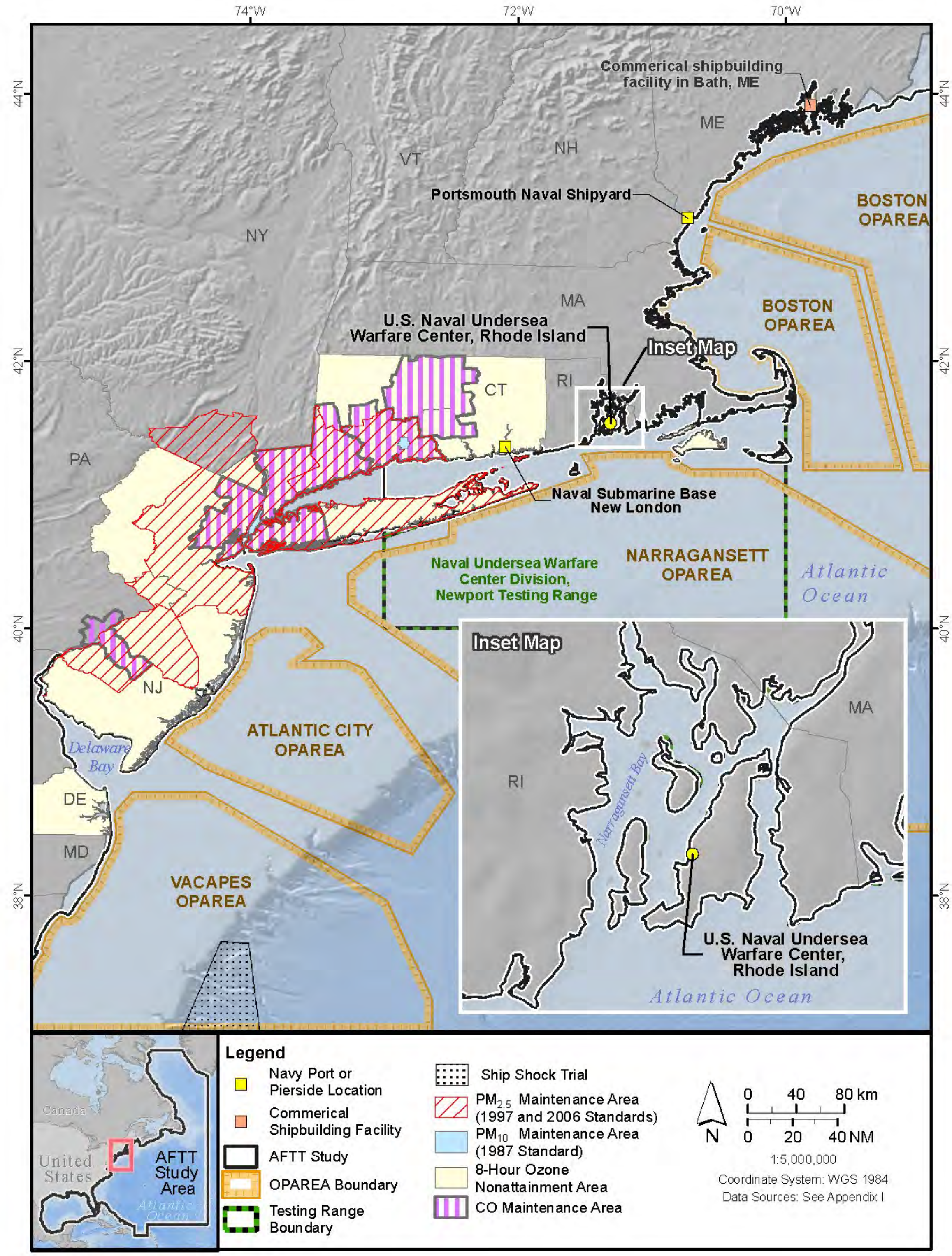
The Greater Connecticut area is designated as moderate nonattainment for ozone. Table 3.1-4 lists Study Area pierside locations and the attainment status for each.

Table 3.1-4: Pierside and Coastal Activity Locations and Their Area's Attainment Status

Pierside Location	Designated Area	National Ambient Air Quality Standards Attainment Status
Portsmouth Naval Shipyard, Kittery Maine; Shipyard – Bath, Maine	Metropolitan Portland/ Cumberland County	Attainment of all applicable standards
Naval Undersea Warfare Center, Division, Newport, Newport, Rhode Island	Providence (all of RI), RI	Attainment of all applicable standards
Naval Submarine Base New London; Groton, Connecticut Shipyard – Groton, Connecticut and Thames River	Greater Connecticut, CT	Moderate nonattainment of the 8-hour ozone standard Attainment of all other applicable standards
Naval Station Norfolk, Norfolk, Virginia; Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach, Virginia; Norfolk Naval Shipyard, Portsmouth, Virginia; Shipyard – Newport News, Virginia Broad Bay; York River; James River and Tributaries	Hampton Roads Intrastate	Attainment of all applicable standards
Cooper River; Charleston Pier, South Carolina	Charleston County	Attainment of all applicable standards
Naval Submarine Base Kings Bay, Georgia	Camden County	Attainment of all applicable standards
Naval Station Mayport, Jacksonville, Florida; St. John's River, Florida	Duval County	Attainment of all applicable standards
Port Canaveral, Cape Canaveral, Florida	Brevard County	Attainment of all applicable standards
Saint Andrews Bay, Florida	Bay County	Attainment of all applicable standards
Shipyard – Pascagoula, Mississippi	Jackson County	Attainment of all applicable standards

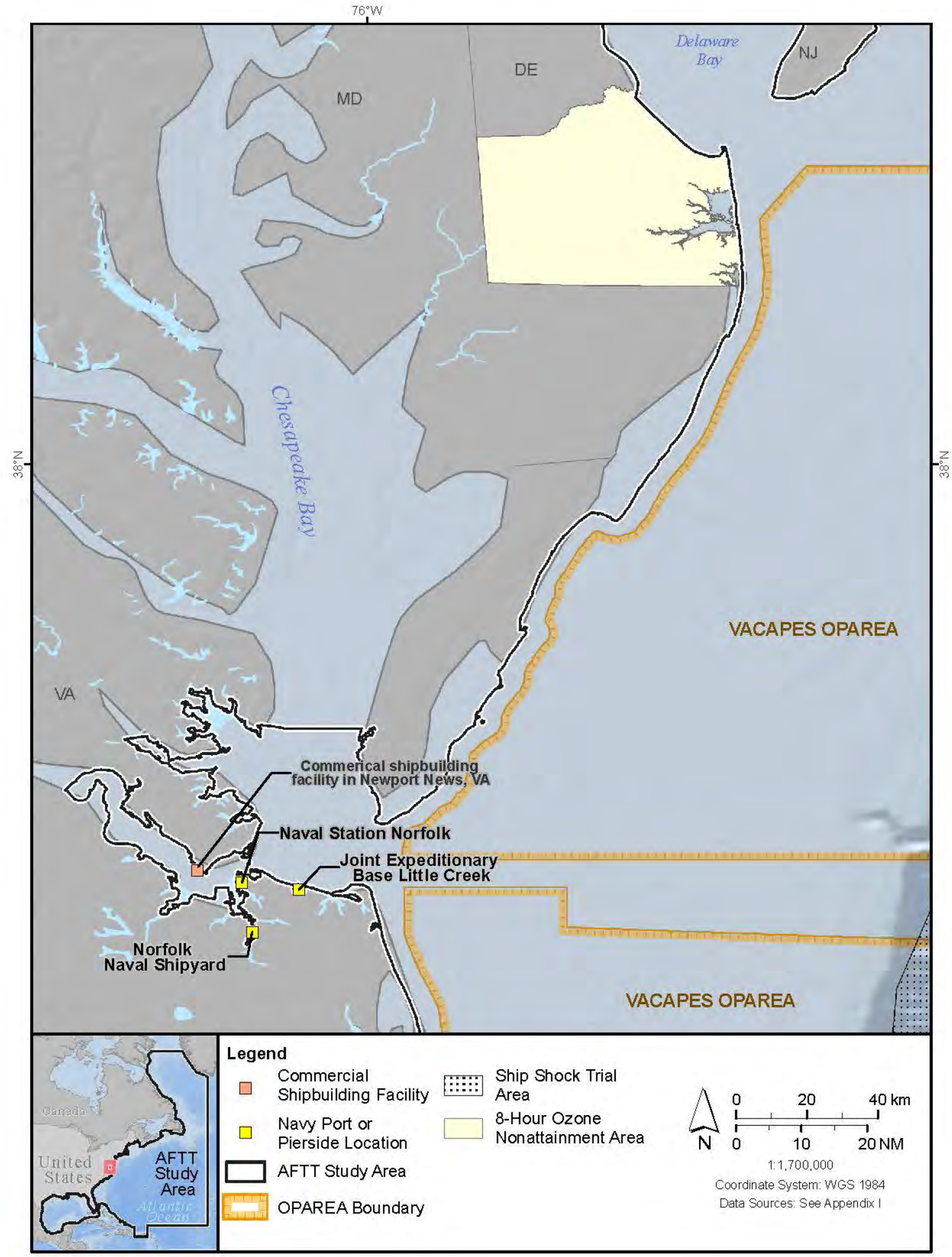
Source: 40 CFR part 81, Subpart C and Green Book Nonattainment and Maintenance Areas (U.S. Environmental Protection Agency, 2017)

Figure 3.1-1 through Figure 3.1-4 show the nonattainment and maintenance areas that are within or adjacent to the AFTT operational area.



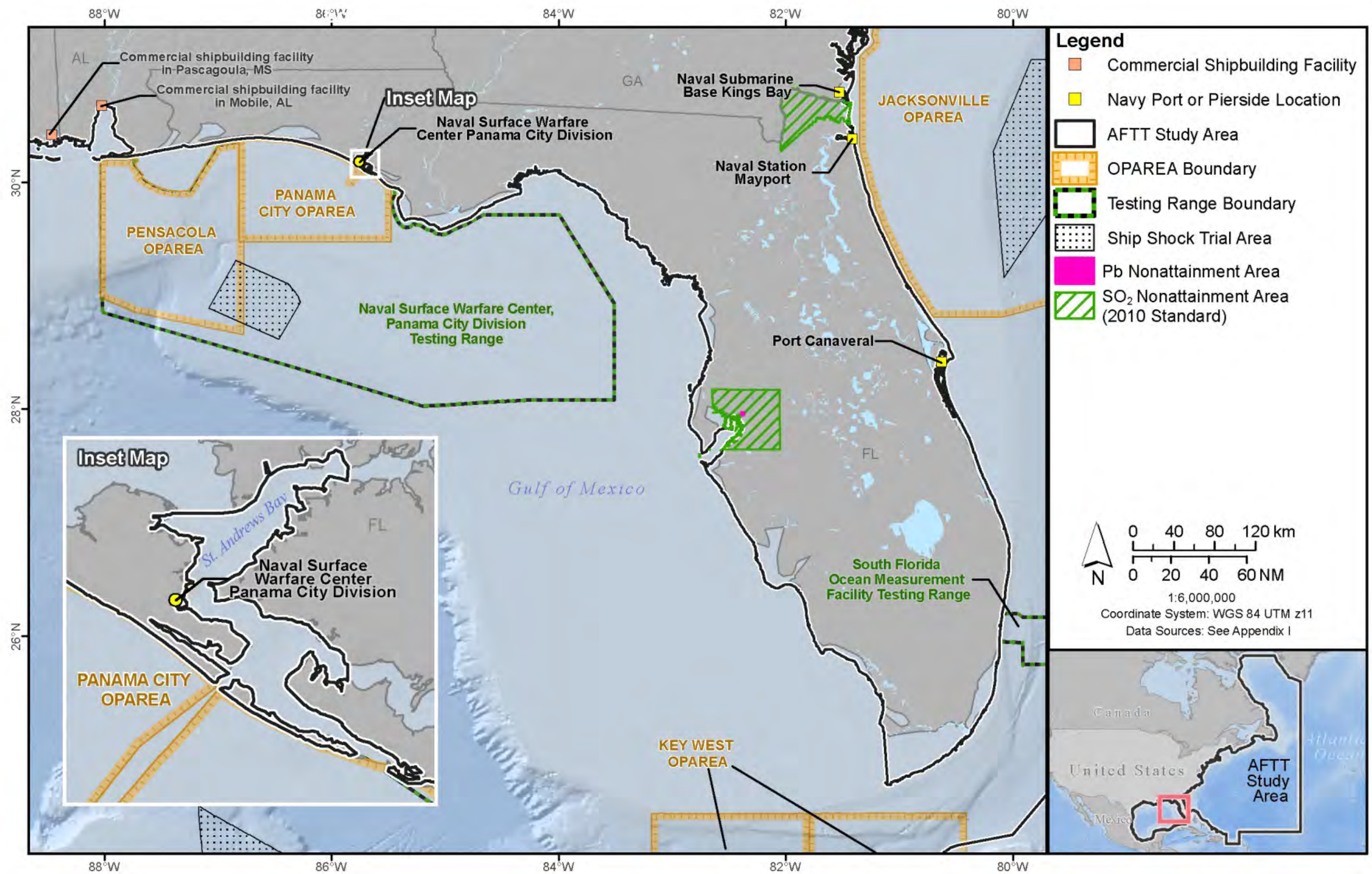
Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operation Area; $PM_{2.5}$: particulate matter less than or equal to 2.5 microns in diameter; PM_{10}: particulate matter less than or equal to 10 microns in diameter.

Figure 3.1-1: Applicable Nonattainment and Maintenance Areas in USEPA Region 1 and 2



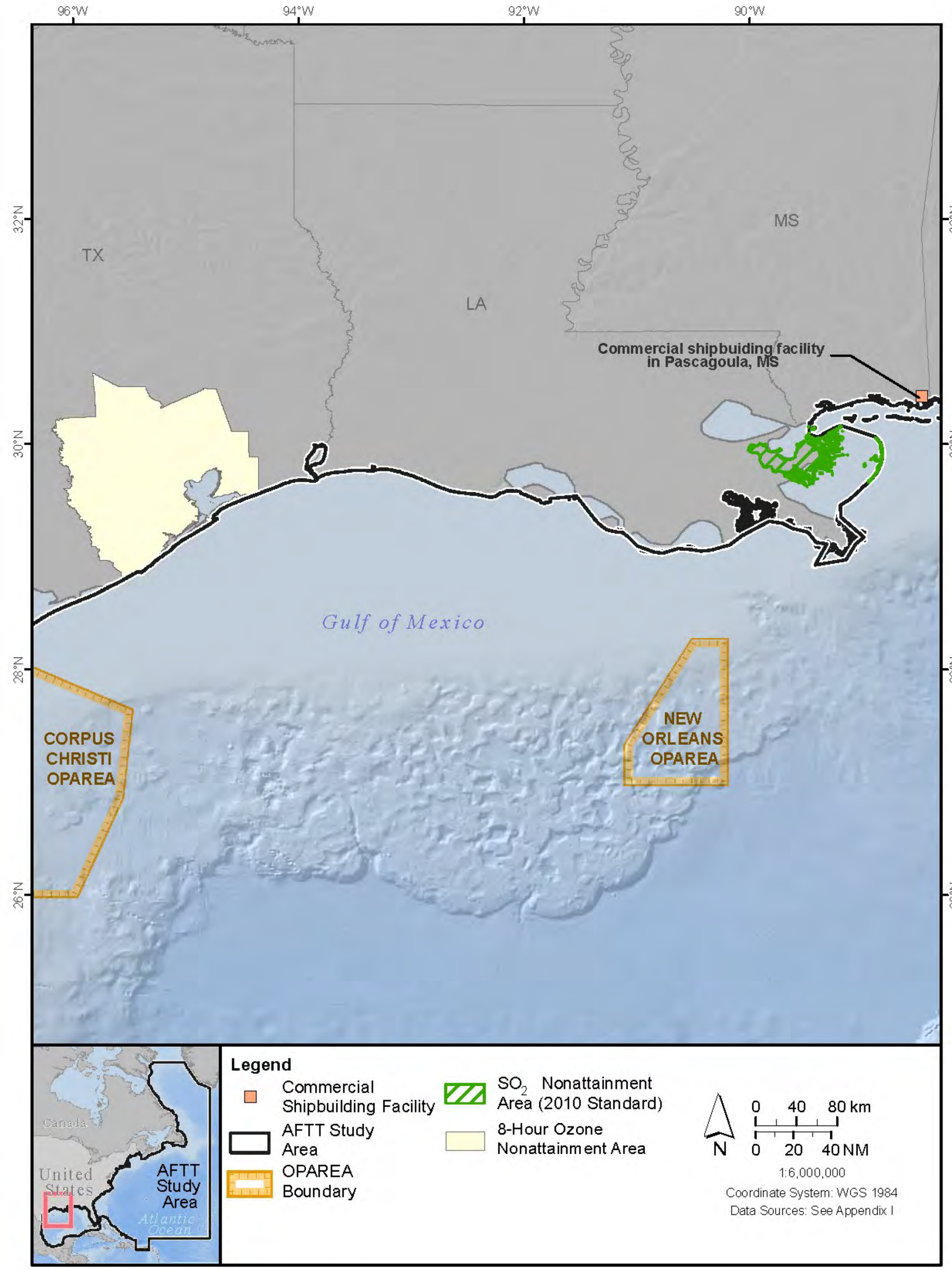
Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operation Area; PM $_{2.5}$: particulate matter less than or equal to 2.5 microns.

Figure 3.1-2: Applicable Nonattainment and Maintenance Areas in USEPA Region 3



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operation Area; SO_2: sulfur dioxide; Pb: lead.

Figure 3.1-3: Applicable Nonattainment and Maintenance Areas in USEPA Region 4



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operation Area. SO_2: sulfur dioxide

Figure 3.1-4: Applicable Nonattainment and Maintenance Areas in USEPA Region 6

3.1.2.3.1 Other Air Basins Adjacent to the Study Area

A substantial portion (over 70 percent) of all AFTT EIS/OEIS training and testing activities occur within these range complexes, which are adjacent to coastal attainment areas but located beyond state waters. The remaining 30 percent are largely conducted well offshore and a small percentage is performed in areas offshore of coastal nonattainment or maintenance areas. These areas include stretches of coastal areas of the northeast, areas adjacent to Nassau County, Florida, the Tampa area, the New Orleans area, and coastal areas around Houston. The migration of emissions from off-shore sources to land is well-documented. In 1997, the International Maritime Organization adopted Annex VI, Regulations for the Prevention of Air Pollution from Ships. These regulations were instituted for the commercial maritime industry due to recognition of the impact of vessel emissions, which can travel hundreds of miles, on coastal receptors and further inland. These emissions are particularly significant around the large ports on the coast of the US, which include New York/New Jersey, Philadelphia, Baltimore, Norfolk, Charleston, Savannah, Jacksonville, Miami, South Louisiana, and Houston, (U.S. Maritime Administration, 2016).

In addition to the OPAREAs and other areas further out to sea, there are also activities that occur within state waters. Vessels traverse state water during ingress/egress to OPAREAs and other Study Area locations further afield. There are also training activities in particular that occur in coastal areas, including riverine and bay locations. The area of greatest activity is in the lower Chesapeake Bay and in tributaries to the Bay, primarily the James and York Rivers in Virginia. Activities in Narragansett Bay are associated with the Naval Undersea Warfare Center, Newport Rhode Island. Additional areas where training or testing occurs within state waters include the St. Johns River near Naval Station Mayport FL, Port Canaveral FL, St. Andrews Bay near Naval Support Activity Panama City FL and the Cooper River near Charleston, SC. Of these, only Naval Station Mayport is located in an Air Quality Control Region with a nonattainment designation within its borders.

3.1.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially impact air quality within the Study Area. Table 3.1-4 to Table 3.1-7 present the total emissions for the baseline and proposed training and testing activity locations under each alternative. The air quality stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to air quality in the Study Area are analyzed below and include the following:

- **Criteria Air Pollutants**

In this analysis, criteria air pollutant emissions estimates were calculated for vessels, aircraft, and munitions. For each alternative, emissions estimates were developed by range complex and other training or testing locations and totaled for the Study Area. Additionally, state waters emissions are separately analyzed for air quality impacts. Details of the emission estimates are provided in Appendix C (Air Quality Emissions Calculations and Record of Non- Applicability). Hazardous air pollutants are analyzed qualitatively in relation to the prevalence of the sources emitting hazardous air pollutants during training and testing activities.

3.1.3.1 Criteria Air Pollutants

The potential impacts of criteria air pollutants are evaluated by first estimating the emissions from training and testing activities in the Study Area for each alternative. These estimates are then used to determine the potential impact of the emissions on the attainment status of the adjacent designated air quality area. For a nonattainment or maintenance area, this involves evaluating the net change in emissions that would result from implementing the Proposed Action, as compared to current emissions, which are classified as the baseline emissions for the purpose of this analysis. The net change is then compared to published *de minimis* thresholds to assess compliance. The baseline emissions are defined as the emissions estimated for the Preferred Alternative that was proposed in the 2013 Atlantic Fleet Training and Testing Final Environmental Impact Statement / Overseas Environmental Impact Statement. Emissions of criteria air pollutants may affect human health directly by degrading local or regional air quality or indirectly by their effects on the environment. Air pollutant emissions may also have a regulatory effect separate from their physical effect, if additional air pollutant emissions change the attainment status of an air quality control region.

The estimate of criteria air pollutant emissions for each alternative is categorized by region (e.g., by range complex or testing range) so that differences in background air quality, atmospheric circulation patterns, regulatory requirements, and sensitive receptors can be addressed. An overall estimate of air pollutant emissions for Navy training and testing activities in the Study Area under each alternative is also provided. Under Alternative 1, emissions were based on the average number of training and testing activities anticipated, based on the prior 6 years of data. Under Alternative 2, emissions were based on the anticipated maximum number of training and testing activities. For vessel operations, the maximum was based on the operations that occurred in 2011 the year of the highest number of operations in the range 2010 – 2015. While this represented the year of most total operations, the number of operations involving specific vessels in the individual operational areas may or may not have been higher than the average number used in Alternative 1. These individual variances do not change the overall result of greater total operations when accounting for all vessels in all regions under Alternative 2.

3.1.3.1.1 Impacts from Criteria Pollutant Emissions under Alternative 1

Table 3.1-5 presents the total estimated emission results under Alternative 1 for each operational region in the Study Area and includes all emissions generated, regardless of proximity to the coastline. Most of these emissions occur beyond state waters, with the majority of emissions in most areas occurring beyond the state water boundaries. For Virginia Capes OPAREA, the use of vessels within the state waters is up to 2%, and in the Jacksonville OPAREA, the use of vessels within state waters is up to 1%.

The subsections that follow evaluate the emission in state waters within the Study Area that include nonattainment or maintenance areas.

Table 3.1-5: Estimated Annual Air Pollutant Emissions from Activities Occurring within the AFTT Study Area, Alternative 1

Range Complex	*Emissions by Air Pollutant (TPY)*					
	VOC	*CO*	*NO_X*	*SO_X*	*PM_{10}*	*$PM_{2.5}$*
Northeast	6.94	45.59	275.06	56.28	14.52	14.52
Virginia Capes	128.06	1,128.22	3,961.83	1,075.04	209.23	209.23
Cherry Point	40.13	343.83	891.52	169.00	41.72	41.72
Jacksonville	48.76	490.23	1,109.36	313.03	75.06	75.06

Table 3.1-5: Estimated Annual Air Pollutant Emissions from Activities Occurring within the AFTT Study Area, Alternative 1 (continued)

Range Complex	*Emissions by Air Pollutant (TPY)*					
	VOC	*CO*	*NO_X*	*SO_X*	*PM_{10}*	*$PM_{2.5}$*
Key West	2.78	13.32	77.58	12.99	4.92	4.92
Gulf of Mexico	9.67	127.25	463.74	116.05	25.83	25.83
Outside Range Complex Areas	53.64	332.74	1,683.07	383.46	55.59	55.59

Notes: CO: carbon monoxide; NO_x: oxides of nitrogen; VOC: volatile organic compounds; SO_x: sulfur oxides; PM_{10}: particulate matter less than or equal to 10 microns in aerodynamic diameter; $PM_{2.5}$: particulate matter less than or equal to 2.5 microns in aerodynamic diameter; tpy: tons per year.

A significant portion of the Study Area activities would occur well offshore. While pollutants emitted in the Study Area under Alternative 1 may at times be carried ashore by winds, most training and testing activities would occur more than 12 NM offshore, and natural mixing would substantially disperse pollutants before they reach the coastal land mass. The contributions of air pollutants generated in the Study Area to the air quality in onshore areas are unlikely to measurably add to existing onshore pollutant concentrations because of the distances these offshore pollutants would be transported and their substantial dispersion during transport.

In addition to the activities occurring beyond territorial waters, there would be activities closer to shore and these were evaluated to assess local onshore impacts.

3.1.3.1.2 Impacts from Criteria Pollutant Emissions under Alternative 1 in Northeast Areas Designated Nonattainment or Maintenance

In the Northeast, the primary areas where air pollution has resulted in designation of nonattainment or maintenance areas lie in the New York-Northern New Jersey-Long Island, NY-NJ-CT Air Quality Control Region (U.S. Environmental Protection Agency, 1972) (see Figure 3.1-1) which is moderate nonattainment for ozone, a maintenance area for particulate matter less than or equal to 2.5 microns in diameter, and includes a maintenance area for particulate matter less than or equal to 10 microns in diameter. A portion of the Eastern Connecticut Intrastate Control Region is also designated as moderate nonattainment for ozone. A very small area of coastal New Hampshire is nonattainment for sulfur dioxide, and there is a small area of ozone nonattainment in the coastal counties of New Jersey as well as near the coast at Seaford, Delaware. Activities in state waters are not scheduled to occur in any of these nonattainment or maintenance areas. The primary location where state waters activities in this region do occur is at Naval Undersea Warfare Center Newport and Narragansett Bay, both of which are in Rhode Island, an area in attainment for all pollutants.

3.1.3.1.3 Impacts from Criteria Pollutant Emissions under Alternative 1 in Jacksonville Florida Areas Designated Nonattainment or Maintenance

In the Southeast, the area where air pollution has resulted in designation of a coastal nonattainment or maintenance area lies in the Nassau County, Florida, which is just north of Jacksonville (see Figure 3.1-3). Both of these counties are in the Jacksonville (Florida)-Brunswick (Georgia) Interstate Air Quality Control Region. A portion of Nassau County is nonattainment for sulfur dioxide. Table 3.1-6 presents the estimated state waters emissions and their relevance to applicable General Conformity thresholds.

Table 3.1-6: Estimated Net Change Annual Air Pollutant Emissions from Activities Occurring in State Waters in the Jacksonville, Florida Area, Alternative 1

	Emissions by Air Pollutant (TPY)					
	VOC	*CO*	*NO_X*	*SO_X*	*PM_{10}*	*$PM_{2.5}$*
Nassau FL SO2 Nonattainment Area						
Total Emissions from all Sources	1.85	8.34	63.03	11.39	1.91	1.91
Baseline	4.98	51.70	31.26	10.50	3.11	3.11
Net Change	-3.13	-43.36	31.76	0.89	-1.20	-1.20
General Conformity Thresholds	NA	NA	NA	100	NA	NA
Exceedance?	NA	NA	NA	No	NA	NA

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.
CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter less than or equal to 2.5 microns in diameter; PM_{10}: particulate matter less than or equal to 10 microns in diameter; SO_X: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Sulfur dioxide emissions in state waters associated with AFTT activities would be below the General Conformity *de minimis* thresholds. As a result, no further analysis of conformity is required and a Record of Non-Applicability, located in Appendix C, was prepared in accordance with Navy guidance.

3.1.3.1.4 Impacts from Criteria Pollutant Emissions under Alternative 1 in the Gulf of Mexico Areas Designated Nonattainment or Maintenance

In the Gulf of Mexico, the primary areas where air pollution has resulted in designation of nonattainment or maintenance areas lie in Hillsborough County, Florida (see Figure 3.1-1) which is nonattainment for sulfur dioxide and lead; Saint Bernard Parish, Louisiana, which is also nonattainment for sulfur dioxide; and the Houston-Galveston-Brazoria ozone nonattainment area. Activities in state waters are not scheduled to occur in any of these nonattainment or maintenance areas. The primary location where state water activities in this region do occur is at Naval Undersea Warfare Center Panama City, Florida which is in attainment for all pollutants.

3.1.3.1.5 Summary of Impacts from Criteria Pollutants under Alternative 1

While pollutants emitted in the Study Area under Alternative 1 may at times be carried ashore by prevailing winds, most training and testing activities would occur beyond state water boundaries and natural mixing would substantially disperse pollutants before they reach the boundaries of the adjacent air quality control regions. Additionally, the primary wind pattern moves from shore to offshore. The contributions of air pollutants generated in the Study Area to the air quality in the air quality control regions are unlikely to measurably add to existing onshore pollutant concentrations because of the distances these offshore pollutants would be transported and their substantial dispersion during transport. Therefore, no significant impacts on air quality as a result of criteria pollutants over state waters would occur; and no significant harm to air quality as a result of criteria pollutant emissions beyond state waters would occur.

3.1.3.1.6 Impacts from Criteria Pollutant Emissions under Alternative 2

Table 3.1-7 presents the total estimated emission results under Alternative 2 for each operational region in the Study Area and includes all emissions generated, regardless of proximity to the coastline. Most of these emissions occur beyond state waters. For Virginia Capes OPAREA, the use of vessels within the state waters is greater than in other portions of the Study Area.

The subsections that follow evaluate the state waters emissions within the regional areas that include nonattainment or maintenance areas. These emissions are compared to the General Conformity *de minimis* thresholds, and are not specific to specific localities. This conservative approach, then, evaluates all nearshore emissions as potentially occurring in any of the applicable nonattainment or maintenance areas.

Table 3.1-7: Estimated Annual Air Pollutant Emissions from Activities Occurring within the AFTT Study Area, Alternative 2

	Emissions by Air Pollutant (TPY)					
	VOC	***CO***	***NO_X***	***SO_X***	***PM_{10}***	***$PM_{2.5}$***
Northeast	6.37	46.75	252.28	48.26	16.90	16.90
Virginia Capes	124.05	1,124.25	4,232.97	1,161.70	353.96	353.96
Cherry Point	29.41	180.79	793.93	190.95	38.81	38.81
Jacksonville	60.49	607.27	2,033.74	546.75	92.58	92.58
Key West	0.92	15.32	30.75	10.59	3.18	3.18
Gulf of Mexico	3.04	32.06	106.10	27.02	14.44	14.44
Outside Range Complex Areas	162.29	569.59	4,160.17	656.71	90.15	90.15

Notes: CO: carbon monoxide; NO_x: oxides of nitrogen; VOC: volatile organic compounds; SO_x: sulfur oxides; PM_{10}: particulate matter less than or equal to 10 microns in aerodynamic diameter; $PM_{2.5}$: particulate matter less than or equal to 2.5 microns in aerodynamic diameter; tpy: tons per year.

A significant portion of the Study Area activities would occur well offshore. While pollutants emitted in the Study Area under Alternative 2 may at times be carried ashore by winds, most training and testing activities would occur more than 12 NM offshore, and natural mixing would substantially disperse pollutants before they reach the coastal land mass. The contributions of air pollutants generated in the Study Area to the air quality in onshore areas are unlikely to measurably add to existing onshore pollutant concentrations because of the distances these offshore pollutants would be transported and their substantial dispersion during transport.

In addition to the activities occurring beyond territorial waters, there would be activities closer to shore and these were evaluated to assess local onshore impacts.

3.1.3.1.7 Impacts from Criteria Pollutant Emissions under Alternative 2 in Northeast Areas Designated Nonattainment or Maintenance

In the Northeast, the primary areas where air pollution has resulted in designation of nonattainment or maintenance areas lies in the New York-Northern New Jersey-Long Island, NY-NJ-CT Air Quality Control Region (U.S. Environmental Protection Agency, 1972) (see Figure 3.1-1) which is moderate nonattainment for ozone, a maintenance area for particulate matter less than or equal to 2.5 microns in diameter, and includes a maintenance area for particulate matter less than or equal to 10 microns in diameter. A portion of the Eastern Connecticut Intrastate Control Region is also designated as moderate nonattainment for ozone. A very small area of coastal New Hampshire is nonattainment for sulfur dioxide, and there is a small area of ozone nonattainment near the coast at Seaford, Delaware. State waters activities are not scheduled to occur in any of these nonattainment or maintenance areas. The primary location where state waters activities in this region do occur is at Naval Undersea Warfare

Center Newport and Narragansett Bay, both of which are in Rhode Island, an area in attainment for all pollutants.

3.1.3.1.8 Impacts from Criteria Pollutant Emissions under Alternative 2 in Jacksonville Florida Areas Designated Nonattainment or Maintenance

In the Southeast, the area where air pollution has resulted in designation of a coastal nonattainment or maintenance area lies in the Nassau County, Florida, which is just north of Jacksonville (see Figure 3.1-3). Both of these counties are in the Jacksonville (Florida)-Brunswick (Georgia) Interstate Air Quality Control Region. A portion of this county is nonattainment for sulfur dioxide. Table 3.1-8 presents the estimated nearshore emissions and their relevance to applicable General Conformity thresholds.

Table 3.1-8: Estimated Annual Air Pollutant Emissions from Activities Occurring within 3 NM of shore in the Jacksonville, Florida Area, Alternative 2

	Emissions by Air Pollutant (TPY)					
	VOC	***CO***	***NO_X***	***SO_X***	***PM_{10}***	***$PM_{2.5}$***
Nassau FL SO_2 Nonattainment Area						
Total Emissions from all Sources	2.04	11.29	69.05	12.58	2.21	2.04
Baseline	4.98	51.70	31.26	10.50	3.11	3.11
Net Change	-2.94	-40.41	37.79	2.09	-0.90	-0.90
General Conformity Thresholds	NA	NA	NA	100	NA	NA
Exceedance?	NA	NA	NA	No	NA	NA

Notes**:** Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter less than or equal to 2.5 microns in diameter; PM_{10}: particulate matter less than or equal to 10 microns in diameter; SO_X: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Sulfur dioxide emissions in state waters that are associated with AFTT activities would be below the General Conformity *de minimis* thresholds. As a result, no further analysis of conformity is required and a Record of Non-Applicability, located in Appendix C, was prepared in accordance with Navy guidance.

3.1.3.1.9 Impacts from Criteria Pollutant Emissions under Alternative 2 in the Gulf of Mexico Adjacent Areas Designated Nonattainment or Maintenance

In the Gulf of Mexico, the primary areas where air pollution has resulted in designation of nonattainment or maintenance areas lie in Hillsborough County, Florida (see Figure 3.1-1) which is nonattainment for sulfur dioxide and lead; Saint Bernard Parish, Louisiana, which is also nonattainment for sulfur dioxide; and the Houston-Galveston-Brazoria ozone nonattainment area. State waters activities are not scheduled to occur in any of these nonattainment or maintenance areas. The primary location where state waters activities in this region do occur is at Naval Undersea Warfare Center Panama City, Florida which is in attainment for all pollutants.

State waters emissions associated with AFTT activities would all be below the General Conformity *de minimis* thresholds. As a result, no further analysis of conformity is required and a Record of Non-Applicability, located in Appendix C, was prepared in accordance with Navy guidance. .

3.1.3.1.10 Summary of Impacts from Criteria Pollutants under Alternative 2

While pollutants emitted in the Study Area under Alternative 2 may at times be carried ashore by prevailing winds, most training and testing activities would occur more than 3 NM offshore, and natural mixing would substantially disperse pollutants before they reach the boundaries of the adjacent air quality control regions. The contributions of air pollutants generated in the Study Area to the air quality in the air quality control regions are unlikely to measurably add to existing onshore pollutant concentrations because of the distances these offshore pollutants would be transported and their substantial dispersion during transport.

3.1.3.1.11 Impacts from Criteria Pollutants under the No Action Alternative

Under the No Action Alternative, training and testing activities associated with the Proposed Action would not be conducted within the AFTT Study Area. Discontinuing training and testing activities in the Study Area under the No Action Alternative would not measurably improve air quality in the Study Area because of the discontinuous nature of the events that constitute the Proposed Action and the fact that most of the air emissions that are generated occur at sea over a wide geographic area. The elimination of the air emissions associated with training activities in the lower Chesapeake Bay and its tributaries may be beneficial to local air quality in this region because it is the area of highest activity in state waters. It should be noted that the air quality in this area already surpasses the National Ambient Air Quality Standards.

3.1.3.2 Greenhouse Gases and Climate Change

Activities conducted as part of the Proposed Action would involve mobile sources using fossil fuel combustion as a source of power. Additionally, the expenditure of munitions could generate greenhouse gas emissions. While the emissions generated by testing and training activities alone would not be enough to cause global warming, in combination with past and future emissions from all other sources they would contribute incrementally to the global warming that produces the adverse effects of climate change.

Greenhouse gas emissions for all of the testing and training activities occurring annually throughout the entire Study Area were calculated using emissions factors provided by the U.S. Navy for aircraft and vessels, and published by the USEPA for munitions. The analysis of greenhouse gas emissions associated with aircraft is limited to those emissions below 3,000 ft. because there is insufficient historical data to document the entire flight path or flight duration of any given aircraft for a specific training or testing event. This is also true for the baseline data so that the totals for the baseline, Alternative 1 and Alternative 2 are comparable. A net decrease in greenhouse gas emissions would be anticipated compared to the baseline estimate, with the largest decrease associated with Alternative 1, as indicated in Table 3.1-9.

Table 3.1-9: Total Greenhouse Gas Emissions from All Study Area Training and Testing Activities

Alternative	*Annual CO_2 Emissions in Metric Tons/Year*
Baseline	1,360,794
Alternative 1	1,088,429
Net Change	-272,364
Alternative 2	1,296,256
Net Change	-64,538

3.1.4 Summary of Potential Impacts on Air Quality

In this analysis, criteria air pollutant and greenhouse gas emissions estimates were calculated for vessels, aircraft, and munitions. For each alternative, emissions estimates were developed by range complex and other training or testing locations and totaled for the Study Area. Details of the emission estimates are provided in Appendix C (Air Quality Emissions Calculations and Example Record of Non-Applicability). Hazardous air pollutants were analyzed qualitatively in relation to the type and prevalence of the sources emitting hazardous air pollutants during training and testing activities.

3.1.4.1 Combined Impacts of All Stressors under Alternative 1

As discussed in Section 3.1.3.1 (Criteria Air Pollutants), emissions associated with Study Area training and testing activities under Alternative 1 primarily occur beyond the boundary for state waters. For fixed-wing aircraft activities, emissions typically occur above the 3,000-ft. mixing layer. Given these characteristics, the impact on air quality from the combination of these resource stressors are expected to be similar to the impacts on air quality for any of these stressors taken individually without any additive synergistic, or antagonistic interaction. A comparison of estimated emissions under Alternative 1 to the baseline indicates that some pollutant emissions would be reduced and others would increase. Emissions of VOCs remain largely static, and PM emissions would undergo a small increase. Carbon monoxide and greenhouse gases would decrease substantially. Nitrogen oxides and sulfur dioxide would increase. A significant cause of the increase in nitrogen oxide and sulfur dioxide emissions is due to the inclusion of more accurate data for riverine and bay testing and training activities, particularly in the Virginia environs. Because these activities were not well accounted for in the analyses presented in the 2013 Atlantic Fleet Training and Testing Final EIS/OEIS, it appears that there has been a sizeable increase. However, it is simply the result of better information and hence a more accurate accounting of what typically occurs in these areas.

3.1.4.2 Combined Impacts of All Stressors under Alternative 2

As discussed in Section 3.1.3.1 (Criteria Air Pollutants), emissions associated with Study Area training and testing activities under Alternative 2 primarily occur beyond the boundary for state waters. For fixed-wing aircraft activities, emissions typically occur above the 3,000-ft. mixing layer. Given these characteristics, the impact on air quality from the combination of these resource stressors are expected to be similar to the impacts on air quality for any of these stressors taken individually without any additive synergistic, or antagonistic interaction. A comparison of estimated emissions under Alternative 2 in comparison to the baseline indicates that some pollutants emissions would be reduced and others would increase. Emissions of VOCs remain largely static, and PM emissions would undergo a small increase. Carbon monoxide and greenhouse gases would decrease substantially. Nitrogen oxides and sulfur dioxide would increase. A significant cause of the increase in nitrogen oxide and sulfur dioxide emissions is due to the inclusion of more accurate data for riverine and bay testing and training activities, particularly in the Virginia environs. Because these activities were not well accounted for in the analyses presented in the 2013 Atlantic Fleet Training and Testing Final EIS/OEIS, it appears that there has been a sizeable increase. However, it is simply the result of better information and hence a more accurate accounting of what typically occurs in these areas.

3.1.4.3 Combined Impacts of All Stressors under the No Action Alternative

As discussed in Sections 3.1.3.1 (Criteria Air Pollutants), training and testing activities associated with the Proposed Action would not be conducted within the AFTT Study Area.

Discontinuing training and testing activities in the Study Area under the No Action Alternative would not measurably improve air quality in the Study Area because of the discontinuous nature of the events that constitute the Proposed Action and the fact that most of the air emissions that are generated occur at sea over a wide geographic area. The elimination of the air emissions associated with training activities in the lower Chesapeake Bay and its tributaries may be beneficial to local air quality in this region because it is the area of highest activity in state waters. It should be noted that the air quality in this area already surpasses the National Ambient Air Quality Standards.

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

TABLE OF CONTENTS

List of Figures

List of Tables

3.2 SEDIMENTS AND WATER QUALITY

SEDIMENTS AND WATER QUALITY SYNOPSIS

The United States Department of the Navy (Navy) considered all potential stressors that sediments and water quality could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the Preferred Alternative:

- Explosives and explosives by products: Impacts from explosives and explosives byproducts would be short-term and local. Impacts from unconsumed explosives and constituent chemical compounds would be minimal and limited to the area adjacent to the munition. Explosives and constituent compounds could persist in the environment depending on the integrity of the undetonated munitions casing and the physical conditions on the seafloor where the munition resides. Chemical and physical changes to sediments and water quality, as measured by the concentrations of contaminants or other anthropogenic compounds, may be detectable and would be below applicable regulatory standards for determining effects on biological resources and habitats.
- Chemicals other than explosives: Impacts from other chemicals not associated with explosives would be both short term and long term depending on the chemical and the physical conditions on the seafloor where the source of the chemicals resides. Impacts would be minimal and localized to the immediate area surrounding the source of the chemical release.
- Metals: Impacts from metals would be minimal and long term and dependent on the metal and the physical conditions on the seafloor where the metal object (e.g., non-explosive munition) resides. Impacts would be localized to the area adjacent to the metal object. Concentrations of metal contaminants near the expended material or munition may be measureable and are likely to be similar to the concentrations of metals in sediments from nearby reference locations.
- Other materials: Impacts from other expended materials not associated with munitions would be both short-term and long-term depending on the material and the physical conditions on the seafloor where the material resides. Impacts would be localized to the immediate area surrounding the material. Chemical and physical changes to sediments and water quality, as measured by the concentrations of contaminants or other anthropogenic compounds near the expended material, are not likely to be detectable and would be similar to the concentrations of chemicals and material residue from nearby reference locations.

3.2.1 INTRODUCTION AND METHODS

3.2.1.1 Introduction

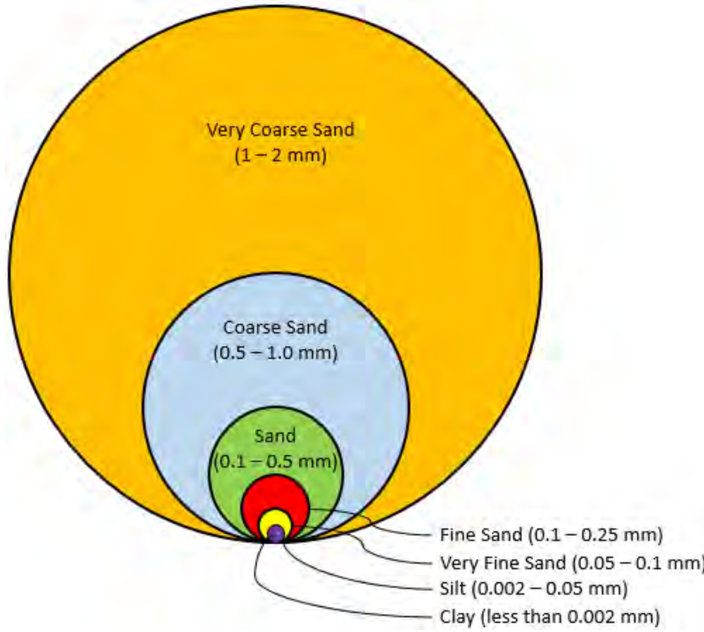
The following sections provide an overview of the characteristics of sediments and water quality in the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area), and describe, in general terms, the methods used to analyze potential impacts of the Proposed Action on these resources.

3.2.1.1.1 Sediments

The discussion of sediments begins with an overview of sediment sources and characteristics in the Study Area, and considers factors that have the potential to affect sediment quality.

3.2.1.1.1.1 Characteristics of Sediments

Sediments consist of solid fragments of organic and inorganic matter at the bottom of bodies of water. Sediments in the marine environment (e.g., in ocean basins) are either terrigenous, meaning that they originate from land, or are biogenic (i.e., formed from the remains of marine organisms). Terrigenous sediments come from the weathering of rock and other substrates and are transported by water, wind, and ice (glaciers) to the seafloor. Biogenic sediments are produced in the oceans by the skeletal remains of single-celled benthic and planktonic organisms (e.g., organisms in the phylum foraminifera and diatoms). When the organism dies, its shell is deposited on the seafloor. The remains are composed primarily of either calcium carbonate or silica, and mixed with clays, form either a calcareous or siliceous ooze (Chester, 2003). Sediments in the Atlantic Ocean are predominantly composed of calcareous oozes and the Pacific Ocean has more siliceous oozes (Kennett, 1982). Sands range in size from 0.05 millimeter (mm) (very fine sands) to 2 mm (very course sands) in diameter (Figure 3.2-1). For comparison, the thickness of a nickel is approximately 2 mm. Sediment types smaller than sands are silts (0.002 to 0.05 mm in diameter) and clays (particles less than 0.002 mm in diameter). Sediments larger than very course sands are considered cobbles (U.S. Department of Agriculture, 1993). Sediments in nearshore waters and on the continental shelf are primarily terrigenous, and sediments farther from land in deep ocean basins are primarily biogenic. Through the downward movement of organic and inorganic particles in the water column, many substances that are otherwise scarce in the water column are concentrated in bottom sediments (Chapman et al., 2003; Kszos et al., 2003).



Note: mm = millimeter

Figure 3.2-1: Sediment Particle Size Comparison

3.2.1.1.1.2 Factors Affecting Marine Sediment Quality

The quality of sediments is influenced by their physical, chemical, and biological components; by where they are deposited; by the properties of seawater; and by other inputs and sources of contamination. Sediments tend to be dynamic, where factors affecting marine sediments often interact and influence each other. These factors are summarized below.

Physical characteristics and processes: At any given site, the texture and composition of sediments are important physical factors that influence the types of substances that are retained in the sediments, and subsequent biological and chemical processes. For example, clay-sized and smaller sediments and similarly sized organic particles tend to bind potential sediment contaminants and potentially limit their movement in the environment (U.S. Environmental Protection Agency, 2009). Conversely, fine-grained sediments are easily disturbed by currents and bottom-dwelling organisms, dredging, storms, and bottom trawling (Eggleton & Thomas, 2004; Hedges & Oades, 1997). Disturbance is also possible in deeper areas, where currents are minimal (Carmody et al., 1973), from mass wasting events such as underwater slides and debris flows (Coleman & Prior, 1988). If re-suspended, fine-grained sediments (and any substances bound to them) can be transported long distances.

Chemical characteristics and processes: The concentration of oxygen in sediments strongly influences sediment quality through its effect on the binding of materials to sediment particles. At the sediment surface, the level of oxygen is usually the same as that of the overlying water. Deeper sediment layers, however, are often low in oxygen (i.e., hypoxic) or have no oxygen (i.e., anoxic), and have a low oxidation-reduction potential, which predicts the stability of various compounds that regulate nutrient and metal availability in sediments. Certain substances combine in oxygen-rich environments and become less available for other chemical or biological reactions.

Biological characteristics and processes: Organic matter in sediments provides food for resident microbes. The metabolism of these microbes can change the chemical environment in sediments and thereby increase or decrease the mobility of various substances and influence the ability of sediments to retain and transform those substances (Mitsch et al., 2009; U.S. Environmental Protection Agency, 2008b). Bottom-dwelling animals often rework sediments in the process of feeding or burrowing. In this way, marine organisms influence the structure, texture, and composition of sediments, as well as, the horizontal and vertical distribution of substances in the sediment (Boudreau, 1998). Moving substances out of or into low or no-oxygen zones in the sediment may alter the form and availability of various substances. The metabolic processes of bacteria also influence sediment components directly. For example, sediment microbes may convert mercury to methyl mercury, increasing its toxicity (Mitchell & Gilmour, 2008).

Location: The quality of coastal and marine sediments is influenced substantially by inputs from adjacent watersheds (Turner & Rabalais, 2003). Proximity to watersheds with large cities or intensively farmed lands often increases the amount of both inorganic and organic contaminants that find their way into coastal and marine sediments. A wide variety of metals and organic substances, such as polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and pesticides—often referred to collectively as "persistent organic pollutants"—are discharged into coastal waters by urban, agricultural, and industrial point and non-point sources in the watershed (U.S. Environmental Protection Agency, 2008b). Location on the ocean floor also influences the distribution and concentration of various elements through local geology and volcanic activity (Demina & Galkin, 2009), as well as through landslides and debris flow events (Coleman & Prior, 1988).

Other Contributions to Sediments: While the greatest mass of sediments is carried into marine systems by rivers (U.S. Environmental Protection Agency, 2008b), wind and rain also deposit materials in coastal waters, and contribute to the mass and quality of sediments. For example, approximately 80 percent of the mercury released by human activities comes from coal combustion, mining and smelting, and solid waste incineration (Agency for Toxic Substances and Disease Registry, 1999). These activities are generally considered to be the major sources of mercury in marine systems (Fitzgerald et al., 2007). Atmospheric deposition of lead is similar in that human activity is a major source of lead in sediments (Wu & Boyle, 1997).

3.2.1.1.2 Water Quality

The discussion of water quality begins with an overview of the characteristics of marine waters, including pH (a measure of acidity), temperature, oxygen, nutrients, salinity, and dissolved elements. The discussion then considers how those characteristics of marine waters are influenced by physical, chemical, and biological processes.

3.2.1.1.2.1 Characteristics of Marine Waters

The composition of water in the marine environment is determined by complex interactions among physical, chemical, and biological processes. Physical processes include region-wide currents and tidal flows, seasonal weather patterns and temperature, sediment characteristics, and unique local conditions, such as the volume of fresh water delivered by large rivers. Chemical processes involve salinity, pH, dissolved minerals and gases, particulates, nutrients, and pollutants. Biological processes involve the influence of living things on the physical and chemical environment. The two dominant biological processes in the ocean are photosynthesis and respiration, particularly by microorganisms. These processes involve the uptake, conversion, and excretion of waste products during growth, reproduction, and decomposition (Mann & Lazier, 1996).

3.2.1.1.2.2 Influences of Marine Properties and Processes on Seawater Characteristics

Ocean currents and tides mix and redistribute seawater. In doing so, they alter surface water temperatures, transport and deposit sediment, and concentrate and dilute substances that are dissolved and suspended in the water. These processes operate to varying degrees from nearshore areas to the abyssal plain. Salinity also affects the density of seawater and, therefore, its movement relative to the sea surface (Libes, 2009). Upwelling brings cold, nutrient-rich waters from deeper areas, increasing the productivity of local surface waters (Mann & Lazier, 1996). Storms and hurricanes also cause strong mixing of marine waters (Li et al., 2008).

Temperature and pH influence the behavior of trace metals in seawater, such as the extent to which they dissolve in water (i.e., the metal's solubility) or their tendency to adsorb to organic and inorganic particles. However, the degree of influence differs widely among metals (Byrne, 1996). The concentration of a given element may change with position in the water column. For example, some metals (e.g., cadmium) are present at low concentrations in surface waters and at higher concentrations at depth (Bruland, 1992), while others decline quickly with increasing depth below the surface (e.g., zinc and iron) (Nozaki, 1997). On the other hand, dissolved aluminum concentrations are highest at the surface, lowest at mid-depths, and increase again at depths below about 1,000 meters (m) (Li et al., 2008).

Substances, such as nitrogen, carbon, silicon, and trace metals, are extracted from the water by biological processes. Others, like oxygen and carbon dioxide, are produced by biological processes. Metabolic waste products add organic compounds to the water, and may also absorb trace metals, removing those metals from the water column. Those organic compounds may then be consumed by biological organisms, or they may aggregate with other particles and sink (Mann & Lazier, 1996; Wallace et al., 1977).

Runoff from coastal watersheds influences local and regional coastal water conditions, especially large rivers. Influences include increased sediments and pollutants, and decreased salinity (Rabalais et al., 2002; Turner & Rabalais, 2003; Wiseman & Garvine, 1995). Coastal bays and large estuaries serve to filter river outflows and reduce total discharge of runoff to the ocean (Edwards et al., 2006; Mitsch et al., 2009). Depending on their structure and components, estuaries can directly or indirectly affect coastal water quality by recycling various compounds (e.g., excess nutrients), sequestering elements in more inert forms (e.g., trace metals), or altering them, such as the conversion of mercury to methyl mercury (Mitchell & Gilmour, 2008; Mitsch & Gosselink, 2007).

3.2.1.1.2.3 Coastal Water Quality

Most water quality problems in coastal waters of the United States are from degraded water clarity or increased concentrations of phosphates or chlorophyll-*a* (U.S. Environmental Protection Agency, 2012b). Water quality indicators measured are dissolved inorganic nitrogen, dissolved inorganic phosphorus, water clarity or turbidity, dissolved oxygen, and chlorophyll-*a*. Chlorophyll-*a* is an indicator of microscopic algae (phytoplankton) abundance used to judge nutrient availability (e.g., phosphates and nitrates). Excess phytoplankton blooms can decrease water clarity and, when phytoplankton die off following blooms, lower concentrations of dissolved oxygen. Most sources of these impacts arise from on-shore point and non-point sources of pollution. Point sources are direct water discharges from a single source, such as industrial or sewage treatment plants, while non-point sources are the result of many diffuse sources, such as runoff caused by rainfall.

3.2.1.2 Methods

The following four stressors may impact sediments or water quality: (1) explosives and explosives byproducts, (2) metals, (3) chemicals other than explosives, and (4) a miscellaneous category of other materials (e.g., plastics). The term "stressor" is used because the military expended materials in these four categories may affect sediments or water quality by altering their physical or chemical characteristics. The potential impacts of these stressors are evaluated based on the extent to which the release of these materials could directly or indirectly impact sediments or water quality such that existing laws or standards would be violated or recommended guidelines would be exceeded. The differences between standards and guidelines are described below.

- **Standards** are established by law or through government regulations that have the force of law. Standards may be numerical or narrative. Numerical standards set allowable concentrations of specific pollutants (e.g., micrograms per liter [μg/L]) or levels of other parameters (e.g., pH) to protect the water's designated uses. Narrative standards describe water conditions that are not acceptable.
- **Guidelines** are non-regulatory, and generally do not have the force of law. They reflect an agency's preference or suggest conditions that should prevail. Guidelines are often used to assess the condition of a resource to guide subsequent steps, such as the disposal of dredged materials. Terms such as screening criteria, effect levels, and recommendations are also used.

3.2.1.2.1 State Standards and Guidelines

State jurisdiction regarding sediments and water quality extends from the low tide line to 3 nautical miles (NM) offshore for all states except Texas and the Gulf coast of Florida where state waters extend to 9 NM offshore. Waters under the jurisdiction of Puerto Rico also extend to 9 NM, and waters under the control of the United States (U.S.) Virgin Islands extend to 3 NM offshore. Creating state-level sediments and water quality standards and guidelines begins with each state establishing a use for the water, which is referred to as its "designated" use. Examples of such uses of marine waters include fishing, shellfish harvesting, and recreation. For this section, a water body is considered "impaired" if any one of its designated uses is not met. Once this use is designated, standards or guidelines are established to protect the water at the desired level of quality. Applicable state standards and guidelines specific to each stressor are detailed in Section 3.2.3 (Environmental Consequences).

3.2.1.2.2 Federal Standards and Guidelines

Federal jurisdiction regarding sediments and water quality extends from 3 to 200 NM along the Atlantic and Gulf coasts of the United States. However, as discussed in the prior paragraph, for Texas, Puerto Rico, and Florida's Gulf coast, federal jurisdiction begins at 9 NM from shore and extends seaward to 200 NM. These standards and guidelines are mainly the responsibility of the U.S. Environmental Protection Agency (USEPA), specifically ocean discharge provisions of the Clean Water Act (33 United States Code [U.S.C.] section 1343). Ocean discharges may not result in "unreasonable degradation of the marine environment." Specifically, disposal may not result in: (1) unacceptable negative effects on human health; (2) unacceptable negative effects on the marine ecosystem; (3) unacceptable negative persistent or permanent effects due to the particular volumes or concentrations of the dumped materials; and (4) unacceptable negative effects on the ocean for other uses as a result of direct environmental impact (40 Code of Federal Regulations [CFR] section 125.122). Applicable federal standards and guidelines specific to each stressor are detailed in Section 3.2.3 (Environmental Consequences). Proposed training and testing activities also occur beyond 200 NM. Even though Clean Water Act regulations may not apply, pertinent water quality standards are used as accepted scientific standards to assess potential impacts on sediments and water quality from the Proposed Action.

The International Convention for the Prevention of Pollution from Ships (Convention) addresses pollution generated by normal vessel operations. The Convention is incorporated into U.S. law as 33 U.S.C. sections 1901–1915. The Convention includes six annexes: Annex I, oil discharge; Annex II, hazardous liquid control; Annex III, hazardous material transport; Annex IV, sewage discharge; Annex V, plastic and garbage disposal; and Annex VI, air pollution. The Navy is required to comply with the Convention; however, the United States is not a party to Annex IV. The discharge of sewage by military vessels is regulated by Section 312(d) of the Clean Water Act. The Convention contains handling requirements and specifies where materials can be discharged at sea, but it does not contain standards related to sediments nor water quality.

The National Defense Authorization Act of 1996 amended Section 312 of the Clean Water Act, directing the USEPA and the Department of Defense to jointly establish the Uniform National Discharge Standards for discharges (other than sewage) incidental to the normal operation of military vessels. The Uniform National Discharge Standards program establishes national discharge standards for military vessels in U.S. coastal and inland waters extending seaward to 12 NM. Twenty-five types of discharges were identified as requiring some form of pollution control (e.g., a device or policy) to reduce or eliminate the potential for impacts. The discharges addressed in the program include, ballast water, deck runoff, and seawater used for cooling equipment. For a complete list of discharges refer to 40 CFR part 1700.4.

These national discharge standards reduce the environmental impacts associated with vessel discharges, stimulate the development of improved pollution control devices aboard vessels, and advance the development of environmentally sound military vessels. The U.S. Navy adheres to regulations outlined in the Uniform National Discharge Standards program, and, as such, the analysis of impacts in this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) will be limited to potential impacts from training and testing activities including impacts on air quality and impacts from military expended materials, but not impacts from discharges addressed under the Convention or the Uniform National Discharge Standards program.

3.2.1.2.3 Intensity and Duration of Impact

The intensity or severity of impact is defined as follows (listed by increasing level of impact):

- Chemical, physical, or biological changes in sediments or water quality would not be detectable and total concentrations would be below or within existing conditions or designated uses.
- Chemical, physical, or biological changes in sediments or water quality would be measurable but total concentrations would be below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses.
- Chemical, physical, or biological changes in sediments or water quality would be measurable and readily apparent but total concentrations would be within applicable standards, regulations, and guidelines. Sediment or water quality would be altered compared to the historical baseline, desired conditions, or designated uses. Mitigation would be necessary and would likely be successful.
- Chemical, physical, or biological changes in sediments or water quality would be readily measurable, and some standards, regulations, and guidelines would be periodically approached, equaled, or exceeded by total concentrations. Sediment or water quality would be frequently altered from the historical baseline, desired conditions, or designated uses. Mitigation measures would be necessary to limit or reduce impacts on sediment or water quality, although the efficacy of those measures would not be assured.

Duration is characterized as either short-term or long-term. Short-term is defined as days or months. Long-term is defined as months or years, depending on the type of activity or the materials involved.

3.2.1.2.4 Measurement and Prediction

Many of the conditions discussed above often influence each other, so measuring and characterizing various substances in the marine environment is often difficult (Byrne, 1996; Ho et al., 2007). For instance, sediment contaminants may also change over time. Valette-Silver (1993) reviewed several studies that demonstrated the gradual increase in a variety of contaminants in coastal sediments that began as early as the 1800s, continued into the 1900s, peaked between the 1940s and 1970s, and declined thereafter (e.g., lead, dioxin, polychlorinated biphenyls). After their initial deposition, normal physical, chemical, and biological processes can re-suspend, transport, and redeposit sediments and associated substances in areas far removed from the source (Hameedi et al., 2002; U.S. Environmental Protection Agency, 2012b). The conditions noted above further complicate predictions of the impact of various substances on the marine environment.

3.2.1.2.5 Sources of Information

Relevant literature was systematically reviewed to complete this analysis of sediments and water quality. The review included journals, technical reports published by government agencies, work conducted by private businesses and consulting firms, U.S. Department of Defense reports, operational manuals, natural resource management plans, and current and prior environmental documents for facilities and activities in the Study Area.

Because of the proximity of inshore and nearshore areas to humans, information on the condition of sediments and water quality in those areas tends to be relatively readily available. However, much less is known about deep ocean sediments and open ocean water quality. Since sediments and water quality in inshore and nearshore areas tends to be affected by various human social and economic activities, two general assumptions are used in this discussion: (1) sediments and water quality generally improve as distance from shore increases; and (2) sediments and water quality generally improve as depth increases.

3.2.1.2.6 Areas of Analysis

The locations where specific military expended materials would be used are discussed under each stressor in Section 3.2.3 (Environmental Consequences).

3.2.2 Affected Environment

The affected environment includes sediments and water quality within the Study Area, from nearshore areas to the open-ocean and deep sea bottom. Existing sediment conditions are discussed first and water quality conditions thereafter.

3.2.2.1 Sediments

The following subsections discuss sediments for each region in the Study Area.

3.2.2.1.1 Sediments Descriptions in Geographic Regions of the Study Area

3.2.2.1.1.1 Sediments in the North Atlantic Region

The North Atlantic region consists of the West Greenland Shelf, the Newfoundland-Labrador Shelf, and the Scotian Shelf Large Marine Ecosystems, as well as the Labrador Current Open Ocean Area. The region includes the coasts and offshore marine areas southwest of Greenland, east and northeast of Newfoundland and Labrador, and surrounding Nova Scotia. Substrate in the North Atlantic region is comprised almost entirely of soft, unconsolidated sediments derived from terrestrial erosion of sedimentary rock. The most common types of sedimentary rock are sandstone and shale. The majority of sediments on the continental shelf were deposited by receding glaciers and weathered terrestrial rock (Kennett, 1982). Within the region, deposits of larger grain-sized gravel are found in the Gulf of Maine, whereas smaller grain-sized, quartz-rich sands dominate the remainder of the northeastern continental shelf (Churchill, 1989). Sediments in the North Atlantic region contain very little carbonate (<5 percent) (Chang et al., 2001; Kennett, 1982).

Although there are no designated range complexes in this region, the area may be used for Navy training and testing activities. See Figure 3.0-1 in Section 3.0 (Introduction) for range complexes within each large marine ecosystem.

Low population densities and low levels of coastal development in the North Atlantic region, limit the amount of pollution from land-based sources in the North Atlantic region (Aquarone & Adams, 2008a, 2008b; Aquarone et al., 2008). However, pollution is increasing from offshore oil and gas development activities (Aquarone & Adams, 2008a, 2008b), and metal pollution exists from prior mineral development activity and atmospheric deposition (Bindler, 2001; Larsen et al., 2001). Natural hydrocarbon seeps are located near Baffin Island to the north (Kvenvolden & Cooper, 2003).

3.2.2.1.1.2 Sediments in the Northeast and Mid-Atlantic Region

Section 3.5 (Habitats) provides a detailed discussion of substrate types within the Northeast and Mid-Atlantic Region, and is summarized here. Almost the entire continental shelf along the U.S. Atlantic coast is composed of sandy sediments. Sediments north of Cape Hatteras are dominated by quartz and feldspar from Precambrian and Paleozoic rocks that were mechanically weathered and deposited by glaciers and rivers. Silicon- and phosphorus-based sediments are locally abundant (Milliman et al., 1972). Sediment in deep areas beyond the continental shelf break is often dominated by biogenic calcareous ooze (i.e., calcium carbonate and clays) (Kennett, 1982). Nearshore areas off capes and at the mouths of bays, such as Chesapeake Bay and Delaware Bay, are influenced by longshore and cross-shelf currents as well as tidal fluctuations (McBride & Moslow, 1991; Murray & Thieler, 2004). Extensive estuaries on the Atlantic coast tend to trap much of the sediment delivered by rivers. Fine-grained sediments that reach the ocean are usually transported shoreward by tides or deposited on the continental slope and beyond.

In contrast to the surrounding areas, fine-grained, sandy clay and silt sediments occur on the continental shelf south of Nantucket Shoals and the coast of Martha's Vineyard in an area known as the "Mud Patch" (Chang et al., 2001). This is the only area of its size on the eastern U.S. continental shelf where surface sediments contain up to 95 percent silt and clay and no rock fragments (Chang et al., 2001; Churchill, 1989).

Sediment Quality in the Northeast and Mid-Atlantic Region

States bordering the Northeast U.S. Continental Shelf Large Marine Ecosystem include Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and northeast North Carolina (Figure 3.0-1 in Section 3.0 Introduction). Information regarding the current quality of sediment in nearshore areas of these states is provided below (Table 3.2-1). Except where otherwise indicated, information provided below, including the data used in the sediment quality map, was drawn from the U.S Environmental Protection Agency National Aquatic Resource Surveys database (U.S. Environmental Protection Agency, 2016).

In 2008, sediments in the northeast coastal region—Maine through Virginia—were rated 76 percent good, 11 percent fair, and 13 percent poor (no data were reported for 1 percent) in an evaluation of coastal conditions by the USEPA (U.S. Environmental Protection Agency, 2008c). Criteria used in the agency's sediment quality index included sediment toxicity, sediment contaminants, and excess sediment carbon contained in organic compounds (total organic carbon). To receive a good rating, no individual samples in the region could be rated as poor, and the rating for sediment contaminants had to be good. A fair rating indicated that none of the individual sample were rated as poor, and the sediment contaminant index was fair. Sediments in an area were rated as poor if one or more samples were rated as poor (U.S. Environmental Protection Agency, 2012b).

Areas that were rated poor in the Northeast and Mid-Atlantic Region were mostly adjacent to urbanized areas and areas of past industrial activity, and included Narragansett Bay, western Long Island Sound, New York-New Jersey Harbor, and the upper portions of Chesapeake Bay. Elevated levels of sediment contaminants, including metals (e.g., arsenic, chromium, mercury, nickel, silver, and zinc), polychlorinated biphenyl, and dichlorodiphenyltrichloroethane (DDT), were the primary reason for the poor ratings in these areas. Overall, in the 2008 assessment, the region rated fair for contaminants, but good for sediment toxicity (only 4 percent of sites rated as poor), and good for total organic carbon in sediments (1 percent poor) (U.S. Environmental Protection Agency, 2012b).

In 2016, the USEPA published another national coastal condition assessment, updating the 2008 assessment with 2010 sampling results (U.S. Environmental Protection Agency, 2016). In comparison to the 2008 assessment, sediment quality in the Northeast and Mid-Atlantic Region has declined, with 60 percent of sediments rated as good, 20 percent rated as fair, and 9 percent rated as poor (data were missing for 11 percent of sampling sites). While 80 percent of sediments were rated as good for contaminants, only 58 percent were rated as good for sediment toxicity, which was the primary reason for the decline in overall sediment quality.

Table 3.2-1: Sediment Quality Criteria and Index, U.S. Atlantic Coast and Gulf of Mexico

Parameter	Site Criteria			Regional Criteria		
	Good	Fair	Poor	Good	Fair	Poor
Sediment Toxicity	Amphipod[1] survival rate ≥ 80%	n/a	Amphipod[1] survival rate < 80%	< 5% of coastal area in poor condition	n/a	≥ 5% of coastal area in poor condition
Sediment Contaminants	No ERM[2] concentration exceeded, and < 5 ERL[3] concentrations exceeded	No ERM[2] concentratio n exceeded and ≥ 5 ERL[3] concentratio ns exceeded	An ERM[2] concentration exceeded for one or more contaminants	< 5% of coastal area in poor condition	5–15% of coastal area in poor condition	> 15% of coastal area in poor condition
Excess Sediment TOC	TOC concentration < 2%	TOC concentratio n 2% to 5%	TOC concentration > 5%	< 20% of coastal area in poor condition	20–30% of coastal area in poor condition	> 30% of coastal area in poor condition
Sediment Quality Index	No poor ratings, sediment contaminants criteria are rated "good"	No poor ratings, sediment contaminants criteria are rated "fair"	One or more individual criteria rated poor	< 5% of coastal area in poor condition, and > 50% in good condition	5–15% of coastal area in poor condition, and > 50% in combined fair and poor condition	> 15% of coastal area in poor condition

[1]Amphipods are small animals found in a wide variety of aquatic habitats. Because they are so widely distributed, they are often used as a quality index for sediments and water bodies.
[2]ERM (effects range-median) is the level measured in the sediment below which adverse biological effects were measured 50% of the time.
[3]ERL (effects range-low) is the level measured in the sediment below which adverse biological effects were measured 10% of the time (Long et al., 1995).
Source: (U.S. Environmental Protection Agency, 2012b)
Notes: % = percent. ≥ = equal to or greater than, < = less than, > = greater than, n/a = not applicable, TOC = total organic carbon.

The sediment toxicity index for marine and estuarine sediments is based on the survival rate of selected estuarine amphipods when the specimens are exposed to samples collected in the field. Sediment toxicity indicates how combinations of anthropogenic and natural chemicals might affect the survival of benthic organisms.

The impact that anthropogenic activities can have over the long term is exemplified by changes observed in Long Island Sound, where development dates to colonial times. Mean concentrations of metals in Long Island Sound have increased substantially and steadily since pre-industrial levels (Table 3.2-2) (Varekamp et al., 2014). The concentrations of silver, cadmium, copper, and mercury showed the greatest increases (between 30 and 6.5 times over background levels); lead, arsenic, and zinc have increased between 2.4 and 3.6 times; and chromium, vanadium, nickel, and barium concentrations have remained close to background levels.

Table 3.2-2: Comparison of Mean Pre-Industrial and Post-Industrial Metal Concentrations in Sediments in Long Island Sound with Sediment Effects Thresholds

Metal	Pre-Industrial Background Mean Concentration (µg/g)	Post-Industrial Mean Concentration (µg/g)	Mean Enrichment Factor	National Oceanic and Atmospheric Administration	
				Effects Range-Low (ppm)	Effects Range-Median (ppm)
Cadmium	0.2	2	9.9	1.2	9.6
Chromium	59	78	1.3	81	370
Copper	8	117	14.6	34	270
Lead	23	83	3.6	46.7	218
Mercury	0.1	0.7	6.5	0.15	0.71
Nickel	25	26	1.0	20.9	51.6
Silver	0.05	1.5	29.8	1.0	3.7
Zinc	68	160	2.4	150	410
Arsenic	2.5	6	2.5	8.2	70
Vanadium	90	101	1.1	NA	NA
Barium	377	230	0.6	NA	NA

Effects range-low is the level measured in the sediment below which adverse biological effects were measured 10% of the time Long et al. (1995).

Effects range-median is the level measured in the sediment below which adverse biological effects were measured 50 percent of the time.

Enrichment Factor is the ratio of the postindustrial and preindustrial concentrations and is a measure of the change in concentration over time (e.g., the concentration of cadmium has increase 9.9 times since preindustrial levels)

Source: Varekamp et al. (2014)

Notes: µg /g = micrograms per gram = ppm = parts per million, NA = Not applicable

The distribution of metals within sediments in the sound varied widely, as did maximum concentrations, and was strongly correlated with fine-grained sediments rich in organic material. With the exception of arsenic, all post-industrial metal concentrations exceeded Effects Range Low levels and were less than Effects Range Median levels; the concentration of arsenic was less than the Effects Range Low level; however, the authors note that there were fewer samples for arsenic available for analysis (Table 3.2-2). Increases in metal concentrations were closely linked to the industrialization of the region, and included many non-point source discharges, such as urban runoff, and point source discharges, such as effluent from waste water treatment facilities located along tributaries of the sound. Overall, concentrations of metal contaminants increased with proximity to New York City, lending additional support to the close association between industrialization and increased sediment contamination.

Polycyclic aromatic hydrocarbons and polychlorinated biphenyls, two widely dispersed contaminants found worldwide in marine sediments have been present in the Study Area for decades (Boehm & Requejo, 1986a; Farrington & Takada, 2014; Farrington & Tripp, 1977; Lamoreaux & Brownawell, 1999). The source of most polycyclic aromatic hydrocarbons introduced into the environment (terrestrial and marine) is from the incomplete combustion of biofuels (Ravindra et al., 2008). Aromatic hydrocarbons can enter the marine environment through multiple means, including as urban runoff, effluent from outfalls serving densely populated urban regions, and as deposition from airborne particulate matter (Farrington & Takada, 2014). While there natural sources of polycyclic aromatic hydrocarbons, such as wildfires and volcanic eruptions, the primary source of aromatic hydrocarbons in the marine environment is emissions from the anthropogenic combustion of fossil fuels, including oil and coal (Farrington & Takada, 2014; Ravindra et al., 2008).

Polychlorinated biphenyls are anthropogenic organic chemicals made up of carbon, hydrogen, and chlorine atoms, and were produced in the United States from 1929 until they were banned in 1979, because of growing concerns over their toxicity and links to a number of adverse health effects, including cancers, neurological disorders, reproductive effects, and immune system effects (Manta Trust, 2017). Even though the production of polychlorinated biphenyls has not occurred in the United States for decades, the chemicals are present in products manufactured prior to 1979 and still in use today (e.g. electrical transformers, cable insulation, paints, and plastics) as well as imported products from countries where polychlorinated biphenyls have not been banned for as long (or at all). The chemicals are resistant to break down in the environment, including in the marine environment, enabling them to persist in a variety forms far from where they originated (Farrington & Takada, 2014; Manta Trust, 2017).

Dichlorodiphenyltrichloroethane (DDT) is a pesticide that was widely used in the United States in the 1950s and 1960s until its production and use was banned in 1972 over concerns of adverse environmental effects (e.g., thinning of bird egg shells resulting in poor reproductive success in multiple species) (Sericano et al., 2014).

The concentration of aromatic hydrocarbons and polychlorinated biphenyls in sediments is positively correlated with total organic carbon content in sediments. Fine-grained sediments (silts and clays) have higher total organic carbon levels than sandy sediments, and areas dominated by fine-grained sediments, like the Mud Patch, tend to act as sinks for polycyclic aromatic hydrocarbons and other contaminants like polychlorinated biphenyls (Boehm & Requejo, 1986a; Lamoreaux & Brownawell, 1999). Disturbance of seafloor sediments with high concentrations of these chemical contaminants can cause resuspension, increased bioavailability, and facilitate the widespread distribution of these contaminants. The use of equipment and products manufactured prior to 1979 with polychlorinated biphenyls can continue to introduce the contaminant into the environment.

Farrington and Takada (2014) provide a summary of four decades of research on persistent organic pollutants, including polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and dichlorodiphenyltrichloroethane (DDT). Concentrations of polycyclic aromatic hydrocarbons measured in benthic dwelling bivalves, so called sentinel organisms, exceeded the National Oceanic and Atmospheric Administration thresholds for environmental effects in multiple samples collected in the northeast and mid-Atlantic regions (Table 3.2-3). Although a number of sites have exceeded effects thresholds, (Farrington & Takada, 2014) the overwhelming trend is that concentrations of these three chemical contaminants is decreasing in bivalves, a proxy for sediments, along the entire U.S. coastline. Only one site in the Study Area, off the coast of North Carolina, is showing an increase in the concentration of polycyclic aromatic hydrocarbons, and no sites in the Study Area are showing an increase in concentrations of polychlorinated biphenyls. Concentrations of dichlorodiphenyltrichloroethane (DDT) are also decreasing in coastal areas along the U.S. coastline (as measured in bivalve bioassays) (Sericano et al., 2014); however, dichlorodiphenyltrichloroethane (DDT) is also resistant to break down in the environment, as are its breakdown products. Nevertheless, by 2050, the concentration of DDT and its breakdown products are expected to be at 10 percent of current levels (Sericano et al., 2014).

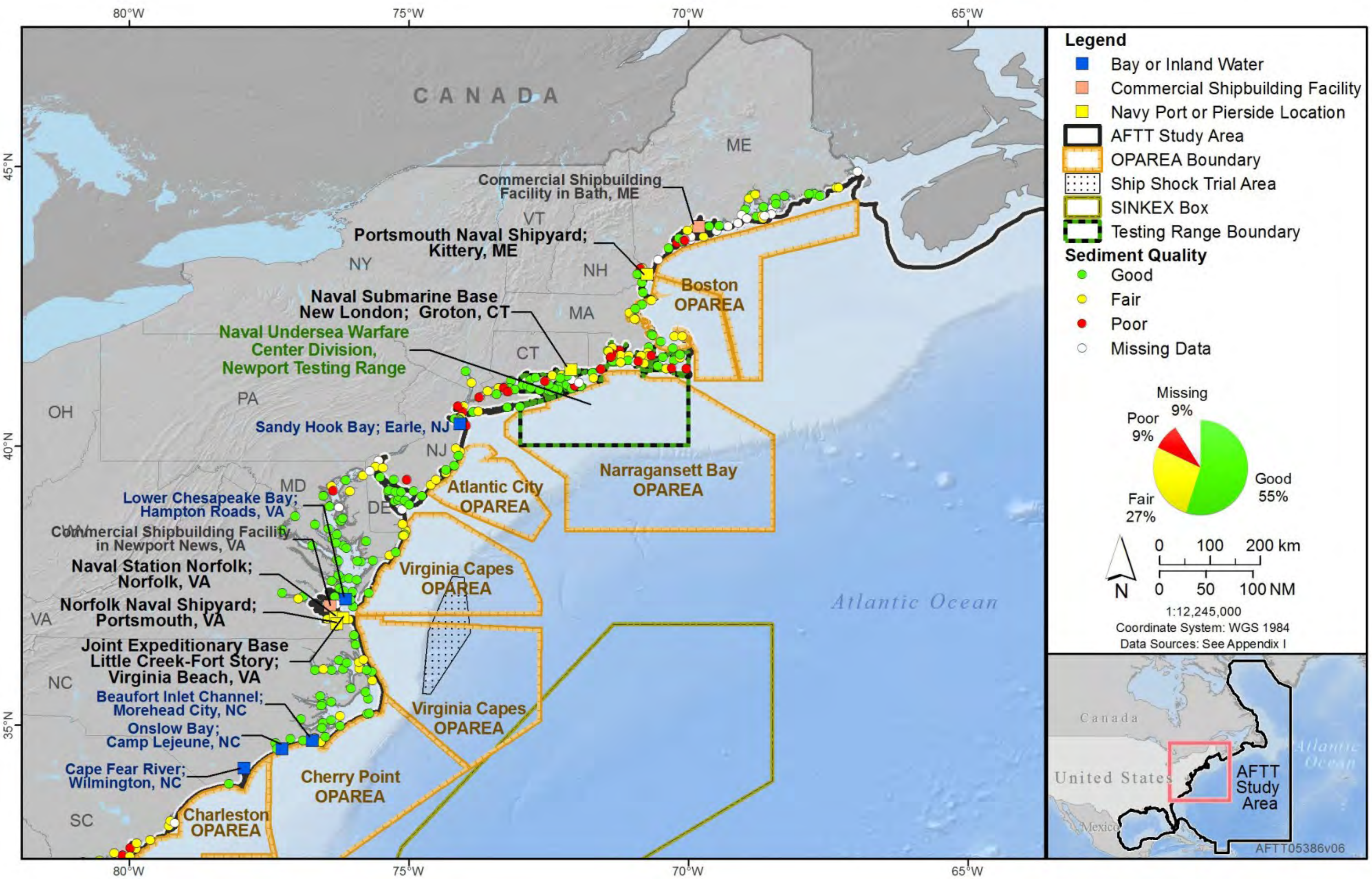
Table 3.2-3: Comparison of Polycyclic Aromatic Hydrocarbons, Polychlorinated Biphenyls and dichlorodiphenyltrichloroethane in Sediment Samples with Sediment Guidelines Developed by the National Oceanic and Atmospheric Administration

Sediment Contaminant	Contaminant Concentration (ppb)				National Oceanic and Atmospheric Administration	
	Northeast	Mid-Atlantic	Southeast	Gulf of Mexico	Effects Range-Low[1]	Effects Range-Median[2]
PAHs	63 – 7,561	47 – 10,717	47 – 2,511	47 – 2,511	4,022	44,792
PCBs	3 – 1,413	4 – 157	4 – 157	4 - 157	22.7	180
DDT[3]	0.001 – 0.15			<MDL – 0.087	1.58	46.1

[1]Effects range-low is the level measured in the sediment below which adverse biological effects were measured 10% of the time Long et al. (1995).
[2]Effects range-median is the level measured in the sediment below which adverse biological effects were measured 50 percent of the time.
[3]Data are from 2009 (Sericano et al. 2014).
Source: Farrington and Takada (2014)
Notes: PAHs = polycyclic aromatic hydrocarbons, ppb = parts per billion, PCBs = polychlorinated biphenyls, DDT = dichlorodiphenyltrichloroethane, MDL = minimum detection level

Maine. Sediment quality along the Maine coast was rated as 51 percent good and 12 percent poor; 37 percent of sampling site data were labeled as missing (Figure 3.2-2). Concerns related to sediments in Maine include polychlorinated biphenyls, mercury, and dioxin. As a result, seafood consumption advisories have been issued. These concerns involve all the state's estuarine and marine habitats. In much smaller areas, bacteria, low dissolved oxygen, copper contamination, and polycyclic aromatic hydrocarbons were also identified (State of Maine Department of Environmental Protection, 2006). Wade and Sweet (2005) reported that sediment from the interior of Casco Bay (Portland, Maine) contains elevated levels of trace metals, polychlorinated biphenyls, dichlorodiphenyltrichloroethane (DDT), and the pesticide chlordane.

New Hampshire. Sediment quality along the New Hampshire coast was rated as 67 percent good, 17 percent fair, and 17 percent poor (Figure 3.2-2). Concerns related to sediments in New Hampshire include included metals, polycyclic aromatic hydrocarbons, and dichlorodiphenyltrichloroethane (DDT). These concerns involve all the state's estuarine and marine waters. Marine sediment samples were analyzed for heavy metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc) and organic compounds (polychlorinated biphenyls and polycyclic aromatic hydrocarbons). Results indicate that, with few exceptions, the levels of contaminants detected in shellfish and sediment were within the range of contaminants found elsewhere in New England, other regions of the United States, and the world. Two estuarine areas were impaired due to pesticides. Ocean waters are listed as impaired due to dioxin, mercury, and polychlorinated biphenyls. As noted above, concerns are related to seafood consumption (New Hampshire Department of Environmental Services, 2008; Paliwoda, 2015).



Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.2-2: Sediment Quality Ratings for the Northeast and Mid-Atlantic Coast

Massachusetts. Sediment quality along the Massachusetts coast was rated as 67 percent good, 6 percent fair, and 24 percent poor; 5 percent of sampling site data were labeled as missing (Figure 3.2-2). Most poor sediment was concentrated in the Boston Harbor area, which rated as 100 percent poor. For Buzzards Bay, sediment quality was rated as 50 percent good and 40 percent poor; 10 percent of sampling site data were labeled as missing.

Rhode Island. Sediment quality along the Rhode Island coast was rated as 64 percent good, 7 percent fair, and 29 percent poor (Figure 3.2-2). In Narragansett Bay sediment quality was rated as 50 percent good and 50 percent poor. Issues included high concentrations of metals, dichlorodiphenyltrichloroethane (DDT), and polychlorinated biphenyls. Contaminated sediments were listed as a concern for 1 square mile ($mi.^2$) of estuarine habitat in Rhode Island. The issue involved "legacy/historical pollutants," such as polychlorinated biphenyls in Narragansett Bay (Rhode Island Department of Environmental Management, 2008). No data were available for Block Island Sound.

Connecticut. Long Island Sound comprises most of the nearshore and estuarine habitat along the Connecticut coast. Sediment quality in Long Island Sound was rated as 71 percent good, 14 percent fair, and 14 percent poor (Figure 3.2-2). Sampling indicated a trend of decreasing impacts from runoff moving east from New York City (Mecray et al., 2000; Varekamp et al., 2014). As discussed above (see Section 3.2.2.1.1.2), sediments in Long Island Sound have been enriched many times over pre-industrial background levels with silver, cadmium, copper, mercury, and lead. Metal concentrations have been decreasing since the peak levels in the 1970s, due in large part to upgrades of sewage treatment facilities to meet requirement of the Clean Water Act and the laws strictly regulating the use of persistent chemical contaminants, such as polychlorinated biphenyls (Varekamp et al., 2014). However, contaminants still occur in concentrations that impact habitat, particularly along the Connecticut coast, which borders the western portion of Long Island Sound where 50 percent of sediments are rated as poor.

New York/New Jersey. Sediment quality in the New York-New Jersey Bay were rated as 100 percent poor on the New York side of the Bay, closer to New York City, and as 67 percent good and 33 percent poor on the New Jersey side (Figure 3.2-2). Issues included elevated concentrations of metals and polychlorinated biphenyls resulting from decades of industrialization and unregulated use and disposal of chemical contaminants (Varekamp et al., 2014). Information for Long Island Sound sediment is presented under the entry for Connecticut and above in Section 3.2.2.1.1.2. Sediment quality in Barnegat Bay on the Atlantic coast was rated 50 percent good and 50 percent poor. Sediment quality for Peconic Bay was rated as 100 percent good. Information for Delaware Bay is provide under the entry for Delaware.

Delaware. Sediment quality in Delaware Bay was rated as 67 percent good; however 33 percent of sampling site data were missing (Figure 3.2-2). The highest levels of sediment contaminants were near Philadelphia and the Maurice River. There may be some point sources for metals, but organic contaminants appear to be primarily from nonpoint sources. Metals and organic contaminants in sediments tend to decrease from upper to lower Delaware Bay. Sediments in coastal zones have trace amounts of metals and organic contaminants (Hartwell & Hameedi, 2006).

Maryland. Maryland's coastal bays provide a natural buffer between Maryland's Eastern Shore and the Atlantic Ocean. Sediment quality in Maryland's three largest coastal bays on the Atlantic coast, Chincoteague Bay, Assawoman Bay, and Isle of Wight Bay, were all rated as 100 percent good in the National Coastal Condition Assessment (U.S. Environmental Protection Agency, 2016) (Figure 3.2-2).

However, the Maryland Coastal Bays Program assess other metrics, including the density of bottom dwelling hard clams and seagrasses, which are an indicator of the quality of benthic habitat. According to the Maryland Coastal Bays Program (2015) "report card," the six coastal bays, including the three already mentioned, collectively received a grade of C+, on a scale of A (good to very good) to F (very poor), for 2014 on the program's index for characterizing the health of each coastal bay. Factors that contribute to the grade include water quality indicators (e.g., chlorophyll-*a*, dissolved oxygen), as well as, seagrass and hard clam densities. Chincoteague Bay (B-) scored well for seagrasses but poor for hard clams. Assawoman Bay (C) had poor to very poor grades for both seagrasses and hard clams, and Isle of Wight Bay (C) also received a very poor grade for seagrasses and saw declines in the density of hard clams. While sediment quality may be good, as reported in the coastal condition assessment, other habitat metrics provide additional insight into the suitability of the benthic habitat for sustaining biological resources.

Virginia. The James River flows into the lower Chesapeake Bay north of Norfolk Harbor. Sediment quality in the lower James River is rated as 50 percent good and 50 percent poor (Figure 3.2-2). Sediment quality in the Elizabeth River, which flows through heavily industrialized and urban areas in the cities of Norfolk, Portsmouth, and Chesapeake was rated as 100 percent poor. On Virginia's Atlantic coast, Back Bay, which is adjacent to Back Bay National Wildlife Refuge, received a sediment quality rating of 100 percent good.

North Carolina. Sediment quality in Albemarle Sound was rated as 83 percent good and 17 percent poor. Sediment quality in Pamlico Sound located south of Albemarle Sound and west of Cape Hatteras is rated as 86 percent good and 14 percent poor. Currituck Sound, located along the Atlantic coast north of Albemarle Sound received a rating of 100 percent good for sediment quality (Figure 3.2-2). Hackney et al. (1998) stated that, "between 37.5 and 75.8 percent of surface sediments in North Carolina's sounds and estuaries were contaminated, and between 19 and 36 percent were highly contaminated." Contaminants included nickel, arsenic, dichlorodiphenyltrichloroethane (DDT), chromium, polychlorinated biphenyls, and mercury. The most contaminated areas were the Neuse and Pamlico Rivers. In general, areas with limited tidal flushing and high river discharge were most contaminated. Hyland et al. (2000), reported that 38 percent of the total area of North Carolina estuaries had at least one chemical contaminant present at a concentration in excess of levels at which biological effects can be expected. The most common contaminants in their study were arsenic, mercury, chromium, nickel, pesticides, and polychlorinated biphenyls. There were relatively few degraded sites in the open portions of Pamlico Sound and smaller estuaries south of Cape Lookout.

Chesapeake Bay. The Chesapeake Bay watershed includes portions of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. In order to simplify the discussion and reduce repetition, sediment issues in Chesapeake Bay are not reviewed on a state-by-state basis because: (1) many of the sediment issues are common to most or all of these bordering states, and (2) Navy training and testing activities discussed in this Environmental Impact Statement/Overseas Environmental Impact Statement are limited to the extreme southeast portion of the bay and do not appreciably impact sediment quality in the bay as a whole.

Point source pollution, urban and suburban runoff from continued development, atmospheric deposition, and agricultural practices in the bay's watershed introduce contaminants into the Bay (Coxon et al., 2016). The U.S. Environmental Protection Agency (2012b) reports widespread occurrence of polychlorinated biphenyls, polycyclic aromatic hydrocarbons, herbicides, and mercury. Localized occurrence of pesticides, including dichlorodiphenyltrichloroethane (DDT), and certain metals (i.e., aluminum, chromium, iron, lead, manganese, and zinc) within the bay also contribute to degraded habitat in those areas.

In 2014, the Chesapeake Bay Program adopted a goal to create or reestablish 85,000 acres (ac.) of tidal and non-tidal wetlands in the bay's watershed by 2025, with the ultimate goal of reducing the bay's Total Maximum Daily Load, a measure of pollutants entering the bay. The bulk of the created or reestablished wetlands acreage (83,000 ac.) would be on agricultural lands, which are significant source of point source pollutants. As of 2016, 7,623 ac. have been created or reestablished on formerly agricultural lands, which is 7.45 percent of the overall goal (Bonfil et al., 2008).

Fish consumption advisories have been issued in all watershed states primarily out of concerns for contamination from mercury and polychlorinated biphenyls (Bonfil et al., 2008). Chesapeake Bay and several small tidal tributaries have had fish advisories for polychlorinated biphenyls in place since 2004 (Virginia Department of Public Health, 2016).

3.2.2.1.1.3 Sediments in the Southeast Region

Moving south from Cape Hatteras, coastal sediment changes from largely land-based sources to largely marine-based sources. Weathering of sediment in the piedmont and coastal plain provinces in the southeast is mostly chemical; deposition of sediment is mostly by rivers. Sediment farther north was more heavily influenced by mechanical (glacial) processes and glacial deposition. Off the coast of the Carolinas, the calcium carbonate content of sediment is between 5 and 50 percent; this increases to 100 percent on the East Florida Shelf. Sources of calcium carbonate include the shells of molluscs, echinoderms, barnacles, coralline algae, foraminifera; and ooids, small (0.25 to 2 mm) spherical deposits of calcium carbonate (Milliman et al., 1972). Some areas of the continental shelf along the southeast coast have been swept clean of sediment by the Gulf Stream, exposing the underlying bedrock (Riggs et al., 1996). Sediment on the continental shelf off the east coast of Florida is primarily composed of silt and clay sized particles (Milliman et al., 1972).

Sediment Quality in the Southeast Region

States in the Southeast Region include southeastern North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida. See Figure 3.0-1 in Section 3.0 (Introduction) for range complexes occurring within this region, and Figure 3.0-3 for their locations in the Southeast U.S. Continental Shelf Large Marine Ecosystem. The current quality of sediments in nearshore areas in this regions is described below. Overall sediment quality for the coastal areas from North Carolina through the southern tip of Florida is rated as good. Sediments for 80 percent of this coastal area rated good, 2 percent rated fair, and 12 percent rated poor (6 percent of the data was missing) (Figure 3.2-3). Except where otherwise indicated, information provided below, including the data used in the sediment quality map, was drawn from the USEPA's National Aquatic Resource Surveys database (U.S. Environmental Protection Agency, 2016). Concentrations of the contaminant chemicals polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and dichlorodiphenyltrichloroethane (DDT) for the southeast region are provided in (Table 3.2-3). Windom et al. (1989) noted that it is not unusual for natural trace metal concentrations in coastal sediment to range over two orders of magnitude, particularly in the southeastern United States. Boehm and Gequejo (1986b) noted that sediment hydrocarbons along the southeast coast were less than 10 parts per million (ppm) in all cases.

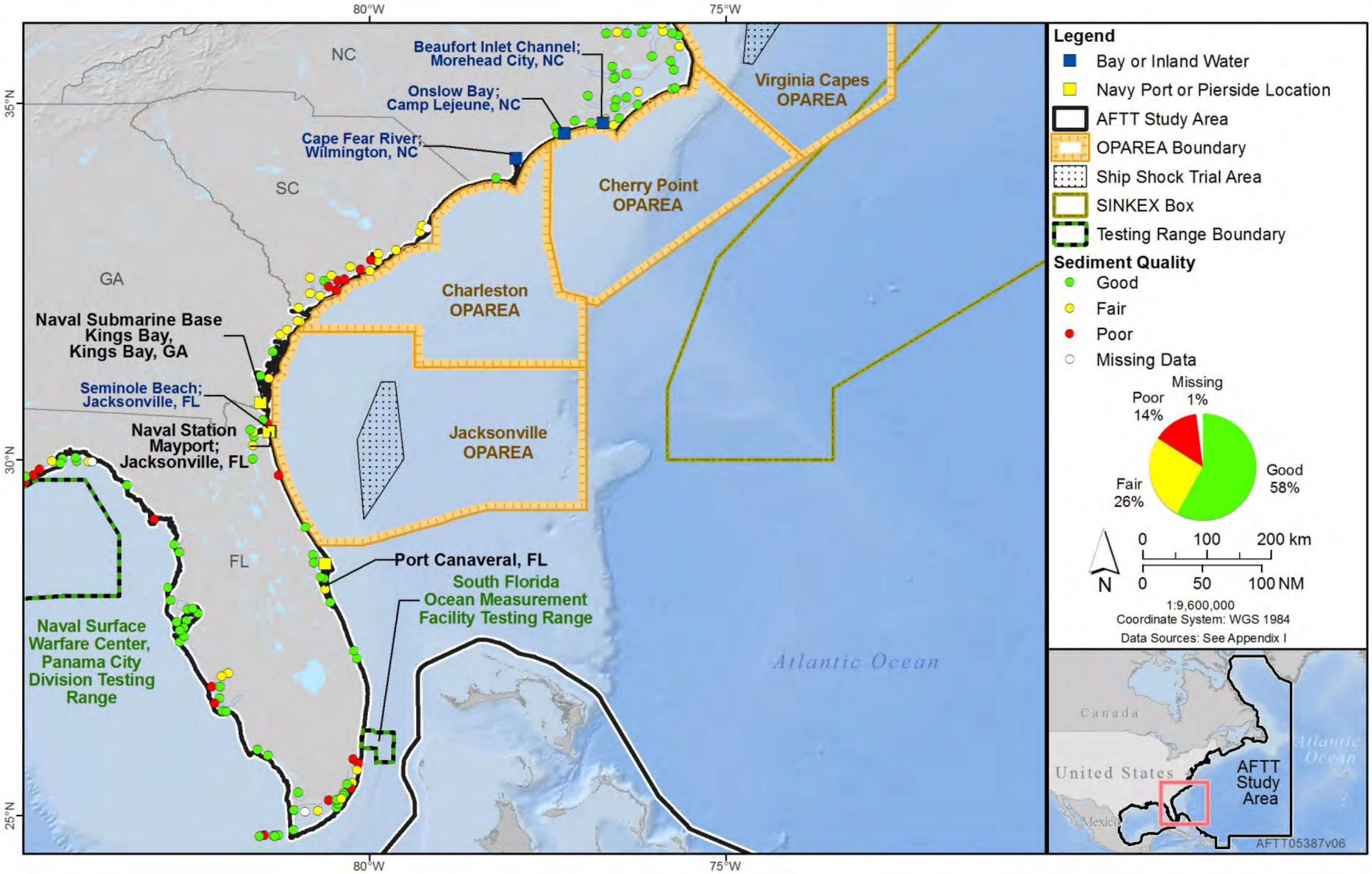
North Carolina. Information regarding sediment along the North Carolina coast is provided in Section 3.2.2.1.1.2 (Sediments in the Northeast and Mid-Atlantic Region).

South Carolina. Sediment quality along the South Carolina coast was rated as 62 percent good and 33 percent poor; 5 percent of sampling site data were missing (Figure 3.2-3). Just over 4 percent of the state's estuarine area (17.3 $mi.^2$) is impaired by metals, mostly by copper, but also nickel and zinc (South Carolina Department of Health and Environmental Control, 2008). A 2006 study found that 33 monitoring points (12 open water and 21 tidal creeks) had at least one contaminant that exceeded concentrations shown to have biological effects in 10 percent of published studies. Contaminants included polycyclic aromatic hydrocarbons, dichlorodiphenyltrichloroethane (DDT), and five metals: arsenic, cadmium, copper, lead, and zinc (Van Dolah et al., 2006).

Georgia. Sediment quality along the Georgia coast was rated as 71 percent as good, 22 percent as fair, and 7 percent rates as poor (Georgia Department of Natural Resources, 2010). In terms of toxicity, 97 percent of Georgia's sediments rated as good and 2 percent rated as poor; 1 percent of sampling site data were missing. In terms of sediment likely to have biological effects, 72 percent rated as good, 24 percent rated as fair, and 4 percent rated poor. Four miles of coastal streams were reported as impaired by mercury, and 2 miles (mi.) were impaired by elevated levels of cadmium. Pesticides (in fish tissue) impaired 8 mi. of coastal streams, and polychlorinated biphenyls (in fish tissue) impaired 26 mi. of coastal streams (Georgia Department of Natural Resources, 2010). Hyland et al. (2006) examined the presence of a wide variety of trace metals and persistent organic pollutants in the water and sediment between 2 and 77 kilometers (km) off the Georgia coast. The maximum values found were well below levels expected to induce biological effects.

Florida. Sediment quality along the Atlantic coast of Florida varied by location. Sediments in the Matanzas River, which runs parallel to coastal route A1A and empties into the ocean at the city of St. Augustine, rated as 100 percent poor (Figure 3.2-3). Sediment quality in the Mosquito Lagoon just north of Cape Canaveral rated as 100 percent good. Sediments in the Indian River Lagoon also rated as 100 percent good based on total organic carbon content. Farther south, sediment quality in Biscayne Bay, located adjacent to and south of Miami, was rated as 60 percent good and 40 percent poor. In a discussion of sediment quality guidelines, MacDonald et al. (1996) noted that Biscayne Bay is contaminated with trace metals, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and pesticides, and that sediment from the St. Johns River had elevated levels of polychlorinated biphenyls. Windom et al. (1989) found lead and zinc-contaminated sediment from Biscayne Bay, apparently influenced by discharge from the Miami River.

In 2010, the Florida Department of Environmental Protection (2010a) assessed metal concentrations in estuarine sediments and determined that concentrations were most often above background levels for cadmium, mercury, lead, and zinc. Also, 70 percent of samples tested for organic chemicals indicated the presence of polycyclic aromatic hydrocarbons. The following metals impaired estuarine habitat: copper (100 $mi.^2$), iron (98 $mi.^2$), nickel (40 $mi.^2$), arsenic (8 $mi.^2$), and lead (7 $mi.^2$). Copper has also impaired 83 mi. of Florida's 8,400 mi. of coastal waters (Florida Department of Environmental Protection, 2010b). More than 993,000 acres of the 1,671,159 acres assessed by the Florida Department of Environmental Protection in 2016 were impaired with at least one contaminant (Washington Tribes, 2015). A study of sediment in south Florida estuaries by Macauley et al. (2002) also found that elevated concentrations of pesticides were fairly common, but that elevated levels of metals were not as common.



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area

Figure 3.2-3: Sediment Quality Ratings for the Southeast Coast

3.2.2.1.1.4 Sediments in the Gulf of Mexico Region

States bordering the Gulf of Mexico Large Marine Ecosystem include Florida (west coast), Alabama, Mississippi, Louisiana, and Texas. Please see Figure 3.0-1 in Section 3.0 (Introduction) for range complexes within each large marine ecosystem and Figure 3.0-4 for their locations in the Gulf of Mexico Large Marine Ecosystem. Except where otherwise indicated, information provided below, including the data used in the sediment quality map, was drawn from the USEPA's National Aquatic Resource Surveys database (U.S. Environmental Protection Agency, 2016).

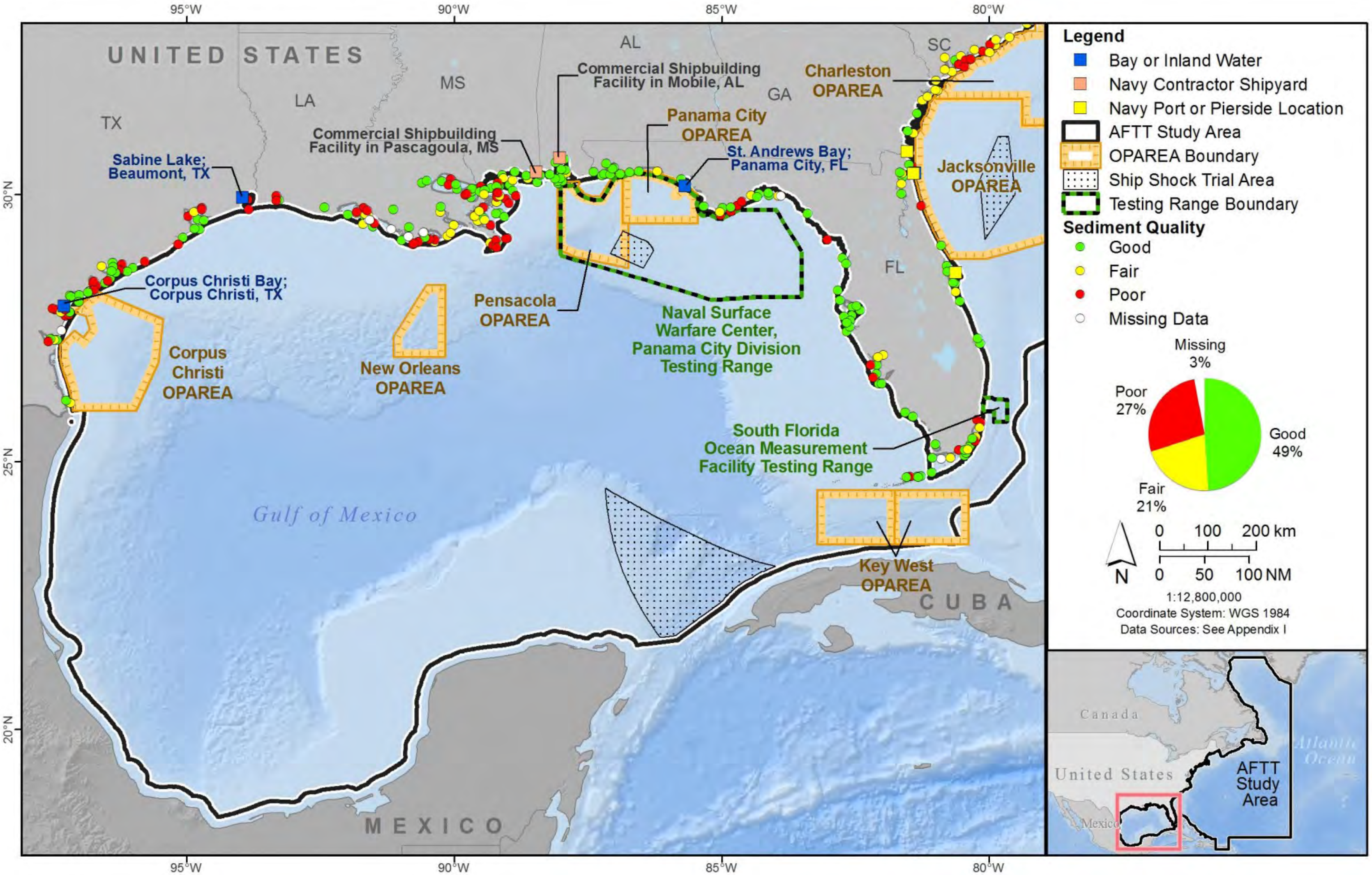
The western and central portions of the Gulf of Mexico are dominated by sediment deposition from the Rio Grande and Mississippi River systems, mostly in the form of sandstone and shale (Galloway et al., 2000). DeSoto Canyon, a submarine feature southwest of Pensacola, Florida, marks the transition between the Mississippi River-influenced sediment to the west (Alabama, Mississippi, Louisiana, and Texas) and the carbonate-dominated sediment to the east and south along western Florida (Gearing et al., 1976). The Naval Surface Warfare Center, Panama City Division Testing Range straddles this transition area. Sediment is predominantly carbonate-sand mixture. Carbonate sources include corals, molluscs, and marine microbes. The amount of organic material mixed with the sand generally increases with the distance from shore. Like other deep ocean areas, the central portions of the Gulf of Mexico are dominated by clay-sized particles (less than 0.002 mm).

Sediment Quality in the Gulf of Mexico Region

Information regarding the quality of sediments in nearshore areas of the states bordering the Gulf of Mexico—Florida, Alabama, Mississippi, Louisiana, and Texas—is provided below. Except where otherwise indicated, information provided below, including the data used in the sediment quality map, was drawn from the USEPA's National Aquatic Resource Surveys database (U.S. Environmental Protection Agency, 2016). In the Gulf of Mexico—from the southern tip of Florida to the Texas-Mexico border—sediment quality was rated as 54 percent good, 17 percent fair, and 25 poor; 4 percent of sampling site data were reported as missing (Figure 3.2-4).

According to Summers et al. (1996), of the sites in the Gulf of Mexico enriched by three or more metals, 44 percent occur near populated areas and 56 percent occur in agricultural watersheds or the Mississippi River. Many contaminated sites are in watersheds with Superfund sites established under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 or are identified by the USEPA National Sediment Inventory as "areas of probable concern" (U.S. Environmental Protection Agency, 2008c). Wade et al. (1988) evaluated coastal sediment at 51 sites in the Gulf of Mexico chosen for their distance from known point sources of polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and chlorinated pesticides. The concentrations of the 18 polycyclic aromatic hydrocarbons tested averaged 507 parts per billion (ppb) (range: less than 5 ppb to 36,701 ppb). Eleven percent of all samples had no detectable polycyclic aromatic hydrocarbons. Polychlorinated biphenyl concentrations ranged from less than 5 to 50 ppb, and chlorinated pesticides ranged from less than 0.02 to 5 ppb, with most samples below the limits of detection.

The Gulf of Mexico has several natural hydrocarbon seeps (Kvenvolden & Cooper, 2003). In the eastern Gulf of Mexico, Boehm and Gequejo (1986b) found that sediment hydrocarbons are mainly marine in origin, although the Loop Current carries hydrocarbon-laden sediment from the Mississippi River into the eastern Gulf (concentration: 0.4–0.5 ppm). West of the Mississippi River, the concentration of hydrocarbons increases in shallow (less than 30 feet [ft.]) nearshore areas (20–70 ppm), and those increases are predominantly from anthropogenic sources.



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area

Figure 3.2-4: Sediment Quality Ratings for the Gulf of Mexico Coast

Along the Texas coast, sediment hydrocarbon concentrations ranged from 0.5 to 20 ppm; proximity to urban and riverine sources increased the contribution from man-made sources. Farther offshore, hydrocarbons carried on wind as a result of burning fuels were more common.

Concentrations of the contaminant chemicals polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and dichlorodiphenyltrichloroethane (DDT) for the Gulf of Mexico region are provided in (Table 3.2-3).

Coastal sediments rated as 93 percent good for contaminants (3 percent fair and 0 percent poor), but just 46 percent good for toxicity (15 percent fair and 25 percent poor). The poor rating for toxicity is the primary reason the extent of the region rated as good for sediment quality decreased from nearly 70 to 54 percent between 2006 and 2010. Contaminants resulting in elevated levels of toxicity included metals, pesticides, polychlorinated biphenyls, and, occasionally, polycyclic aromatic hydrocarbons (U.S. Environmental Protection Agency, 2016). Except where otherwise indicated, information provided below was drawn from the National Coastal Condition Aquatic Resource Surveys (U.S. Environmental Protection Agency, 2016).

The Deepwater Horizon oil spill occurred in the Gulf of Mexico in 2010, leaking millions of gallons of oil into the Gulf over 87 days. The impact area extended approximately from the Florida panhandle to western Louisiana, and 143 of the sites sampled during the 2010 survey fell within those boundaries (U.S. Environmental Protection Agency, 2016). The same sampling protocols used to collect samples for previous coastal condition assessments were used during the 2010 survey, which allowed for a comparison with past survey results. Sediment toxicity in the areas impacted by the oil spill showed an increase from 8 percent in the 2005-2006 survey to 27 percent in the 2010 survey, which was a significantly greater increase than observed in other areas of the Gulf.

Florida. Within the Gulf of Mexico, the sediment quality in Charlotte Harbor, Tampa Bay, and Sarasota Bay were all rated as 100 percent good (Figure 3.2-4). Sediment quality in Florida Bay, located between the southern tip of Florida and the Florida Keys, was rated as 83 percent poor with 17 percent of sampling site data reported as missing. Florida Bay was severely impacted by a seagrass die-off in 1987, which led to subsequent increases in turbidity and the frequency of algal blooms (Boyer et al., 1999). Restoration of the bay is dependent on reestablishing seagrass communities to their historic state. Modeling by Herbert et al. (2011) predicts that increasing the freshwater inflow from the Everglades would substantially alter conditions within the eastern portion of the bay and create favorable habitat for seagrasses that were present in the bay prior to the die-off.

Sediment samples from Pensacola Bay near port facilities were contaminated by lead and zinc (Windom et al., 1989). Lewis et al. (2001) noted that sediment in three bayous of Pensacola Bay contained, on average, as much as 10 times more total heavy metals (e.g., cadmium, copper, and zinc) than sediment collected in Pensacola Bay near the entrance to the bayous. Pesticide concentrations were as much as 45 times greater in the bayou sediment than in those from Pensacola Bay. The authors noted that the bayous were acting as sinks or reservoirs for many contaminants, reducing their transport and availability in Pensacola Bay. The probable source of the contamination was storm water runoff from urbanized watersheds. The authors also indicated that metals and persistent organic pollutant levels in three bayous of Pensacola Bay decreased with distance from shore (seaward).

MacDonald et al. (1996) noted that sediment from Tampa Bay and Pensacola Bay is contaminated with trace metals, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and pesticides. Sediment from Choctawhatchee Bay and St. Andrew Bay is contaminated by metals, polycyclic aromatic hydrocarbons, and pesticides; and sediments from St. Andrew, Apalachicola, Naples, Rookery bays, and Charlotte Harbor had elevated levels of polychlorinated biphenyls. As noted above, more recent data indicate that sediment quality has improved in Tampa Bay and Charlotte Harbor (and possibly in other locations as well) since the mid-1990s.

Alabama. Mobile Bay make up nearly the entire Alabama coastline. Sediment quality in Mobile Bay was rated as 92 percent good and 8 percent poor (Figure 3.2-4). Mobile Bay, in addition to the sources of polycyclic aromatic hydrocarbons common to a major port, is also the site of coal burning facilities, natural gas production facilities, and drilling platforms (Peachey, 2003). The Alabama coast has impaired ocean and estuarine habitat due to mercury (201 $mi.^2$) and thallium (94 $mi.^2$) (Alabama Department of Environmental Management, 2010). According to Peachey (2003), Mobile Bay and eight smaller bodies of water were designated as impaired due to high levels of pesticides, persistent organic pollutants, and metals. The study found that the level of polycyclic aromatic hydrocarbons in bay sediments decreased from the upper bay to the lower bay, and that the main source of the polycyclic aromatic hydrocarbons was the burning of fossil fuels.

Mississippi. Sediment quality in the Mississippi Sound was rated as 86 percent good and 14 percent poor (Figure 3.2-4). Most sites sampled along the Mississippi coast indicated good sediment quality, including in Biloxi Bay and the eastern portion of Chandeleur Sound.

Louisiana. Louisiana has numerous coastal water bodies that were assessed as part of the national coastal condition assessment (U.S. Environmental Protection Agency, 2016); however sediment quality in the larger coastal bays and in smaller bays adjacent to the Gulf of Mexico are most relevant to the analysis in the EIS/OEIS. Sediment quality in the western portion of Chandeleur Sound was rated as 50 percent good and 50 percent poor (Figure 3.2-4). Sediment quality in Black Bay, which is closer to shore than Chandeleur Sound and downstream of New Orleans was rated as 100 percent poor. East Bay is located at the mouth of the Mississippi River and adjacent to the southernmost coastline in Louisiana. Sediments in East Bay were rated as 33 percent good and 67 percent poor. Sediments in coastal areas downstream of New Orleans and other areas receiving outflow from the Mississippi River have historically been affected by polycyclic aromatic hydrocarbons, pesticides, and some heavy metals (Santschi et al., 2001; Van Metre & Horowitz, 2013; Wang et al., 2014). In addition, polycyclic aromatic hydrocarbons, which are associated with petroleum products, were detected farther from shore in sediments on the continental shelf; however these hydrocarbons differed in chemical structure from those found in nearshore marsh sediments, indicating that the shelf hydrocarbons originated from offshore sources rather than urban runoff or atmospheric deposition (Wang et al., 2014). Farther west and adjacent to undeveloped coastline, sediment quality in Caillou Bay and Terrebone Bay were rated as 100 percent good. Sediment quality in Atchafalaya Bay at the mouth of the Atchafalaya River was rated as 67 percent good and 33 percent poor.

Texas. Galveston Bay, Matagorda Bay, and Corpus Christi Bay are the three largest coastal embayment along the Texas coast. Sediment quality in in Galveston Bay rated as 50 percent good and 50 percent poor (Figure 3.2-4). Galveston Bay sediments are rated as very good for metal contaminants (Lester & Gonzalez, 2011). Sediment concentrations in the five areas within the bay that have been sampled regularly since the 1970s have improved for all metals, with the exception of mercury levels in the Houston shipping channel. The concentrations of organic contaminants associated with industrial processes, including polycyclic aromatic hydrocarbons and polychlorinated biphenyls, have also increased in the Houston shipping channel while sediments in other areas of the bay remain in very good condition. Farther south along the coastline, Matagorda Bay sediment quality was rated as 67 percent good and 33 percent poor, and sediment quality in Corpus Christi Bay was rated as 29 percent good and 71 percent poor.

3.2.2.1.1.5 Sediments in the Caribbean Region

The Caribbean Sea Large Marine Ecosystem includes offshore marine areas south and southeast of the Florida Keys. Within the Study Area, the majority of the Key West Range Complex is located within this ecosystem. See Figure 3.0-1 for range complexes within each large marine ecosystem and Figure 3.0-4 for their locations in the Caribbean Sea Large Marine Ecosystem in Section 3.0 (Introduction). Sediment in the Straits of Florida consists of 50–95 percent carbonate sand, mud, and silt (Cronin, 1983). Sediment distribution in shallower areas (100 to 500 m) is influenced by tides and the Gulf of Mexico Loop Current; those at intermediate depths are influenced by the eastward-flowing Florida Current; and low-energy, westward-flowing currents dominate in deeper areas (> 800 m) (Brooks & Holmes, 1990). Sediments in Florida Bay are discussed above in the sections specific to Florida. Contamination of sediment and shellfish by organic and inorganic compounds was low in nearshore areas of Key West (Cantillo et al., 1997).

Sediment Quality in the Caribbean Region

Sediment quality in Puerto Rico was not assessed in the 2016 publication of the coastal condition assessment, but a 2012 publication, the National Coastal Condition Report IV, did assess sediment quality in island territories (U.S. Environmental Protection Agency, 2012b). Coastal sediment in Puerto Rico was rated as 72 percent good, 2 percent fair, and 20 percent poor with 6 percent of data missing. Elevated levels of total organic carbon and contaminants in approximately 10 percent of coastal areas sample contributed to the poor ratings (U.S. Environmental Protection Agency, 2012b).

As discussed in Section 3.2.3.3 (Metals), Pait et al. (2010) surveyed areas at Vieques, Puerto Rico, that had been used extensively for Navy training and found generally low concentrations of metals in marine sediments. Coastal sediment in the U.S. Virgin Islands was rated as 83 percent good and 17 percent poor. Elevated levels of total organic carbon and sediment toxicity were found at several sites across the islands of St. Croix, St. Thomas, and St. Johns (U.S. Environmental Protection Agency, 2012b). Whitall et al. (2015) sampled sediments in Fish and Coral bays on St. John's Island in the U.S. Virgin Islands and analyzed the samples for metal contaminants, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and other chemical contaminants. Sediment contamination was low, with the exception of copper and chlordane concentrations which exceeded their Effects Range Low thresholds.

3.2.2.1.2 Marine Debris, Military Materials, and Marine Sediments

In 2010, the Navy conducted hydrographic and geophysical surveys and sediment sampling with benthic imagery acquisitions off the coast of Florida so that sensitive underwater features could be avoided during construction of the Undersea Warfare Training Range. Approximately 700 square nautical miles (NM^2) of seabed across the shelf break in water depths ranging from 120 to 1,200 ft. were mapped, with image acquisition from a remotely operated vehicle. Although the study's intent was not to inventory debris on the seafloor, observations of debris were noted when observed. Trash was noted in multiple locations; however, only one instance of military materials was detected (a MK 58 Mod 1 marine location marker used for antisubmarine warfare, search and rescue operations, man-overboard markings, and as a target for practice bombing at sea) (U.S. Department of the Navy, 2010a). Evidence of decomposition and colonization of benthic organisms can be seen in Figure 3.2-5. Other studies in the

Atlantic Ocean inventoried marine debris (i.e., Law et al., 2010; Sheavly, 2007; Sheavly, 2010), but did not differentiate military materials from trash from other sources.

Figure 3.2-5: Marine Marker Deposited on a Mound at 300 meter Depth

As suggested by the seafloor survey reported in Keller et al. (2010), of the 469 tows in which marine debris was recovered, none of the debris off of Washington, Oregon, or Northern California contained military expended material. Watters et al. (2010) conducted a visual survey of the seafloor that included a portion of the Navy's Southern California Range Complex as part of a 15-year quantitative assessment of marine debris on the seafloor off the California coast. Watters et al. (2010) found plastic was the most abundant material and, along with recreational monofilament fishing line, dominate in the debris (note that U.S. Navy vessels have a zero-plastic trash discharge policy and return all plastic waste to appropriate disposition sites on shore). There was only one item found that was potentially "military" in origin.

Because they are buoyant, many types of plastic items float and may travel thousands of miles in the ocean (U.S. Commission on Ocean Policy, 2004). Exceptions include heavy nets and ropes. Because many plastics remain in the water column, additional discussion of marine debris is provided in Section 3.0.3.3.6 (Ingestion Stressors). Although plastics are resistant to degradation, they do gradually break down into smaller particles due to sunlight (photolysis) and mechanical wear (Law et al., 2010). Thompson et al. (2004) found that microscopic particles were common in sediment at 18 beaches around the United Kingdom. They noted that such particles were ingested by small filter and deposit feeders, with unknown effects. The fate of plastics that sink beyond the continental shelf is largely unknown. However, analysis of debris in the center of an area near Bermuda with a high concentration of plastic debris on the surface showed no evidence of plastic as a substantial contributor to debris sinking at depths of 1,650–10,500 ft. (Law et al., 2010). Marine microbes and fungi are known to degrade biologically produced polyesters such as polyhydroxyalkanoates, a bacterial carbon and energy source (Doi et al., 1992). Marine microbes also degrade other synthetic polymers, although at slower rates (Shah et al., 2008).

3.2.2.1.3 Climate Change and Sediment

Aspects of climate change that influence sediment include increasing ocean acidity (pH), increasing sea surface water temperatures, and increasing storm activity. Breitbarth et al. (2010) referred to seawater temperature and pH as "master variables for chemical and biological processes," and noted that effects of changes on trace metal biogeochemistry "may be multifaceted and complex." Under more acidic conditions, metals tend to dissociate from particles to which they are bound in sediment, become more soluble, and potentially more available.

As noted in the beginning of this section, tropical storms can have significant impacts on the resuspension and distribution of bottom sediment (Wren & Leonard, 2005). However, no consensus appears to exist on whether climate change will generate more tropical storms or whether those storms will be more intense. If storm frequency and intensity increase, the additional disturbance of sediment may impact water quality in nearshore and coastal areas. A more detailed discussion of this issue is provided in Section 3.2.2.2 (Water Quality).

3.2.2.2 Water Quality

The current state of water quality in the Study Area, from nearshore areas to the open-ocean and deep sea bottom, is discussed below. Additional information on ocean currents in the Study Area is included in Section 3.0.2 (Ecological Characterization of the Study Area).

Table 3.2-4: Water Quality Screening Criteria for Metals and Organic Contaminants in Marine Waters

Metal	*Water Quality Guidelines – National Oceanic and Atmospheric Administration (ppb)*	
	Acute	*Chronic*
Antimony	1,500	500
Arsenic	69	36
Barium	1,000	200
Beryllium	1,500	100
Boron	N	1,200
Cadmium	40	8.8
Chromium III	10,300	27.4
Chromium IV	1,100	50
Cobalt	N	1
Copper	4.8	3.1
Iron	300	50
Lead	210	8.1
Mercury	1.8	0.94
Molybdenum	N	23
Nickel	74	8.2
Silver	0.95	N
Tin (tributyltin)	0.42	0.0074
Zinc	90	81
Organic Chemicals		
PAHs (Total)	300	N
PCBs (Sum)	0.033	0.03
DDT (Sum)	0.065	0.0005
Dieldrin	0.355	0.00095

Notes: Criteria are pH dependent. N = None provided.
PCB = polychlorinated biphenyl, PAH = polycyclic aromatic hydrocarbons, DDT = dichlorodiphenyltrichloroethane, ppb = parts per billion

3.2.2.2.1 Water Quality in the North Atlantic Region

The North Atlantic Region consists of the West Greenland Shelf, the Newfoundland-Labrador Shelf, and the Scotian Shelf Large Marine Ecosystems, as well as the Labrador Current Open Ocean Area. The area includes the coasts and offshore marine areas southwest of Greenland, east and northeast of Newfoundland and Labrador, and those surrounding Nova Scotia. Although there are no designated range complexes in this region, the area may be used for Navy training and testing activities.

Because of the low population densities and low levels of development, pollution from land-based sources is limited in the North Atlantic area (Aquarone & Adams, 2008a, 2008b; Aquarone et al., 2008). However, pollution is increasing from oil and gas development activities (Aquarone & Adams, 2008a, 2008b), and concern has been expressed regarding spills, discharges, and contaminants from marine vessels (Aquarone & Adams, 2008b).

3.2.2.2.2 Water Quality in the Northeast and Mid-Atlantic Region

The Northeast Region includes the Northeast and Virginia Capes Range Complexes and the Naval Undersea Warfare Center Division, Newport Testing Range. The testing range includes waters of Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, and Long Island Sound.

3.2.2.2.2.1 Open Ocean Water Quality

Sauer et al. (1989) surveyed the micro-surface layer and subsurface water at five open ocean sites off the Delaware-New Jersey shore for the presence of polychlorinated biphenyls and several chlorinated pesticides. Micro-surface layer samples collected contained polychlorinated biphenyl concentrations between less than 2 and 20 nanograms per liter (ng/L; 2–20 parts per trillion) and pesticide concentrations between less than 7 and 80 ng/L (7–80 parts per trillion). Subsurface water samples contained polychlorinated biphenyl concentrations between 0.007 and 0.17 ng/L (0.007–0.17 parts per trillion), and pesticide concentrations between 0.01 and 0.09 ng/L (0.01–0.09 parts per trillion). The screening criterion for acute concentrations of polychlorinated biphenyls is 0.033 parts per billion (equivalent to 33 parts per trillion), which is greater than the concentrations measured in the micro-surface layer measured by Sauer et al. (1989) (Table 3.2-4). The upper limit of the concentration of pesticides measured in the micro-surface layer exceeded the acute criterion for dichlorodiphenyltrichloroethane (DDT), but was well below the chronic level. The micro-surface layer represents the interface between the ocean and the atmosphere and is defined as the upper 1.0 mm of the water column (Wurl & Obbard, 2004). However the interface can serve as both a sink and a source of anthropogenic contaminants, including chlorinated hydrocarbons and heavy metals, and because of its physical and chemical properties, concentrations of chemicals can be several hundred times greater than in subsurface waters (Wurl & Obbard, 2004). Concentrations of polychlorinated biphenyls in the open ocean in the North Atlantic and Gulf of Mexico have been measures at <1 ng/L and open-ocean concentrations of dichlorodiphenyltrichloroethane (DDT) were measured as <0.2 ng/L (Wurl & Obbard, 2004).

In the western North Atlantic, Wallace et al. (1977) tested surface waters between Massachusetts and Bermuda. The authors reported that concentrations of metals measured in the study were well below the effects thresholds shown in Table 3.2-4.

In all cases except cadmium, the maximum values were found closest to the shore southeast of Cape Cod. The authors noted that suspended clay minerals and biologically produced particles are important concentrators of trace metals in the marine environment, and that the influence of river-borne suspended sediment extends approximately 1 mi. offshore.

3.2.2.2.2.2 Nearshore Water Quality

States bordering the Northeast and Mid-Atlantic Region include Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and northeast North Carolina. Information regarding the current quality of marine waters in nearshore areas of these states is provided below.

The U.S. Environmental Protection Agency (2016) rated the waters along the northeast U.S. Atlantic coast as 44 percent good, 49 percent fair and 6 percent poor (Figure 3.2-6). Most of these poor sites were concentrated in a few estuarine systems, such as the New York/New Jersey Harbor, upper Delaware Bay, and upper Chesapeake Bay. The poor ratings were based on chlorophyll-*a* (a measure of turbidity) and low dissolved oxygen. Past and ongoing industrial activities also impact water quality (Aquarone & Adams, 2008c). Except where otherwise indicated, information provided below, including the data used in the water quality map, was drawn from the USEPA's National Aquatic Resource Surveys database (U.S. Environmental Protection Agency, 2016).

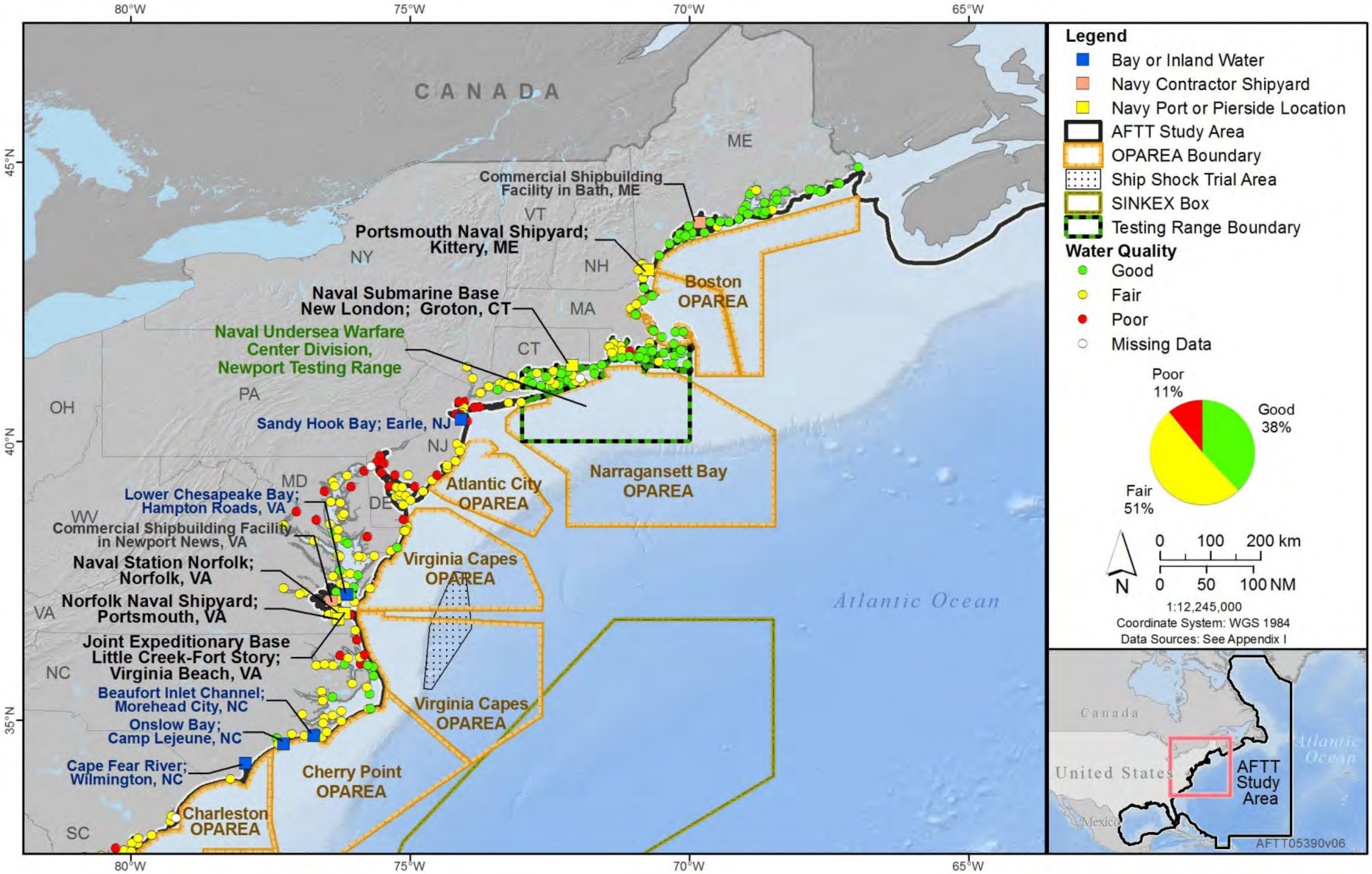
Maine. Water quality for all the estuaries and bays assessed in Maine is rated 88 percent good and 12 percent fair (Figure 3.2-6). All estuarine and marine waters in Maine have an advisory for the consumption of shellfish, specifically lobster tomalley, the green substance found inside the carapace that many consider to be a delicacy, due to the presence of polychlorinated biphenyls and dioxins, presumed to be from atmospheric deposition or prior industrial activity (U.S. Environmental Protection Agency, 2008a).

New Hampshire. Water quality for coastal waters, including estuaries and bays, assessed in New Hampshire is rated as 33 percent good and 67 percent fair (Figure 3.2-6). The main concerns were over the contaminants dioxin, polychlorinated biphenyls, and mercury. Elevated levels of nutrients, pathogens, and turbidity were also noted as factors impacting water quality. Offshore and nearshore waters assessed in the surveys were also considered impaired based on similar concerns.

Massachusetts. Water quality for 82 percent of estuaries and bays assessed in Massachusetts is rated good, and 15 percent is rated fair, and 3 percent is poor, mostly due to the presence of pathogens (Figure 3.2-6). Toxic organics, high levels of nutrients, and low dissolved oxygen were also cited as contributors to fair and poor water quality.

Rhode Island. Water quality for 64 percent of estuaries and bays assessed in Rhode Island is rated good, and 36 percent is rated fair (Figure 3.2-6). The main contributors to impaired water quality included low dissolved oxygen levels, fecal coliform, and excess nutrients (i.e., nitrogen).

Connecticut. Water quality for 25 percent of estuaries and bays assessed in Connecticut is rated good, and 75 percent is rated fair (Figure 3.2-6). The main contributors to impaired water quality included low dissolved oxygen levels, eutrophication, and excess nutrients (i.e., nitrogen).



Notes: AFTT = Atlantic Fleet Training and Testing, OPAREA = Operating Area

Figure 3.2-6: Water Quality Ratings for the Northeast and Mid-Atlantic Coast

New York. Water quality for 45 percent of estuaries and bays assessed in New York is rated good, 33 percent is rated fair, and 20 percent is rated poor (Figure 3.2-6). The main contaminant affecting water quality was polychlorinated biphenyls; other factors contributing to poor water quality included total coliform (bacteria in the water), low dissolved oxygen levels, elevated concentrations of cadmium, and excess nutrients (i.e., nitrogen). The most highly polluted areas were nearshore waters off of New York Harbor.

New Jersey. Water quality for 61 percent of estuaries and bays assessed in New Jersey is considered fair, and 39 percent is considered poor (Figure 3.2-6). The main contributors to impaired water quality included pesticides, polychlorinated biphenyls, low dissolved oxygen levels, and elevated concentrations of mercury. The report notes similar concerns for coastal and offshore marine waters.

Delaware. Water quality for all the estuaries and bays assessed in Delaware is rated as 45 percent fair and 45 percent poor with 10 percent of data reported as missing (Figure 3.2-6). Excess nutrients (nitrogen and phosphorus), and pathogens were contributed approximately equally to reduced water quality. Poorest water quality was in the upper Delaware Bay downstream of Wilmington, DE, the state's largest city.

Maryland. Water quality for 44 percent of the Maryland's coastal waters is rated good, 33 percent is rated fair, and 22 percent is rated poor (Figure 3.2-6). Wazniak et al. (2004) indicates that water quality conditions in Maryland's coastal bays range from generally degraded conditions within or close to tributaries to better conditions in the bay regions farther from shore. Excess nutrient levels are a contributor to most of the impaired waters. Tributaries generally show poor to very degraded water quality, primarily due to high nutrient inputs, while the open bays have good to excellent water quality. The Maryland Coastal Bays Program uses water quality indicators (e.g., chlorophyll-*a*, dissolved oxygen) as well as other metrics such as seagrass and hard clam densities to assess or grade the health of Maryland's coastal bays (Maryland Coastal Bays Program, 2015). The 2014 "report card" indicates that the collectively received a grade of C+, on a scale of A (good to very good) to F (very poor), on the program's index for characterizing the health of each coastal bay. Specifically for the water quality components of the report card, Chincoteague Bay (overall B-) scored good to very good for nitrogen, phosphorus, and chlorophyll-*a*, and dissolved oxygen was moderate. Assawoman Bay (C), scored as moderate for dissolved oxygen, nitrogen, and phosphorus (declined since 2013), and chlorophyll-*a* was very good (improved since 2013). Isle of Wight Bay (C) scored good to very good for nitrogen and chlorophyll-*a*, moderate for dissolved oxygen (a significant improvement), but poor to very poor for phosphorus. In Newport Bay (C-), chlorophyll-*a* was very good, and dissolved oxygen, nitrogen, and phosphorus were all moderate, an overall improvement since 2013.

Also, the northern bays are generally in poorer condition than the southern bays due to the extent of development and, to a lesser degree, the extent of flushing that occurs. Areas within the tidal portion of the Potomac River have been placed on the state 303(d) "impaired waters" list because of contamination by polychlorinated biphenyls (Interstate Commission on the Potomac River Basin, 2008).

Virginia. Water quality for 22 percent of coastal waters in Virginia is rated good, 74 percent is rated fair, and 4 percent is rated poor (Figure 3.2-6). The main issues involve polychlorinated biphenyls, noxious aquatic plants, and low dissolved oxygen. Water quality parameters are measured at over 4,000 stations in Virginia's coastal zone. Monitoring data show that 316 coastal water bodies are impaired (Virginia Department of Environmental Quality, 2001). Shellfish concerns are related to bacteria, and health advisories have been issued for fish consumption related to polychlorinated biphenyls and mercury (Virginia Department of Environmental Quality, 2010).

North Carolina. Water quality along the North Carolina coast is rated as 25 percent good, 64 percent fair, and 11 percent poor. The main issues reported are mercury and selenium (at limited locations) in fish tissue. Impaired water quality was observed in the state's large coastal estuaries. In Albemarle Sound, 67 percent of survey sites reported either fair or poor water quality, and in Currituck Sound, 100 percent of sites rate poor for water quality. According to Mallin (2000), most estuaries in North Carolina exhibit low-to-moderate eutrophication. However, conditions in three estuaries—the Pamlico River, Neuse River, and New River—were rated as highly eutrophic based on frequency and extent of algal blooms, bottom-water hypoxia and anoxia, fish kills, and loss of submerged aquatic vegetation. Impairment is primarily the result of runoff from agricultural and urban areas that leads to excess nutrients and increased turbidity from algal blooms.

Chesapeake Bay. Bay water is listed as impaired under Section 303(d) of the federal Clean Water Act due to excess nutrients and sediment (U.S. Geological Society, 2005). The most contaminated sites were concentrated at the northern end of the bay, where development is most intensive. Nutrient enrichment in the bay arises from agricultural and other nonpoint source runoff, and municipal and industrial wastewater treatment facilities (U.S. Army Corps of Engineers, 2009).

The Chesapeake Bay watershed includes portions of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. In order to simplify the discussion and reduce repetition, water quality issues in the bay are not reviewed on a state-by-state basis because: (1) many of the water quality issues are common to most or all of these bordering states; and (2) Navy training and testing activities are limited to the extreme southeast portion of the bay and do not appreciably impact water quality issues in the bay as a whole.

3.2.2.2.3 Water Quality in the Southeast Region

The Southeast U.S. Continental Shelf Large Marine Ecosystem includes the Navy Cherry Point and Jacksonville Range Complexes, and the South Florida Ocean Measurement Facility Testing Range. See Figure 3.0-1 in Section 3.0 (Introduction) for the locations of these areas.

3.2.2.2.3.1 Open Ocean Water Quality

Of the large marine ecosystems in the Study Area, the southeast is judged to be in the best ecological condition (Aquarone et al., 2008). Sauer et al. (1989) surveyed the micro-surface layer and subsurface water at five open ocean sites between Cape Hatteras, North Carolina and Florida for the presence of polychlorinated biphenyls and several chlorinated pesticides. Micro-surface layer samples collected contained polychlorinated biphenyl concentrations between less than 0.5 and 1.5 ng/L and pesticide concentrations between less than 0.5 and 1.0 ng/L. Subsurface water samples contained polychlorinated biphenyl concentrations between 0.003 and 0.424 ng/L and pesticide concentrations between 0.013 and 0.1 ng/L. No concentrations exceeded the acute concentration criteria for either contaminant. The concentration of pesticides exceeded the chronic concentration criterion for dichlorodiphenyltrichloroethane (DDT) in the micro-surface layer, but not in the subsurface layers (Table 3.2-4).

3.2.2.2.3.2 Nearshore Water Quality

States bordering the Southeast U.S. Continental Shelf Large Marine Ecosystem include southeast North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida. Information regarding the current quality of marine waters in the nearshore areas of these states is provided below (Figure 3.2-7). The USEPA (2016) rated 21 percent good, 69 percent of the waters along the southeast coast as fair, and 9 percent of the sites sampled rated poor. Except where otherwise indicated, information provided below, including the data used in the water quality map, was drawn from the USEPA's National Aquatic Resource Surveys database (U.S. Environmental Protection Agency, 2016).

North Carolina. Refer to the Section 3.2.2.2.2.2 (Nearshore Water Quality) for the Northeast and Mid-Atlantic states.

South Carolina. For South Carolina, water quality for 86 percent of coastal waters is rated fair, 10 percent is rated poor, and 5 percent is reported as missing (Figure 3.2-7). Estuaries in South Carolina exhibit low or moderate eutrophication (Mallin et al., 2000). Poor water quality is primarily linked to high turbidity levels which reduce water clarity in coastal and estuarine areas.

Georgia. Water quality along Georgia's coast is rated as 57 percent fair and 43 percent poor based on five indicators: dissolved oxygen, dissolved inorganic nitrogen, dissolved inorganic phosphorus, turbidity as measured by chlorophyll-*a*, and water clarity (Figure 3.2-7). Eighty percent of the state's estuaries rated fair, 18 percent rated poor, and 2 percent rated good. Increasing eutrophication and decreasing water clarity were noted as concerns (Georgia Department of Natural Resources, 2005).

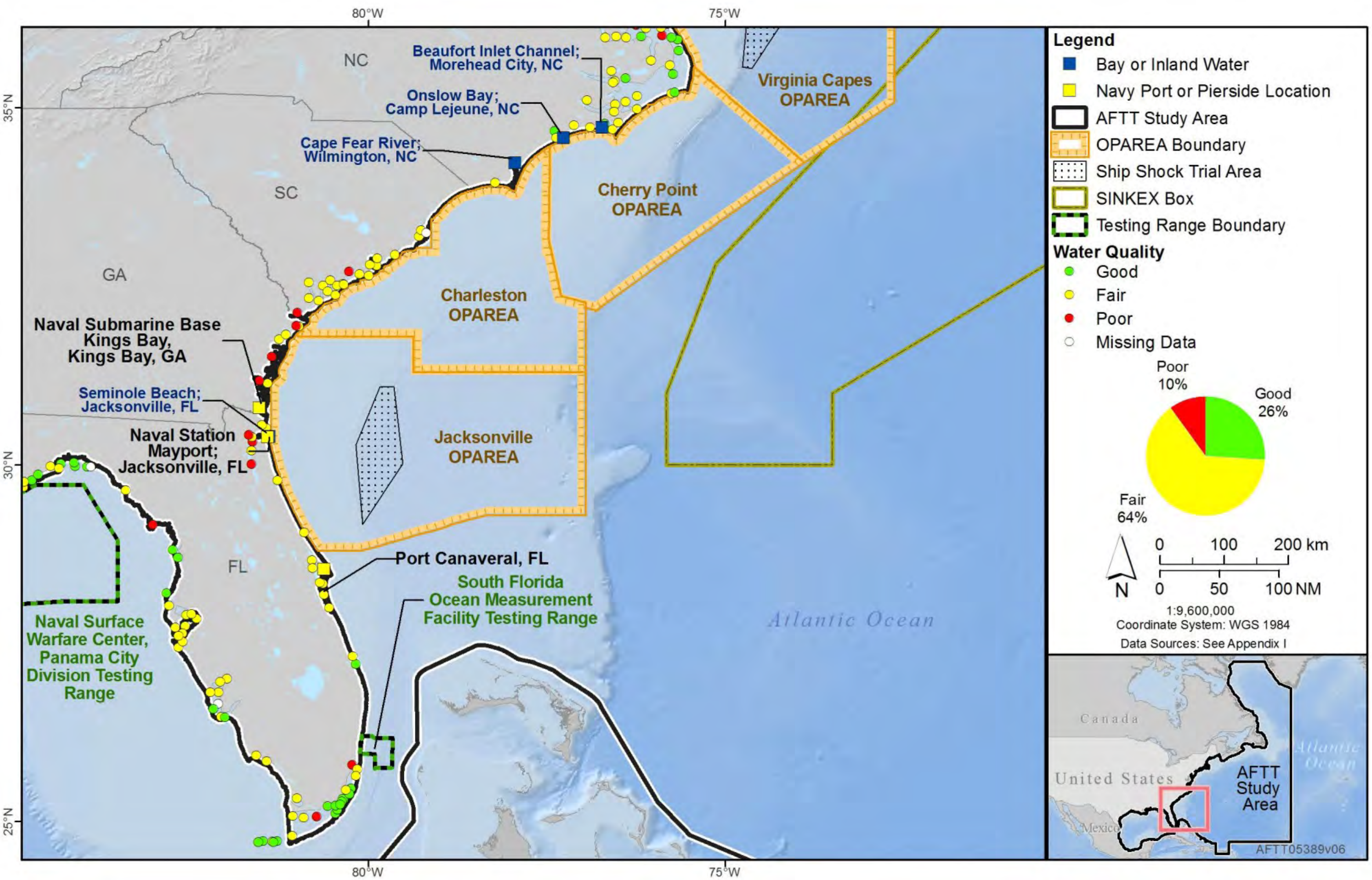
Florida. Water quality along Florida's Atlantic coast is rated 13 percent good, 70 percent fair, and 17 percent poor (Figure 3.2-7). Most of the state's estuaries and coastal waters are considered impaired because of mercury in fish tissue, low dissolved oxygen, high turbidity as measured by chlorophyll-*a* concentrations, fecal coliform, and bacteria in shellfish. Harmful algal blooms and nutrient enrichment are of increasing concern (Florida Department of Environmental Protection, 2010a).

3.2.2.2.4 Water Quality in the Gulf of Mexico Region

The Gulf of Mexico Region includes the Gulf of Mexico Range Complex, which consists of four Operating Areas: Panama City, Pensacola, New Orleans, and Corpus Christi. Also within the Gulf of Mexico Large Marine Ecosystem are the Naval Surface Warfare Center, Panama City Division Testing Range (Florida) and a portion of the Key West Range Complex. See Figure 3.0-1 in Section 3.0 (Introduction) for range complexes within each large marine ecosystem and Figure 3.0-4 for their locations in the Gulf of Mexico Large Marine Ecosystem.

3.2.2.2.4.1 Open Ocean Water Quality

Unlike the other areas, no open ocean areas are specifically designated for the Gulf of Mexico. However, Sauer et al. (1989) surveyed the micro-surface layer and subsurface water at six sites in the west central part of the Gulf of Mexico for the presence of polychlorinated biphenyls and several chlorinated pesticides. Micro-surface layer samples collected contained polychlorinated biphenyl concentrations between less than 0.2 and 1.0 ng/L and pesticide concentrations between less than 0.1 and 0.5 ng/L. Subsurface water samples contained polychlorinated biphenyl concentrations between 0.0006 and 0.0024 ng/L and pesticide concentrations between 0.0002 and 1.46 ng/L. No concentrations exceeded the acute concentration criteria for either contaminant. The highest concentration of pesticides equaled the chronic concentration criterion for dichlorodiphenyltrichloroethane (DDT) in the micro-surface layer, and exceeded the chronic concentration criterion in the subsurface layers (Table 3.2-4).



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area

Figure 3.2-7: Water Quality Ratings for the Southeast Coast

3.2.2.2.4.2 Nearshore Water Quality

States bordering the Gulf of Mexico Region include the Gulf coast of Florida, Alabama, Mississippi, Louisiana, and Texas. Information regarding the current quality of marine waters in the nearshore areas of these states is provided. The USEPA (2016) rated the gulf waters as 16 percent good, 58 percent fair, and 24 percent poor. Various combinations of all the water quality indicators were responsible for poor site conditions. Onshore development, oil and gas extraction, and excess nutrients are the main sources of stress on the Gulf of Mexico (Heileman & Rabalais, 2008). Except where otherwise indicated, information provided below, including the data used in the water quality map, was drawn from the USEPA's National Aquatic Resource Surveys database (U.S. Environmental Protection Agency, 2016).

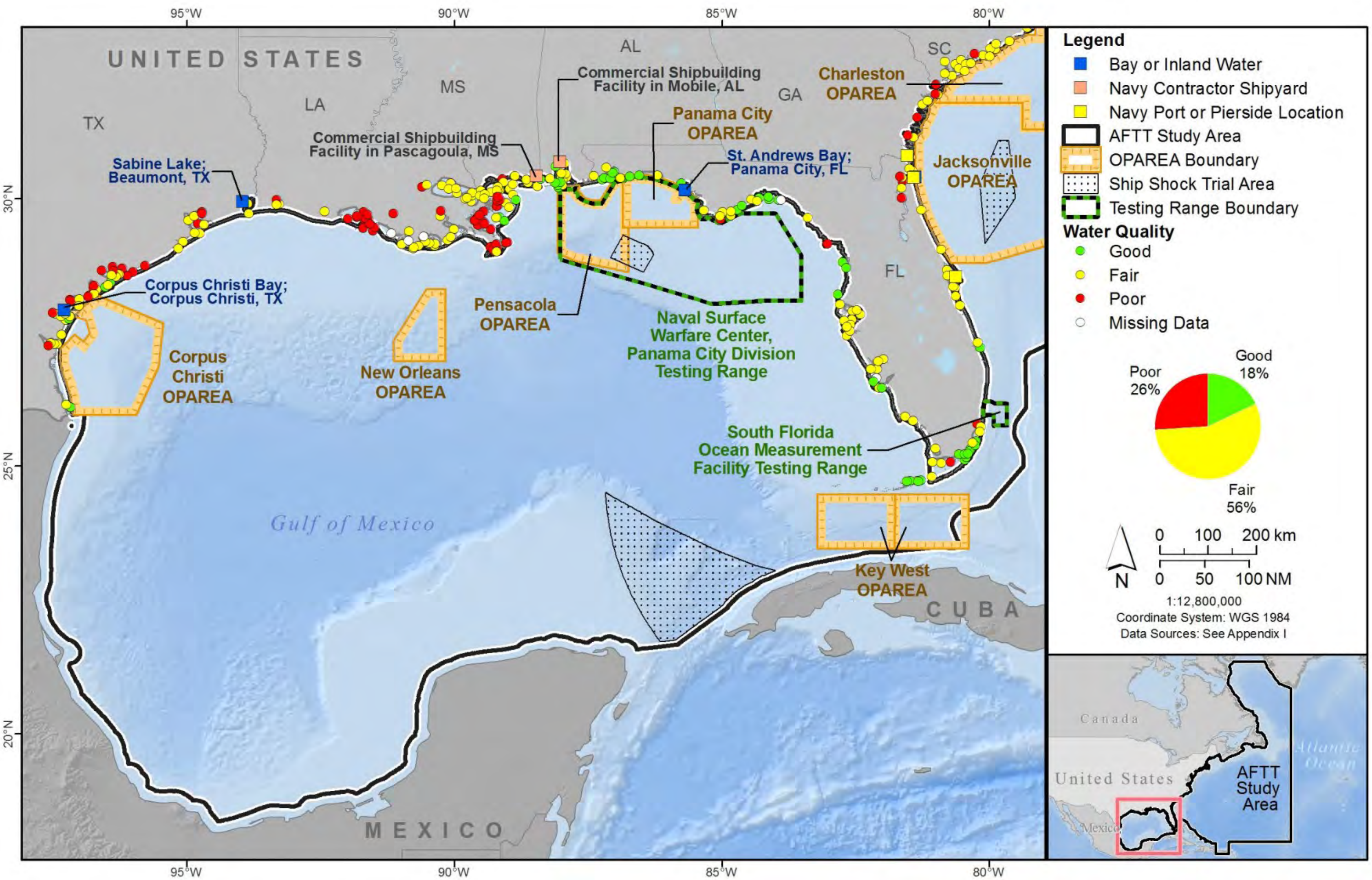
Florida. Water quality along Florida's Gulf coast is rated 47 percent good, 47 percent fair, and 4 percent poor with 3 percent of data reported as missing (Figure 3.2-8). Mercury in fish tissue, bacteria in shellfish, low dissolved oxygen, high turbidity as measured by chlorophyll-*a*, and fecal coliform are also concerns along the Gulf coast.

Lewis et al. (2001) studied the impacts of urbanization on three areas in Pensacola Bay. Although total metal concentrations varied widely, copper and zinc were most commonly detected in surface waters. Average levels for copper exceeded both the chronic (3.1 µg/L) and acute (4.8 µg/L) exposure levels established to protect marine life. Cadmium, chromium, and nickel were detected in fewer samples but, where detected, concentrations exceeded chronic exposure levels. Concentrations of most chlorinated pesticides, polycyclic aromatic hydrocarbons, and all polychlorinated biphenyls were below the limits of detection. The most commonly detected pesticides were diazinon (0.03–0.22 µg/L) and atrazine (0.03–0.30 µg/L). The authors noted that some pesticides occasionally exceeded the recommended maximum surface water concentration of 0.004 µg/L and that total polycyclic aromatic hydrocarbon concentrations at some sites exceeded the recommended annual average of less than or equal to 0.031 µg/L, but these occasions were "uncommon." Petroleum hydrocarbons were detected in surface water collected from several sites, but most commonly in Bayou Grande, where the average concentrations ranged from 1.1 to 8.9 µg/L.

Alabama. Water quality for the coastal waters assessed for Alabama were rated 35 percent good and 65 percent fair (Figure 3.2-8). Pathogens (e.g., fecal bacteria) and mercury in fish tissue contributed to reduced water quality.

Mississippi. Of the 23 mi. of coastal Mississippi shoreline assessed, 10 percent rated good, 80 percent rated fair, and 10 percent rated as poor (Figure 3.2-8). The main issue was pathogens (fecal bacteria). Sampling along the coast indicated degraded water clarity and high phosphorus levels contributed to poor water quality.

Louisiana. Water quality for the coastal waters assessed for Louisiana were rated 3 percent good, 47 percent fair, and 46 percent poor with 3 percent of data reported as missing (Figure 3.2-8). Clark and Goolsby (2000) studied herbicide concentrations in the Mississippi River at Baton Rouge between 1991 and 1997. Peak herbicide concentrations generally followed peak discharges in late winter or early spring. Herbicides and their metabolites were detected in more than half of the samples (e.g., alachlor, atrazine, metolachlor, deethylatrazine, and cyanazine). No compound exceeded 5 µg/L, and the total herbicide concentration did not exceed 10 µg/L. None of the average annual concentrations of the herbicides examined in that study exceeded maximum contaminant levels or the health advisory levels established at that time.



Notes: AFTT = Atlantic Fleet Training and Testing; OPAREA = Operating Area

Figure 3.2-8: Water Quality Ratings for the Gulf of Mexico Coast

Texas. Water quality for the coastal waters in Texas were rated 11 percent good, 55 percent fair, and 34 percent poor (Figure 3.2-8). In nearshore waters and estuaries, the main concerns were with bacteria (in oyster waters) and low dissolved oxygen. Farther offshore, impairment was associated with bacteria concentrations and mercury in fish tissue.

3.2.2.2.5 Water Quality in the Caribbean Region

The Caribbean Region includes offshore marine areas south and southeast of the Florida Keys. Within the Study Area, the majority of the Key West Range Complex is located within this ecosystem. See Figure 3.0-1 in Section 3.0 (Introduction) for range complexes within each large marine ecosystem and Figure 3.0-4 for their locations in the Caribbean Sea Large Marine Ecosystem. These marine waters are clear and poor in nutrients (Heileman & Mahon, 2008). Water quality in nearshore waters of Puerto Rico was not assessed in the 2016 publication of the coastal condition assessment, but a 2012 publication, the National Coastal Condition Report IV, did assess sediment quality in island territories (U.S. Environmental Protection Agency, 2012b). Coastal water quality in Puerto Rico was rated as 50 percent good, 40 percent fair, and 10 percent poor. Poor water clarity ratings in combination with elevated dissolved inorganic phosphorous levels or chlorophyll-*a* concentrations at individual sites resulted in the poor ratings (U.S. Environmental Protection Agency, 2012b). Several of the poor water quality ratings were in coastal areas near San Juan, the most populous city on the island. Coastal water quality in the U.S. Virgin Islands was rated as 60 percent good, 34 percent fair, and 0 percent poor with 6 percent of data reported as missing (U.S. Environmental Protection Agency, 2012b).

Specific information regarding water quality in the Key West Range Complex could not be located. As with other coastal areas, nearshore water quality is mostly influenced by onshore activities and development, plus the discharge of solid waste and wastewater from commercial and cruise vessels (Heileman & Mahon, 2008; Lapointe et al., 1994).

3.2.2.2.6 Marine Debris and Water Quality

The National Marine Debris Monitoring Program developed three categories of marine debris for its study of the extent of man-made materials in the oceans: land-based, ocean-based, and general (i.e., origin unspecified) (Sheavly, 2007). Land-based debris may blow in on the wind, be washed in with storm water, arise from recreational use of coastal areas, and be generated by extreme weather such as hurricanes. Ocean-based sources of marine debris include commercial shipping and fishing, private boating, offshore mining and extraction, and legal and illegal dumping at sea. Ocean current patterns, weather and tides, and proximity to urban centers, industrial and recreational areas, shipping lanes, and fishing grounds influence the types and amount of debris found (Sheavly, 2010). These materials are concentrated at the surface and in the near-surface water column.

According to Sheavly (2010), land-based sources account for about half of marine debris, and ocean- and waterway-based sources contribute another 18 percent. Galgani et al. (2015) confirm that the majority of marine debris originates from land. Land-based debris included syringes, condoms, metal beverage cans, motor oil containers, balloons, six-pack rings, straws, tampon applicators, and cotton swabs as well as other items. Ocean-based debris included gloves, plastic sheets, light bulbs and tubes, oil and gas containers, pipe-thread protectors, nets, traps and pots, fishing line, light sticks, rope, salt bags, fish baskets, cruise line logo items, and floats and buoys. Plastics, generally referring to petroleum-based, manmade materials, make up the vast majority of marine debris (Galgani et al., 2015; (Law et al., 2014). Microscopic plastic fragments enter the marine environment from use as scrubbers in hand cleaning and other cosmetic products, abrasive beads for cleaning ships, and deterioration of macroscopic plastics

(Teuten et al., 2007). Microplastic beads commonly used in cosmetic products such as facial scrubs and other exfoliants are not broken down in wastewater treatment facilities and are largely not filtered out of the waste stream before they are flushed into the marine environment in enormous quantities (Chang, 2015; Napper et al., 2015). These microbeads are found worldwide in marine sediments, persist in the marine environment, and accumulate up the food chain (Cole & Galloway, 2015).

Plastics may serve as vehicles for transport of various pollutants, whether by binding them from seawater or from the constituents of the plastics themselves. Mato et al. (2001) noted that polypropylene resin pellets (precursors to certain manufactured plastics) collected from sites in Japan contained polychlorinated biphenyls, dichlorodiphenyldichloroethylene (a breakdown product of DDT), and the persistent organic pollutant nonylphenol (a precursor to certain detergents). Polychlorinated biphenyls and dichlorodiphenyldichloroethylene were adsorbed from seawater. The original source of nonylphenol was less clear; it may have originated from the pellets themselves or may have been adsorbed from the seawater and accumulated on the surface of plastics. Microbeads have also been shown to adsorb hydrophobic chemical contaminants, such as DDT, from seawater, allowing for the accumulation and transport of these often toxic chemicals to widely dispersed areas of the oceans. While the impacts on the marine ecosystem are largely unknown, some examples illustrating potential widespread impacts have been discussed. For example, it has been suggested that white and blue microplastic beads, common in many exfoliants, resemble plankton and may be mistakenly ingested by plankton-feeding fishes, which rely on visual cues to find prey (Napper et al., 2015; Wright et al., 2013). The long-term effects on the environment from the proliferation of microbeads and other micro plastics are still being researched. Since there is no way of effectively removing micro plastics from the marine environment, and given that plastics are highly resistant to degradation, it is likely that the quantity of micro plastics in the marine environment will only continue to increase, and therefore the likelihood of environmental impacts can only increase (Napper et al., 2015). The only way to reduce long-term impacts is to reduce or eliminate the use of micro plastics, a course of action that is gaining recognition (Chang, 2015).

Marine debris findings in the Study Area (Sheavly, 2007) are provided in Table 3.2-5. In a recent survey of marine debris in the North Atlantic, 62 percent of all net tows contained detectable amounts of plastic debris (Law et al., 2010). The highest concentrations were observed between 22° and 38°north latitude (roughly south of Florida to Maine). Tows closest to land, such as along the Florida coast and in the Gulf of Maine, found relatively small amounts of plastic.

Because of their buoyancy, many types of plastic items float and may travel thousands of miles in the ocean (U.S. Commission on Ocean Policy, 2004). Exceptions include heavy nets and ropes. Although plastics are resistant to degradation, they do gradually breakdown into smaller particles due to sunlight and mechanical wear (Law et al., 2010). A study by Teuten et al. (2007) indicated that the water-borne phenanthrene (a type of polycyclic aromatic hydrocarbon) adhered preferentially to small pieces of plastic ingested by a bottom-dwelling marine lugworm and incorporated into its tissue. Marine microbes and fungi are known to degrade biologically produced polyesters, such as polyhydroxyalkanoates, a bacterial carbon and energy source (Doi et al., 1992). Marine microbes also degrade other synthetic polymers, although at slower rates (Shah et al., 2008).

Table 3.2-5: Percent Marine Debris by Source in Atlantic Fleet Training and Testing Study Area

Sheavly Study Area	*Locations within Study Area*	*Land-Based (%)*[1]	*Ocean-Based (%)*[1]	*General (%)*[1]
Region 1 (Provincetown, Massachusetts to Canadian border)	Northeast Range Complexes	28	42	30
Region 2 (Cape Cod, Massachusetts to Beaufort, North Carolina)	Northeast and Virginia Capes Range Complexes; Naval Undersea Warfare Center Division, Newport Testing Range	63	7	30
Region 3 (Morehead City, North Carolina to Port Everglades, Florida)	Navy Cherry Point and Jacksonville Range Complexes; South Florida Ocean Measurement Facility	41	14	44
Regions 4 & 5 (Port Everglades, Florida to Mexican border)	Gulf of Mexico and Key West Range Complexes; Naval Surface Warfare Center, Panama City Division Testing Range	48	16	36

[1]Numbers may not sum due to rounding.
Notes: % = percent

Annex V of the International Convention for the Prevention of Pollution from Ships prohibits the discharge of plastic waste from vessels at sea, and the U.S. Act to Prevent Pollution from Ships brought U.S. public vessels in alignment with the international convention. The National Defense Authorization Act of 1996 specifically directed the Navy to install plastic waste processors aboard the surface fleet. The U.S. Navy's plastics waste processors compress and melt shipboard-generated plastic waste into dense, sanitary disks of compressed plastics that can be stored over long at-sea deployments. The plastic wastes items include lightly contaminated food containers as well as clean plastics and other materials that may be combined with, or contain, plastic components that cannot be processed in the normal solid waste stream. The plastic waste disks are offloaded for proper disposal once a ship comes into port. The plastic compression technology enables Navy ships to operate at sea over long time periods without discharging plastics into the oceans.

3.2.2.2.7 Climate Change and Water Quality

According to the U.S. Global Change Research Program, the rise in ocean temperature over the last century will continue into the future, with continued and perhaps increasing impacts on ocean circulation, marine chemistry, and marine ecosystems. Because the ocean currently absorbs about a quarter of human-produced carbon dioxide emissions, increasing carbon dioxide absorption will increase acidification of ocean waters. This in turn will alter the distribution, abundance, and productivity of many marine species and affect water quality in coastal and open ocean waters (Melillo, 2014).

Key findings of the 2014 National Climate Assessment that may pertain to waters in the AFTT Study Area:

- Local sea level rise (amplified by coastal subsidence) is greater than the global average for the Chesapeake Bay.
- Sea level rise and related flooding and erosion threaten coastal homes, infrastructure, and commercial development, including ports.

- Ecosystems of the southeast are vulnerable to loss from relative sea level rise, especially tidal marshes and swamps.
- The incidence of harmful algal blooms is expected to increase with climate change, as are health problems previously uncommon in the region.
- The number of land-falling tropical storms may decline in the gulf, reducing important rainfall, while there has been an increase in the frequency of tropical storms and major hurricanes in the North Atlantic.
- The Florida Keys, South Florida, and coastal Louisiana are particularly vulnerable to additional sea level rise and saltwater intrusion.

The Paris Agreement builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

At the 2015 Paris Climate Conference, 195 parties to the United Nations Framework Convention on Climate Change adopted the first-ever universal, global climate agreement, referred to as the Paris Agreement in which all countries voluntarily set and committed to individual carbon reduction goals. The Agreement marks the latest step in the evolution of the United Nations climate change initiative and builds on the work undertaken under the Convention over the past several decades.

The Paris Agreement seeks to accelerate and intensify the actions and investment needed for sustaining low carbon emissions into the future. Its central aim is to strengthen the global response to the threat of climate change and greenhouse gas emissions by limiting a global temperature rise over this century to no more than 2 degrees Celsius above pre-industrial levels. The Paris Agreement also includes a commitment to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

The United States signed the Paris Agreement on April 22, 2016, and on September 3, 2016, the United States accepted ratification of the Agreement. However, on June 1, 2017, the President announced that the United States would withdraw from the Paris Agreement. The official withdrawal requires a formal process, which will take nearly four years to complete. According to the rules of the Paris Agreement, a nation wishing to withdraw must first submit a document to the United Nations specifying its intent to withdraw. The submission of the document is permitted only after three years have passed since the agreement entered into force, in this case November 4, 2016. The earliest the United States can submit its written notice is November 4, 2019, and the earliest the United States could complete the withdrawal process is November 4, 2020.

3.2.3 Environmental Consequences

This section evaluates how and to what degree the training and testing activities described in Chapter 2 (Description of Proposed Action and Alternatives) may impact sediments and water quality in the Study Area. Tables 2.6-1 through 2.6-4 present proposed training and testing activity locations for each alternative, including number of events conducted annually and over a five-year period for alternatives 1 and 2. Each water quality stressor is introduced, analyzed by alternative, and analyzed for training activities and testing activities. Potential impacts could be from:

- releasing materials into the water that subsequently disperse, react with seawater, or may dissolve over time.

- depositing materials on the ocean bottom and any subsequent interactions with sediments or the accumulation of such materials over time.
- depositing materials or substances on the ocean bottom and any subsequent interaction with the water column.
- depositing materials on the ocean bottom and any subsequent disturbance of those sediments or their resuspension in the water column.

These potential impacts may result from four stressors: (1) explosives and explosives byproducts, (2) metals, (3) chemicals other than explosives, and (4) Other materials. The term "stressor" is used because materials in these four categories may directly impact sediments and water quality by altering their physical and chemical characteristics.

The area of analysis for sediments and water quality includes the estuaries, nearshore areas, and the open ocean (including the seafloor) in the Study Area. The environmental fate of explosives, explosion byproduct, metals, and other chemicals and materials constituents depends on environmental factors, geochemical conditions, and various mechanisms that transport the constituents in the environment. Some natural transport mechanisms, such as advection by currents, dispersion, dissolution (dissolving), precipitation by chemical reaction, and adsorption (the adhesion of a chemical constituent onto the surface of a particle in the environment [e.g., clay]) reduce concentrations in water and redistribute constituents between the water and sediments. Other processes, such as biodegradation, may change or destroy the explosive compounds but would not affect metals. For this analysis, potential impacts on sediments and water quality from military expended materials that come to rest in sediment at a given distance from shore are assumed to be similar whether off the Atlantic coast or the Gulf of Mexico.

3.2.3.1 Explosives and Explosives Byproducts

Explosives may be introduced into the seawater and sediments by the Proposed Action. The explosive fillers contained within the munitions used during training and testing activities and their degradation products can enter the environment through high-order detonations (i.e., the munition functions as intended and the vast majority of explosives are consumed), low-order detonations (i.e., the munition partially functions with only a portion of the explosives consumed), or unexploded munitions (i.e., the munition fails to detonate and explosives remain in the casing). In the case of a successful detonation, only a small or residual amount of explosives may enter the marine environment (U.S. Environmental Protection Agency, 2012a). A low-order detonation would result in some residual explosives and some unconsumed explosives remaining in the munitions casing entering the water. In the case of unexploded munitions, the explosives contained in the munition would not be consumed and would remain encased within the munition as it enters the environment. The munitions casing may corrode or rupture over time and release explosives into the sediments and water column.

The behavior of explosives and explosives byproducts in marine environments and the extent to which those constituents of explosives have adverse impacts are influenced by a number of processes, including the ease with which the explosive dissolves in a liquid such as water (solubility), the degree to which explosives are attracted to other materials in the water (e.g., clay-sized particles and organic matter, sorption), and the tendency of the explosives to evaporate (volatilization). These characteristics, in turn, influence the extent to which the material is subject to biotic (biological) and abiotic (physical and chemical) transformation and degradation (Pennington & Brannon, 2002). The solubility of various explosives is provided in Table 3.2-6. In the table, higher values indicate greater solubility. For example, high melting explosive is virtually insoluble in water. Table salt, which dissolves easily in water, is included in the table for comparison.

Table 3.2-6: Water Solubility of Common Explosives and Explosive Degradation Products

Compound	***Water Solubility1 (mg/L at 20 ˚C)***
Table salt (sodium chloride)[2]	357,000
Ammonium perchlorate (O)	249,000
Picric acid (E)	12,820
Nitrobenzene (D)	1,900
Dinitrobenzene (E)	500
Trinitrobenzene (E)	335
Dinitrotoluene (D)	160
Trinitrotoluene (TNT) (E)	130
Tetryl (E)	51
Pentaerythritol tetranitrate (E)	43
Royal Demolition Explosive (E)	38
High Melting Explosive (E)	7

[1]Units are milligrams per liter (mg/l) at 20 degrees Celsius.
[2]Table salt is not an explosive degradation product
Notes: D = explosive degradation product, E = explosive, O = oxidizer additive; TNT = trinitrotoluene
Source: U.S. Department of the Navy (2008a)

According to Walker et al. (2006), trinitrotoluene (TNT), royal demolition explosive, and high melting explosive experience rapid biological and photochemical degradation in marine systems. The authors noted that productivity in marine and estuarine systems is largely controlled by the limited availability of nitrogen. Because nitrogen is a key component of explosives, they are attractive as substrates for marine bacteria that metabolize other naturally-occurring organic matter, such as polycyclic aromatic hydrocarbons. Juhasz and Naidu (2007) also noted that microbes use explosives as sources of carbon and energy.

Carr and Nipper (2003) indicated that conversion of trinitrotoluene (TNT) to carbon dioxide, methane, and nitrates in coastal sediments (a process referred to as mineralization) occurred at rates that were typical for naturally occurring compounds such as phenanthrene, fluoranthene, toluene, and naphthalene. They noted that transformation of 2, 6-dinitrotoluene and picric acid by organisms in sediments is dependent on temperature and type of sediment (e.g., finer-grained). Pavlostathis and Jackson (2002) reported that the marine microalgae *Anabaena* spp. were highly efficient at the removal and metabolism of trinitrotoluene (TNT) in a continuous flow experiment. Nipper et al. (2002) noted that irreversible binding to sediments and biodegradation of 2, 6-dinitrotoluene, tetryl, and picric acid occurred in fine-grained sediments high in organic carbon resulting in lower concentrations of the contaminants. Cruz-Uribe et al. (2007) noted that three species of marine macroalgae metabolize trinitrotoluene (TNT) to 2-amino-4,6-dinitrotoluene and 4-amino-2, 6-dinitrotoluene, and speculate that "the ability of marine macroalgae to metabolize trinitrotoluene (TNT) is widespread, if not generic." The studies cited above indicate that trinitrotoluene (TNT) and its constituent products can be removed from the environment by naturally occurring biological processes in sediments, reducing sediment toxicity from these chemical contaminants.

Singh et al. (2009) indicated that biodegradation of royal demolition explosive and high melting explosive occurs with oxygen (aerobic) and without oxygen (anoxic or anaerobic), but that they were more easily degraded under anaerobic conditions. Crocker et al. (2006) indicated that the mechanisms of high melting explosive and royal demolition explosive biodegradation are similar, but that high melting explosive degrades more slowly. Singh et al. (2009) noted that royal demolition explosive and high melting explosive are biodegraded under a variety of anaerobic conditions by specific microbial species and by mixtures of such species. Zhao et al. (2004a); Zhao et al. (2004b) found that biodegradation of royal demolition explosive and high melting explosive occurs in cold marine sediments.

According to Singh et al. (2009), typical end products of the degradation of royal demolition explosive include nitrite, nitrous oxide, nitrogen, ammonia, formaldehyde, formic acid, and carbon dioxide. Crocker et al. (2006) stated that many of the primary and secondary intermediate compounds from biodegradation of royal demolition explosive and high melting explosive are unstable in water and spontaneously decompose. Thus, these explosives are degraded by a combination of biotic and abiotic reactions. Formaldehyde is subsequently metabolized to formic acid, methanol, carbon dioxide, or methane by various microorganisms (Crocker et al., 2006).

A series of research efforts focused on World War II underwater munitions disposal sites in Hawaii (Briggs et al., 2016; Kelley et al., 2016; Koide et al., 2016; University of Hawaii, 2010) and an intensively used live fire range in the Mariana Islands (Smith & Marx, 2016) provide information in regard to the impacts of undetonated materials and unexploded munitions on marine life.

On a localized scale, research at World War II munitions ocean disposal sites in Hawaii investigated nearby sediments, seawater, or marine life to determine if released constituents from the munitions (including explosive components and metals) could be detected. Comparisons were made between disposal site samples and “clean” reference sites. The samples analyzed showed no confirmed detection for explosives.

Investigations by Kelley et al. (2016) and Koide et al. (2016) found that intact munitions (i.e., ones that failed to detonate or non-explosive practice munitions) residing in or on soft sediments habitats provided hard substrate similar to other disposed objects or “artificial reefs” that attracted “hard substrate species,” which would not have otherwise colonized the area. Sampling these species revealed that there was no bioaccumulation of munitions-related chemicals in the species (Koide et al., 2016).

On a broader scale, the island of Farallon De Medinilla (in the Mariana Islands) has been used as a target area for both explosive and non-explosive munitions since 1971. Between 1997 and 2012, the Navy has conducted 14 underwater scientific surveys around the island, providing a consistent, long-term investigation of a single site where munitions have been used regularly (Smith & Marx, 2016). Marine life assessed during these surveys included algae, corals, benthic invertebrates, sharks, rays, bony fishes, and sea turtles. The investigators found no evidence over the 16-year period, that the condition of the physical or biological resources had been adversely impacted to a significant degree by the training activities (Smith & Marx, 2016). Furthermore, they found that the health, abundance, and biomass of fishes, corals and other marine resources were comparable to or superior to those in similar habitats at other locations within the Mariana Archipelago.

These findings are consistent with other assessments such as that done for the Potomac River Test Range at Dahlgren, Virginia which was established in 1918 and is the Nation’s largest fully instrumented, over-the-water gun-firing range. Munitions tested at Dahlgren has included rounds from small caliber guns up to the Navy's largest (16 inch [in.] guns), bombs, rockets, mortars, grenades, mines, depth charges, and torpedoes (U.S. Department of the Navy, 2013a). Results from the assessment indicate that munitions expended at Dahlgren have not contributed significant concentrations of explosive materials or explosives byproducts to the Potomac River water and sediments given those contributions are orders of magnitude less than concentrations already present in the Potomac River from natural and manmade sources (U.S. Department of the Navy, 2013b).

Underwater detonations for training purposes have been conducted approximately five miles off the coast of Virginia Beach, Virginia using demolition charges on non-explosive underwater mine shapes. Training activities at the underwater ordnance disposal site began after World War II, but became a regular occurrence in 1968. The primary munitions used at the site are the M112 demolition charge (consisting of 91 percent hexahydro-1,3,5-trinitro-1,3,5-triazine [i.e., royal demolition explosive]), M456 detonation cord (containing pentaerythritoltetranitre [also referred to as "PETN"]), and the M700 time blasting fuse. Based on the analysis reported in U.S. Department of the Navy (2012), accumulation of explosive byproducts was not expected to occur in sediments at the site, because of the infrequent nature of the detonations, the small amounts of chemicals of concern produced by the detonations, and the large attenuation capacities of the affected water body (i.e., nearshore areas of the Atlantic Ocean).

In summary, multiple investigations since 2007 involving survey and sampling of World War II munition dump sites off Oahu Hawaii and other locations, have found the following: (1) chemicals and degradation products from underwater munitions "do not pose a risk to human health or to fauna living in direct contact with munitions," (2) metals measured in sediment samples next to World War II munitions are lower than naturally occurring marine levels and "do not cause a significant impact on the environment," and (3) sediment is not a significant sink of chemicals released by degradation of the explosive components in munitions (Edwards et al., 2016).

Bauer and Kendall (2010) reported on the collection and analysis of sediment samples that were tested for the presence of explosive compounds at Vieques, Puerto Rico following the cessation of Navy training activities on the island. Sediment samples were analyzed for the parent compounds, 2,4,6-trinitrotoluene (TNT), High Melting Explosive, Royal Demolition Explosive, and Tetryl (2,4,6-trinitrophenyl-n-methylnitramine), and for degradation products including 1,3,5-trinitrobenzene, 2,4-dinitrotoluene, and 2,6-dinitrotoluene. Of the 78 samples collected, 14 showed signs of containing explosive compounds and required a more in depth analysis to confirm the presence of explosive compounds or degradation products. The analysis revealed that explosives were either not present or were present at such low concentrations that they could not be measured.

The concentration of explosive munitions and any associated explosives byproducts at any single location in the Study Area would be a small fraction of the totals that have accumulated over decades at World War II era dump sites and military ranges. Based on findings from much more intensively used locations, effects on sediments from the use of explosive munitions during training and testing activities would be negligible by comparison. As a result, explosives by-products and unexploded munitions would have no meaningful effect on sediments.

Most explosive material is consumed in an explosion, so the vast majority of explosive material entering the marine environment would be in the form of unexploded munitions. Failure rates are not available for the vast majority of munitions used in the Proposed Action; however, based on the data that are available Table 3.2-7, a 5-percent munitions failure rate was selected as a reasonable average rate to estimate the failure rates for all munitions used in the Proposed Action. Based on the available data, low-order detonation rates for all munitions are assumed to be at least an order of magnitude less than the failure rates and are not considered in the analysis.

Table 3.2-7: Failure and Low-Order Detonation Rates of Military Munitions

Munitions	*Failure Rate (Percent)*	*Low-Order Detonation Rate (Percent)*
Guns/artillery	4.68	0.16
Hand grenades	1.78	n/a
Explosive munitions	3.37	0.09
Rockets	3.84	n/a
Submunitions	8.23	n/a

Source: Rand Corporation (2005)
Note: n/a = not available

Most activities involving explosives and explosives byproducts would be conducted more than 3 NM offshore in each range complex and testing range. Activities in these areas (3–200 NM) would be subject to federal sediment and water quality standards and guidelines.

Explosives are also used in nearshore areas (low tide line to 3 NM) specifically designated for mine countermeasure and mine neutralization activities. These activities would be subject to state sediment and water quality standards and guidelines.

For explosives byproducts, “local” refers to the water column in the vicinity of the underwater detonation. For unconsumed explosives, “local” refers to the area of potential impact from explosives in a zone of sediment about 6 ft. in diameter around the unconsumed explosive where it comes to rest on the seafloor.

3.2.3.1.1 Impacts from Explosives and Explosives Byproducts under Alternative 1

3.2.3.1.1.1 Impacts from Explosives and Explosives Byproducts under Alternative 1 for Training Activities

The distribution of explosives used in training activities is not uniform throughout the Study Area. Approximately 30 percent of the explosives used annually during training activities would be used in the Jacksonville Range Complex and 60 percent would be used in the Virginia Capes Range Complex. The remaining 10 percent would be distributed in other locations of the Study Area. Of all explosive munitions used during training activities, approximately 55 percent of explosives used in the Jacksonville Range Complex and 60 percent of explosives used in the Virginia Capes Range Complex would have a net explosive weight between 0.1 and 0.25 pounds (lb.) per munition. Training activities are further described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Table 2.3-2 and Table 2.6-1.

The highest concentrations of munitions residues results from munitions failures (i.e., low-order detonations). As a general rule, between 10,000 and 100,000 high-order detonations deposit the same mass of explosives residue as one low-order detonation of the same munition(U.S. Environmental Protection Agency, 2012a) Therefore, an estimate of the amount of explosives material and byproducts from an explosion that would be introduced into the environment is based solely on the failure rate for each type of munition, discounting the negligible contribution from munitions that successfully detonate. The military does not track failure rates for all munitions. The available data typically report failure rates ranging from less than 2 percent up to 10 percent (Table 3.2-7). For the purpose of estimating the amount of explosives and explosives byproducts entering the marine environment, a 5-percent failure rate is applied to all types of munitions used during training activities. The amount of explosive materials is estimated by multiplying the failure rate by the number of explosive munitions and the net explosive weight of each munition used during training activities.

To better organize and facilitate the analysis of approximately 300 individual sources of underwater acoustic sound or explosive energy, a series of source classifications, or source bins, were developed (see Section 3.0.3.3.1, Acoustic Stressors and Section 3.0.3.3.2, Explosive Stressors). Each source bin for explosive munitions is defined by a range of net explosive weights (e.g., bin E3 has a range of 0.5 to 2.5 lb. net explosive weight). To estimate the amount of explosive materials entering the environment, the average net explosive weight was calculated for each source bin. For example, for bin E1 (0.1 to 0.25 lb. net explosive weight) under Alternative 1:

Explosives = 0.05 (Failure Rate) x 1,600 (Munitions) x 0.175 lb. (Average NEW) = 14 lb.

One other factor needs to be considered when estimating the amount of explosives entering the environment in munitions that fail to detonate. The net explosive weight of an explosive munition is based on the equivalent amount of trinitrotoluene (TNT) that would be required to generate the desired amount of energy upon detonation. Most modern munitions no longer use trinitrotoluene (TNT) as the primary explosive material. Other more powerful and stable explosives such as royal demolition explosive are used in a greater number of explosive munitions. Because royal demolition explosive is more powerful than trinitrotoluene (TNT), a lesser amount of royal demolition explosive is needed to generate the equivalent explosion using trinitrotoluene (TNT). The equivalency factors for royal demolition explosive is 1.60, meaning that, to generate an explosion equivalent to 1 kilogram (kg) of trinitrotoluene (TNT) only 0.625 kg of royal demolition explosive is needed. Revising the equation above to incorporate the TNT equivalency factor:

Explosives = 0.05 (Failure Rate) x 1,600 (Munitions) x 0.175 lb. (Average NEW) x 0.625 (equivalency factor) = 8.75 lb.

Using this approach, and considering all training activities in the AFTT Study Area, up to approximately 4,000 lb. of explosive material could enter the environment annually in the form of munitions that failed to detonate. Approximately 40 percent, or 1,600 lb. of explosives, would come from munitions in the E5 bin. These munitions are used at least 3 NM and often more than 12 NM from shore, which diminishes any potential impact on nearshore sediments and water quality. Water depth increases with distance from shore, such that munitions residing on the seafloor at depths greater than 250 m would be in a low light, low temperature environment slowing the corrosion of munitions casings and that degradation of any exposed explosives. Larger projectiles (e.g., missiles, rockets, bombs) that fail to detonate would enter the water at a high rate of speed, and, depending on the type of seafloor substrate (e.g., soft sediments), can become imbedded in the seafloor. Munitions that are buried partially or completely beneath sediments may remain intact for decades where geochemical conditions (e.g., low dissolved oxygen) inhibit corrosion of the metal casing. Studies conducted at several Navy ranges where explosives have been used for decades indicate that explosives constituents are released into the aquatic environment over long periods of time and do not result in water or sediment toxicity (Briggs et al., 2016; U.S. Department of the Navy, 2010b, 2010c, 2013c).

The overarching conclusions from the Hawaii Undersea Military Munitions Assessment project is that degrading munitions at the disposal site do not pose a risk to human health or to the fauna living in direct contact with the degrading munitions (Edwards et al., 2016). During a comprehensive survey of the site, explosive materials were detected in sediments at only two locations and the concentrations were low. Concentrations of metals introduced into sediments and the water column from deteriorating munitions casings were below screening levels for the marine environment, and the authors concluded that the metals are not impacting the environment.

Data supporting these conclusions were collected from World War II era munitions disposal sites characterized by relatively high concentrations of munitions. Munitions used in the proposed training activities would be widely dispersed by comparison, resulting in lower concentrations of munitions that failed to detonate and lower concentrations of residual explosives and explosives byproducts than reported in Edwards et al. (2016). Based on this analysis, impacts on sediments and water quality are expected to be minimal.

In the event a munition fails to detonate, the explosives contained within the intact munition would remain isolated from the water column and sediments. Based on analyses of munitions disposal sites, explosives would only leach from the munitions casing slowly, over decades, once the munitions casing corrodes and is breached, exposing the explosives to seawater or sediments (Briggs et al., 2016). Small amounts of explosives may leach into sediments and the adjacent water column. In the event the munition fails to detonate but the casing is nevertheless breached upon impact, explosives may enter the water column as the breached munitions sinks to the seafloor. Analysis from munitions disposal sites indicates that munitions constituents and degradation products are only detected at measurable levels in sediments within a few feet of a degrading munition. Many constituents released into the water column would be expected to dissolve (refer to Table 3.2-6 for water solubility) and disperse with ocean currents and not concentrate at levels that would result in water toxicity. Explosives released into sediments from a partially buried munition may persist in sediments or degrade slowly over time if the explosive material or its constituents are not soluble in seawater (e.g., Royal Demolition Explosive). In deepwater (> 250 m), benthic habitats, bottom temperatures are near freezing, and dissolved oxygen levels are low (or event anoxic) in sediments only a few inches below the water column-seafloor interface. These physical conditions inhibit degradation and dispersion of the explosives and constituents beyond an isolated area adjacent to the munition. Based on this analysis, impacts on sediments and water quality are expected to be minimal.

The sinking exercise activity is likely to result in the highest concentration of munitions of any proposed training or testing activity. During each sinking exercise, for example, an estimated 216 explosive munitions would be expended, 93 percent of which would consist of large-caliber projectiles in the E5 bin. Approximately 178 lb. of explosive materials would be released per sinking exercise in the form of intact munitions that fail to detonate. For the purpose of this example the area encompassing the sinking exercise activity is estimated to be approximately 2 NM^2. Thus, during each sinking exercise, approximately 108 munitions would be used per NM^2 and 89 lb. of explosive material per NM^2 would sink to the ocean floor encased within munitions that failed to detonate. During an actual sinking exercise munitions are directed at the target vessel, which has an area much less than 2 NM^2, and it is likely that a failure rate of less than 5 percent would occur for this type of activity. All Sinking Exercises are conducted at least 50 NM from shore in waters at least 6,000 ft. deep. Based on these conditions and the results of the analysis of munitions degradation rates in the studies described above, which occurred at shallower depths and closer to shore, adverse effects on seafloor sediments and water quality are not expected even in areas where the concentration of munitions is likely to be relatively high.

3.2.3.1.1.2 Impacts from Explosives and Explosives Byproducts under Alternative 1 for Testing Activities

The distribution of explosives used in testing activities is not uniform throughout the Study Area. Approximately 30 percent of the explosives used annually during testing activities would be used in the Jacksonville Range Complex and 50 percent would be used in the Virginia Capes Range Complex. The remaining 20 percent would be distributed in other locations of the Study Area. Of all explosive munitions used during testing activities, approximately 70 percent are in the E1 bin (0.1 to 0.25 lb. per munition). Excluding munitions in the E1 bin, which primarily consist of medium caliber projectiles, approximately 50 percent of other munitions are in the E3 bin (0.5 to 2.5 lb. net explosive weight) and 30 percent are in the E5 bin (5 to 10 lb.).

As described for training activities in Section 3.2.3.1.1.1, over 98 percent of explosives byproducts introduced into the environment would result from the failure of a munition to detonate, because little to no explosive material remains after a successful detonation. The amount of residual explosives materials resulting from testing activities is estimated in the same way it was estimated for training activities: by multiplying the failure rate by the number of explosive munitions and the average net explosive weight for the bin in which each explosive munitions is classified.

The Ship Shock Trial activity conducted by Naval Sea Systems Command is the only activity that would use explosives in the E16 and E17 bins. In the event munitions in either of these two bins fail to detonate during a ship shock trial as planned, they would be detonated by other means and would not remain in the environment as undetonated munitions. Therefore, munitions in the E16 and E17 bins were excluded from estimates of the amount of explosives entering the environment in munitions that fail to detonate.

For testing activities in the AFTT Study Area, up to approximately 2,400 lb. of explosive material would enter the environment annually in munitions that failed to detonate. Approximately 44 percent, 1,150 lb., are from munitions in the E10 bin (250 to 500 lb.), which are used at least 3 NM and often more than 12 NM from shore, and 15 percent are from munitions failures in the E5 bin. The testing activities Air to Surface Missile Test and Missile and Rocket Testing use all munitions in the E10 bin. For more information on those activities, refer to Appendix A (Activity Descriptions).

In the event a munition fails to detonate, the explosives would remain mostly intact and contained within the munitions casing, which is composed mostly of iron with smaller quantities of other metals. Explosive materials would only leach from the casing slowly, over years, as the casing corrodes and degrades in the deepwater (> 250 m) environment. Once exposed to the environment, explosives materials are quickly broken down into constituent materials (Briggs et al., 2016). Ocean currents would quickly disperse constituents entrained into the water column. Chemical constituents that settle onto sediments in the immediate vicinity of the munition are likely to persist in the environment due to a combination of low water solubility, the products of hydrolysis forming a coating that prevents further decomposition, and near freezing temperatures at deepwater sites that typically inhibit chemical dissolution (Briggs et al., 2016).

Larger projectiles used in testing activities that fail to detonate would enter the water at a high rate of speed and may become imbedded in soft sediments, depending on water depth and the composition of seafloor substrate. Munitions buried partially or completely beneath sediments may remain intact for decades where geochemical conditions (e.g., low dissolved oxygen) inhibit corrosion of the metal casing. Studies conducted at several Navy ranges where explosives have been used for decades indicate that explosives constituents are released into the aquatic environment over long periods of time and do not result in water or sediment toxicity (Briggs et al., 2016; U.S. Department of the Navy, 2010b, 2010c, 2013c). Based on the results from studies of underwater munitions disposal sites and water ranges, impacts on sediments and water quality are expected to be minimal and localized.

The overarching conclusions from the Hawaii Undersea Military Munitions Assessment project is that degrading munitions at the disposal site do not pose a risk to human health or to the fauna living in direct contact with the degrading munitions (Edwards et al., 2016). During a comprehensive survey of the site, explosive materials were detected in sediments at only two locations and the concentrations were low. Concentrations of metals introduced into sediments and the water column from deteriorating munitions casings were below screening levels for the marine environment, and the authors concluded that the metals are not impacting the environment.

Data supporting these conclusions were collected from World War II era munitions disposal sites characterized by relatively high concentrations of munitions. Munitions used in the proposed testing activities would be widely dispersed by comparison, resulting in lower concentrations of munitions that failed to detonate and lower concentrations of residual explosives and explosives byproducts than reported in Edwards et al. (2016). Based on this analysis, impacts on sediments and water quality are expected to be minimal.

3.2.3.1.2 Impacts from Explosives and Explosives Byproducts under Alternative 2

3.2.3.1.2.1 Impacts from Explosives and Explosives Byproducts under Alternative 2 for Training Activities

Under Alternative 2, the number of explosive munitions used during training activities would be the same as under Alternative 1. Therefore, the impacts of underwater explosives and explosives byproducts would be the same as described under Alternative 1.

3.2.3.1.2.2 Impacts from Explosives and Explosives Byproducts under Alternative 2 for Testing Activities

Under Alternative 2, the number of explosive munitions used during the Airborne Mine Neutralization Test conducted by Naval Air Systems Command would increase over Alternative 1. The activity, which is conducted at the NSWC Panama City Training Range and the Virginia Capes Range Complex would use 10 E11 mines (5 in each location) and 10 E4 neutralizers (5 in each location). However, the amount of explosives entering the environment would remain essentially the same, because mines that failed to detonate as planned would be detonated by other means and would not be permitted to remain in the environment as intact munitions. Based on a 5-percent failure rate, only 2 to 3 neutralizers would be expected to fail over five years, resulting in no more than 15 lb. of explosives deposited on the seafloor in intact munitions over five years. This is a less than one tenth of one percent of the total amount of explosives released under Alternative 1 and is negligible. The amount of explosives byproducts would increase; however, for the reasons described above in Section 3.2.3.1.1.1, the amount of additional explosives byproducts entering the environment would be undetectable and impacts would therefore be the same as under Alternative 1.

3.2.3.1.3 Impacts from Explosives and Explosives Byproducts under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Under this alternative, there would be no potential for impacts on sediments and water quality from training and testing activities. It is reasonable to assume that ceasing all training and testing activities involving the use of explosives would decrease the amounts of related chemical constituents in marine waters and sediments in the Study Area. The effect, however, would likely not be measureable due to the rapid dissolution and dispersion of explosives and explosives byproducts in the water column and the slow, sometimes decades-long corrosion of undetonated munitions on the seafloor. Explosives and explosives byproducts released into sediments from degrading munitions would be decomposed and disperse, or, if persistent in sediments, would only be expected at higher concentrations in sediments within a few feet of the munition.

3.2.3.2 Chemicals Other Than Explosives

Under the Proposed Action, chemicals other than explosives are associated with the following military expended materials: (1) solid-fuel propellants in missiles and rockets; (2) Otto Fuel II torpedo propellant and combustion byproducts; (3) polychlorinated biphenyls in target vessels used during sinking exercises; (4) other chemicals associated with munitions; and (5) chemicals that simulate chemical warfare agents, referred to as “chemical simulants.”

Hazardous air pollutants from explosives and explosives byproducts are discussed in Section 3.1 (Air Quality). Explosives and explosives byproducts are discussed in Section 3.2.3.1 (Explosives and Explosives Byproducts). Fuels onboard manned aircraft and vessels are not reviewed, nor are fuel-loading activities, refueling at sea, onboard operations, or maintenance activities reviewed, because they are not part of the Proposed Action.

The largest chemical constituent of missiles is solid propellant. Solid propellant contains both the fuel and the oxidizer, a source of oxygen needed for combustion. An extended-range Standard Missile-2 typically contains 1,822 lb. of solid propellant. Ammonium perchlorate is an oxidizing agent used in most modern solid-propellant formulas (Chaturvedi & Dave, 2015). It normally accounts for 50 to 85 percent of the propellant by weight. Ammonium dinitramide may also be used as an oxidizing agent. Aluminum powder as a fuel additive ranges from 5 to 22 percent by weight of solid propellant; it is added to increase missile range and payload capacity. The high-explosives high melting explosive (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine) and royal demolition explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine) may be added, although they usually comprise less than 30 percent of the propellant by weight. Many of the constituents used in propellants are also commonly used for commercial purposes but require additional processing to achieve certain properties necessary for rocket and missile propulsion. (Missile Technology Control Regime, 1996).

The U.S. Environmental Protection Agency issued a paper characterizing the munitions constituents accumulated at over 30 military sites around the United States and Canada where explosives and propellants have been used (U.S. Environmental Protection Agency, 2012b). The sites assessed in the paper were all land-based ranges; however, the results are useful for analyzing similar activities conducted at sea. The paper noted that perchlorate was generally not detected at anti-tank ranges and that perchlorate is so soluble in water and mobile in soil that surface accumulation apparently does not occur. The paper includes a case study that estimates the amount of residual perchlorate deposited from a rocket fired at a test track. The rocket propellant contained 68 lb. of ammonium perchlorate. Samples were collected both behind the firing point and along the test track before and after the rocked was fired. No differences in perchlorate concentrations in soils were detected at any location before or after the firing, and all measurements recorded perchlorate concentrations of less than 1 microgram per kilogram (μg/kg). That case study concluded that 99.997 percent of perchlorate is consumed by the rocket motor (U.S. Environmental Protection Agency, 2012b). Jenkins et al. (2008) found similar results from an air-launched AIM-7 missile, a missile used by the Navy and similar to missiles used in the Proposed Action. These studies, and others cited in each paper, demonstrate that the motors used in rockets and missiles are highly efficient at burning propellant fuels, leaving only trace amounts often at undetectable levels in the environment.

Several torpedoes (e.g., MK-54) use Otto Fuel II as a liquid propellant. Otto Fuel II is composed of primarily three synthetic substances: Propylene glycol dinitrate and nitro-diphenylamine (76 percent), dibutyl sebacate (22 percent) and 2-nitrodiphenylamine as a stabilizer (2 percent). Propylene glycol dinitrate, which is a liquid, is the explosive component of Otto Fuel II. Dibutyl sebacate, also known as sebacic acid, is also a liquid. It is used commercially to make plastics, many of which are used for packaging food, and to enhance flavor in foods such as ice cream, candy, baked goods, and nonalcoholic drinks. The third component, 2-nitrodiphenylamine, is a solid substance used to control the combustion of the propylene glycol dinitrate (U.S. Health and Human Services 1995). Combustion byproducts of Otto Fuel II include nitrous oxides, carbon monoxide, carbon dioxide, hydrogen, nitrogen, methane, ammonia, and hydrogen cyanide. During normal venting of excess pressure or upon failure of the torpedo's buoyancy bag, the following constituents are discharged: carbon dioxide, water, hydrogen, nitrogen, carbon monoxide, methane, ammonia, hydrochloric acid, hydrogen cyanide, formaldehyde, potassium chloride, ferrous oxide, potassium hydroxide, and potassium carbonate (Waters et al., 2013).

Target vessels are only used during sinking exercises, which occur infrequently. Polychlorinated biphenyls are a concern because they are present in certain solid materials (e.g., insulation, wires, felts, and rubber gaskets) on vessels used as targets for sinking exercises. These vessels are selected from a list of Navy-approved vessels that have been cleaned in accordance with U.S. Environmental Protection Agency (USEPA) guidelines (U.S. Environmental Protection Agency, 2014). By rule, a sinking exercise must be conducted at least 50 NM offshore and in water at least 6,000 ft. deep (40 CFR part 229.2).

The USEPA estimates that as much as 100 lb. of polychlorinated biphenyls remain onboard sunken target vessels. The USEPA considers the contaminant levels released during the sinking of a target to be within the standards of the Marine Protection, Research, and Sanctuaries Act (16 U.S.C. 1341, et seq.) (U.S. Environmental Protection Agency, 2014). Under a 2014 agreement with the USEPA, the Navy will not likely use aircraft carriers or submarines as the targets for a sinking exercise (U.S. Environmental Protection Agency, 2014). Based on these considerations, polychlorinated biphenyls will not be considered further.

Table 3.2-8 lists the chemical constituents produced in the combustion of propellants and fuels, as described above, and list constituents remaining after the detonations of non-munitions, such as spotting charges and tracers. Not all of the listed chemical constituents in propellant and Otto Fuel II would be used in combination; some are substitutes that would replace another chemical in the list, depending on the type of propellant used. For example, ammonium perchlorate is the preferred oxidizer in propellant, but ammonium dinitramide could act as the oxidizer in some propellants. These constituents are in addition to the explosives contained in munitions, which were discussed in Section 3.2.3.1 (Explosives and Explosives Byproducts).

The environmental fate of Otto Fuel II and its components is largely unknown. Neither the fuel mixture nor its three main components are particularly volatile or soluble in water; however, when mixed with water propylene glycol dinitrate forms a volatile mixture, making evaporation an important fate process (U.S. Department of Health and Human Services, 1995). The compound 2-Nitrodiphenylamine may precipitate from water or be taken up by particulates. Dibutyl sebacate is rapidly biodegraded. Neither propylene glycol dinitrate nor 2-nitrodiphenylamine are readily biodegradable, but both of these chemicals break down when exposed to ultraviolet light (Powell et al., 1998).

Lead azide, titanium compounds, perchlorates, barium chromate, and fulminate of mercury are not natural constituents of seawater. Lead oxide is a rare, naturally occurring mineral. It is one of several lead compounds that form films on lead objects in the marine environment (Agency for Toxic Substances and Disease Registry, 2007). Metals are discussed in more detail in Section 3.2.3.3 (Metals).

Because chemical and biological warfare agents remain a security threat, the Department of Defense uses relatively harmless compounds (chemical simulants) as substitutes for chemical and biological warfare agents to test equipment intended to detect their presence. Chemical and biological agent detectors monitor for the presence of chemical and biological warfare agents and protect military personnel and civilians from the threat of exposure to these agents. The simulants trigger a response by sensors in the detection equipment without irritating or injuring personnel involved in testing detectors.

Table 3.2-8: Constituents in Munitions Other Than Explosives

Munitions Component	***Constituent***
Pyrotechnics Tracers Spotting Charges	Barium chromate Potassium perchlorate Chlorides Phosphorus Titanium compounds
Oxidizers	Lead (II) oxide
Propellant (rockets and missiles)	High melting explosive Royal demolition explosive Hydroxyl-terminated polybutadiene Carboxyl-terminated polybutadiene Polybutadiene-acrylic acid-acrylonitrile Triphenyl bismuth Nitrate esters Nitrated plasticizers Polybutadiene-acrylic acid polymer Elastomeric polyesters Polyethers Nitrocellulose plasticized with nitroglycerine 2-nitrodiphenylamine N-methyl-4-nitroaniline Hydrazine
Otto Fuel II (torpedoes)	Propylene glycol dinitrate and Nitro-diphenylamine (76 percent by weight) dibutyl sebacate (22 percent by weight 2-nitrodiphenylamine (2 percent by weight) Combustion Products (nitrous oxides, carbon monoxide, carbon dioxide, hydrogen, nitrogen, methane, ammonia, hydrogen cyanide) Venting or Buoyancy Bag Failure (hydrochloric acid, hydrogen cyanide, formaldehyde, potassium chloride, ferrous oxide, potassium hydroxide, and potassium carbonate)

Table 3.2-8: Constituents in Munitions Other Than Explosives (continued)

Munitions Component	*Constituent*
Chemical Simulants	Navy Chemical Agent Simulant 82 glacial acetic acid triethyl phosphate sulfur hexafluoride 1,1,1,2 tetrafluoroethane 1,1-difluoroethane
Delay Elements	Barium chromate Potassium perchlorate Lead chromate
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury Potassium perchlorate
Primers	Lead azide

Navy Chemical Agent Simulant 82 (commonly referred to as NCAS-82), glacial acetic acid, triethyl phosphate, sulfur hexafluoride, 1,1,1,2 tetrafluoroethane (a refrigerant commonly known as R134), and 1,1-difluoroethane (a refrigerant commonly known as R-152a) are also referred to as gaseous simulants and can be released in smaller quantities in conjunction with glacial acetic acid or triethyl phosphate releases. The types of biological simulants that may be used include spore-forming bacteria, non-spore-forming bacteria, ovalbumin, bacteriophage MS2, and *Aspergillus niger*. The simulants are generally dispersed by hand at the detector or by aircraft as a fine mist or aerosol. The exposure of military personnel or the public to even small amounts of real warfare agents, such as nerve or blistering agents, or harmful biological organisms, such as anthrax, is potentially harmful and is illegal in most countries, including the United States. Furthermore, their use, including for the testing of detection equipment, is banned by international agreement.

Simulants must have one or more characteristic of a real chemical or biological agents —size, density, or aerosol behavior—to effectively mimic the agent. Simulants must also pose a minimal risk to human health and the environment to be used safely in outdoor tests. Simulants are selected using the following criteria: (1) safety to humans and the environment, and (2) the ability to trigger a response by sensors used in the detection equipment. Simulants must be relatively benign (e.g., low toxicity or effects potential) from a human health, safety, and environmental perspective. Exposure levels during testing activities should be well below concentrations associated with any adverse human health or environmental effects. The degradation products of simulants must also be harmless. Given these criteria for choosing simulants for use in testing activities, it is reasonable to conclude that simulants would have no impact on sediments and water quality in the Study Area. Simulants are not analyzed further in this section.

3.2.3.2.1 Impacts from Chemicals Other Than Explosives under Alternative 1

3.2.3.2.1.1 Impacts from Chemicals Other Than Explosives under Alternative 1 for Training Activities

The distribution of munitions that use chemicals other than explosives is not uniform throughout the Study Area. The largest quantities of chemicals would be derived from the use of propellants and fuels in munitions, specifically rockets, missiles, and torpedoes. Approximately 48 percent of these munitions, used annually during training activities would be used in the Jacksonville Range Complex and 43 percent would be used in the Virginia Capes Range Complex. The remaining 9 percent would be distributed in other locations of the Study Area. Of all of these munitions, approximately 94 percent are rockets (expending the byproducts of propellant combustion), and 4 percent are missiles. Approximately 100 torpedoes using Otto Fuel II would be used annually. The propellant used by rockets and missiles is typically consumed prior to impact at the water's surface even if the munition fails to detonate upon impact, leaving little residual propellant to enter the water. By contrast, torpedo fuel is consumed underwater and all combustion products enter the marine environment.

For properly functioning munitions, chemical, physical, or biological changes in sediments or water quality would not be detectable. Impacts would be minimal for the following reasons: (1) the size of the area in which expended materials would be distributed is large; (2) most propellant combustion byproducts are benign, while those of concern would be diluted to below detectable levels within a short time; (3) most propellants are consumed during normal operations; (4) most byproducts of Otto Fuel II combustion are naturally occurring chemicals, and most torpedoes are recovered after use, such that any fuel that is not consumed would be recovered along with the torpedo, limiting any direct exposure of sediments and water to Otto Fuel II; (5) the failure rate of munitions using propellants and other combustible materials is low; and (6) most of the constituents of concern are biodegradable by various marine organisms or by physical and chemical processes common in marine ecosystems.

3.2.3.2.1.2 Impacts from Chemicals Other Than Explosives under Alternative 1 for Testing Activities

The distribution of munitions that use chemicals other than explosives is not uniform throughout the Study Area. Approximately 28 percent of these munitions used annually during testing activities would be used in the Virginia Capes Range Complex, 25 percent would be used in the Jacksonville Range Complex, 23 percent would be used in the Navy Cherry Point Range Complex, and 23 percent would be used in the Northeast Range Complexes. Of all of these munitions used during testing activities, approximately 90 percent are biological chemical simulants, which, as noted above, are benign and would have no impact on sediments and water quality. Excluding biological simulants, 38 percent of munitions using chemicals other than explosives are rockets (expending the byproducts of propellant combustion), 30 percent are missiles, and 30 percent are torpedoes (using Otto Fuel II).

For properly functioning munitions, chemical, physical, or biological changes in sediments or water quality would not be detectable. Impacts would be minimal for the following reasons: (1) the size of the area in which expended materials would be distributed is large; (2) most propellant combustion byproducts are benign, while those of concern would be diluted to below detectable levels within a short time; (3) most propellants are consumed during normal operations; (4) most byproducts of Otto Fuel II combustion are naturally occurring chemicals, and most torpedoes are recovered after use, such that any fuel that is not consumed would be recovered along with the torpedo, limiting any direct exposure of sediments and water to Otto Fuel II; (5) the failure rate of munitions using propellants and other combustible materials is low; and (6) most of the constituents of concern are biodegradable by various marine organisms or by physical and chemical processes common in marine ecosystems.

3.2.3.2.2 Impacts from Chemicals Other Than Explosives under Alternative 2

3.2.3.2.2.1 Impacts from Chemicals Other Than Explosives under Alternative 2 for Training Activities

Under Alternative 2, the number of expended munitions that use propellants (missiles and rockets) and Otto Fuel II (torpedoes) would be the same as described under Alternative 1. The amounts of other expended materials which could release chemicals into the marine environment would be similar to the amounts under Alternative 1. Therefore, the release of chemicals derived from propellants and fuels would have the same environmental impacts as described under Alternative 1.

3.2.3.2.2.2 Impacts from Chemicals Other Than Explosives under Alternative 2 for Testing Activities

The number of munitions that use propellants (rockets and missiles) and Otto Fuel II (torpedoes) annually would increase under Alternative 2. Over a five-year period, an additional 400 rockets, 130 missiles, and 300 torpedoes would be used during testing activities. Because rocket and missile motors are over 99 percent efficient at burning propellant, no additional measurable amounts of propellant or combustion products would enter the water column. As described in Section 3.2.3.2 (Chemicals Other than Explosives), most byproducts of Otto Fuel II combustion are naturally occurring chemicals. Most practice torpedoes are recovered after use, such that any fuel that is not consumed would be recovered along with the torpedo limiting any direct exposure of sediments and water to Otto Fuel II. Therefore, the use of torpedoes would not result in the accumulation of byproducts of Otto Fuel II in water or sediments. The amounts of other expended materials which could release chemicals into the marine environment would be similar to the amounts under Alternative 1. Therefore, the release of chemicals derived from propellants and fuels would have the same environmental impacts as described under Alternative 1.

3.2.3.2.3 Impacts from Chemicals Other Than Explosives under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Under this alternative, there would be no potential for impacts on sediments and water quality from training and testing activities. It is reasonable to assume that ceasing all training and testing activities involving the use of chemicals other than explosives would decrease the amounts of these chemicals and their constituents in marine waters and sediments in the Study Area. The effect, however, would likely not be measureable due to the highly efficient use of propellants and fuels by motors used in rockets and missiles, resulting in often undetectable trace amounts of propellants expended into the environment. Perchlorates, which make up a large percentage of rocket and missile propellants, are also water soluble and would dissolve and be dispersed in surface waters and would not accumulate in marine sediments. Similarly, it is unlikely that Otto Fuel II used in torpedoes would be exposed to sediments or water, and most combustion byproducts of Otto Fuel II occur naturally in the marine environment.

3.2.3.3 Metals

Anthropogenic sources of metals include the processing of industrial ores (e.g., iron ore), production of chemicals, fertilizers used in agriculture, the marine industry (e.g., anti-fouling anti-corrosion paints), runoff from urban and suburban sprawl, dredge spoil disposal, exhaust from automotive transportation, atmospheric deposition, and industrial emissions (Jarup, 2016). Metals are introduced into nearshore and offshore marine waters and sediments by the Proposed Action. Because of the physical and chemical reactions that occur with metals in marine systems, many metals will precipitate out of seawater and settle in solid form on the seafloor where they can concentrate in sediments. Thus, metal contaminants in sediments are a greater issue than metals in the water column.

Military expended materials such as steel bomb bodies or fins, missile casings, small arms projectiles, and naval gun projectiles may contain small percentages (less than 1 percent by weight) of lead, manganese, phosphorus, sulfur, copper, nickel, tungsten, chromium, molybdenum, vanadium, boron, selenium, columbium, or titanium. Small-caliber projectiles are composed of steel with small amounts of aluminum and copper and brass casings that are 70 percent copper and 30 percent zinc. Medium- and large-caliber projectiles are composed of steel, brass, copper, tungsten, and other metals. The 20 mm cannon shells used in close-in weapons systems are composed mostly of tungsten alloy. Some projectiles have lead cores (U.S. Department of the Navy, 2008b). Torpedo guidance wire is composed of copper and cadmium coated with plastic (U.S. Department of the Navy, 2008a). Sonobuoy components include batteries and battery electrodes, lead solder, copper wire, and lead used for ballast. Thermal batteries in sonobuoys are contained in an airtight, sealed and welded stainless steel case that is 0.03–0.1 in. thick and resistant to the battery electrolytes (U.S. Department of the Navy, 2008a). Rockets are usually composed of steel and steel alloys, although composite cases made of glass, carbon, or Kevlar fiber are also used (Missile Technology Control Regime, 1996).

Non-explosive practice munitions consist of ammunition and components that contain no explosive material, and may include (1) ammunition and components that have had all explosive material removed and replaced with non-explosive material, (2) empty ammunition or components, and (3) ammunition or components that were manufactured with non-explosive material in place of all explosive material. These practice munitions vary in size from 25 to 500 lb. and are designed to simulate the characteristics of explosive munitions for training and testing activities. Some non-explosive practice munitions may also contain unburned propellant (e.g., rockets), and some may contain spotting charges or signal cartridges for locating the point of impact (e.g., smoke charges for daylight spotting or flash charges for night spotting) (U.S. Department of the Navy, 2010c). Non-explosive bombs—also called "practice" or "bomb dummy units"—are composed mainly of iron and steel casings filled with sand, concrete, or vermiculite. These materials are similar to those used to construct artificial reefs. Large, non-explosive bombs are configured to have the same weight, size, center of gravity, and ballistics as explosive bombs (U.S. Department of the Navy, 2006). Practice bombs do not contain the explosives materials.

Decommissioned vessels used as targets for sinking exercises are selected from a list of U.S. Navy-approved vessels that have been cleaned or remediated in accordance with USEPA guidelines. By rule, vessel-sinking exercises must be conducted at least 50 NM offshore and in water at least 6,000 ft. deep (40 CFR part 229.2). The USEPA requires the contaminant levels released during the sinking of a target to be within the standards of the Marine Protection, Research, and Sanctuaries Act (16 U.S.C. 1341, et seq.).

In general, three things happen to materials that come to rest on the ocean floor: (1) they lodge in sediments where there is little or no oxygen below 4 in., (2) they remain on the ocean floor and begin to react with seawater, or (3) they remain on the ocean floor and become encrusted by marine organisms. As a result, rates of deterioration depend on the metal or metal alloy and the conditions in the immediate marine and benthic environment. If buried deep in ocean sediments, materials tend to decompose at much lower rates than when exposed to seawater (Ankley, 1996). With the exception of torpedo guidance wires and sonobuoy parts, sediment burial appears to be the fate of most munitions used in marine warfare (Environmental Sciences Group, 2005).

When metals are exposed to seawater, they begin to slowly corrode, a process that creates a layer of corroded material between the seawater and uncorroded metal. This layer of corrosion removes the metal from direct exposure to the corrosiveness of seawater, a process that further slows movement of the metals into the adjacent sediments and water column. This is particularly true of aluminum. Elevated levels of metals in sediments would be restricted to a small zone around the metal, and any release to the overlying water column would be diluted. In a similar fashion, as materials become covered by marine life, both the direct exposure of the material to seawater and the rate of corrosion decrease. Dispersal of these materials in the water column is controlled by physical mixing and diffusion, both of which tend to vary with time and location. The analysis of metals in marine systems begins with a review of studies involving metals used in military training and testing activities that may be introduced into the marine environment.

In one study, the water was sampled for lead, manganese, nickel, vanadium, and zinc at a shallow bombing range in Pamlico Sound (estuarine waters of North Carolina) immediately following a training event with non-explosive practice bombs. All water quality parameters tested, except nickel, were within the state limits. The nickel concentration was significantly higher than the state criterion, although the concentration did not differ significantly from the control site located outside the bombing range. The results suggest that bombing activities were not responsible for the elevated nickel concentrations (U.S. Department of the Navy, 2010c, 2012).

The results of a separate study conducted by the U.S. Marine Corps near the bombing sites in Pamlico Sound sampled sediments and water quality for 26 different constituents, including lead and magnesium, related to munitions use. With the exception of perchlorate, which was found at extremely low concentrations in only 4 of 95 sediment samples, no constituents were found above minimum detection limits (U.S. Department of the Navy, 2010c). The concentrations of all other chemical constituencies were believed to be consistent with background levels in nearshore sediments and sea water. Perchlorate concentrations in sediments near the bombing targets were more likely to be from naturally occurring sources rather than associated with bombing range activities given that perchlorate is extremely soluble in water. The results of the sampling indicate that munitions constituents are not accumulating at concentrations that pose a risks to ecological receptors or humans and are not migrating from the bombing sites to off-range areas.

A study by Pait et al. (2010) of previous Navy training areas at Vieques, Puerto Rico found generally low concentrations of metals in marine sediments. Areas in which live ammunition and loaded weapons were used ("live-fire areas") were included in the analysis. These results are relevant because the concentrations of expended munitions at Vieques are significantly greater than would be found anywhere in the AFTT Study Area. Table 3.2-9 compares the sediment concentrations of several metals from those naval training areas with sediment screening levels established by the National Oceanic and Atmospheric Administration (Buchman, 2008).

As shown in Table 3.2-9, average sediment concentrations of the metals evaluated, except for copper, were below both the threshold and probable effects levels (metrics similar to the effects range levels). The average copper concentration was above the threshold effect level, but below the probable effect level. For other elements: (1) the mean sediment concentration of arsenic at Vieques was 4.37 micrograms per gram (µg/g), and the highest concentration was 15.4 µg/g. Both values were below the sediment quality guidelines examined, and (2) the mean sediment concentration of manganese in sediment was 301 µg/g, and the highest concentration was 967 µg/g (Pait et al., 2010). The National Oceanic and Atmospheric Administration did not report threshold or probable effects levels for manganese.

Table 3.2-9: Concentrations of and Screening Levels for Selected Metals in Marine Sediments, Vieques, Puerto Rico

Metal	*Sediment Concentration (µg/g)*			*Sediment Guidelines – National Oceanic and Atmospheric Administration (µg/g)*	
	Minimum	*Maximum*	*Average*	*Threshold Effects Level**	*Probable Effects Level**
Cadmium	0	1.92	0.15	0.68	4.21
Chromium	0	178	22.5	52.3	160
Copper	0	103	25.9	18.7	390
Lead	0	17.6	5.42	30.24	112
Mercury	N/R	0.112	0.019	130	700
Nickel	N/R	38.3	7.80	15.9	42.8
Zinc	N/R	130	34.4	124	271

*Threshold Effects Level and Probable Effects Level are metrics similar to the effects range metrics (i.e., Effects Range Low and Effects Range Median) used to assess potential effects of contaminants on sediments. The Threshold Effects Levels is the average of the 50th percentile and the 15th percentile of a dataset and the Probable Effects Level is the average of the 50th percentile and the 85th percentile of a dataset.
Notes: µg/g = micrograms per gram, N/R = not reported

The impacts of lead and lithium were studied at the Canadian Forces Maritime Experimental and Test Ranges near Nanoose Bay, British Columbia, Canada (Environmental Sciences Group, 2005). These materials are common to expendable mobile anti-submarine warfare training targets, acoustic device countermeasures, sonobuoys, and torpedoes. The study noted that lead is a naturally-occurring metal in the environment, and that typical concentrations of lead in seawater in the test range were between 0.01 and 0.06 ppm, while concentration of lead in sediments was between 4 and 16 ppm. Cores of marine sediments in the test range show a steady increase in lead concentration from the bottom of the core to a depth of approximately 20 cm. This depth corresponds to the late 1970s and early 1980s, and the lead contamination was attributed to atmospheric deposition of lead from gasoline additives. The sediment cores showed a general reduction in lead concentration to the present time, coincident with the phasing out of lead in gasoline by the mid-1980s. The study also noted that other training ranges have shown minimal impacts of lead ballasts because they are usually buried deep in marine sediments where they are not biologically available. The study concluded that the lead ballasts would not adversely impact marine organisms because of the low probability of mobilization of lead.

A study by the Navy examined the impacts of materials from activated seawater batteries in sonobuoys that freely dissolve in the water column (e.g., lead, silver, and copper ions), as well as nickel-plated steel housing, lead solder, copper wire, and lead shot used for sonobuoy ballast (Naval Facilities Engineering Command, 1993). The study concluded that constituents released by saltwater batteries as well as the decomposition of other sonobuoy components did not exceed state or federal standards, and that the reaction products are short-lived in seawater.

A series of research efforts focused on World War II underwater munitions disposal sites in Hawaii (Briggs et al., 2016; Kelley et al., 2016; Koide et al., 2016; University of Hawaii, 2010) and an intensively used live fire range in the Mariana Islands (Smith & Marx, 2016) provide information in regard to the impacts of undetonated materials and unexploded munitions on marine life.

On a localized scale, research at World War II munitions ocean disposal sites in Hawaii investigated nearby sediments, seawater, or marine life to determine if metals could be detected. For metals, although there were localized elevated levels of arsenic and lead in several biota samples and in the sediment adjacent to the munitions, the origin of those metals could not be definitively linked to the munitions since comparison of sediment between the clean reference site and the disposal site showed relatively little difference. This was especially the case for a comparison with samples for ocean disposed dredge spoils sites (locations where material taken from the dredging of harbors on Oahu was disposed). At individual sampling sites adjacent to munitions, the concentrations of metals were not significantly higher as compared to the background at control sites and not significant in comparison to typical deep-sea marine sediments (Briggs et al., 2016). Observations and data collected also did not indicate any adverse impact to the localized ecology due to the presence of munitions degrading for over 75 years when compared to control sites. When specifically looking at marine organisms around the munitions (Kelley et al., 2016; Koide et al., 2016), the analysis indicated that in soft bottom habitats the expended items were providing hard substrate similar to other disposed objects or “artificial reefs” that attracted “hard substrate species” that would not have otherwise colonized the area and that there was no bioaccumulation of munitions-related chemicals for the species sampled (Koide et al., 2016).

On a broader scale, the island of Farallon de Medinilla (in the Mariana Islands) has been used as a target area since 1971. Between 1997 and 2012, there were 14 underwater scientific survey investigations around the island providing a long-term look at potential impacts on the marine life from training and testing involving the use of munitions (Smith & Marx, 2016). Munitions use has included explosive rounds from gunfire, high explosive bombs by Navy aircraft and U.S. Air Force B-52s, in addition to the expenditure of inert rounds and non-explosive practice bombs. Marine life assessed during these surveys included algae, corals, benthic invertebrates, sharks, rays, bony fishes, and sea turtles. The investigators found no evidence over the 16-year period, that the condition of the biological resources had been adversely impacted to a significant degree by the training activities (Smith & Marx, 2016). Furthermore, they found that the health, abundance, and biomass of fishes, corals, and other marine resources were comparable to or superior to those in similar habitats at other locations within the Mariana Archipelago.

These findings are consistent with other assessments such as those performed for the Potomac River Test Range at Dahlgren, Virginia which was established in 1918 and is the Nation’s largest fully instrumented, over-the-water gun-firing range. Munitions tested at Dahlgren has included rounds from small-caliber guns up to the Navy’s largest (16-in. guns), bombs, rockets, mortars, grenades, mines, depth charges, and torpedoes (U.S. Department of the Navy, 2013a). Results from the assessment indicate that munitions expended at Dahlgren have not contributed significant concentrations of metals to the Potomac River and that the concentrations of metals in local sediments are orders of magnitude lower than in other areas of the Potomac River where metals are introduced from natural and other manmade sources (U.S. Department of the Navy, 2013b).

3.2.3.3.1 Impacts from Metals under Alternative 1

3.2.3.3.1.1 Impacts from Metals under Alternative 1 for Training Activities

Many activities included in the Proposed Action would expend munitions and other materials with metal components. Refer to Chapter 2 (Description of Proposed Action and Alternatives) for information on training activities and their frequency of annual occurrence under Alternative 1 and Appendix A (Activity

Descriptions) for a detailed description of munitions and other materials that would be used during training activities.

The distribution of non-explosive munitions and other expended materials composed of or containing metals that are used in training activities is not uniform throughout the Study Area. Non-explosive munition are the largest portion of expended objects composed of metal or containing metal components (with the exception of target vessels). Approximately 50 percent of the non-explosive munitions and other expended metals used annually during training activities would be used in the Virginia Capes Range Complex, 24 percent in the Jacksonville Range Complex, and 15 percent would be used in the Navy Cherry Point Range Complex. The remaining 11 percent would be distributed in other locations of the Study Area. Over 8 million munitions and other items containing metals would be used in the Study Area annually; 75 percent of those munitions and items are small caliber projectiles and over 20 percent are medium caliber projectiles. Small caliber projectiles are less than 0.5 in. in diameter and a few inches in length, and weigh up to 0.17 lb. A 30 mm medium caliber projectile is larger, weighing just under 1 lb., and it is approximately 30 mm (or about 1 in.) in diameter and 7 in. long.

While the Navy is proposing to conduct one Sinking Exercise per year, historically, the Navy has not conducted this activity on an annual basis. The last Sinking Exercise conducted in the Atlantic was in 2009; one was also conducted in 2008. A Navy vessel used as a target would weigh between 5,000 and 10,000 tons (aircraft carriers would not be used as a target in Sinking Exercises). The vessel used during the Sinking Exercise would comprise a substantial amount of the metal used in the Study Area by weight, and would also represent the greatest concentration of expended metal objects (including munitions) in any location in the Study Area once the vessel sinks to the seafloor. As noted in previous sections, decommissioned vessels used as targets for sinking exercises have been cleaned or remediated in accordance with USEPA guidelines. Sinking exercises must be conducted at least 50 NM offshore and in water at least 6,000 ft. deep (40 CFR part 229.2). The USEPA considers the contaminant levels associated with the sinking of a target vessel to be within the standards of the Marine Protection, Research, and Sanctuaries Act (16 U.S.C. 1341, et seq.).

Metals from munitions, vessels and other targets, and other expended materials would sink to the seafloor where they would most likely be buried or partially buried in sediments, depending on the type of seafloor substrate. In the AFTT Study Area, the offshore substrate is predominantly composed of soft sediments (see Section 3.5, Habitats), which would increase the likelihood of complete or partial burial of expended materials, including munitions. Metals exposed to the seawater would slowly corrode over years or decades, releasing small amounts of water soluble metal compounds into the water column and corrosion products into adjacent sediments. The low, near freezing water temperatures and low oxygen levels in sediments only a few inches below the water column-seafloor interface that characterize deepwater (> 250 m), benthic habitats would inhibit corrosion of metals and any dispersion of metals and corrosion products beyond isolated areas adjacent to the munition.

As described in Section 3.2.3.3 (Metals), sediment samples collected from World War II era munitions disposal sites and heavily used Navy ranges show that metals are not impacting sediment quality despite longtime use and high concentrations of military munitions composed primarily of metal components. The concentration of munitions and other expended materials containing metals in any one location in the AFTT Study Area would be a small fraction of that from a munitions disposal site, a target island used for 45 years, or a water range in a river used for almost 100 years. Chemical, physical, or biological changes to sediments or water quality in the Study Area would not be detectable and would be similar to nearby areas without munitions or other expended materials containing metals. This conclusion is based on the following: (1) most of the metals are benign, and those of potential concern make up a small percentage of expended munitions and other metal objects; (2) metals released through corrosion would be diluted by currents or bound up and sequestered in adjacent sediment; (3) elevated concentrations of metals in sediments would be limited to the immediate area around the expended material; and (4) the areas over which munitions and other metal components would be distributed are large.

Based on findings from these and other intensively used locations, the sediment and water quality effects from metals used in munitions, expended materials, target vessels, or other devices resulting from any of the proposed activities would be negligible by comparison.

3.2.3.3.1.2 Impacts from Metals under Alternative 1 for Testing Activities

The distribution of non-explosive munitions and other expended materials composed of or containing metals that are used in testing activities is not uniform throughout the Study Area. Munition are the largest portion of expended objects composed of metal or containing metal components. Approximately 36 percent of the non-explosive munitions and other expended metals used annually during testing activities would be used in the Virginia Capes Range Complex, and 29 percent would be used in the Jacksonville Range Complex. The remaining 35 percent would be more widely distributed in other locations of the Study Area. Over 12 million munitions and other items containing metals would be used in the Study Area annually; over 45 percent of those munitions and items are non-explosive medium caliber projectiles, 17 percent are non-explosive large caliber projectiles, and 10 percent are small caliber projectiles.

As described in Section 3.2.3.3 (Metals), sediment samples collected from World War II era munitions disposal sites and heavily used Navy ranges show that metals are not impacting sediment quality despite longtime use and high concentrations of military munitions composed primarily of metal components. The concentration of munitions and other expended materials containing metals in any one location in the Study Area would be a small fraction of that from a munitions disposal site, a target island used for 45 years, or a water range in a river used for almost 100 years. Chemical, physical, or biological changes to sediments or water quality in the Study Area would not be detectable and would be similar to nearby areas without munitions or other expended materials containing metals. This conclusion is based on the following: (1) most of the metals are benign, and those of potential concern make up a small percentage of expended munitions and other metal objects; (2) metals released through corrosion would be diluted by currents or bound up and sequestered in adjacent sediment; (3) elevated concentrations of metals in sediments would be limited to the immediate area around the expended material; and (4) the areas over which munitions and other metal components would be distributed are large (thousands of square nautical miles).

Based on findings from these and other intensively used locations, the sediment and water quality effects from metals used in munitions, expended materials, or other devices resulting from any of the proposed activities would be negligible by comparison.

3.2.3.3.2 Impacts from Metals under Alternative 2

3.2.3.3.2.1 Impacts from Metals under Alternative 2 for Training Activities

Under Alternative 2, the number of munitions and other expended materials containing metals used during training activities would be the same as under Alternative 1. Therefore, metals contained in munitions and other military expended materials would have the same environmental impacts as described under Alternative 1.

3.2.3.3.2.2 Impacts from Metals under Alternative 2 for Testing Activities

Under Alternative 2, the number of munitions and other expended materials containing metals used during testing activities would increase compared to the number under Alternative 1. As shown in Chapter 2 (Description of Proposed Action and Alternatives) Tables 2.6-2 through 2.6-4, several Navy testing activities would be conducted more often under Alternative 2, resulting in an increase of 10 explosive mines and 40 neutralizers (10 explosive and 30 non-explosive) used annually. Under Alternative 1, no explosive mines would be used by Naval Air Systems Command. In addition, some activities would be conducted more frequently over a five-year period, resulting in the use of more munitions and other expended materials (see Tables 2.6-2 through 2.6-4). Over the five-year period, there would be an overall 8 percent increase in munitions and other expended materials containing metals used under Alternative 2. These include 300 additional torpedo accessories, which contain lead ballast; over 600 neutralizers, over 70,000 medium caliber projectiles (30 percent explosive and 70 percent non-explosive); 170 missiles (70 percent explosive and 30 percent non-explosive); over 600 rockets (60 percent explosive and 40 percent non-explosive); and 60 surface targets.

The increase in the use of munitions and other objects containing metals would increase the amount of metals introduced into the seafloor environment over the amount in Alternative 1. However, the increase is not a substantial increase over the number of munitions used under Alternative 1 and would not alter the conclusions presented for Alternative 1. Specifically, the concentration of munitions and other expended materials containing metals in any one location in the AFTT Study Area would be a small fraction of the concentrations found on a munitions disposal site, a target island used for 45 years, or a water range in a river used for almost 100 years. The increase in the chemical, physical, or biological changes to sediments or water quality in the Study Area would not be detectable. The areas over which the additional 9 percent of munitions and other metal components would be distributed are large (thousands of square nautical miles); therefore any increase would have a negligible effect on metal concentrations in seafloor sediments.

Based on findings from intensively used locations, the sediment and water quality effects from metals used in munitions, expended materials, or other devices resulting from any of the proposed activities would be negligible by comparison. Therefore, metals in munitions and other military expended materials would have the same environmental impacts as under Alternative 1.

3.2.3.3.3 Impacts from Metals under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Under this alternative, there would be no adverse impacts on sediments and water quality from training and testing activities. It is reasonable to assume that ceasing all training and testing activities involving the use of non-explosive munitions and other expended materials containing metals would decrease the amounts of metal contaminants in marine waters and sediments. The effect, however, would likely not be measureable due to the slow, sometimes decades-long corrosion rates of metals on the seafloor. Metals released into sediments from corroding munitions and other metallic materials would only be expected at marginally higher concentrations in sediments within a few feet of the munition relative to a nearby location without munitions. Furthermore, most metals used in non-explosive munitions and other expended materials occur naturally in the marine environment and would not be elevated to toxic levels by slowly corroding munitions or other metallic materials.

3.2.3.4 Other Materials

Under the Proposed Action, other materials include marine markers and flares, chaff, towed and stationary targets, and miscellaneous components of other expended objects. These materials and components are either made mainly of non-reactive or slowly reactive materials (e.g., glass, carbon fibers, and plastics) or break down or decompose into benign byproducts (e.g., rubber, steel, iron, and concrete). Most of these objects would settle to the seafloor where they would (1) be exposed to seawater, (2) become lodged in or covered by seafloor sediments, (3) become encrusted by oxidation products such as rust, (4) dissolve slowly, or (5) be covered by marine organisms such as coral. Plastics may float or descend to the bottom, depending upon their buoyancy. Marine markers and flares are largely consumed during use.

Towed and stationary targets include floating steel drums, towed aerial targets, the trimaran, and inflatable, floating targets. The trimaran is a three-hulled boat with a 4 ft. square sail that is towed as a moving target. Large, inflatable, plastic targets can be towed or left stationary. Towed aerial targets are either (1) rectangular pieces of nylon fabric 7.5 ft. by 40 ft. that reflect radar or lasers; or (2) aluminum cylinders with a fiberglass nose cone, aluminum corner reflectors (fins), and a short plastic tail section. This second target is about 10 ft. long and weighs about 75 lb. These four targets are recovered after use, and will not be considered further.

Marine markers are pyrotechnic devices that are dropped on the water's surface during training exercises to mark a position, to support search and rescue activities, or as a bomb target. The MK 58 marker is a tin tube that weighs about 12 lb. Markers release smoke at the water surface for 40 to 60 minutes. After the pyrotechnics are consumed, the marine marker fills with seawater and sinks. Iron and aluminum constitute 35 percent of the marker weight. To produce the lengthy smoke effect, approximately 40 percent of the marker weight is made up of pyrotechnic materials. The propellant, explosive, and pyrotechnic constituents of the MK 58 include red phosphorus (2.19 lb.) and manganese (IV) dioxide (1.40 lb.). Other constituents include magnesium powder (0.29 lb.), zinc oxide (0.12 lb.), nitrocellulose (0.000017 lb.), nitroglycerin (0.000014 lb.), and potassium nitrate (0.2 lb.). The failure rate of marine markers is approximately 5 percent (U.S. Department of the Navy, 2010b, 2010c).

Flares are used to signal, to illuminate surface areas at night in search and attack operations, and to assist with search and rescue activities. They range in weight from 12 to 30 lb. The major constituents of flares include magnesium granules and sodium nitrate. Containers are constructed of aluminum, and the entire assembly is usually consumed during flight. Flares may also contain a primer such as trinitrotoluene (TNT), propellant (ammonium perchlorate), and other explosives. These materials are present in small quantities (e.g., 1.0×10^{-4} ounces [oz.] of ammonium perchlorate and 1.0×10^{-7} oz. of explosives). Small amounts of metals are used to give flares and other pyrotechnic materials bright and distinctive colors. Combustion products from flares include magnesium oxide, sodium carbonate, carbon dioxide, and water. Illuminating flares and marine markers are usually entirely consumed during use; neither is intended to be recovered. Table 3.2-10 summarizes the components of markers and flares (U.S. Department of the Air Force, 1997).

Table 3.2-10: Summary of Components of Marine Markers and Flares

Flare or Marker	*Constituents*	*Composition (%)*
LUU-2 Paraflare	Magnesium granules, sodium nitrate, aluminum, iron, trinitrotoluene (TNT), royal demolition explosive, ammonium perchlorate, potassium nitrate, lead, chromium, magnesium, manganese, nickel	Magnesium (54), sodium nitrate (26), aluminum (14), iron (5)
MK45 Paraflare	Aluminum, sodium nitrate, magnesium powder, nitrocellulose, trinitrotoluene (TNT), copper, lead, zinc, chromium, manganese, potassium nitrate, pentaerythritol-tetranitrate, nickel, potassium perchlorate	Magnesium (45), sodium nitrate (30), aluminum (22)
MK58 Marine Marker	Aluminum, iron, chromium, copper, lead, lead dioxide, manganese dioxide, manganese, nitroglycerin, red phosphorus, potassium nitrate, silver, zinc, zinc oxide	Iron (60), aluminum (35)

Most of the pyrotechnic components of marine markers are consumed and byproducts are released into the air. Thereafter, the aluminum and steel canister sinks to the bottom. Combustion of red phosphorus produces phosphorus oxides, which have a low toxicity to aquatic organisms. The amount of flare residue is negligible. Phosphorus contained in the marker settles to the seafloor, where it reacts with the water to produce phosphoric acid until all phosphorus is consumed by the reaction. Phosphoric acid is a variable, but normal, component of seawater (Sverdrup et al., 1970). The aluminum and iron canisters are expected to be covered by sand and sediment over time, to become encrusted by chemical corrosion, or to be covered by marine plants and animals. Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, adheres to particulates, and is transported to the bottom sediments (Monterey Bay Research Institute, 2010).

Red phosphorus, the primary pyrotechnic ingredient, constitutes 18 percent of the marine marker weight. Toxicological studies of red phosphorus revealed an aquatic toxicity in the range of 10–100 milligrams per liter (10–100 ppm) for fish, *Daphnia* (a small aquatic crustacean), and algae (European Flame Retardants Association, 2002). Red phosphorus slowly degrades by chemical reactions to phosphine and phosphorus acids. Phosphine is very reactive and usually undergoes rapid oxidation. The final products, phosphates, are harmless (California Environmental Protection Agency, 2003). A study by the U.S. Department of the Air Force (1997) found that, in salt water, the degradation products of flares that do not function properly include magnesium and barium.

Chaff is an electronic countermeasure designed to confuse enemy radar by deflecting radar waves and thereby obscuring aircraft, ships, and other equipment from radar tracking sources. Chaff consists of small, thin glass fibers coated in aluminum that are light enough to remain in the air anywhere from 10 minutes to 10 hours (Farrell & Siciliano, 2007). Chaff is typically packaged in cylinders that measure approximately 6 in. by 1.5 in. (15.2 cm by 3.8 cm), weigh about 5 oz. (140 grams [g]), and contain a few million fibers. Chaff may be deployed from an aircraft or may be launched from a surface vessel.

The chaff fibers are approximately the thickness of a human hair (generally 25.4 microns in diameter), and range in length from 0.8 to 5.1 cm. The major components of the chaff glass fibers and the aluminum coating are provided in Table 3.2-11 (Arfsten et al., 2002; Farrell & Siciliano, 2007; Spargo et al., 1999; U.S. Department of the Air Force, 1997).

Factors influencing chaff dispersion include the altitude and location where it is released, prevailing winds, and meteorological conditions (Hullar et al., 1999; Spargo, 2007). Doppler radar has tracked chaff plumes containing approximately 900 g of chaff drifting 200 mi. from the point of release, with the plume covering a volume of greater than 400 cubic miles (Arfsten et al., 2002). Based on the dispersion characteristics of chaff, large areas of open water would be exposed to chaff, but the chaff concentrations would be low. For example, Hullar et al. (1999) calculated that an area 8 km by 12 km (96 square kilometers) would be affected by deployment of a single cartridge containing 150 g of chaff. The resulting chaff concentration would be about 5.4 g per NM^2. This corresponds to less than 0.005 fiber per square meters, assuming that each canister contains 5 million fibers.

Chaff is generally resistant to chemical weathering and likely remains in the environment for long periods. However, all the components of chaff's aluminum coating are present in seawater in trace amounts, except magnesium, which is present at 0.1 percent (Nozaki, 1997). Aluminum and silicon are the most common minerals in the earth's crust as aluminum oxide and silicon dioxide, respectively. Aluminum is the most common metal in the Earth's crust and also occurs naturally in trace amounts in the aquatic environment. Ocean waters are constantly exposed to these minerals, so the addition of small amounts of chaff would not affect water quality or sediment composition (Hullar et al., 1999).

Table 3.2-11: Major Components of Chaff

Component	*Percent by Weight*
Glass Fiber	
Silicon dioxide	52–56
Alumina	12–16
Calcium oxide, magnesium oxide	16–25
Boron oxide	8–13
Sodium oxide, potassium oxide	1–4
Iron oxide	≤ 1
Aluminum Coating	
Aluminum	99.45 (minimum)
Silicon and Iron	0.55 (maximum)
Copper	0.05
Manganese	0.05
Zinc	0.05
Vanadium	0.05
Titanium	0.05
Others	0.05

The dissolved concentration of aluminum in seawater ranges from 1 to 10 µg/L (1 to 10 ppb). For comparison, the concentration in rivers is 50 µg/L (50 ppb). In the ocean, aluminum concentrations tend to be higher on the surface, lower at middle depths, and higher again at the bottom (Li et al., 2008). Aluminum is a very reactive element, and is seldom found as a free metal in nature except under highly acidic (low pH) or alkaline (high pH) conditions. It is found combined with other elements, most commonly with oxygen, silicon, and fluorine. These chemical compounds are commonly found in soil, minerals, rocks, and clays (Agency for Toxic Substances and Disease Registry, 2008; U.S. Air Force, 1994). Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, and is scavenged by particulates and transported to bottom sediments (Monterey Bay Research Institute, 2010).

Because of their light weight, chaff fibers tend to float on the water surface for a short period. The fibers are quickly dispersed by waves and currents. They may be accidentally or intentionally ingested by marine life, but the fibers are non-toxic. Chemicals leached from the chaff would be diluted by the surrounding seawater, reducing the potential for chemical concentrations to reach levels that can affect sediment quality or benthic habitats.

Schiff (1977) placed chaff samples in Chesapeake Bay water for 13 days. No increases in concentration of greater than 1 ppm of aluminum, cadmium, copper, iron, or zinc were detected. Accumulation and concentration of chaff constituents is not likely under natural conditions. A U.S. Air Force study of chaff analyzed nine elements under various pH conditions: silicon, aluminum, magnesium, boron, copper, manganese, zinc, vanadium, and titanium. Only four elements were detected above the 0.02 milligrams per liter detection limit (0.02 ppm): magnesium, aluminum, zinc, and boron (U.S. Air Force, 1994). Tests of marine organisms detected no impacts of chaff exposure at levels above those expected in the Study Area (Farrell & Siciliano, 2007).

3.2.3.4.1 Impacts from Other Materials under Alternative 1

3.2.3.4.1.1 Impacts from Other Materials under Alternative 1 for Training Activities

The distribution of other expended materials used in training activities would not be uniform throughout the Study Area. These other expended materials include marine markers and flares, chaff, expendable towed and stationary targets, non-explosive sonobuoys, fiber-optic cables, and miscellaneous components. Approximately 44 percent of these other expended materials would be used annually in the Jacksonville Range Complex, 30 percent in the Key West Range Complex, and 20 percent would be used in the Navy Cherry Point Range Complex. Over 270,000 other expended materials would be used in the Study Area annually; 46 percent of those materials are chaff, 34 percent are flares, and 16 percent are non-explosives sonobuoys (i.e., passive and acoustic), which contain metals and other materials including plastics. The composition of chaff is much like clay minerals common in ocean sediments (aluminosilicates), and studies indicate that impacts are not anticipated even at concentrations many times the level anticipated during proposed training activities. Most pyrotechnics in marine markers and flares are consumed during use and combustion byproducts are expended into the air. The failure rate of flares and marine markers is low (5 percent), and the remaining amounts are small and subject to additional chemical reactions and subsequent dilution in the ocean.

Under Alternative 1, approximately 94,000 flares would be used in the AFTT Study Area, and approximately 4,700 (5 percent) would enter the water with unconsumed pyrotechnic materials. As show in Table 3.2-10, the bulk of these materials are metals and other chemical compounds that occur naturally in the marine environment and would be dispersed at low concentrations in the water column or would sink to the seafloor. The analysis and conclusions presented in Section 3.2.3.3 (Metals) would apply to metals in pyrotechnics as well, and the analysis concludes that sediment and water quality effects from metals would be negligible. The small amounts of explosives used in flares, specifically trinitrotoluene (TNT) and royal demolition explosive, released into the sediments would not impact marine sediments for the same reasons presented in Section 3.2.3.1 (Explosives and Explosives Byproducts). Based on the results of studies conducted at multiple marine and freshwater ranges where explosives have been used intensively over decades, no impacts on sediments and water quality from explosives in unconsumed flares would be expected.

Plastics and other floating expended materials (e.g., rubber components) would either degrade over time in the water column or on the seafloor or wash ashore. Materials that sink to the seafloor would be widely distributed over the large areas used for training. As described in Section 3.2.2.1.2 (Marine Debris, Military Materials, and Marine Sediments), the worldwide use and disposal of plastics is rapidly increasing the amount of plastic debris accumulating in large areas of the world's oceans. Small pieces of plastic debris associated with the use of chaff, flares, and targets would likely persist in the marine environment as floating debris in the water column or on the seafloor. Plastic debris floating near the surface and exposed to the sun and mechanical wear and tear would breakdown over time. Plastic debris that sinks in the water column below the photic zone or to the seafloor would degrade more slowly or not at all. Because only small pieces of plastics would be expended—larger pieces from targets are recovered—and dispersed over a large area, only negligible impacts on sediments or water quality are expected. The potential effects of plastic debris from military expended materials on living marine resources and habitats are analyzed in other sections of the EIS/OEIS.

Devices temporarily deployed on the seafloor and then recovered following completion of the activity would likely increase turbidity in the vicinity of the device. Most seafloor devices are stationary; however some devices (e.g., crawlers) are mobile and move very slowly along the bottom. While a minimal increase in turbidity would be expected during installation, recovery, and, if applicable, movement of seafloor devices, particularly where the seafloor is composed of soft sediments, the increase is expected to be negligible and have no lasting impact on sediments or water quality.

3.2.3.4.1.2 Impacts from Other Materials under Alternative 1 for Testing Activities

The distribution of other expended materials used in testing activities would not be uniform throughout the Study Area. These other expended materials include marine markers and flares, chaff, expendable towed and stationary targets, non-explosive sonobuoys, fiber-optic cables, and miscellaneous components. Approximately 35 percent of these other expended materials would be used annually in the Virginia Capes Range Complex, 29 percent in the Jacksonville Range Complex, 9 percent would be used in the Gulf of Mexico Range Complex, and 8 percent each would be used in the Key West Range Complex and the Northeast Range Complex. The remaining 11 percent would be distributed in other locations of the Study Area. Over 264,000 other expended materials would be used in the Study Area annually; 65 percent of those materials are sabots. A sabot is a device used to keep a projectile centered in the barrel during firing. Sabots are constructed of metal with plastic parts. Of the remaining other expended materials, 13 percent are non-explosive sonobuoys, 9 percent are chaff, and 8 percent are flares.

Most pyrotechnics in marine markers and flares are consumed during use combustion byproducts are expended into the air. The failure rate of flares and marine makers is low (5 percent), and the remaining amounts are small and subject to additional chemical reactions and subsequent dilution in the ocean. The analysis and conclusions presented in Section 3.2.3.3 (Metals) would apply to metals in pyrotechnics as well, and the analysis concludes that sediment and water quality effects from metals would be negligible. The small amounts of explosives used in flares, specifically trinitrotoluene (TNT) and royal demolition explosive, released into the sediments would not impact marine sediments for the same reasons presented in Section 3.2.3.1 (Explosives and Explosives Byproducts). Based on the results of studies conducted at multiple marine and freshwater ranges where explosives have been used intensively over decades, no impacts on sediments and water quality from explosives in unconsumed flares would be expected.

Plastics and other floating expended materials (e.g., rubber components) would either degrade over time in the water column or on the seafloor or wash ashore. Materials that sink to the seafloor would be widely distributed over the large areas used for training. As described in Section 3.2.2.1.2 (Marine Debris, Military Materials, and Marine Sediments), the worldwide use and disposal of plastics is rapidly increasing the amount of plastic debris accumulating in large areas of the world’s oceans. Small pieces of plastic debris associated with the use of chaff, flares, and targets would likely persist in the marine environment as floating debris in the water column or on the seafloor. Plastic debris floating near the surface and exposed to the sun and mechanical wear and tear would breakdown over time. Plastic debris that sinks in the water column below the photic zone or to the seafloor would degrade more slowly or not at all. Because only small pieces of plastics would be expended—larger pieces from targets are recovered—and dispersed over a large area, only negligible impacts on sediments or water quality are expected. The potential effects of plastic debris from military expended materials on living marine resources and habitats are analyzed in other sections of the Draft EIS/OEIS. Some testing activities would involve the use of a biodegradable polymer as part of a vessel entanglement system. Based on the constituents of the biodegradable polymer, the Navy anticipated that the material will breakdown into small pieces within a few days to weeks. The polymer will breakdown further and dissolve into the water column within weeks to a few months. The final breakdown products are all environmentally benign and will be dispersed quickly to undetectable concentrations within the water column.

Devices temporarily deployed on the seafloor and then recovered following completion of the activity would likely increase turbidity in the vicinity of the device. Most seafloor devices are stationary; however some devices (e.g., crawlers) are mobile and move very slowly along the bottom. While a minimal increase in turbidity would be expected during installation, recovery, and, if applicable, movement of seafloor devices, particularly where the seafloor is composed of soft sediments, the increase is expected to be negligible and have no lasting impact on sediments or water quality.

3.2.3.4.2 Impacts from Other Materials under Alternative 2

3.2.3.4.2.1 Impacts from Other Materials under Alternative 2 for Training Activities

Under Alternative 2, the number of other expended materials would increase by just 0.6 percent. The additional expended materials are non-explosive buoys and their small decelerator/parachutes and bathythermographs. The small increase in plastics, metals, and explosives in the additional expended materials would not change the conclusions presented under Alternative 1. Therefore, other materials would have the same environmental impacts as under Alternative 1.

3.2.3.4.2.2 Impacts from Other Materials under Alternative 2 for Testing Activities

Under Alternative 2, the number of other expended materials would increase by 0.3 percent. The additional expended materials are non-explosive sonobuoys and their small decelerator/parachutes. The small increase in plastics and metals in the additional expended materials would not change the conclusions presented under Alternative 1. Therefore, other materials would have the same environmental impacts as under Alternative 1.

3.2.3.4.3 Impacts from Other Materials under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Under this alternative, there would be no adverse impacts on sediments and water quality from training and testing activities. It is reasonable to assume that ceasing all training and testing activities involving the use of military expended materials would decrease the amounts these materials in marine waters and sediments. The effect, however, would likely not be measureable due to the slow, sometimes decades-long degradation of these materials, including plastics, in the water column and on the seafloor. Other expended materials in sediments would have only negligible impacts, because only small pieces of plastics would be expended—larger pieces from targets are recovered—and dispersed over a large area.

3.2.4 Summary of Potential Impacts on Sediments and Water Quality

The stressors that may impact sediments and water quality include explosives and explosives byproducts, metals, chemicals other than explosives, and other materials. 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 the stressors on sediments and water quality. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the sections above. Stressors associated with Navy training and testing activities do not typically occur in isolation but rather occur in some combination. For example, some anti-submarine warfare activities use explosive sonobuoys which may introduce residual explosives, explosives byproducts, metals, and plastic materials into the environment during a single activity. An analysis of the combined impacts of all stressors on sediments and water quality considers the potential consequences of aggregate exposure to all stressors and the repetitive or additive consequences of exposure over multiple years.

3.2.4.1 Combined Impact of all Stressors under Alternative 1

Most Navy training and testing activities impact small, widely-dispersed areas of the Study Area, limiting the spatial extent of sediments and the water column that would be exposed to contaminants to isolated areas within the Study Area. However, some Navy activities recur in the same location (e.g., gunnery and mine warfare activities), which concentrates munitions and other materials and their associated stressors in those areas. Despite recent, comprehensive data collection and analysis specific to military munitions impacts on sediments and water quality (Briggs et al., 2016; Edwards & Bełdowski, 2016; Edwards et al., 2016; Tomlinson & De Carlo, 2016), analysis of the potential effects from the Proposed Action is mainly qualitative. Where combinations of explosives, explosives byproducts, metals, and other chemicals and materials are co-located, the potential for combined impacts is present (Thompson et al., 2009).

When considered together, the impact of the four stressors would be additive. Under Alternative 1, chemical, physical, or biological changes in sediments and water quality would be minimal and only detectable in the immediate vicinity of munitions. Even in areas were multiple munitions and expended materials are located in close proximity (e.g., munitions disposal sites) chemical degradation products from each source or item are largely isolated from each other. The low failure rate of explosive munitions proposed for use reduces the likelihood of exposure to explosives materials that remain in in-tact munitions. Measurable concentrations of contaminants and other chemicals in the marine environment from munitions disposal sites have been shown to be below screening levels or similar to nearby reference areas where munitions are not present. Many components of non-explosive munitions and other expended materials are inert or corrode slowly over years. Metals that could impact benthic habitat at higher concentrations comprise only a small portion of the alloys used in expended materials, and corrosion of metals in munitions casings and other expended materials is a slow process that allows for dilution. The chemicals products from hydrolysis are predominantly naturally occurring chemicals. Elevated concentrations of metals and other chemical constituents in sediments would be limited to small zones adjacent to the munitions or other expended materials and would still most likely remain below screening levels even after years residing on the seafloor. It is also possible that Navy stressors will combine with non-Navy stressors, particularly in nearshore areas and bays, such as the mouth of Chesapeake Bay, to exacerbate already impacted sediments and water quality. This is qualitatively discussed in Chapter 4 (Cumulative Impacts).

3.2.4.2 Combined Impact of all Stressors under Alternative 2

Under Alternative 2, when considered separately, the impacts of the four stressors on sediments and water quality would be the same as discussed under Alternative 1, because the types and amounts of explosives, chemicals other than explosives, metals, and military expended materials are approximately equivalent under the two alternatives.

The amounts of explosives are greater under Alternative 2, because of the nominal increase in munitions used in some testing activities under Alternative 2. While the potential impact to sediments would be greater than under Alternative 1, metals in the additional munitions would be subject to the same slow degradation rates expected to occur in the deepwater environment limiting any increase in metal concentrations to sediments that are immediately adjacent a munition (see Section 3.2.3.3 [Metals] for additional discussion). As non-explosive or unexploded munitions degrade over time on the seafloor, they may become encrusted with oxidation products (e.g., rust) or by marine organisms attracted to hard substrates, which would further slow degradation rates. As discussed in Section 3.2.3.1 (Explosives and Explosives Byproducts), degrading munitions at World War II era munitions disposal sites do not pose a risk to human health or to the fauna living in direct contact with the degrading munitions (Edwards et al., 2016). During a comprehensive survey of a disposal site off of Hawaii, explosive materials were detected in sediments at only two locations and the concentrations were low. Data supporting these conclusions were collected from several World War II era munitions disposal sites and ranges characterized by relatively high concentrations of munitions. Munitions used in the proposed training and testing activities would be widely dispersed by comparison, resulting in lower concentrations of munitions that failed to detonate and lower concentrations of residual explosives and explosives byproducts than reported in Edwards et al. (2016).

Based on this analysis, impacts on sediments and water quality may be greater than under Alternative 1, but would still be minimal. Therefore, combined impacts from all stressors would also be similar to impacts described under Alternative 1.

3.2.4.3 Combined Impact of all Stressors under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Under this alternative, there would be no adverse impacts on sediments and water quality from training and testing activities. It is reasonable to assume that ceasing all training and testing activities involving the use of explosives and explosives byproducts, metals, chemicals other than explosives, and other materials would decrease the amounts these materials in marine waters and sediments. The effect, however, would likely not be measureable due to the slow, sometimes decades-long corrosion of metals on the seafloor. Metals, explosives, and explosives byproducts released into sediments from corroding munitions and other metallic materials would only be expected at marginally higher concentrations in sediments within a few feet of the munition relative to a nearby location without munitions. Furthermore, most metals used in non-explosive munitions and other expended materials occur naturally in the marine environment and would not be elevated to toxic levels by slowly corroding munitions or other metallic materials. The effect of chemicals other than explosives would likely not be measureable due to the highly efficient use of propellants and fuels by motors used in rockets and missiles, resulting in often undetectable trace amounts of propellants expended into the environment. Perchlorates, which make up a large percentage of rocket and missile propellants, are also water soluble and would dissolve and be dispersed in surface waters and would not accumulate in marine sediments. Other expended materials in sediments would have only negligible impacts, because only small pieces of plastics would be expended—larger pieces from targets are recovered—and dispersed over a large area.

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

TABLE OF CONTENTS

List of Figures

List of Tables

3.3 Vegetation

VEGETATION SYNOPSIS

The United States Department of the Navy considered all potential stressors that vegetation could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the Preferred Alternative (Alternative 1):

- Acoustics: Acoustic stressors are not applicable to vegetation due to the lack of hearing capabilities of vegetation and are not analyzed further in this section.
- Explosives: Explosives could affect vegetation by destroying individual plants or damaging parts of plants; however, there would be no persistent or large-scale effects on the growth, survival, distribution or structure of vegetation due to relatively fast growth, resilience, and abundance of the most affected species (e.g., phytoplankton, seaweed).
- Energy: Energy stressors are not applicable to vegetation because vegetation have a limited sensitivity to energy stressors and therefore will not be analyzed further in this section.
- Physical Disturbance and Strike: Physical disturbance and strike could affect vegetation by destroying individual plants or damaging parts of plants; however, there would be no persistent or large-scale effects on the growth, survival, distribution or structure of vegetation due to relatively fast growth, resilience, and abundance of the most affected species (e.g., phytoplankton, seaweed).
- Entanglement: Entanglement stressors are not applicable to vegetation due to sedentary nature of vegetation and is not analyzed further in this section.
- Ingestion: Ingestion stressors are not applicable because all vegetation in the study area uses photosynthesis and does not ingest, therefore, the ingestion stressor is not analyzed for vegetation.
- Secondary: Project effects on sediment, water, or air quality would be minor, temporary, and localized and could have short-term, small-scale secondary effects on vegetation; however, there would be no persistent or large-scale effects on the growth, survival, distribution, or structure of vegetation due to relatively fast growth, resilience, and abundance of the most affected species (e.g., phytoplankton, seaweed).

3.3.1 Introduction

This section provides analysis of potential impacts on vegetation found in the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area) and an introduction to the species that occur in the Study Area.

Vegetation includes diverse taxonomic/ecological groups of marine algae throughout the Study Area, as well as flowering plants in the coastal and inland waters. The types of vegetation present in the Study Area are described in this section and the affected environmental baseline is discussed in Section 3.3.2 (Affected Environment). The analysis of environmental consequences is presented in Section 3.3.3 (Environmental Consequences), and the potential impacts of Alternative 1 and Alternative 2 are summarized in Section 3.3.4 (Summary of Potential Impacts on Vegetation). Additional information on the biology, life history, and conservation of marine vegetation can be found on the websites of the following agencies and groups:

- National Marine Fisheries Service (NMFS)
- Conservation International
- Algaebase
- National Museum of Natural History

3.3.2 Affected Environment

Three subsections are included in this section. General background information is given in Section 3.3.2.1 (General Background), which provides brief summaries of habitat use and threats that affect or have the potential to affect natural communities of vegetation within the Study Area. Protected species listed under the Endangered Species Act (ESA) are described in Section 3.3.2.2 (Endangered Species Act-Listed Species). General types of vegetation that are not listed under the ESA are briefly reviewed in Section 3.3.2.3 (Species Not Listed under the Endangered Species Act).

3.3.2.1 General Background

3.3.2.1.1 Habitat Use

Factors that influence the distribution and abundance of vegetation in the coastal and open ocean areas of the Study Area are the availability of light, nutrients, salinity, substrate type (important for rooted or attached vegetation), storms and currents, tidal schedule, temperature, and grazing by herbivores (Green & Short, 2003; Short et al., 2007).

Marine ecosystems depend almost entirely on the energy produced by marine vegetation through photosynthesis (Castro & Huber, 2000), which is the transformation of the sun's energy into chemical energy. In the lighted surface waters of the open-ocean and coastal waters, marine algae and flowering plants have the potential to provide oxygen and habitat for many organisms in addition to forming the base of the marine food web (Dawes, 1998).

The affected environment comprises two major ecosystem types - the open ocean and coastal waters, and two major habitat types: the water column and bottom (benthic) habitat. Vegetation grows only in the sunlit portions of the open ocean and coastal waters, referred to as the "photic" or "euphotic" zone, which extends to a maximum depth of roughly 200 meters (m) (National Ocean Service, 2015). Because depth in most of the open ocean exceeds the euphotic zone, benthic habitat for vegetation is limited primarily to the large marine ecosystem landward of the open ocean. The basic taxonomic groupings of vegetation include microalgae (e.g., phytoplankton), macroalgae (e.g., seaweed), submerged rooted vegetation (e.g., seagrass), and emergent wetlands (e.g., cordgrass).

The euphotic zones of the water column in the Study Area are inhabited by phytoplankton, single-celled (sometimes filamentous or chain forming), free-floating algae primarily of four groups including blue-green algae, dinoflagellates, coccolithophores, and diatoms. The importance of each group is summarized below (Levinton, 2013a; Levinton, 2013b):

- Diatoms dominate the phytoplankton at high latitudes. They are single-celled organisms with shells made of silica, which sometimes form chains of cells.
- Blue-green algae are found in and may dominate nearshore waters of restricted circulation and/or brackish (low salinity) waters as well as the open ocean. Blue-green algae convert atmospheric nitrogen to ammonia which can then be taken up by plants and animals.

- Dinoflagellates are covered with cellulose plates that dominate the phytoplankton at low latitudes and in summer and autumn at higher latitudes. Rapid population increases in dinoflagellates can result in "red tides" and "harmful algal blooms." Toxins produced by some dinoflagellates accumulate in the animals that consume them and can cause poisoning among the higher level human and marine mammal consumers.
- Coccolithophores are nearly spherical and secrete a skeleton of calcium carbonate plates. They can be dominant in the phytoplankton of tropical as well as sub-polar seas. They account for approximately one third of calcium carbonate production in the entire ocean.

Other types of algae that can also be abundant in the phytoplankton, although usually less so than the four groups above, include silicoflagellates, green algae, and cryptomonad flagellates (Levinton, 2013c).

Multicellular, macroscopic algae, commonly referred to as seaweeds, include green, brown, and red algae. Seaweeds have complex life histories; the stage that is attached to the hard substrate is called a thallus. The thallus may be attached by means of a specialized structure (the holdfast), and further differentiated into a stem-like structure (stipe), and flattened sections (blades or fronds) that are specialized for light capture, whereas other parts are specialized for reproduction or floatation (Levinton, 2013c).

Algae distributions are shaped by water temperature differences that are directed by the Loop Current, Gulf Stream, and North Atlantic Gyre Open Ocean Areas (Spalding et al., 2003). The number of species and proportion of red, brown, and green algae vary along the coast of the Study Area. The overall number of species of red and green algae is higher than brown algae in the warmer waters of the Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea Large Marine Ecosystems. Brown algae species are more common in the colder waters of the Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems (Dawes, 1998).

Some of the common and ecologically important seaweeds found on shoreline and bottom habitats of the Study Area include the following.

- Sea lettuce (green algae comprising multiple species of Ulva) is abundant on intertidal sand and mudflats as well as on rocky shores throughout the study area. Sea lettuce is an important food source for fish and invertebrates.
- Kelps (brown algae of the genus Laminaria) are dominant on temperate, low intertidal and shallow subtidal rocky shores of the Study Area. Kelp beds are important 3-dimensional habitats for fish and invertebrates.
- Coralline algae (several genera of red algae) incorporate calcite into the thallus – which makes them relatively resistant to grazing - and include both crustose (flat) and foliose (branching) forms. Coralline algae contribute to reef development in tropical environments.

In general, more delicate, highly branched or foliose seaweeds with high surface area are prevalent in low-energy, high-light environments, whereas crustose and robust forms with sturdy thalli and holdfasts are more prevalent in high-energy environment (Levinton, 2013c; Peckol & Searles, 1984).

Finally, large areas of the western tropical to subtropical Atlantic and Gulf of Mexico, in both open ocean and coastal regions, are covered with floating mats of *Sargassum* (a brown alga). *Sargassum* mats are an important source of primary production, and constitute a type of essential fish habitat (Gower & King, 2008; Gower et al., 2013; South Atlantic Fishery Management Council, 2002). In recent years, accumulations of *Sargassum* along the Gulf of Mexico coast of the southern U.S. have led to eutrophication, fish die-offs, and have negatively affected local economies (Doyle & Franks, 2015).

Vascular plants in the Study Area include seagrasses, cordgrasses, and mangroves, all of which have more limited distributions than algae (which are non-vascular), and typically occur in intertidal or shallow (< 40 feet [ft.]) subtidal waters (Green & Short, 2003). The relative distribution of seagrasses is influenced by the availability of suitable substrate occurring in low-wave energy areas at depths that allow sufficient light exposure for growth. Seagrasses as a rule require more light than algae, generally 15 to 25 percent of surface incident light (Fonseca et al., 1998; Green & Short, 2003). Seagrass species distribution is also influenced by water temperatures of the Loop Current, Florida Current, and Gulf Stream (Spalding et al., 2003).

Emergent wetland vegetation of the Study Area is typically dominated by cordgrasses (*Spartina* spp.), which form dense colonies in salt marshes that develop in temperate areas in protected, low-energy environments on soft substrate, along the intertidal portions of coastal lagoons, tidal creeks or rivers, or estuaries, wherever the sediment is adequate to support plant root development (Levinton, 2013e; Mitsch et al., 2009).

Mangroves and cordgrasses have similar requirements, but mangroves are not tolerant of freezing temperatures. Their occurrence on the Atlantic coast of the U.S. is concentrated in tropical and subtropical waters with sufficient freshwater input. Refer to Section 3.3.2.3 (Species Not Listed under the Endangered Species Act) for distribution information.

3.3.2.1.2 General Threats

Environmental stressors on marine vegetation are the result of human activities (industrial, residential, and recreational activities) and natural occurrences (e.g., storms, surf, and tides).

Human-made stressors that act on marine vegetation include excessive nutrient input (such as fertilizers), siltation (the addition of fine particles to the ocean), pollution (oil, sewage, trash) (Mearns et al., 2011), climate change (Arnold et al., 2012; Doney et al., 2012; Martinez et al., 2012; Olsen et al., 2012), fishing practices (Mitsch et al., 2009; Steneck et al., 2002), shading from structures, habitat degradation from construction and dredging (National Marine Fisheries Service, 2002), and introduced or invasive species (Hemminga & Duarte, 2000; Spalding et al., 2003; Williams & Smith, 2007). The seagrass, cordgrass, and mangrove taxonomic group is often more sensitive to stressors than the algal taxonomic groups, and their presence in the Study Area has decreased as a result. A review of seagrass from 1879 to 2006 found that global seagrass coverage decreased by 75 percent overall (Waycott et al., 2009). The great diversity of algae makes generalization difficult, but overall, algae are resilient and are able to colonize disturbed environments created by stressors (Levinton, 2013a).

Areas of tidal marsh are also diminished by sinking substrate, a process known as marsh subsidence. Shoreline development can also have fairly severe impacts on coastal wetland habitats, including accelerated erosion, loss of fringing marshes, and increased scouring and turbidity in nearshore waters (Bozek & Burdick, 2005; National Research Council, 2007). Areal coverage of salt marsh typically dominated by cordgrass on the U.S. Atlantic and Gulf of Mexico coasts decreased dramatically during the 20th century, with additional losses of 1 and 1.8 percent on the Atlantic and Gulf coasts, respectively, from 1998 to 2004 (Stedman & Dahl, 2008). Likewise, the global mangrove resource decreased by 50 percent from aquaculture, changes in hydrology (water movement and distribution), and sea level rise (Feller et al., 2010).

Each type of vegetation is sensitive to additional unique stressors as discussed below.

3.3.2.1.2.1 Water Quality

Water quality in the Study Area is impacted by sedimentation and turbidity as well as the introduction of harmful contaminants. Common ocean pollutants include toxic compounds such as metals, herbicides, and other organic chemicals; excess nutrients from fertilizers and sewage; detergents; oil; and other solids. Coastal pollution and agricultural runoff may cause toxic red tide events in the Study Area (Hayes et al., 2007). Degraded water quality also has the potential to damage seagrass by stimulating algal growth, which results in negative impacts on seagrass habitat such as shading (Thomsen et al., 2012).The majority of seagrass loss mentioned earlier (Waycott et al., 2009) is attributable to anthropogenic stressors, especially large-scale nutrient enrichment and sedimentation which reduces light penetration to the leaf (Dennison et al., 1993; Orth et al., 2006; Stevenson et al., 1993; Steward & Green, 2007; Twilley et al., 1985).

Oil in runoff from land-based sources, natural seeps, and accidental spills (such as off-shore drilling and oil tanker leaks) are some of the major sources of pollution in the marine environment (Levinton, 2013d). The type and amount of oil spilled, weather conditions, season, location, oceanographic conditions, and the method used to remove the oil (containment or chemical dispersants) are some of the factors that determine the severity of the impacts. Sensitivity to oil varies among species and within species, depending on the life stage; generally, early life stages are more sensitive than adult stages (Hayes et al., 1992; Michel & Rutherford, 2013). The tolerance to oil pollutants varies among the types of marine vegetation, but their exposure to sources of oil pollutants makes them all vulnerable.

Oil pollution, as well as chemical dispersants used in response to oil spills, can impact seagrasses directly by smothering the plants, or indirectly by lowering their ability to combat disease and other stressors (Michel & Rutherford, 2013; U.S. National Response Team, 2010). Seagrasses that are totally submerged are less susceptible to oil spills since they largely escape direct contact with the pollutant. Depending on various factors, oil spills can result in a range of effects from no impact to long-lasting impacts, such as decreases in eelgrass density (Kenworthy et al., 1993; Peterson, 2001). Algae are relatively resilient to oil spills, while mangroves are highly sensitive to oil exposure. Contact with oil can cause mangrove death, leaf loss, and failure to germinate (Hoff et al., 2002). Salt marshes (e.g., cordgrass) can also be severely impacted by oil spills, with long-term effects (Culbertson et al., 2008; Michel & Rutherford, 2013).

3.3.2.1.2.2 Commercial Industries

Seagrasses are uprooted by dredging, scarred by boat propellers (Hemminga & Duarte, 2000; Spalding et al., 2003), and uprooted and broken by anchors (Francour et al., 1999). Seagrass that is uprooted can take years to regrow (Dawes et al., 1997). A variety of commercial development, operations, and activities may impact marine vegetation (e.g., oil/gas development, telecommunications infrastructure, wind energy development, shipping and cruise vessels, commercial and recreational fishing, aquaculture, and eco-tourism) (Crain et al., 2009). Commercial activities are conducted under permits and regulations that require companies to avoid and minimize impacts to sensitive vegetation (e.g., seagrass, emergent wetlands). Commercial and recreational fishing in bays and estuaries directly and indirectly impacts seagrass beds and emergent wetlands in shallow coastal waters of the Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems the Study Area. Physical damage to seagrass beds results from anchoring, propeller scarring, and the deployment of traps, trawl gear, and rakes to harvest fish and invertebrates; seagrass beds are slow to recover from damage. Boat wakes in sheltered inland waters can erode shorelines and fringing wetlands that would otherwise be relatively stable (Fonseca & Malhorta, 2012; Parnell et al., 2007). Bottom disturbance incidental to fishing also increases turbidity, reducing seagrass establishment, growth, and recovery from disturbance (Blaber et al., 2000).

Sargassum is harvested as an adjunct for a variety of products including medicines, fertilizer, livestock feed and edible seaweed products. Harvesting too much *Sargassum* is a threat to this resource (McHugh, 2003; Trono & Tolentino, 1993). To maintain this resource, *Sargassum* is managed under the Fishery Management Plan for Pelagic *Sargassum* Habitat of the South Atlantic Region due to its importance as Essential Fish Habitat for numerous species (South Atlantic Fishery Management Council, 2002).

Kelp harvesting for edible seaweed is expanding as an industry in New England, raising concerns about the ecological effects of harvesting on the associated marine animals that depend on kelp beds as habitat. Maine has recently developed a rockweed fishery management plan aimed at ensuring the sustainable use of this resource (Maine Department of Marine Resources, 2014).

Finally, intensifying port development overlaps and threatens seagrass meadows in bays and estuaries throughout the world (Benham et al., 2016). Port development is accompanied by development of surrounding areas which tends to increase runoff and sedimentation; the construction of over-water structures that shade the bottom; and dredging, which eliminates shallow water habitat, reduces light availability by increasing turbidity, and also contributes to sedimentation. Shading and sedimentation have been shown to have combined negative effects on seagrass growth, indicating the potential for large-scale impacts to seagrass ecosystems from port development (Benham et al., 2016).

3.3.2.1.2.3 Disease and Parasites

Diseases and parasites are not known to constitute a major threat to marine vegetation at present.

3.3.2.1.2.4 Invasive Species

Invasive species are those that have been introduced into an area and tend to spread rapidly, often aided by disturbed conditions and the absence of natural enemies, causing ecological and/or economic harm (National Ocean Service, 2015). Invasive species are inadvertently discharged in ballast water, arrive in “fouling” communities on boat hulls, and imported through aquaculture and the aquarium trade. Invasive marine species compete with and displace native marine vegetation, whereas invasive invertebrate and fish species impact native marine vegetation through herbivory and more subtly through the alteration of ecological relationships. Changes in marine vegetation caused by invaders have cascading effects on the associated fish and invertebrate communities. The exact number of invasive species in the Study Area is uncertain but is undoubtedly in the hundreds given that at least 64 have been documented in the Gulf of Maine alone (Gulf of Mexico Fishery Management Council, 2010). At least 17 species of non-native marine algae are established in Massachusetts (Massachusetts Office of Coastal Zone Management, 2013).

Examples of invasive species’ impacts on vegetation in the Study Area include an invasive seagrass, *Halophila stipulacea*, from the Indian Ocean, that has recently become established in the Eastern Caribbean and is displacing the native seagrass, *Syringodium filiforme* (Willette & Ambrose, 2012). In emergent wetlands, cordgrasses are damaged by storms and have been replaced in many locations along the Atlantic coast in recent decades by an invasive non-native genotype of the common reed (*Phragmites australis*). Whereas the native common reed is restricted to the upper fringes of salt marshes, the non-native genotype spreads throughout the intertidal zone and into freshwater marshes, displacing a variety of emergent wetland plants and altering the structure and function of marsh communities (Levinton, 2013a).

3.3.2.1.2.5 Climate Change

The impacts of anthropogenically induced climate change on the marine environments include rising sea levels, ocean acidification, increased sea temperature, and an increase in severe weather events. All of these changes may have impacts on vegetation in the Study Area. As described by Harley et al. (2006), "Abiotic changes in the environment have direct impacts on dispersal and recruitment, and on individual performance at various stages in the life cycle. Additional effects are felt at the community level via changes in the population size and per capita effects of interacting species. The proximate ecological effects of climate change thus include shifts in the performance of individuals, the dynamics of populations, and the structure of communities. Taken together, these proximate effects lead to emergent patterns such as changes in species distributions, biodiversity, productivity, and microevolutionary processes provide a general model of potential ecological responses to climate change."

The most obvious consequence of sea level rise will be an upward shift in species distributions, but this can only occur along natural or undisturbed shorelines, where the overall photic zone can move upslope with sea level rise. Under such conditions, most species are expected to be able to keep pace with predicted rates of sea level rise, with the exception of some slow-growing, long lived species such as many corals (Knowlton & Kraus, 2001). The effect of sea level rise on bottom illumination is more significant along shorelines with artificial vertical stabilization (e.g., bulkheads, sea walls) that prevent upslope movement of shallow, nearshore habitats (Harley et al., 2006). However, dramatic ecological changes could result from decreased habitat availability within a particular depth zone. For example, intertidal habitat area may be reduced by 20 - 70 percent over the next 100 years in ecologically important North American bays, where steep topography and anthropogenic structures (e.g. sea walls) prevent the inland migration of mudflats and sandy beaches (Galbraith et al., 2005)). Sea level rise may also reduce the spatial extent of biogenic habitat by outpacing the accretion rates of marshes and coral reefs (Knowlton & Kraus, 2001; Rabalais et al., 2002).

Rising sea levels will alter the amount of sunlight reaching various areas, which may decrease the photosynthetic capabilities of vegetation in those areas. However, the fast growth and resilient nature of vegetation may enable most species to adapt to these changes (Harley et al., 2006). Increased sea temperature may lead to several impacts that could affect vegetation. Warmer waters may lead to a greater stratification in the water column which may support harmful algal blooms (World Ocean Review, 2015). The stratification may also inhibit upwelling, as seen during El Niño events, which would prevent nutrients from circulating to the surface (Lehmköster, 2015; World Ocean Review, 2015). Additionally, increased sea temperatures may lead to changes in the composition of vegetation communities (Schiel et al., 2004). Increases in severe weather events may lead to increased erosion and sedimentation in the marine environments and higher energy wave action (Coelho et al., 2009).

Vegetation is susceptible to water quality changes from erosion and disturbances from storm events. Increased storm events are expected to have negative impacts on the species diversity in kelp ecosystems (Byrnes et al., 2011). The impacts of ocean acidification on vegetation are poorly understood (Harley et al., 2006).

3.3.2.1.2.6 Marine Debris

Marine debris is not a threat to vegetation.

3.3.2.2 Endangered Species Act-Listed Species

One species of vegetation federally listed as endangered, threatened, candidate, or proposed under the ESA potentially occurs in the Study Area. That species, Johnson's seagrass (*Halophila johnsonii*) (listed as threatened), is described below.

3.3.2.2.1 Johnson's seagrass (*Halophila johnsonii*)

3.3.2.2.1.1 Status and Management

In 1998, Johnson's seagrass was the first marine plant species to be designated as federally threatened under the ESA by NMFS (*Federal Register* 63[117]: 49035-49041, September 14, 1998). In 2000, 10 areas in southeast Florida were designated as critical habitat (*Federal Register* 65[66]: 17786-17804, April 5, 2000); see Figure 3.3-1. The general physical and biological features of the critical habitat areas are "adequate water quality, salinity levels, water transparency, and stable, unconsolidated sediments that are free from physical disturbance" (*Federal Register* 65[66]: 17786-17804, April 5, 2000). Designated critical habitat areas also fulfill one or more of the following five criteria (*Federal Register* 65[66]: 17786-17804, April 5, 2000):

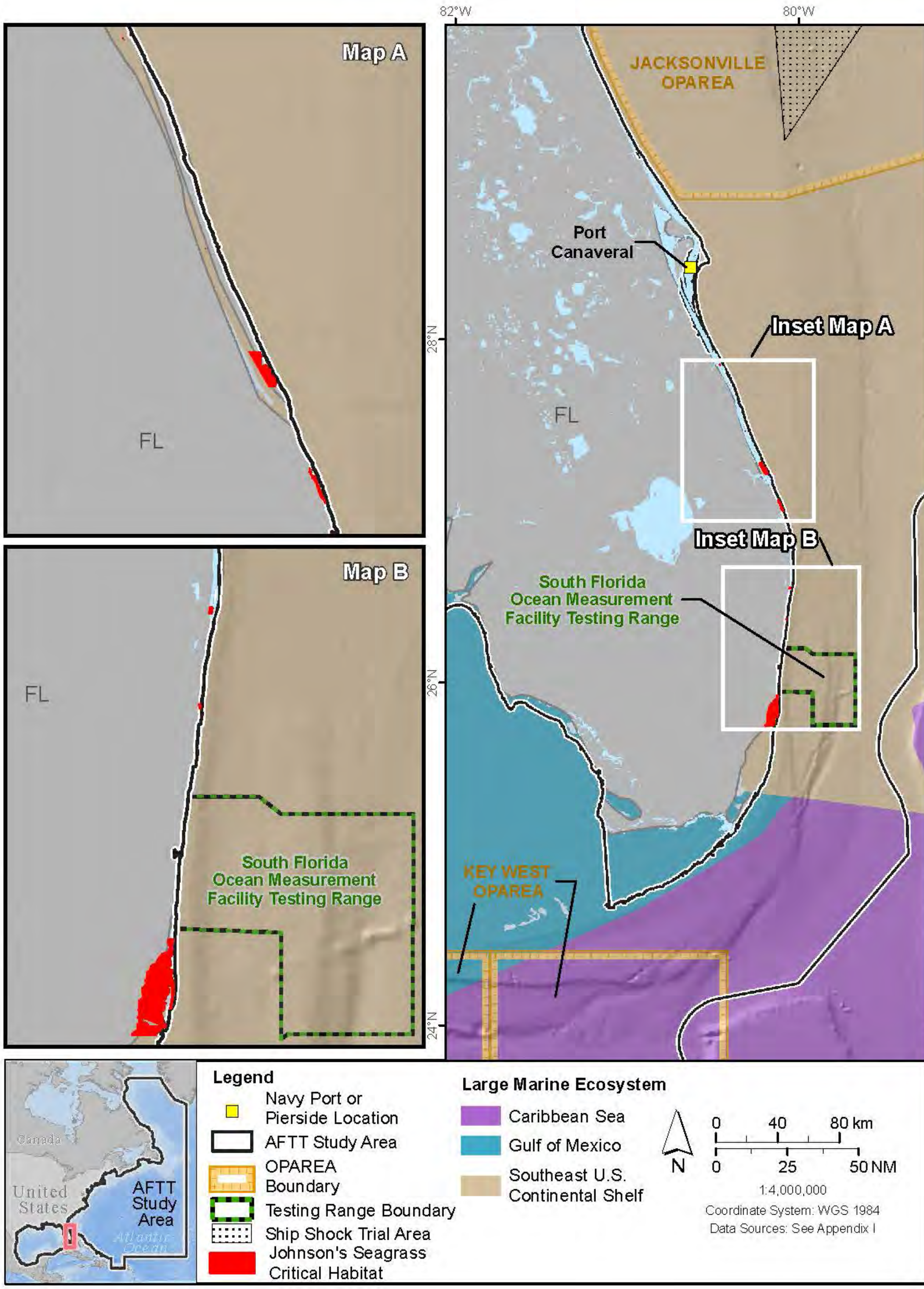
- locations with populations that have persisted for 10 years,
- locations with persistent flowering plant populations,
- locations at the northern and southern range limits of the species,
- locations with unique genetic diversity, and
- locations with a documented high abundance of Johnson's seagrass compared to other areas in the species' range.

3.3.2.2.1.2 Habitat and Geographic Range

The preferred habitat for Johnson's seagrass is coastal lagoons and bays, from the area covered at high tide to depths of up to 3 m (National Marine Fisheries Service, 2002). It is found year-round in sediments of loose sand and silt-clay in beds with other species of seagrass (Creed et al., 2003; Eiseman & McMillan, 1980).

Johnson's seagrass has a disjunct and patchy distribution along the southeast coast of Florida in the Southeast U.S. Continental Shelf Large Marine Ecosystem. This species is not found in any other large marine ecosystem or in any open ocean areas. It is reported to occur between 11.5 NM north of Sebastian Inlet (Indian River Lagoon) and Biscayne Bay on the southeast coast of Florida in lagoons and bays (Florida Department of Environmental Protection, 2010a; National Marine Fisheries Service, 2002). Although the geographic range of the species overlaps the Study Area, designated critical habitat areas do not; they are more limited and occur in parts of the Indian River Lagoon and Biscayne Bay in Florida (Figure 3.3-1). A recent study reported Johnson's seagrass north of Sebastian Inlet, which extends the northern limit of this species by 11.5 nautical miles (NM); the extension is considered temporary and only expected to occur under favorable conditions (Virnstein & Hall, 2009).

No training or testing activities are proposed in the lagoons or bays where Johnson's seagrass occurs and they do not overlap with the critical habitat of this species. The naval facilities at Port Canaveral and the South Florida Ocean Measurement Facility Testing Range are the closest Navy training and testing areas to the distribution of Johnson's seagrass. Taking the northern extension into consideration, the northern limit for Johnson's seagrass is estimated to be 22 NM away from Port Canaveral.



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

Figure 3.3-1: Designated Critical Habitat Areas for Johnson's Seagrass Adjacent to the Study Area

The South Florida Ocean Measurement Facility Testing Range is less than 2 NM away from Johnson's seagrass critical habitat.

3.3.2.2.1.3 Population Trends

There are an estimated 502,000 acres (ac) of Johnson's seagrass between Sebastian Inlet and Biscayne Bay, Florida (Florida Department of Environmental Protection, 2010a; National Marine Fisheries Service, 2002). Population and abundance trends for this species are difficult to approximate due to its fairly recent identification as a distinct species (Eiseman & McMillan, 1980), short-lived nature, and rareness of quantitative population data (Creed et al., 2003; National Marine Fisheries Service, 2002; Virnstein et al., 2009). Since the 1970s, seagrass species have decreased by approximately 50 percent in the Indian River Lagoon, which constitutes a large part of the range for Johnson's seagrass (Woodward-Clyde Consultants, 1994). This decline of seagrasses in the Indian River Lagoon was likely due to human impacts on water quality and marine substrates (Woodward-Clyde Consultants, 1994). Compared to other seagrasses within its range in the Indian River area (Hobe Sound, Jupiter Sound, and Fort Pierce Inlet), Johnson's seagrass is the least abundant (Virnstein et al., 1997; Virnstein & Hall, 2009).

3.3.2.2.1.4 Species-Specific Threats

Johnson's seagrass is vulnerable to the threats to seagrasses discussed in Section 3.3.2.1.2 (General Threats). This species is especially vulnerable to these threats because of its limited distribution and reproductive capability (no seed production), which result in its limited potential for recovery (National Marine Fisheries Service, 2002).

3.3.2.3 Species Not Listed Under the Endangered Species Act

Vegetation within the Study Area is comprised of many thousands of species of plants spanning many taxonomic groups (taxonomy is a method of classifying and naming organisms). For this analysis, vegetation has been divided into eight major taxonomic groups, referred to as phyla (plural of phylum), that have distinct morphological, biochemical, physiological, and life history traits that reflect their evolutionary history and influence their distributions and ecological relationships. Table 3.3-1 below provides general descriptions of these major vegetation groups in the Study Area and their vertical distributions. Subsections following Table 3.3-1 describe these groups in more detail. The distribution and condition of abiotic (non-living) substrate associated with habitats for attached macroalgae and rooted vascular plants (e.g., seagrass), and the impact of stressors are described in Section 3.5 (Habitats).

Table 3.3-1: Major Groups of Vegetation in Study Area

Major Vegetation Groups		***Distribution within Study Area[2]***		
Common Name[1] (Taxonomic Group)	***Description***	***Open Ocean***	***Large Marine Ecosystem***	***Inland Waters***
Blue-green algae (phylum Cyanobacteria)	Photosynthetic bacteria that are abundant constituents of phytoplankton and benthic algal communities, accounting for the largest fraction of carbon and nitrogen fixation by marine vegetation; existing as single cells or filaments, the latter forming mats or crusts on sediments and reefs.	Water column	Water column, bottom	Water column, bottom

Table 3.3-1: Major Groups of Vegetation in Study Area (continued)

Major Vegetation Groups		***Distribution within Study Area***[2]		
Common Name[1] ***(Taxonomic Group)***	***Description***	***Open Ocean***	***Large Marine Ecosystem***	***Inland Waters***
Dinoflagellates (phylum Dinophyta [Pyrrophyta])	Most are single-celled, marine species of algae with two whip-like appendages (flagella). Some live inside other organisms, and some produce toxins that can result in red tide or ciguatera poisoning.	Water column	Water column	Water column
Green algae (phylum Chlorophyta)	May occur as single-celled algae, filaments, and seaweeds.	None	Water column, bottom	Water column, bottom
Coccolithophores (phylum Haptophyta [Chrysophyta, Prymnesiophyceae])	Single-celled marine phytoplankton that surround themselves with microscopic plates of calcite. They are abundant in the surface layer and are a major contributor to global carbon fixation.	Water column	Water column	Water column
Diatoms (phylum Ochrophyta [Heterokonta, Chrysophyta, Bacillariophyceae])	Single-celled algae with a cylindrical cell wall (frustule) composed of silica. Diatoms are a primary constituent of the phytoplankton and account up to 20 percent of global carbon fixation.	Water column	Water column, bottom	Water column, bottom
Brown algae (phylum Phaeophyta [Ochrophyta])	Brown algae are large multi-celled seaweeds that include vast floating mats of *Sargassum*.	Water column	Water column, bottom	Water column, bottom
Red algae (phylum Rhodophyta)	Single-celled algae and multi-celled large seaweeds; some form calcium deposits.	Water column	Water column, bottom	Water column, bottom
Vascular plants (phylum Tracheophyta)	Includes seagrasses, cordgrass, mangroves and other rooted aquatic and wetland plants in marine and estuarine environments, providing food and habitat for many species.	None	Bottom	Bottom

Notes: [1]Taxonomic groups are based on Roskov et al. (2015); (Ruggiero & Gordon, 2015). Alternative classifications are in brackets []. Phylum and division may be used interchangeably.
[2]Vertical distribution in the Study Area is characterized by open-ocean oceanographic features (Labrador Current, Gulf Stream, and North Atlantic Gyre) or by coastal waters of large marine ecosystems (Caribbean Sea, Gulf of Mexico, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, and West Greenland Shelf).

3.3.2.3.1 Blue-Green Algae (Phylum Cyanobacteria)

Blue-green algae are photosynthetic bacteria that include single-celled and filamentous forms that inhabit the lighted surface water and seafloor of the world's oceans (Roskov et al., 2015). Like other bacteria, they are *prokaryotes* – their cells lack internal membrane-bound organelles such as a nucleus and they do not reproduce by mitosis. The remaining groups of plants discussed below are *eukaryotes* – whose cells have internal organelles and reproduce by mitosis. Blue-green algae are important primary producers, accounting for much of the carbon (and nitrogen) fixation and oxygen production in the ocean. More than 1,000 species of blue-green algae occur in the Study Area (Castro & Huber, 2000).

Blue-green algae are an important food source for both zooplankton (free-floating animals) and grazing organisms (e.g., mollusks: chitons and limpets) on the seafloor. Blue-green algae occur in all large marine ecosystems, open ocean areas, and inland waters (e.g., lower Chesapeake Bay, Narragansett Bay, and St. Andrew Bay) of the Study Area. Common species of blue-green algae that occur in the Study Area are *Microcystis aeruginosa* and members of the genus *Synechococcus*.

3.3.2.3.2 Dinoflagellates (Phylum Dinophyta)

Dinoflagellates are single-celled, predominantly marine algae (Roskov et al., 2015). Together with diatoms and coccolithophorids, they constitute the majority of marine eukaryotic phytoplankton (Marret & Zonneveld, 2003). Thousands of species live in the surface waters of the Study Area (Castro & Huber, 2000). Most dinoflagellates are photosynthetic, and many can also ingest small food particles. They occur in all large marine ecosystems, open ocean areas, and inland waters of the Study Area. Photosynthetic dinoflagellate symbionts (zooxanthellase) live inside corals and are essential to calcification and reef-building. Organisms such as zooplankton feed on dinoflagellates. Some dinoflagellates produce toxins and are responsible for some types of harmful algal blooms caused by sudden increases of nutrients (e.g., fertilizers) from land into the ocean or changes in temperature and sunlight (Levinton, 2013d). Additional information on harmful algal blooms can be accessed on the Centers for Disease Control and the National Oceanic and Atmospheric Administration websites. Common species of dinoflagellates that occur in the Study Area are *Polysphaeridium zoharyi* and *Tectatodinium pellitum* (Marret & Zonneveld, 2003).

3.3.2.3.3 Green Algae (Phylum Chlorophyta)

Green algae include single-celled and multi-celled types that form sheets or branched structures (Roskov et al., 2015). These multi-celled types of green algae are referred to as macroalgae (seaweed) (National Oceanic and Atmospheric Administration, 2011). Hundreds of marine species of green algae are common in well-lit, shallow water. Green seaweeds, like most macroalgae, are found attached to hard to intermediate (gravel to cobble-sized particles) substrate throughout the Study Area, although some species occur on firm sand and mud (Levinton, 2013d). Other types of green single-celled algae are planktonic (float freely in the ocean) and are found in the surface waters of the open ocean areas of the Study Area in addition to the areas where the macroalgae occur. Green algae species are eaten by various organisms, including zooplankton and snails. Some common species of green algae that occur in the Study Area are sea lettuce (*Ulva lactuca*) and members of the genus *Enteromorpha*.

3.3.2.3.4 Coccolithophores (Phylum Haptophyta)

Coccolithophores are single-celled phytoplankton that are especially abundant in tropical oceans but also bloom seasonally at higher latitudes. They are nearly spherical and covered with plates made of calcite (calcium carbonate) which account for approximately one-third of calcium carbonate production. They are an often-abundant component of the phytoplankton and account for a large fraction of primary production and carbon sequestration in the ocean. Blooms produce a strong bluish-white reflection that may cover thousands of square miles (Levinton, 2013a).

3.3.2.3.5 Diatoms (Phylum Ochrophyta)

Diatoms are primarily planktonic (although many species are benthic), single-celled organisms with cell walls made of silica (Castro & Huber, 2000). Approximately 6,000 species of marine diatoms are known. Diatoms occur in the lighted areas - the upper 200 m (see Figure 3.0-3 in Section 3.0.2.2, Bathymetry) – of the water column and benthic habitat throughout the Study Area. Diatoms also contribute significantly to the long-term sequestration of carbon in the oceans and are a major food source for zooplankton. The silica content of diatom cells has been shown to significantly affect zooplankton grazing, growth, and reproduction rates; rates are reduced when silica content is higher (Liu et al., 2016).

3.3.2.3.6 Brown Algae (Phylum Phaeophyta)

Brown algae are predominately marine species with structures varying from fine filaments to thick leathery forms (Castro & Huber, 2000). Most species are attached to the seafloor in coastal waters although a free-floating type of brown algae, *Sargassum* (*Sargassum* spp.) occurs in the Study Area. Another major type of brown macroalgae that occurs in the Study Area is kelp (*Laminaria* spp.). Kelp and *Sargassum* are discussed in more detail below.

3.3.2.3.6.1 Kelp

Kelp is a general term that refers to brown algae of the order Laminariales. Kelp plants are made of three parts: the leaf-like blade(s), the stipe (a stem-like structure), and the holdfast (a root-like structure that anchors the plant to the bottom). Kelps are represented by three macroalgae species in the Study Area: *Laminaria saccharina, Laminaria longicruris*, and *Laminaria digitata* (Egan & Yarish, 1988). These species are prostrate; their blades form low beds covering the bottom (Steneck et al., 2002). Kelp are anchored to hard surfaces on the seafloor (Levinton, 2013a). These kelp species occur from the low tide line out to depths as great as 65 ft. (20 m) depending on the water clarity (Luning, 1990; Steneck et al., 2002) along the rocky, northwest Atlantic shores in large subtidal stands where sufficient nutrients are available (Vadas et al., 2004). In the Study Area, *Laminaria* spp. occur from Greenland to Long Island in the Newfoundland-Labrador Shelf and Scotian Shelf Large Marine Ecosystems, and in the northern part of the Northeast U.S. Continental Shelf Large Marine Ecosystem (Mathieson et al., 2009; Steneck et al., 2002). In Long Island Sound, one of the most extensive kelp beds, consisting of *Laminaria longicuris*, is at Black Ledge, Groton, Connecticut, just offshore of the Thames River Estuary. Growth rates of 1 inch (in.) (2.5 centimeters [cm]) per day were measured at this location, which is also at the southern limit for kelp in the Study Area (Egan & Yarish, 1990).

The primary productivity and structural complexity of kelp forests support diverse communities of fish and invertebrates. In addition, kelp beds are extremely important in moderating the effects of wave action on shorelines. Organisms such as sea urchins and crustaceans feed on kelp (Steneck et al., 2002).

3.3.2.3.6.2 *Sargassum*

The dominant open-ocean species of *Sargassum* in the Study Area are *Sargassum natans* and *Sargassum fluitans*. These species float freely on the sea surface and grow in clumps and mats (Coston-Clements et al., 1991). Accumulations of *Sargassum* are vital to some species and economically important to commercial fisheries and other industries. It provides foraging areas and habitat for marine organisms (e.g., sea turtles, birds, and fish) and raw materials for fertilizers and medicines (South Atlantic Fishery Management Council, 2002). Designated critical habitat for loggerhead sea turtles (*Caretta caretta*) includes *Sargassum* habitat, defined as developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially Sargassum (National Marine Fisheries Service, 2014). See Sections 3.6 (Fishes), 3.7 (Marine Mammals), 3.8 (Reptiles), and 3.9 (Birds), for more information.

Over-harvesting of *Sargassum* is a threat to this resource (McHugh, 2003; Trono & Tolentino, 1993). To maintain this resource, *Sargassum* is managed under the Fishery Management Plan for Pelagic

Sargassum Habitat of the South Atlantic Region due to its importance as Essential Fish Habitat for numerous species (South Atlantic Fishery Management Council, 2002).

In the Study Area, *Sargassum* is widely distributed in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems, and in the Gulf Stream and North Atlantic Gyre Open Ocean Areas. In the North Atlantic, *Sargassum* occurs mainly within the physical bounds of the North Atlantic Gyre Open Ocean Area (see Figure 3.0-1), between latitudes 20 degrees (°) N and 40° N, and between longitude 30° W and the western edge of the Gulf Stream—a region known as the Sargasso Sea (Gower et al., 2006; South Atlantic Fishery Management Council, 2002). Some exchange occurs among the *Sargassum* populations in the Caribbean Sea, Gulf of Mexico, and the North Atlantic. Recent satellite image evidence suggests that *Sargassum* originates in the northwest Gulf of Mexico every spring and is moved into the Atlantic east of Cape Hatteras in late summer by the Loop Current and Gulf Stream, and later appears northeast of the Bahamas in the beginning of the next year (Gower & King, 2008). See Section 3.0.2.3 (Currents, Circulation Patterns, and Water Masses) for more information on the Loop Current and Gulf Stream.

The difficulty of tracking and sampling *Sargassum* makes acquiring information about its distribution and abundance difficult. Estimates based on towed net samples for the North Atlantic range from 4.4 to 12 million U.S. tons (Butler et al., 1983; South Atlantic Fishery Management Council, 2002). A more recent estimate based on satellite imaging data puts the average total mass of *Sargassum* at 2 million U.S. tons in the Gulf of Mexico and the Atlantic (1 million U.S. tons in each) (Gower & King, 2008). Using the low and high abundance estimates (2 million U.S. tons to 12 million U.S. tons) and a conversion factor of 25 grams per square meter of *Sargassum* (Gower et al., 2006), approximately 21,000 square nautical miles (NM^2) to 130,000 NM^2 of the Study Area is covered by *Sargassum*. Given the size of the Study Area (approximately 2.6 million NM^2), the relative coverage of *Sargassum* ranges from less than 1 percent to 5 percent of the sea surface.

3.3.2.3.7 Red Algae (Phylum Rhodophyta)

Red algae are predominately marine, with approximately 4,000 species of microalgae worldwide (Castro & Huber, 2000). Red macroalgae species have various forms from fine filaments to thick calcium carbonate crusts and require a surface to attach to such as hard bottom or another plant. Red macroalgae and some microalgae species are found attached to the seafloor or on sediment, respectively, in all of the large marine ecosystems and the inland waters of the Study Area (Adey & Hayek, 2011; Levinton, 2013a). Planktonic microalgae are present in the surface waters of the open ocean areas of the Study Area in addition to the areas where the macroalgae occur. Some common species of red algae that occur in the Study Area are in the genus *Lithothamnion* (crustose coralline algae). Red algae are a food source for various zooplankton, sea urchins, fishes, and chitons.

3.3.2.3.8 Seagrasses, Cordgrasses, and Mangroves (Phylum Spermatophyta)

3.3.2.3.8.1 Seagrasses

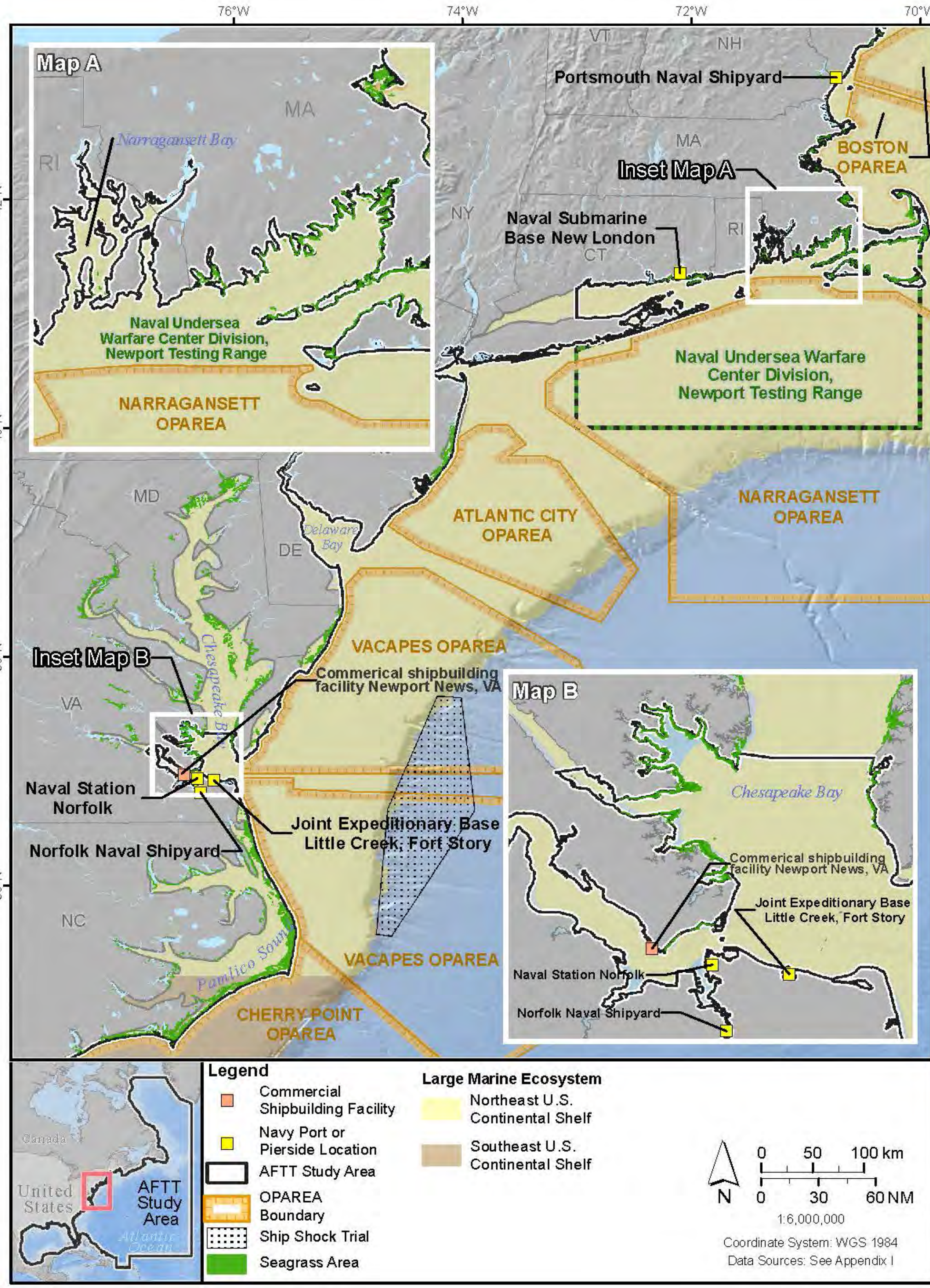
Seagrasses are unique among flowering plants in their ability to grow submerged in shallow marine environments. Seagrasses grow predominantly in shallow, subtidal, or intertidal sediments sheltered from wave action in estuaries, lagoons, and bays (Phillips & Meñez, 1988) and can extend over a large area to form seagrass beds (Garrison, 2004; Gulf of Mexico Program, 2004; Phillips & Meñez, 1988). Seagrasses, including ESA-listed Johnson's seagrass, serve as a food source for numerous species (e.g., green sea turtles, West Indian manatees, and various plant-eating fishes) (Heck et al., 2003; National Marine Fisheries Service, 2010). Seagrasses also constitute essential fish habitat for managed fisheries and are important as nursery habitat for juvenile stages along the eastern seaboard (South Atlantic Fishery Management Council, 2009). Seagrass meadows may provide an "acoustic refuge" for fish by impeding the transmission of high-frequency clicks used by bottlenose dolphins to detect fish, while enhancing the transmission of low-frequency sounds used in fish communication (Wilson et al., 2013).

Seagrasses occur in all Atlantic and Gulf of Mexico coastal states, except for Georgia and South Carolina (Fonseca et al., 1998). In the Study Area, seagrasses grow from the intertidal zone to a maximum depth of 295 ft. (90 m) as reported for *Halophila engelmannii* in the clear, protected waters off southern Florida (Ferguson & Wood, 1994; Florida Department of Environmental Protection, 2010b; Fourqurean et al., 2002; Green & Short, 2003; Gulf of Mexico Program, 2004). Depth limits for seagrasses in inland portions of the Study Area are 6 m in Narragansett Bay (Narragansett Bay Estuary Program, 2010), 1 m in Chesapeake Bay (Orth & Moore, 1988), and 2.4 m in St. Andrew Bay (Florida Department of Environmental Protection, 2010b). The largest area of seagrass in the Study Area occurs in the Gulf of Mexico Large Marine Ecosystem, followed by the Southeast U.S. Continental Shelf, and the Northeast U.S. Continental Shelf Large Marine Ecosystems (see Figure 3.3-2 through Figure 3.3-4 and Table 3.3-2) (Spalding et al., 2003). The vast majority of the mapped seagrass area is located within inland waters or very close to shore in the nearshore-estuarine environment; unvegetated beaches or vegetated rocky shores border the vast majority of the oceanic/marine portion of the Study Area.

Table 3.3-2: Presences of Seagrass Species within the Study Area

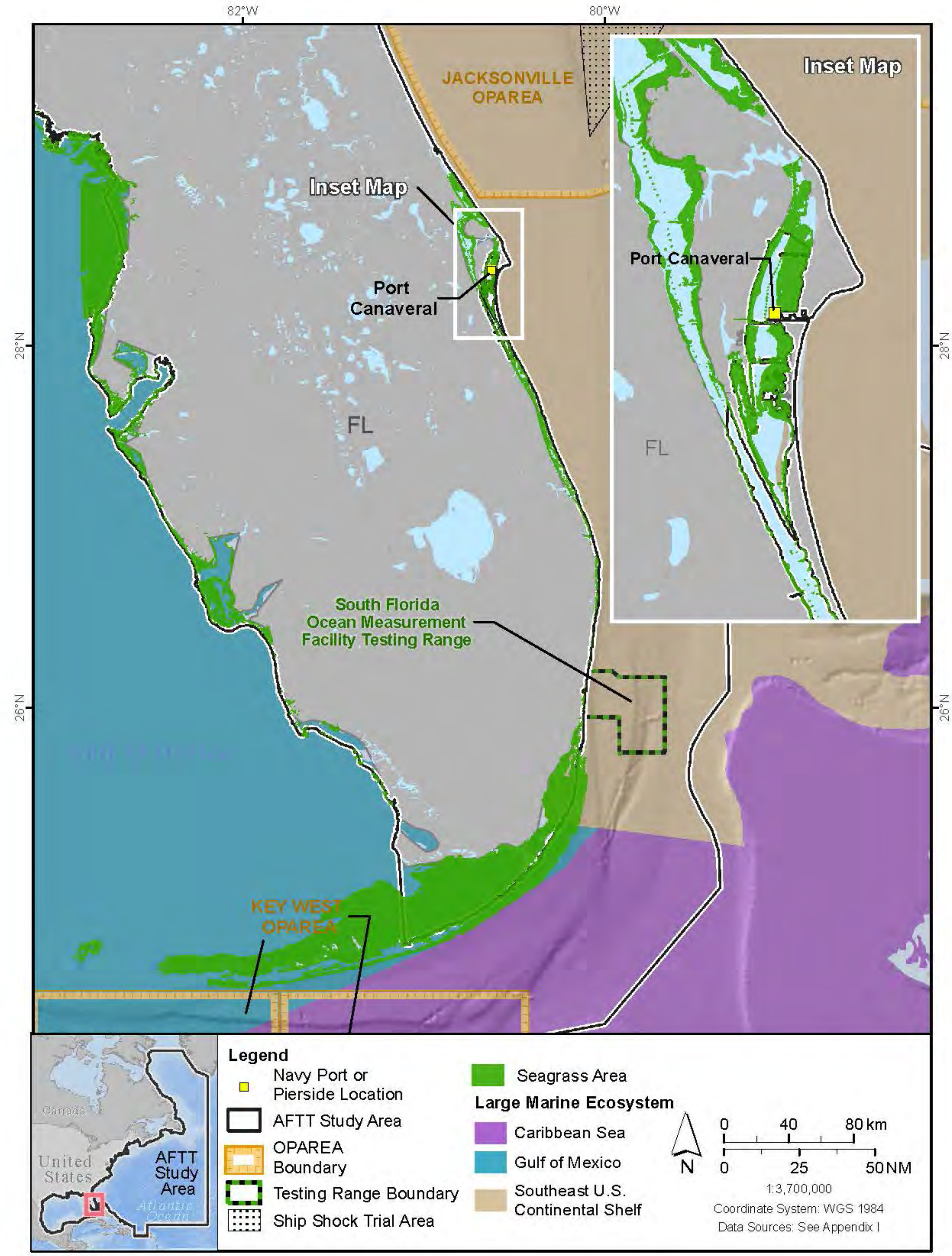
Seagrass Species	***Presence in the Study Area[1]***
Clover grass (*Halophila baillonii*)	Gulf of Mexico, Caribbean Sea
Eelgrass (*Zostera marina*)	West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf
Engelmann's seagrass (*Halophila engelmannii*)	Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea
Johnson's seagrass (*Halophila johnsonii*)	Southeast U.S. Continental Shelf
Manatee grass (*Syringodium filiforme*)	Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea
Paddle grass (*Halophila decipiens*)	Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea
Shoal grass (*Halodule wrightii*)	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea
Turtlegrass (*Thalassia testudinum*)	Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea
Widgeon grass (*Ruppia maritima*)	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea

Note(s): [1]Presence in the Study Area indicates the coastal waters of large marine ecosystems (Gulf of Mexico, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Caribbean Sea, Scotian Shelf, Newfoundland-Labrador Shelf, and West Greenland Shelf) in which the species are found.
Source(s): Spalding et al. (2003)



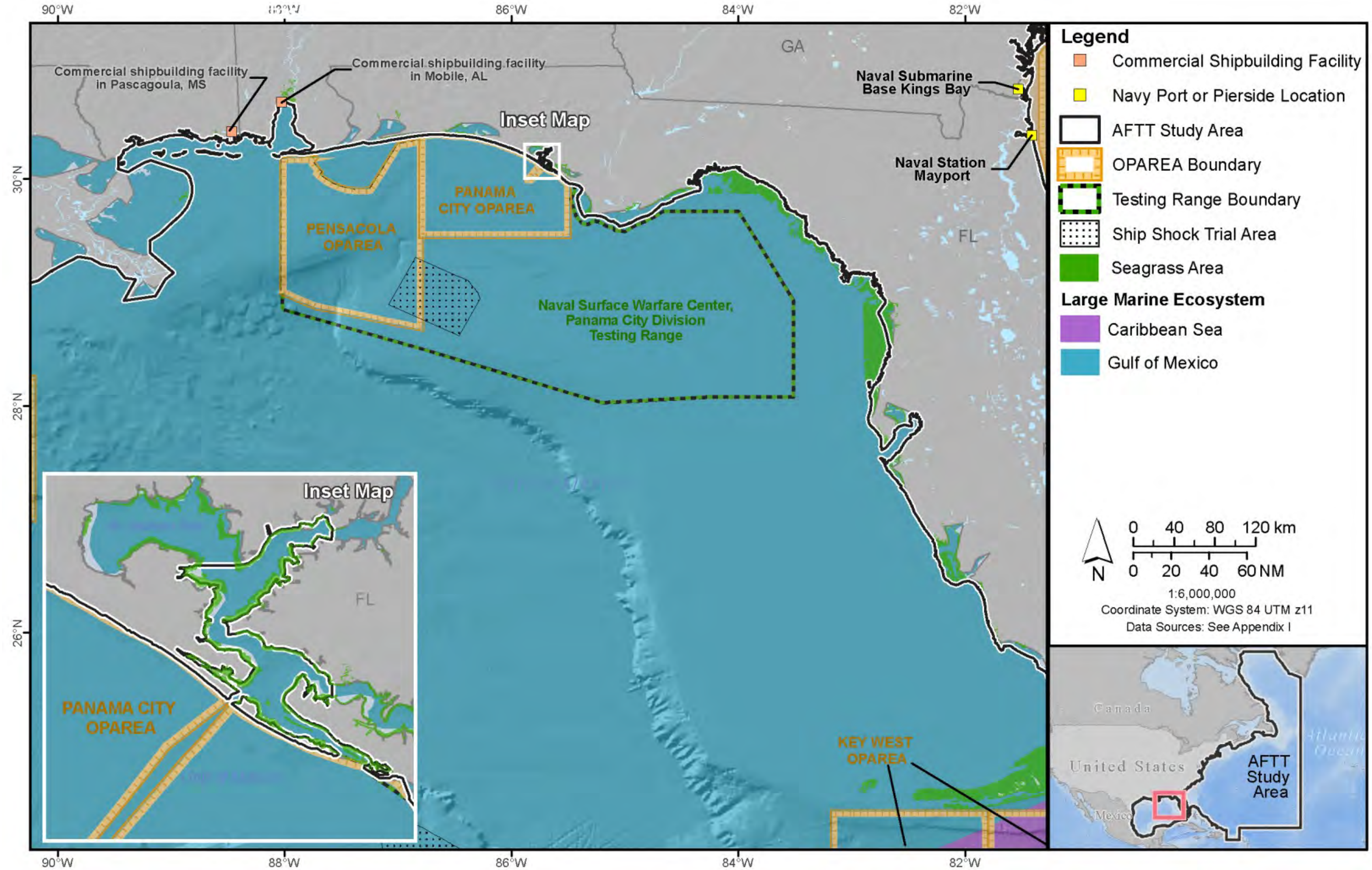
Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

Figure 3.3-2: Seagrass Occurrence in Mid Atlantic and New England



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

Figure 3.3-3: Seagrass Occurrence in South Florida



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

Figure 3.3-4: Seagrass Occurrence in the Gulf of Mexico

3.3.2.3.8.2 Cordgrasses

The most common plant species of salt and brackish marshes in the Study Area is known as smooth or salt-marsh cordgrass (*Spartina alterniflora)* (Mitsch et al., 2009). Cordgrasses and other emergent marsh species are salt-tolerant, moderate-weather (temperate) species and an integral component of salt marsh vegetation. Salt and brackish marshes develop in intertidal, protected low-energy environments, usually in coastal lagoons, tidal creeks or rivers, or estuaries. The difference between salt and brackish marsh is based on salinity, reflecting the amount of freshwater inflow: salt marshes have salinities of 18 - 30 parts per thousand (ppt), whereas brackish marshes have salinities of 0.5 -18 ppt (Mitsch et al., 2009).

Salt and brackish marshes are the dominant coastal wetland types along much of the Atlantic and Gulf Coasts of the U.S. Cordgrasses occur in salt marshes from Maine to Florida, and along the Gulf of Mexico from Louisiana to Texas (Mitsch et al., 2009). On shorelines bordering the Study Area, the largest areas of cordgrass-dominated salt marsh are in the Gulf of Mexico Large Marine Ecosystem, covering an estimated 2,498,225 ac (1,011,000 hectares [ha]), while an additional 1,653,130 ac (669,000 ha) of salt marsh occurs in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems (Watzin & Gosselink, 1992). The vast majority of marsh shoreline, however, is located within inland waters along soft shorelines, mostly outside of the Study Area, e.g., upstream in tidal creeks and on the upper part of the shore (detailed maps are provided in the Essential Fish Habitat Assessment). Beaches or rocky shores border the vast majority of the oceanic portion of the Study Area (Spalding et al., 2003).

3.3.2.3.8.3 Mangroves

Mangroves are a group of woody plants that have adapted to estuarine environments (where salt water and freshwater mix) (Ruwa, 1996). Mangroves inhabit marshes and mudflats in tropical and subtropical areas. Within the Study Area, three mangrove species occur in the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems (Table 3.3-3). Mangroves occur from Cedar Key to Cape Canaveral, Florida (Mitsch et al., 2009). The northern limit for mangroves in Florida is St. Augustine. The largest continuous tract of mangrove forest in the Study Area is found in the Florida Everglades system (U.S. Geological Survey, 2003).

Table 3.3-3: Presence of Mangrove Species in the Study Area

Mangrove Species	*Presence in the Study Area*[1]
Red mangrove (*Rhizophora mangle*)	Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea
Black mangrove (*Avicennia germinans*)	Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea
White mangrove (*Laguncularia racemosa*)	Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea

Sources: (Ellison et al., 2007a, 2007b, 2007c)

Notes: [1]Presence in the Study Area indicates the coastal waters of large marine ecosystems (Gulf of Mexico, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Caribbean Sea, Scotian Shelf, Newfoundland-Labrador Shelf, and West Greenland Shelf) in which the species are found.

3.3.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially impact vegetation known to occur within the Study Area. Tables 2.6-1 through 2.6-4 present the baseline and proposed typical training and testing activity locations for each alternative (including number of events). General characteristics of all Navy stressors were introduced in Section 3.0.3.3 (Identifying Stressors for Analysis), and the susceptibility to stressors for living resources were introduced in Section 3.0.3.6 (Biological Resource Methods). The stressors vary in intensity, frequency, duration, and location within the Study Area. Each stressor is discussed below, and those that are applicable (having potential impacts) to vegetation are listed below and analyzed for impacts.

- **Explosives** (explosions in air, explosions in water)
- **Physical disturbance and strikes** (vessels and in-water devices, aircraft and aerial targets, military expended materials, seafloor devices, pile driving)
- **Secondary stressors** (impacts to habitat, impacts to prey availability)

The analysis includes consideration of the mitigation that the Navy will implement to avoid potential impacts on vegetation from explosives and from physical disturbance and strikes. Mitigation for vegetation will be coordinated with NMFS through the consultation processes.

3.3.3.1 Acoustic Stressors

Acoustic stressors are not applicable to vegetation because of the lack of hearing capabilities of vegetation and will not be analyzed in this section.

3.3.3.2 Explosive Stressors

3.3.3.2.1 Impacts from Explosives

Various types of explosives are used during training and testing activities. The type, number, and location of activities that use explosives are described in Section 3.0.3.3.2 (Explosive Stressors) and the resulting footprints on bottom habitats are quantified in Appendix F (Military Expended Materials and Direct Strike Impact Analysis) and summarized in Section 3.5 (Habitats). Most detonations would occur in waters greater than 200 ft. in depth and more than 3 NM from shore.

The potential for an explosion to injure or destroy vegetation would depend on the amount of vegetation present, the number of munitions used, and their net explosive weight. In areas where vegetation and locations for explosions overlap, vegetation on the surface of the water, in the water column, or rooted in the seafloor may be impacted.

Single-celled algae likely overlap with underwater and sea surface explosion locations. If single-celled algae are in the immediate vicinity of an explosion, only a small number of them are likely to be impacted relative to their total population level. Additionally, the extremely fast growth rate and ubiquitous distribution of phytoplankton (Caceres et al., 2013; Levinton, 2013a) suggest no meaningful impact on this resource. The low number of explosions in the water column relative to the amount of single-celled algae in the Study Area also decreases the potential for impacts. The impact on single-celled algae populations would not be detectable; therefore, it will not be discussed further.

Macroalgae attached to the seafloor, floating *Sargassum,* and seagrasses may all occur in locations where explosions are conducted and may be adversely impacted for different reasons. Much of the attached macroalgae grows on hard bottom areas and artificial structures.

Attached macroalgae grow quickly and are resilient to high levels of wave action (Mach et al., 2007), which may aid in their ability to recover from and withstand wave action caused by underwater explosions near them on the seafloor. Floating *Sargassum* is more resilient to physical disturbance than seagrass, but there are more explosions on or near the surface where they co-occur. Seagrasses take longer to recover from physical disturbance than macroalgae, but there are a relatively low number of explosions on or near the bottom where they co-occur. The only mapped seagrass occurring where underwater explosions are proposed is in the Key West Range Complex. Neither the ESA-listed species

Johnson's seagrass, nor its critical habitat, overlap areas that would be subject to impacts from explosives.

Attached macroalgae typically need hard or artificial substrate in order to grow. The potential distribution of attached macroalgae can be inferred by the presence of hard or artificial substrate that occurs at depths of less than 200 m throughout the Study Area, although most macroalgae growth and of kelp in particular in the Study Area occurs at depths less than about 45 m, depending on water clarity, temperature, and nutrients (Peckol & Ramus, 1988). See Section 3.5 (Habitats) for information regarding the distribution of hard substrate in the Study Area. Calculations in Appendix F (Military Expended Materials and Direct Strike Calculations) indicate that only a very small fraction of the total amount of hard substrate in any part of the Study Area would be impacted by explosives. As a result, if attached macroalgae are in the immediate vicinity of an explosion, only a small number of them are likely to be impacted relative to their total population level.

Sargassum distribution is difficult to predict (Gower & King, 2008; South Atlantic Fishery Management Council, 2002) and it may overlap with any of the locations where sea surface and underwater explosions are conducted. Only explosions occurring on or at shallow depth beneath the surface have the potential to impact floating macroalgae like *Sargassum*. In the Study Area, the relative coverage of *Sargassum* is very low ranging from less than 1 percent to 5 percent of the sea surface; see Section 3.3.2.3.5 (Diatoms and Brown Algae [Phylum Ochrophyta]) for details. *Sargassum* may be impacted by surface disturbances from shallow underwater or sea surface explosions, although *Sargassum* is resilient to natural conditions caused by wind, wave action, and severe weather that may break apart pieces of the mat or cause the mats to sink. In the unlikely situation that a *Sargassum* mat is broken by an explosion, the broken pieces may develop into new *Sargassum* mats because *Sargassum* reproduces by vegetative fragmentation (new plants develop from pieces of the parent plant) (South Atlantic Fishery Management Council, 1998). Impacts to *Sargassum* from explosions may potentially collapse the pneumatocysts (air sacs) that keep the mats floating at the surface. Evidence suggests that *Sargassum* will remain floating even when up to 80 percent of the pneumatocysts are removed (Zaitsev, 1971). So even if an explosion caused the collapse of most of a *Sargassum* mat's pneumatocysts, it may not cause it to sink.

Ship shock trials employ the underwater detonation of large explosives but occur in designated areas well offshore, in waters too deep for bottom impacts (see Figure 2.3-1). As described above, Sargassum is fairly resilient to damage from explosions, and procedural mitigation for ship shock trials (Table 5.3-18) includes the avoidance of mats of floating vegetation. Accordingly, ship shock trials would not affect attached or floating vegetation and will not be analyzed further in this section.

The potential for seagrass to overlap with underwater and surface explosions is limited to the Key West Range Complex based on relevant mapping data, Figure 3.3-3 (Florida Fish and Wildlife Conservation Commission-Fish and Wildlife Research Institute, 2012). Seagrasses may potentially be uprooted or damaged by sea surface or underwater explosions. They are much less resilient to disturbance relative to *Sargassum*; regrowth after uprooting can take up to 10 years (Dawes et al., 1997). Explosions may also temporarily increase the turbidity (sediment suspended in the water) of nearby waters, but the sediment would be expected to settle or disperse to pre-explosion conditions within a relatively short time (minutes to hours depending on sediment type and currents). Sustained high levels of turbidity may reduce the amount of light that reaches vegetation which it needs to survive. This scenario is not likely given the low number of explosions planned in areas where seagrasses grow, i.e. estuaries, lagoons, and bays (Phillips & Meñez, 1988).

3.3.3.2.1.1 Impacts from Explosives Under Alternative 1

Impacts from Explosives Under Alternative 1 for Training Activities

Under Alternative 1, vegetation would be exposed to surface and underwater explosions and associated underwater impulsive sounds from high-explosive munitions (including bombs, missiles, torpedoes, medium- and large–caliber projectiles), mines, and demolition charges. Explosives would be used throughout the Study Area but typically in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and in the Gulf Stream Open Ocean Area. Explosives at or beneath the water surface would be used in all training range complexes. The only underwater explosions in the Key West Range Complex would result from use of 10- to 60-lb shaped charges placed on the bottom by divers. Training activities involving the use of explosives are listed in Table B-1 of Appendix B (Activity Stressor Matrices), whereas the number and proposed locations of those activities are presented in Table 2.6-1 of Chapter 2 (Description of Proposed Action and Alternatives). A discussion of explosives and the number of detonations in each source class are provided in Section 3.0.3.3.2 (Explosive Stressors). The largest source class proposed for training under Alternative 1 is E12 (650 - 1,000 lb. net explosive weight), used during bombing exercises (air-to-surface) and sinking exercises.

Impacts to algae near the surface (phytoplankton and *Sargassum*) would be localized and temporary as discussed above and are unlikely to affect the abundance, distribution or productivity of vegetation. As discussed above, the depths, substrates, and relatively small areas of explosive footprints in comparison to vegetation distributions and total habitat areas in the Study Area indicate relatively little overlap between explosive footprints and the distribution of attached macroalgae or seagrasses. Furthermore, the majority of explosions take place in soft bottom habitats as described in Section 3.5 (Habitats). As a result, explosions would have (if any) localized, temporary impacts consisting of damage to or the removal of individual plants and relatively small patches of vegetation. Vegetation is expected to regrow or recolonize the open patches created by explosives within a fairly short time (less than one year), resulting in no long-term effects on the productivity or distribution of attached macroalgae or seagrasses. Similarly, for *Sargassum* floating on the surface, explosions may shred individual plants in patches of *Sargassum*, but vegetative regrowth as well as the redistribution of *Sargassum* by currents would occur, resulting in only localized, temporary effects on distribution, cover and productivity. As described in Chapter 5 (Mitigation), activities that use explosives would not commence when concentrations of floating vegetation are observed prior to an activity, although *Sargassum* could be impacted where small patches are undetected or it drifts into the area after the activity starts. While the intent of the mitigation measure is to avoid impacting animals often associated with *Sargassum* mats, the result is also to minimize the potential for damage to *Sargassum*.

Based on Appendix F (Military Expended Material and Direct Strike Impact Analysis, Table F-34), it is estimated that over the 5-year period, a total of approximately 45 ac of bottom habitat would be impacted by explosive fragments associated with training activities under Alternative 1. Ninety percent of the area potentially impacted would be soft-bottom habitat and thus have no direct impact on vegetation. The area of attached macroalgae habitats potentially impacted represents a very small fraction of the habitat within each training area and the Study Area as a whole, and much of that area would be avoided with the implementation of mitigation for seafloor resources or too deep for bottom impacts from surface explosions. The greatest potential for impacts on attached macroalgae would be on relatively small patches of hard or intermediate substrate that are unmapped or otherwise not included in the Protective Measures Assessment Protocol. Temporary disturbance of these habitats is not expected to affect the distribution, abundance, or productivity of vegetation.

As discussed in Section 5.3.3 (Explosive Stressors) and Section 5.4 (Mitigation Areas to be Implemented), the Navy will implement mitigation to avoid impacts from explosives on marine mammals and sea turtles (wherever activities occur) and on seafloor resources (within mitigation areas throughout the Study Area). Some biological resources can be indicators of potential marine mammal or sea turtle presence because marine mammals or sea turtles have been known to seek shelter in, feed on, or feed among them. For example, young sea turtles have been known to hide from predators and eat the algae associated with floating concentrations of *Sargassum*. For applicable explosive activities, if floating vegetation is observed prior to the initial start of an activity, the activity will either be relocated to an area where floating vegetation is not observed in concentrations, or the initial start of the activity will be halted until the mitigation zone is clear of the floating vegetation concentrations (there is no requirement to halt activities if vegetation floats into the mitigation zone after activities commence). One example of a mitigation designed for marine mammals and sea turtles that will consequently also help avoid potential impacts on vegetation is a requirement for the Navy to avoid commencing detonations within 600 yd. around an explosive sonobuoy if floating vegetation is observed. One example of a mitigation for seafloor resources is that the Navy will not conduct explosive mine countermeasure and neutralization activities within a specified distance of shallow-water coral reefs, live hard bottom habitat, artificial reefs, and shipwrecks The mitigation for seafloor resources will consequently also help avoid potential impacts on vegetation that occurs in these areas.

The overlap of seagrass with this stressor does not include ESA-listed Johnson's seagrass (Figure 3.3-1), and the total impact footprint of the planned underwater explosions on bottom habitats in the Key West Range Complex is estimated as only 0.24 ac under Alternative 1 for training activities (Appendix F [Military Expended Materials and Direct Strike Impact Analysis, Table F-32]). This is a small area relative to the gross estimation of 130 NM^2 of seagrass in the range complex. Underwater explosions conducted for training activities are not expected to cause any risk to seagrass because: (1) the potential impact area of underwater explosions is very small relative to seagrass distribution, (2) the low number of charges reduces the potential for impacts, (3) disturbance (substrate disruption and turbidity) would be temporary and 4) most importantly, the proximity of seagrass to shallow coral reefs, hard bottom, and other mitigation areas (see Figures 3.4-8 and 3.4-9) protects large areas of seagrass from explosives training. Underwater and surface explosions are not anticipated to affect any of the general physical and biological features of critical habitat or areas that meet critical habitat criteria for Johnson's seagrass.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

Impacts from Explosives Under Alternative 1 for Testing Activities

Under Alternative 1, vegetation would be exposed to explosions at or beneath the water surface and the associated underwater impulsive sounds from high-explosive munitions (including bombs, missiles, torpedoes, and naval gun shells), mines, demolition charges, explosive sonobuoys, and ship shock trial charges. Explosives would be used throughout the Study Area, but most typically in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea Large Marine Ecosystems and in the Gulf Stream Open Ocean Area. Underwater explosions at or near the water surface could occur in all of the testing ranges and range complexes. Testing activities involving the use of explosives are listed in Table B-2 of Appendix B (Activity Stressor Matrices), whereas the number and proposed locations of those activities are presented in Table 2.6-2 and Table 2.6-3 of Chapter 2

(Description of Proposed Action and Alternatives). A discussion of explosives and the number of detonations in each source class are provided in Section 3.0.3.3.2 (Explosive Stressors). The largest source class proposed for annually occurring testing under Alternative 1 is E14 (1,741 to 3,625 lbs net explosive weight), used during Mine Warfare testing at Naval Surface Warfare Center, Panama City Division Testing Range. Larger source classes may be used in the Northeast U.S. Continental Shelf Large Marine Ecosystem, Southeast U.S. Continental Shelf Large Marine Ecosystem, and in the Gulf Stream Open Ocean Area during ship shock trials of three platforms in the Virginia Capes, Jacksonville, or Gulf of Mexico Range Complexes. Large ship shock trials could use charges up to source class E17 (14,500 - 58,000 lbs net explosive weight), while small ship shock trials could use charges up to source class E16 (7,250 - 14,500 lbs net explosive weight). Each full ship shock trial would use up to four of these charges in total (each one detonated about a week apart). In addition, explosives use would occur in the Key West Range Complex during sonobuoy lot acceptance testing and at Naval Surface Warfare Center, Panama City Division for line charge testing.

Impacts to algae near the surface (phytoplankton and *Sargassum)* would be localized and temporary as discussed above for training activities and are unlikely to affect the abundance, distribution or productivity of vegetation. As discussed above, the depths, substrates, and relatively small areas of explosive footprints in comparison to vegetation distributions and total habitat areas in the Study Area indicate relatively little overlap between explosive footprints and the distribution of attached macroalgae or seagrasses. As a result, explosions would have (if any), localized, temporary impacts consisting of damage to or the removal of individual plants and relatively small patches of vegetation. Vegetation is expected to regrow or recolonize the open patches created by explosives within a fairly short time (less than one year), resulting in no long-term effects on the productivity or distribution of attached macroalgae or seagrasses. Similarly, for *Sargassum* floating on the surface, explosions may shred individual plants in patches of *Sargassum*, but vegetative regrowth as well as the redistribution of *Sargassum* by currents would occur, resulting in only localized, temporary effects on distribution, cover and productivity.

Based on Appendix F (Military Expended Material and Direct Strike Impact Analysis, Table F-35), it is estimated that over the 5-year period, a total of approximately 71 ac of bottom habitat would be impacted by explosive fragments associated with testing activities under Alternative 1. Eighty-three percent of the area impacted would be soft-bottom habitat and thus have no effect on vegetation. The impacted area of hard and intermediate bottom habitat represents a very small fraction of the habitat within each range and the Study Area as a whole. With the exception of line charge testing, which occurs in the surf zone at Naval Surface Warfare Center Panama City Division (Table 2.6-3; see activity description in Appendix A, A.3.2.7.3), most of the area affected would be too deep to support benthic algae. Line charge testing at Naval Surface Warfare Center Panama City Division occurs on sandy bottom habitats that do not support seagrass or algae. As a result, temporary disturbance of these habitats is not expected to affect the distribution, abundance, or productivity of vegetation.

As discussed in Section 5.3.3 (Explosive Stressors) and Section 5.4 (Mitigation Areas to be Implemented), the Navy will implement mitigation to avoid impacts from explosives on marine mammals and sea turtles (wherever activities occur) and on seafloor resources (within mitigation areas throughout the Study Area). Some biological resources can be indicators of potential marine mammal or sea turtle presence because marine mammals or sea turtles have been known to seek shelter in, feed on, or feed among them. For example, young sea turtles have been known to hide from predators and eat the algae associated with floating concentrations of *Sargassum*. For applicable explosive activities, if floating vegetation is observed prior to the initial start of an activity, the activity will either be relocated to an area where floating vegetation is not observed in concentrations, or the initial start of the activity will be halted until the mitigation zone is clear of the floating vegetation concentrations (there is no requirement to halt activities if vegetation floats into the mitigation zone after activities commence). One example of a mitigation designed for marine mammals and sea turtles that will consequently also help avoid potential impacts on vegetation is a requirement for the Navy to avoid commencing detonations within 600 yd. around an explosive sonobuoy if floating vegetation is observed. One example of a mitigation for seafloor resources is that the Navy will not conduct explosive mine countermeasure and neutralization activities within a specified distance of shallow-water coral reefs, precious coral beds, live hard bottom habitat, artificial reefs, and shipwrecks. The mitigation for seafloor resources will consequently also help avoid potential impacts on vegetation that occurs in these areas.

The overlap of seagrass with this stressor does not include ESA-listed Johnson's seagrass (Figure 3.3-1), although explosives would be used for testing activities in the Key West Range Complex under Alternative 1 (Tables 3.0-26 and 3.0-27).

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat. The Navy will consult with the NMFS, as required by Section 7(a)(2) of the ESA in that regard.

3.3.3.2.1.2 Impacts from Explosives Under Alternative 2

Impacts from Explosives Under Alternative 2 for Training Activities

Impacts from explosives under Alternative 2 for training activities would be virtually identical (less than 1 percent difference in any location or overall) to those of Alternative 1 (Appendix F [Military Expended Materials and Direct Strike Impact Analysis, Table F-34]).

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 will have no effect on Johnson's seagrass or its designated critical habitat.

Impacts from Explosives Under Alternative 2 for Testing Activities

Impacts from explosives under Alternative 2 for testing activities would affect slightly greater areas than those of Alternative 1 (Appendix F [Military Expended Materials and Direct Strike Impact Analysis, Table F-30]). Based on proportional impacts as calculated in Appendix F (Military Expended Materials and Direct Strike Impact Analysis, Table F-35), it is estimated that over the 5-year period, approximately 80 ac of bottom habitat would be impacted by explosive fragments associated with testing activities under Alternative 2, versus 71 ac under Alternative 1. The difference is almost entirely due to the greater number of testing activities conducted on the Virginia Capes Range Complex and Naval Surface Warfare Center, Panama City Division Testing Range under Alternative 2; these activities would impact soft-bottom habitat in relatively deep water and thus have no effect on benthic vegetation. Testing activities under Alternative 2 would result in the temporary disturbance of relatively small areas of hard and intermediate bottom habitat, but is not expected to affect the distribution, abundance, or productivity of vegetation.

The overlap of seagrass with this stressor does not include ESA-listed Johnson's seagrass (Figure 3.3-1), although explosives would be used for testing activities in the Key West Range Complex under Alternative 2 (Appendix F [Military Expended Materials and Direct Strike Impact Analysis], Table F-25).

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 will have no effect on Johnson's seagrass or its designated critical habitat. The Navy will consult with the NMFS, as required by Section 7(a)(2) of the ESA in that regard.

3.3.3.2.1.3 Impacts from Explosives Under the No Action Alternative

Impacts from Explosives Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various explosive stressors would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.3.3.3 Energy Stressors

Energy stressors include electromagnetic devices, lasers, and radar; their use and physical effects are described in Section 3.0.3.3.3 (Energy Stressors). Although plants are known to respond to magnetic field variations, effects on plant growth and development are not well understood (Maffei, 2014). The area of potential effects from electromagnetic devices or lasers is so small (limited to a few meters from source), and temporary, as to be discountable in terms of any effect on vegetation. Radar, which is high-frequency electromagnetic radiation, is not known to affect plants, and is rapidly absorbed and does not propagate more than a few feet under water. Energy stressors are not applicable to vegetation because of the lack of sensitivity of vegetation and will not be analyzed further in this section.

3.3.3.4 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts on vegetation of the various types of physical disturbance and strike stressors that may occur during Navy training and testing activities on vegetation within the Study Area. For a list of Navy training and testing activities that involve these stressors refer to Tables B-1 and B-2, respectively, in Appendix B (Activity Stressor Matrices). The physical disturbance and strike stressors that may impact marine vegetation include (1) vessels, (2) in-water devices, (3) military expended materials, and (4) seafloor devices. Explosives are analyzed separately in Section 3.3.3.2 (Explosive Stressors).

The evaluation of the impacts from physical strike and disturbance stressors on vegetation focuses on proposed activities that may cause vegetation to be damaged by an object that is moving through the water (e.g., vessels and in-water devices), dropped into the water (e.g., military expended materials), deployed on the seafloor (e.g., mine shapes and anchors), or detonated in the water column (e.g., explosive fragments). Not all activities are proposed throughout the Study Area. Wherever appropriate, specific geographic areas of potential impact are identified.

Single-celled algae may overlap with physical disturbance or strike stressors, but the impact would be minimal relative to their total population level and extremely high growth rates (Caceres et al., 2013). They also move with the surface tension of the water and tend to flow around a disturbance. Therefore, they will not be discussed further. Seagrasses and macroalgae on the seafloor and *Sargassum* on the sea surface are the only types of vegetation that occur in locations where physical disturbance or strike stressors may be more than minimal, in terms of impact. Therefore, only seagrasses, macroalgae, and *Sargassum* are analyzed further for potential impacts from physical disturbance or strike stressors.

There is no overlap of any of the physical disturbance and strike stressors with the known distribution of or designated critical habitat for Johnson's seagrass.

3.3.3.4.1 Impacts from Vessels and In-Water Devices

Vessels

Several different types of vessels (ships, submarines, boats, amphibious vehicles) are used during training and testing activities throughout the Study Area, as described in Section 3.0.3.3.4.1 (Vessels and In-Water Devices). Vessel movements occur intermittently, are variable in duration, ranging from a few hours to a few weeks, and are dispersed throughout the Study Area. Events involving large vessels are widely spread over offshore areas, while smaller vessels are more active in nearshore areas and inland waters. The location and hours of Navy vessel usage for testing and training activities are most dependent upon the location of Navy ports, piers, and established at-sea testing and training ranges. With the exception of the establishment of the Undersea Warfare Training Range, the Navy's use of these areas has not appreciably changed in the last decade and are not expected to change in the foreseeable future.

The potential impacts from Navy vessels used during training and testing activities on vegetation are based on the vertical distribution of the vegetation. Vessels may impact vegetation by striking or disturbing vegetation on the sea surface or on the seafloor (the latter would only occur where amphibious vessels operate in nearshore to shore environments) (Spalding et al., 2003). Considering attached macroalgae does not typically persist along high energy beaches where amphibious landing occur, the only type of marine vegetation that may potentially be disturbed by vessels is *Sargassum*. *Sargassum* distribution is difficult to predict (Gower & King, 2008; South Atlantic Fishery Management Council, 2002) and it may overlap with many locations where vessels are used. In the Study Area, the relative coverage of *Sargassum* is very low ranging from less than 1 percent to 5 percent of the sea surface; see Section 3.3.2.3.5 (Brown Algae [Phylum Phaeophyta]) for details. *Sargassum* may be impacted by vessels, although *Sargassum* is resilient to natural conditions caused by wind, wave action, and severe weather that may break apart pieces of the mat or cause the mats to sink. In the unlikely situation that a *Sargassum* mat is broken by a vessel or in-water device, the broken pieces may develop into new *Sargassum* mats because *Sargassum* reproduces by vegetative fragmentation (new plants develop from pieces of the parent plant) (South Atlantic Fishery Management Council, 1998). Impacts to *Sargassum* from vessels may potentially collapse the pneumatocysts that keep the mats floating at the surface. Evidence suggests that *Sargassum* will remain floating even when up to 80 percent of the pneumatocysts are removed (Zaitsev, 1971). Even if a vessel strike results in the collapse of most of a *Sargassum* mat's pneumatocysts, it may not cause it to sink.

Seagrasses are resilient to the lower levels of wave action that occur in sheltered estuarine shorelines, but are susceptible to vessel propeller scarring and substrate erosion by vessel wakes (Sargent et al., 1995; Stevenson et al., 1979), although vessel wakes appear to have only localized effects and are not considered a significant threat to seagrasses in general (Orth et al., 2010). Some tropical seagrasses can take up to 10 years to fully regrow and recover from propeller scars (Dawes et al., 1997). However, seagrasses do not typically grow along high energy beaches with shifting soft shore and bottom habitat, and thus do not overlap with amphibious combat vehicle activities based on relevant literature and resource maps (Florida Fish and Wildlife Conservation Commission-Fish and Wildlife Research Institute, 2012; North Carolina Department of Environmental and Natural Resources, 2012).

Seafloor macroalgae may be present in locations where these vessels occur, but the impacts would be minimal because vessels typically avoid direct contact with the bottom, and due to the resilience, distribution, and biomass of macroalgae. Because seafloor macroalgae in coastal areas are adapted to natural disturbances, such as storms and wave action that can exceed 10 m per second (Mach et al., 2007), macroalgae will quickly recover from vessel movements.

In-Water Devices

Several different types of in-water devices (i.e., towed devices, unmanned surface and underwater vehicles) are used during training and testing activities throughout the Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives) and Section 3.0.3.3.4.1 (Vessels and In-Water Devices). As described in Section 2.3.3 (Standard Operating Procedures), prior to deploying a towed in-water device from a manned platform, the Navy searches the intended path of the device for any floating debris (e.g., driftwood) and other objects (e.g., concentrations of floating vegetation), which have the potential to obstruct or damage the device. The standard operating procedure for towed in-water device safety could result in a secondary benefit to vegetation through a reduction in the potential for physical disturbance and strike of a towed in-water device.

The potential impacts from Navy in-water devices used during training and testing activities on marine vegetation are largely the same as those described above for vessels except as noted below. Vegetation on the seafloor such as seagrasses and macroalgae are unlikely to be impacted by in-water devices - which do not normally contact the bottom. Towed in-water devices include towed targets that are used during activities such as missile exercises and gun exercises. These devices are operated at low speeds either on the sea surface or below it. The analysis of in-water devices will focus on towed surface targets because of the potential for impacts on marine algae.

The only type of marine vegetation that may potentially be disturbed by in-water devices is *Sargassum*. Potential impacts would be as described for vessels and would be localized and temporary due to the ability of *Sargassum* mats to remain floating and regrow despite fragmentation from strikes.

3.3.3.4.1.1 Impacts from Vessels and In-Water Devices Under Alternative 1

Estimates of relative vessel and in-water device use by location for each alternative are provided in Tables 3.0-17 - 3.0-22 of Section 3.0.3.3.4.1 (Vessels and In-Water Devices). These estimates are based on the number of activities predicted for each alternative. While these estimates provide a prediction of use, actual Navy vessel and in-water device use depends upon military training and testing requirements, deployment schedules, annual budgets, and other unpredictable factors. Testing and training concentrations are most dependent upon locations of Navy shore installations and established testing and training ranges.

Impacts from Vessels and In-Water Devices Under Alternative 1 for Training Activities

Vessels

Under Alternative 1, a variety of vessels would be used in the Study Area during up to 31,215 annual training activities, as described in Section 3.0.3.3.4.1 (Vessels and In-Water Devices). Most activities would include either one or two vessels and may last from a few hours to two weeks. Roughly 85 percent of vessel activities would occur in the Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes, while another 10 percent would occur in the inland waters (Tables 3.0-17 and 3.0-18). Vessel use would occur elsewhere throughout the Study Area but at much lower frequency. A large proportion of the vessel activity in the inland waters consists of small craft (less than 50 ft.) which often travel at high speed (greater than 10 knots) (Tables 3.0-18 and 3.0-19). The most heavily used areas would be in the Southeast and Northeast U.S. Continental Shelf Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area.

The wakes from large, high speed ferries have been implicated in shoreline erosion in at least one study (Parnell et al., 2007). More generally, however, the wakes associated with vessel traffic have not been identified as a cause of seagrass declines (Orth et al., 2010; Stevenson et al., 1979). Wakes from small Navy boats in the inland waters are unlikely to have measurable impacts on vegetation because Navy vessels represents a small fraction of total maritime traffic and the wakes generated by small Navy boats which, for safety reasons are not operated at excessive speeds near shore, are similar to wind waves that naturally occur.

Amphibious training events occur on sandy beaches such as at Marine Corps Base Camp Lejeune and at Mayport Naval Station where seagrass and attached macroalgae are not expected because of the regular use and disturbance of the same areas by amphibious training exercises, as well as waves and currents that are too strong for vegetation to establish. The training ranges noted above for the majority of training activities intersect habitat for attached macroalgae and floating vegetation (*Sargassum*), suggesting potential impacts. However, the attached macroalgae may only be temporarily disturbed, and the floating *Sargassum* mats are resilient to disturbance as described in the previous introductory section on impacts.

Pursuant to the ESA, the use of vessels during training activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

Vessels used in training activities under Alternative 1 would not cause a detectable impact on *Sargassum* because: (1) the relative coverage of *Sargassum* in the Study Area is low, and (2) *Sargassum* is resilient and regrowth after exposure to vessels is expected to be rapid. Based on these factors, potential impacts to *Sargassum* from vessels are not expected to result in detectable changes to its growth, survival, or propagation, and are not expected to result in population-level impacts.

The net impact of vessels on attached macroalgae and seagrass should be reduced based on standard operating procedures that discourage directly impacting the bottom, and the minimal potential for disturbance to resilient seaweeds from propulsion systems operating near the bottom. Seagrasses are more vulnerable to localized damage from propellers where inland vessel training overlaps the navigable portion of their habitat, though this stressor is considering very minor compared to other seagrass stressors (e.g., nutrient enrichment). The impact of vessel wakes on emergent wetlands is confined to high speed vessel movement along sheltered inland shorelines where a minimal impact is likely indistinguishable from that of other vessel traffic.

On the open ocean, strikes of vegetation would be limited to floating marine algae. Vessel movements may disperse or fragment algal mats. Because algal distribution is patchy, mats may re-form, and events would be on a small spatial scale.

The net impact of vessels on vegetation is expected to be negligible under Alternative 1, based on (1) relatively small areas of spatial coincidence between vessel disturbance zones and the distribution of sensitive vegetation; (2) the quick recovery of most vegetation types; and (3) the short-term nature of most vessel movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas.

In-Water Devices

The use of in-water devices for training under Alternative 1 would occur during up to 6,894 annual activities. Activities would be concentrated in the Virginia Capes Range Complex with up to 3,809 activities annually, over half of the total for Alternative 1. The Jacksonville Range Complex would support up to 1,357 (20 percent of total) activities annually, whereas the Navy Cherry Point Range Complex would support up to 819 (12 percent of total) activities annually. Other parts of the Study Area would be used less frequently (Tables 3.0-21 and 3.0-22).

Under Alternative 1, the impacts from in-water devices during training activities would be minimal disturbances of algal mats and seaweeds. Seagrass bed damage is not likely but, if it occurs, the impacts would be minor, such as damage from short-term turbidity increases.

In-water devices used in training activities under Alternative 1 would not cause a detectable impact on *Sargassum* because: (1) the relative coverage of *Sargassum* in the Study Area is low, and (2) new growth may result from *Sargassum* exposure to in-water devices. Based on these factors, potential impacts to *Sargassum* from in-water devices are not expected to result in detectable changes to its growth, survival, or propagation, and are not expected to result in population-level impacts.

On the open ocean, strikes of vegetation would be limited to floating marine algae. Unmanned surface vessel or towed device movements may disperse or fragment algal mats. Because algal distribution is patchy, mats may re-form, and events would be on a small spatial scale.

Under Alternative 1, the impacts from in-water devices during training activities would be minimal disturbances of algal mats and seaweeds, primarily due to localized water motion, sediment disturbance and short-term turbidity increases. Seagrass bed damage is not likely to occur.

Pursuant to the ESA, the use of in-water devices during training activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

The net impact of in-water devices on vegetation is expected to be negligible under Alternative 1, based on (1) relatively small areas of spatial coincidence between disturbance zones from in-water devices and the distribution of sensitive vegetation; (2) the quick recovery of most vegetation types; and (3) the short-term nature of in-water device usage and local disturbances of the surface water and bottom habitat (the latter by bottom crawling devices), with some temporary increase in suspended sediment in shallow areas.

Impacts from Vessels and In-Water Devices Under Alternative 1 for Testing Activities

Vessels

Under Alternative 1, the Navy would use a variety of vessels in up to 6,298 annual testing activities in the Study Area, as described in Section 3.0.3.3.4.1 (Vessels and In-Water Devices). Most activities would include either one or two vessels and may last from a few hours to two weeks. Vessel testing activities would occur in all range complexes and testing ranges, and would be spread somewhat more evenly than training activities (Tables 3.0-17 and 3.0-18).

On the open ocean, vessel strikes of vegetation would be limited to floating marine algae, primarily *Sargassum* in the Study Area. Vessel movements may disperse or fragment algal mats. Because floating algae distributions are driven by winds and currents, mats that are broken up by vessel movements would tend to re-form, and events would be on a small spatial scale. Navy testing activities involving vessel movement would not impact the general health of marine algae.

Vessel disturbance and strike impacts on emergent marsh and seagrass vegetation due to testing activities would be essentially the same as described previously for training activities, with the exception that no amphibious vehicles are used in testing.

Testing activities may occur near seagrass beds (e.g., in the South Florida Ocean Measurement Facility) where vessels participating in testing events may cross sandy shallow habitat that could support the ESA-listed Johnson's seagrass. However, vessel movements at this location and elsewhere would not directly impact the bottom and the temporary increase in water motion from vessels would be similar to natural wave action and unlikely to dislodge plants or increase turbidity to the point that photosynthesis may be impacted.

Pursuant to the ESA, the use of in-vessels during testing activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

Vessels used in testing activities under Alternative 1 would not cause a detectable impact on *Sargassum* because: (1) the relative coverage of *Sargassum* in the Study Area is low, and (2) new growth may result from *Sargassum* exposure to vessels. Based on these factors, potential impacts to *Sargassum* from vessels are not expected to result in detectable changes to its growth, survival, or propagation, and are not expected to result in population-level impacts.

The net impact of vessels on vegetation is expected to be negligible under Alternative 1, based on (1) relatively small areas of spatial coincidence between vessel disturbance zones and the distribution of sensitive vegetation; (2) the quick recovery of most vegetation types; and (3) the short-term nature of most vessel movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas.

In-Water Devices

The use of in-water devices for testing under Alternative 1 would occur during up to 5,370 annual activities. Activities would be concentrated in the Naval Undersea Warfare Center Newport and Naval Surface Warfare Center Panama City Division Testing Ranges, these two locations accounting for 62 percent of all activities (Tables 3.0-21 and 3.0-22).

Under Alternative 1, the impacts from in-water devices during training activities would be minimal disturbances of algal mats and seaweeds. Seagrass bed damage is not likely but, if it occurs, the impacts would be minor, such as damage from short-term turbidity increases. In-water devices used in testing activities under Alternative 1 would not cause a detectable impact on *Sargassum* because: (1) the relative coverage of *Sargassum* in the Study Area is low, and (2) new growth may result from *Sargassum* exposure to in-water devices. Based on these factors, potential impacts to *Sargassum* from in-water devices are not expected to result in detectable changes to its growth, survival, or propagation, and are not expected to result in population-level impacts.

Under Alternative 1, the impacts from in-water devices during testing activities would be minimal disturbances of algal mats and seaweeds, primarily due to localized water motion, sediment disturbance and short-term turbidity increases. Seagrass bed damage is not likely to occur.

Pursuant to the ESA, the use of in-water devices during testing activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

On the sea surface, towed and unmanned surface target strikes of vegetation would be limited to floating marine algal mats. Towed surface target and unmanned surface vehicle movements may disperse or injure algal mats. However, algal mats may re-form, and testing events would be on a small spatial scale. Therefore, Navy testing activities involving towed surface targets are not expected to impact the general health of marine algae.

The net impact of in-water devices on vegetation is expected to be negligible under Alternative 1, based on (1) relatively small areas of spatial coincidence between in-water device disturbance zones and the distribution of sensitive vegetation; (2) the quick recovery of most vegetation types; and (3) the short-term nature of in-water device movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas.

3.3.3.4.1.2 Impacts from Vessels and In-Water Devices Under Alternative 2

Impacts from Vessels and In-Water Devices Under Alternative 2 for Training Activities

Vessels

Vessel impacts from training under Alternative 2 would be as described previously for Alternative 1, but for minor differences in the number of activities by location. Compared to Alternative 1, under Alternative 2, training activities including vessels would be similarly distributed across ranges and facilities, but the number of activities would increase by roughly 1 percent (Tables 3.0-17 and 3.0-18). Taking into account this small incremental increase in activities, the net impact on vegetation is still expected to be nearly identical to that of Alternative 1, and negligible based on (1) relatively small areas of spatial coincidence between vessel disturbance zones and the distribution of sensitive vegetation; (2) the quick recovery of most vegetation types; and (3) the short-term nature of most vessel movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas.

Pursuant to the ESA, the use of vessels during training activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

In-Water Devices

In-water device impacts from training under Alternative 2 would be as described previously for Alternative 1, but for minor differences in the number of activities by location. Compared to Alternative 1, under Alternative 2, training activities including in-water devices would be similarly distributed across ranges and facilities, but the number of activities would increase by roughly 1 percent (Table 3.0-21). Taking into account this small incremental increase in activities, the net impact on vegetation is still expected to be nearly identical to that of Alternative 1, and negligible based on (1) relatively small areas of spatial coincidence between vessel disturbance zones and the distribution of sensitive vegetation; (2) the quick recovery of most vegetation types; and (3) the short-term nature of most vessel movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas.

Pursuant to the ESA, the use of in-water devices during training activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

Impacts from Vessels and In-Water Devices Under Alternative 2 for Testing Activities

Vessels

Vessel impacts from testing under Alternative 2 would be as described previously for Alternative 1, but for minor differences in the number of activities by location. Compared to Alternative 1, under Alternative 2, testing activities including vessels would be similarly distributed across ranges and facilities, but the number of activities would decrease by roughly 0.5 percent (Table 3.0-17 and 3.0-18). Taking into account this small incremental reduction in activities, the net impact on vegetation is still expected to be nearly identical to that of Alternative 1, and negligible based on (1) relatively small areas of spatial coincidence between vessel disturbance zones and the distribution of sensitive vegetation; (2)

the quick recovery of most vegetation types; and (3) the short-term nature of most vessel movements and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas.

Pursuant to the ESA, the use of vessels during testing activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

In-Water Devices

The locations, number of events, and potential effects associated with in-water device use for testing activities would be the same under Alternatives 1 and 2. Refer to Section 3.3.4.1 (Combined Impacts of All Stressors Under Alternative 1) and Section 3.3.4.2 (Combined Impacts of All Stressors Under Alternative 2) for a discussion of impacts on vegetation.

Pursuant to the ESA, the use of in-water devices during testing activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

3.3.3.4.1.3 Impacts from Vessels and In-Water Devices Under the No Action Alternative

Impacts from Vessels and In-Water Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various physical disturbance and strike stressors (e.g., vessels and in-water devices) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.3.3.4.2 Impacts from Aircraft and Aerial Targets

Aircraft and aerial target stressors are not applicable to vegetation and will not be analyzed further in this section.

3.3.3.4.3 Impacts from Military Expended Materials

This section analyzes the strike potential to vegetation of the following categories of military expended materials: (1) all sizes of non-explosive practice munitions, (2) expendable targets, and (3) expended materials other than munitions, such as sonobuoys, ship hulks, and miscellaneous accessories (e.g., canisters, endcaps, and pistons). Fragments from explosives are analyzed in Section 3.3.3.2.1 (Impacts from Explosives). See Appendix F (Military Expended Material and Direct Strike Impact Analysis) for more information on the types, locations, and quantities of military expended materials proposed to be used. The potential for impacts to marine vegetation from military expended materials would depend on the presence and amount of vegetation, and the size and number of military expended materials. Areas expected to have the greatest amount of expended materials are the Northeast U.S. Continental Shelf Large Marine Ecosystem, the Southeast U.S. Continental Shelf Large Marine Ecosystem, and the Gulf Stream Open Ocean Area (specifically within the Virginia Capes and Jacksonville Range Complexes).

Most types of military expended materials are deployed in the open ocean where they may impact *Sargassum*. Based on Appendix A (Navy Activity Descriptions), however, some expended materials including small and medium caliber projectiles and their associated casings, target fragments, marine markers (e.g., smoke floats), and countermeasures could be introduced into estuarine or nearshore areas where shallow water vegetation such as emergent wetlands, seagrass, and macroalgae may be located.

In the Study Area, the relative coverage of *Sargassum* is very low, ranging from less than 1 percent to 5 percent of the sea surface. Section 3.3.2.3.6.2 (*Sargassum*) contains additional detail. *Sargassum* may be impacted by military expended materials, although *Sargassum* is resilient to natural conditions caused by wind, wave action, and severe weather that may break apart pieces of the mat or cause the mats to sink. In the unlikely situation that a *Sargassum* mat is broken by military expended materials, the broken pieces may develop into new *Sargassum* mats because *Sargassum* reproduces by vegetative fragmentation (new plants develop from pieces of the parent plant) (South Atlantic Fishery Management Council, 1998). Impacts to *Sargassum* from military expended materials may potentially collapse the pneumatocysts that keep the mats floating at the surface. Evidence suggests that *Sargassum* will remain floating even when up to 80 percent of the pneumatocysts are removed (Zaitsev, 1971). Even if a military expended material's strike results in the collapse of most of a *Sargassum* mat's pneumatocysts, it may not cause it to sink. In addition, if enough military expended materials are deposited on *Sargassum*, the mats can potentially sink, but sinking occurs as a natural part of the aging process of *Sargassum* (Schoener & Rowe, 1970).

Some types of attached macroalgae such as kelp only occur in a very small part of the Study Area in the Northeast U.S. Continental Shelf Large Marine Ecosystem, specifically in the Northeast Range Complexes, where a small fraction of the activities that involve military expended materials would be conducted, and most of those would impact offshore soft-bottom habitat that does not support kelp (Section 3.0.3.3.4.2, Military Expended Materials and Appendix F, Military Expended Material and Direct Strike Impact Analysis [Tables F-29 and F-30]; see also Figure 3.5-14). These circumstances limit kelp exposure to this stressor, although practice munitions are likely to fall on hard bottom that supports kelp. Other species of attached macroalgae may be found throughout the offshore range complexes on hard substrates in waters deeper than kelp but no deeper than about 200 m. Shallower offshore waters could be impacted by falling MEM, but the vegetation is fast growing and resilient to physical disturbance (Mach et al., 2007).

Most deposition of military expended materials occurs within the confines of established training and testing areas, although there is some deposition of expended materials in inshore waters (e.g., small caliber shell casings and smoke floats in Chesapeake Bay and tributaries). The most heavily impacted areas are away from the coastline on the continental shelf and slope and the potential for impacts to vegetation other than *Sargassum* is low.

Military expended materials can potentially impact seagrass on the seafloor by disturbing, crushing, or shading which may interfere with photosynthesis. In the event that seagrass is not able to photosynthesize, its ability to produce energy is compromised. The intersection of seagrasses and military expended materials is limited. The only range complex where military expended materials overlap with seagrasses is in the Key West Range Complex based on relevant mapping data, (Figure 3.3-3 (Florida Fish and Wildlife Conservation Commission-Fish and Wildlife Research Institute, 2012) and 3.3-3. Seagrass also occurs in relatively close proximity to testing ranges where expended materials would be generated, including the Naval Undersea Warfare Center Testing Range and South Florida Ocean Measurement Facility (Figures 3.3-2 and 3.3-3) and may be affected by materials that drift shoreward in these locations.

Seagrasses generally grow in waters that are sheltered from wave action such as estuaries, lagoons, and bays (Phillips & Meñez, 1988) landward of offshore training and testing ranges. However, seagrass does occur within many inland training locations such as Chesapeake Bay. The impacts of military expended materials falling on seagrass beds are minimized by the flexible/fluid nature of seagrass blades and typical avoidance of extremely shallow water where vessel propulsion is impacted. The potential for detectable impacts on seagrasses from expended materials would be low given the small size or low density (e.g., small projectiles, small decelerators/parachutes, endcaps, and pistons) of the majority of the materials that could be used in or drift into these areas from offshore. Larger, denser materials, such as non-explosive practice munitions and sonobuoys would be used farther offshore and are likely to sink rapidly where they land. Falling materials could cause bottom sediments to be suspended. Resuspension of the sediment could temporarily impact water quality and decrease light exposure but since it would be short-term (hours), the combined stressors from military expended materials would not likely impact the general health of seagrasses. Neither the ESA-listed species Johnson's seagrass, nor its critical habitat, overlap with the Study Area; however, an analysis of potential impacts is included due to its proximity to training and testing activity areas.

The following are descriptions of the types of military expended materials that can potentially impact *Sargassum*, attached macroalgae, and seagrass. *Sargassum* may potentially overlap with military expended materials anywhere in the Study Area. Attached macroalgae could be associated with hard bottom or intermediate bottom habitat (as described in Section 3.5, Habitats) anywhere in the Study Area in depths less than 200 m. The Key West Range Complex is the only location where these materials may overlap with seagrasses. Appendix F (Military Expended Materials and Direct Strike Impacts) present the number and location of activities that involve military expended materials that are proposed for use during training and testing activities by location and alternative.

Small-, Medium-, and Large-Caliber Projectiles. Small-, medium-, and large-caliber non-explosive practice munitions, or fragments of high-explosive projectiles expended during training and testing activities rapidly sink to the seafloor. The majority of these projectiles would be expended in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area in the Virginia Capes Range Complex. Because of the small size of projectiles and their casings, damage to marine vegetation is unlikely. Large-caliber projectiles are primarily used offshore (at depths mostly greater than 85 ft. while small- and medium-caliber projectiles may be expended in both offshore and coastal areas (at depths mostly less than 85 ft.). *Sargassum* and other marine algae and, to a lesser extent (because of their limited coastal distribution), seagrasses, could occur where these materials are expended.

Bombs, Missiles, and Rockets. Bombs, missiles, and rockets, or their fragments (if high-explosive) are expended offshore (at depths mostly greater than 85 ft.) during training and testing activities, and rapidly sink to the seafloor. *Sargassum* and other marine algae could occur where these materials are expended, but seagrass generally does not because of water depth limitations for activities that expend these materials.

Decelerators/Parachutes. Decelerators/Parachutes of varying sizes are used during training and testing activities. The types of activities that use decelerators/parachutes, the physical characteristics of these expended materials, where they are used, and the number of activities that would occur under each alternative are described in Section 3.0.3.3.5 (Entanglement Stressors). Seagrass may overlap with the use of some types of decelerators/parachutes in the Gulf of Mexico Large Marine Ecosystem in the Key West Range Complex. *Sargassum* and other mmarine algae could occur in any of the locations where these materials are expended.

Targets. Many training and testing activities use targets. Targets that are hit by munitions could break into fragments, whereas targets such as Expendable Mobile Anti-Submarine Training Targets

(Table 3.0-27) that are expended without being hit by munitions and broken into fragments are also considered. Expended targets and fragments vary in size and type, but most are expected to sink. Pieces of targets that are designed to float are recovered when possible. Target fragments would be spread out over large areas. *Sargassum* and other marine algae and seagrass could occur where these materials are expended.

Countermeasures. Defensive countermeasures (e.g., chaff and flares) are used to protect against incoming weapons (e.g., missiles). Chaff is made of aluminum-coated glass fibers and flares are pyrotechnic devices. Chaff, chaff canisters (pistons), and flare end caps are expended materials. Chaff and flares are dispensed from aircraft or fired from ships. Seagrass may overlap with chaff and flares expended in the Gulf of Mexico Large Marine Ecosystem in the Key West Range Complex. *Sargassum* and other marine algae could occur in any of the locations that these materials are expended.

Vessel Hulks. Vessel hulks are large expended materials that result from sinking exercises in specific open ocean areas, outside the coastal portions of the range complexes. Since the potential impacts of vessel movements and munitions use are considered elsewhere, and the vessel hulks are sunk in the abyssal zone (too deep to support attached vegetation), potential impacts from vessel hulks as a physical disturbance and strike stressor will not be analyzed further in this section.

3.3.3.4.3.1 Impacts from Military Expended Materials Under Alternative 1

Impacts from Military Expended Materials Under Alternative 1 for Training Activities

As indicated in Appendix F (Military Expended Material and Direct Strike Impact Analysis), for training activities under Alternative 1, areas with the greatest number of expended materials are expected to be the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, and the Gulf Stream Open Ocean Area. By far the greatest numbers of materials would be expended within the Virginia Capes, Jacksonville, and Navy Cherry Point Range Complexes, which would also have the largest areas of impact, along with the area used for sinking exercises (Table F-2).

Appendix F (Military Expended Material and Direct Strike Impact Analysis) provides the approximate footprints of military expended materials associated with training activities. The worst-case analysis of potential impacts (Tables F-28 and F-30) shows that even if impacts were to be concentrated within hard or intermediate bottom habitats, much less than 0.01 percent of any substrate type could be affected annually or over 5 years. For the analysis of potential impacts to vegetation, the proportional impact, assuming a uniform, non-overlapping distribution of activities and associated military expended materials within each training area, is considered a more realistic, though still unlikely, approximation of the acreage affected. This scenario does not account for areas of concentrated training, nor does it account for the clumping of military expended materials and explosives in a particular area and over a particular substrate type where a training or testing activity occurs. In reality, there are numerous factors presented in the previous section that reduce the impacts footprints on substrate types and associated vegetation reported in Appendix F. Based on proportional impacts as provided in Table F-32, it is estimated that annually, approximately 7 ac of hard bottom habitat, 6 ac of intermediate bottom habitat, 63 ac of soft-bottom habitat, and 5 ac of unknown bottom habitat would be impacted by military expended materials associated with training activities under Alternative 1 (see Section 3.5, Habitats for more detailed analysis). Macroalgae occurs primarily on hard substrate but may be present on all substrate types in waters less than approximately 200 m deep. The expended material footprint areas also include mapped seagrass in the Key West Range Complex in addition to some inland training areas.

As discussed in Section 5.4.1 (Mitigation Areas for Seafloor Resources), the Navy will implement mitigation to avoid impacts from military expended materials on seafloor resources in mitigation areas throughout the Study Area. For example, the Navy will not conduct gunnery activities within a specified distance of shallow-water coral reefs. The mitigation will consequently also help avoid potential impacts on vegetation that occurs in these areas.

Military expended materials used for training activities are not expected to pose a severe risk to marine algae or seagrass because: (1) there would be relatively small areas impacted relative to the area of vegetation; (2) most of the expended materials would fall offshore where only resilient macroalgae (either floating or attached to the seafloor) are present; (3) rapid recovery of macroalgae where impacts did occur either by colonizing the surface of expended materials or regrowth; and (4) mitigation will help avoid impacts to marine algae or seagrasses that are in proximity to shallow water coral reefs. Based on the factors summarized here and described in Section 3.3.3.4.3, potential impacts on marine algae and seagrass from military expended materials are 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 vegetation.

For the reasons discussed above, pursuant to the ESA, military expended materials produced by training activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

Impacts from Military Expended Materials Under Alternative 1 for Testing Activities

As indicated in Appendix F (Military Expended Material and Direct Strike Impact Analysis), for testing activities under Alternative 1, areas with the greatest number of expended materials are expected to be the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, and the Gulf Stream Open Ocean Area. By far the greatest numbers of materials would be expended within the Jacksonville and Virginia Capes Range Complexes, which would also have the largest areas impacted (Table F-15).

Appendix F (Military Expended Material and Direct Strike Impact Analysis) provides the approximate footprints of military expended materials associated with testing activities. The worst-case analysis of potential impacts (Tables F-29 and F-31) shows that even if impacts were to be concentrated within hard or intermediate bottom habitats, much less than 0.01 percent of any substrate type could be affected annually or over 5 years. For the analysis of potential impacts to vegetation, the proportional impact, assuming a uniform, non-overlapping distribution of activities and associated military expended materials within each testing area, is considered a more realistic, though still unlikely, approximation of the acreage affected. This scenario does not account for areas of concentrated training, nor does it account for the clumping of military expended materials and explosives in a particular area and over a particular substrate type where a training or testing activity occurs. In reality, there are numerous factors presented in the previous section that reduce the impacts footprints on substrate types and associated vegetation reported in Appendix F. Based on proportional impacts as provided in Table F-33, it is estimated that annually, approximately 7 ac of hard bottom habitat, 7 ac of intermediate bottom habitat, 52 ac of soft-bottom habitat, and less than 1 ac of unknown bottom habitat would be impacted by military expended materials associated with testing activities under Alternative 1 (see Section 3.5, Habitats for more detailed analysis). Macroalgae occurs primarily on hard substrate but may be present on all substrate types in waters less than approximately 200 m deep. The expended material footprint areas also include mapped seagrass in the Key West Range Complex in addition to some inland training areas.

Depending on the size and type or composition of the expended materials and where they happen to strike vegetation, plants could be killed, fragmented, covered, buried, sunk, or redistributed. This type of disturbance would not likely differ from conditions created by waves or rough weather. If enough military expended materials land on algal mats, the mats can sink. Sinking occurs as a natural part of the aging process of marine algae (Schoener & Rowe, 1970). The likelihood is low that mats would accumulate enough material to cause sinking from military activities, as military expended materials are dispersed widely through an activity area. The few algal mats that would prematurely sink would not have an impact on populations. Strikes would have little impact, and would not likely result in the mortality of floating algal mats or other algae, although these strikes may injure the organisms that inhabit or are often associated with floating vegetation, including invertebrates, fish, sea turtles, marine mammals, and birds. See Sections 3.4 (Invertebrates), 3.6 (Fishes), 3.7 (Marine Mammals), 3.8 (Reptiles), and 3.9 (Birds and Bats) respectively.

As discussed in Section 5.4.1 (Mitigation Areas for Seafloor Resources), the Navy will implement mitigation to avoid impacts from military expended materials on seafloor resources in mitigation areas throughout the Study Area. For example, the Navy will not conduct gunnery activities within a specified distance of shallow-water coral reefs. The mitigation will consequently also help avoid potential impacts on vegetation that occurs in these areas.

Military expended materials used for testing activities are not expected to pose a risk to marine algae or seagrass because: (1) there would be relatively small areas of spatial coincidence between military expended material footprints and the distribution of sensitive vegetation; (2) plants and patches of vegetation affected by expended materials are likely to regrow when torn or damaged, and to recolonize temporarily disturbed areas, within a relatively short time; and (3) seagrass overlap with areas where the stressor occurs is very limited see Figure 3.3-3). Based on these factors, potential impacts on marine algae and seagrass from military expended materials are 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 vegetation.

For the reasons discussed above, pursuant to the ESA, military expended materials produced by testing activities as described under Alternative 1 would have no effect on Johnson’s seagrass or its designated critical habitat.

3.3.3.4.3.2 Impacts from Military Expended Materials Under Alternative 2

Impacts from Military Expended Materials under Alternative 2 for Training Activities

Based on Appendix F (Military Expended Material and Direct Strike Impact Analysis, Tables F-28 and F-30) the footprints of military expended materials associated with training under Alternative 2 would be essentially the same (within rounding to tenths of an acre) as those of Alternative 1 as described previously, the only difference being 1 ac more of soft bottom impact over 5 years. The slight increase in soft bottom impact would occur predominantly within the Gulf of Mexico Range Complex and would be of no consequence to vegetation.

Activities under Alternative 2 would occur at a similar rate and frequency relative to Alternative 1, and physical disturbance and strike stress experienced by individual plants or plant communities from military expended materials under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. Therefore, military expended materials associated with training activities under Alternative 2 would have essentially the same impacts as Alternative 1 and, similar to

Alternative 1, would not affect the distribution, abundance, or productivity of vegetation, have population-level effects, or affect the distribution, abundance, or productivity of vegetation.

For the reasons discussed above, pursuant to the ESA, military expended materials produced by training activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

Impacts from Military Expended Materials Under Alternative 2 for Testing Activities

Based on Appendix F (Military Expended Material and Direct Strike Impact Analysis, Tables F-29 and F-31) the footprints of military expended materials associated with testing under Alternative 2 would be nearly identical to those of Alternative 1, with less than 1 percent difference annually or over the 5-year period in acreage affected in any habitat category, range complex or testing range.

Activities under Alternative 2 would occur at a similar rate and frequency relative to Alternative 1, and physical disturbance and strike stress experienced by individual plants or plant communities from military expended materials under Alternative 2 for testing activities are not expected to be meaningfully different than those described under Alternative 1. Therefore, military expended materials associated with testing activities under Alternative 2 would be essentially the same as those of Alternative 1 and would not affect the distribution, abundance, or productivity of vegetation or have population-level effects.

For the reasons discussed above, pursuant to the ESA, military expended materials produced by testing activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

3.3.3.4.3.3 Impacts from Military Expended Materials Under the No Action Alternative

Impacts from Military Expended Materials Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various physical disturbance and strike stressors (e.g., military expended materials) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.3.3.4.4 Impacts from Seafloor Devices

For lists of the activities that use seafloor devices, see Appendix B (Activity Stressor Matrices); Section 3.0.3.3.4.3 (Seafloor Devices, Tables 3.0-34 and 3.0-35) provides locations and numbers of those activities. Seafloor devices include items that are placed on, dropped on, or moved along the seafloor such as anchors, anchor blocks, mine shapes, bottom-placed instruments, bottom-placed targets that are recovered (not expended), and robotic bottom-crawling unmanned underwater vehicles.

The use of anchors for precision anchoring training exercises involves the release of anchors in designated locations. These training activities typically occur within predetermined shallow water anchorage locations near ports with seafloors consisting of soft bottom substrate in areas that do not typically support seagrass or attached macroalgae. Mines shapes are deployed from various platforms and secured with up to a 2,700 lb. concrete mooring block. Mine shapes and anchors are normally deployed over soft sediments and are generally recovered within 7 to 30 days following the completion of the training or testing events. In the unlikely event of drop on seaweed, there would be a temporary impact while the anchor is present and thereafter, before regrowth. Mines shapes would likely not be deployed in the seagrass meadows because they are too shallow for typical deployments designed to simulate contact with a surface ship transiting deeper water." Mine shapes laid by fixed-wing aircraft in mine laying training exercises may not be recoverable, and are not recovered for several of the testing activities (Appendix A [Navy Activity Descriptions]).

Bottom placed instruments and targets would not be deployed in shallow and intertidal habitats that support seagrass or emergent marsh, or on deeper hard bottom habitats that support macroalgae. Therefore these devices are not expected to impact vegetation.

Crawlers are fully autonomous, battery-powered amphibious vehicles used for functions such as reconnaissance missions in territorial waters. These devices are used to classify and map underwater mines in shallow water areas. The crawler is capable of traveling 2 ft. per second along the seafloor and can avoid obstacles. The crawlers are equipped with various sonar sensors and communication equipment that enable these devices to locate and classify underwater objects and mines while rejecting miscellaneous clutter that would not pose a threat. Crawlers move over the surface of the seafloor could damage fragile vegetation as they move over the substrate. The crawlers may leave a trackline of depressed vegetation and sediments approximately 2 ft. wide (the width of the device) in their wake. However, since these crawlers operate in shallow water, any disturbed sediments would be redistributed by wave and tidal action shortly (days to weeks) following the disturbance. Disturbed vegetation should recover quickly from the temporary depression, as opposed to dredging or similar adverse impacts.

3.3.3.4.4.1 Impacts from Seafloor Devices Under Alternative 1

Impacts from Seafloor Devices Under Alternative 1 for Training Activities

As indicated in Section 3.0.3.3.4.3 (Seafloor Devices), for training activities under Alternative 1, seafloor devices would be used in the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, as well as Gulf Stream Open Ocean Area—predominantly within the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes; and in many inland water locations but predominantly in lower Chesapeake Bay, Narragansett Bay, the James River and Tributaries (Virginia), Cooper River (South Carolina), Mayport (Florida), and York River (Virginia) (Tables 3.0-34 and 3.0-35).

As detailed in Appendix F (Military Expended Material and Direct Strike Impact Analysis, Tables F-10, F-11, F-13), the overwhelming majority of bottom-placed devices used in training are recovered mine shapes.

Seafloor device operation, installation, or removal can potentially impact seagrass by physically removing vegetation (e.g., uprooting), crushing, temporarily increasing the turbidity (sediment suspended in the water) of waters nearby, or shading seagrass which may interfere with photosynthesis. If seagrass is not able to photosynthesize, its ability to produce energy is compromised. However, the intersection of seagrasses and seafloor devices is limited and suspended sediments would settle in a few hours. The only training use of seafloor devices that may potentially overlap with seagrass in the Study Area involves bottom-crawling unmanned underwater vehicles used in the Gulf of Mexico Large Marine Ecosystem in the Naval Surface Warfare Center, Panama City Division Testing Range, St. Andrew Bay, Florida.

Seagrasses and other vegetation found within relatively shallow waters of the Study Area are adapted to natural disturbance, and recover quickly from storms, as well as from wave and surge action. Bayside marine plant species, such as seagrasses, are found in areas where wave action is minimal. The use of seafloor devices may impact benthic habitats with vegetation, but the impacts would be limited in scale and temporary (not resulting in permanent loss of vegetation or damage to the habitat and its ability to support vegetation) for the following reasons:

- Impacts to vegetation would be limited to temporary coverage (7 to 30 days) until the mine shape is retrieved. Where vegetation is present, the most abundant and important species, including seagrasses and various types of macroalgae (Bedinger et al., 2013), propagate through subsurface rhizomes which function in nutrient uptake as well as in anchoring the plant. Mine shapes would cover a few square ft., affecting a small portion of an algal or seagrass bed. Following retrieval of the mine shape, relatively rapid regrowth of shoots from rhizomes would occur in the affected area.
- The impact of seafloor devices on attached macroalgae or seagrass is likely to be inconsequential because: (1) the area exposed to the stressor is extremely small relative to overall availability of habitat of each type, (2) most seafloor devices would be placed in soft bottom areas lacking attached macroalgae or seagrass habitat, to avoid snagging, and (3) rapid recovery of macroalgae or seagrass expected in the unlikely event of deployment on hard substrate or seagrass habitat. Based on the factors summarized here and described in Section 3.3.3.4.4 (Impacts from Seafloor Devices), activities involving seafloor devices are not expected to yield any discernable impacts on the population of vegetation in the Study Area.

The Navy will implement mitigation that includes not conducting precision anchoring (except in designated anchorages) within the anchor swing circle of shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks to avoid potential impacts from seafloor devices on seafloor resources in mitigation areas throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). This mitigation will consequently help avoid potential impacts on vegetation that occurs in these areas.

For the reasons discussed above, pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

Impacts from Seafloor Devices Under Alternative 1 for Testing Activities

As indicated in Section 3.0.3.3.4.3 (Seafloor Devices), under Alternative 1, seafloor device use for testing activities would occur with greatest frequency at the Naval Undersea Warfare Center Newport Testing Range, Naval Surface Warfare Center Panama City Testing Range, Virginia Capes Range Complexes, and South Florida Ocean Measurement Facility. Crawlers are used primarily on testing ranges (Appendix A, Navy Activity Descriptions, see A.3.2.4.6). Otherwise, as detailed in Appendix F (Military Expended Material and Direct Strike Impact Analysis, Table F-19), the overwhelming majority of bottom-placed devices used in testing activities are recovered mine shapes.

As for training activities, the use of seafloor devices may impact benthic habitats with vegetation, but the impacts would be limited in scale and temporary (not resulting in permanent loss of vegetation or damage to the habitat and its ability to support vegetation) for the same reasons as stated above for training. In addition, crawler movement over the surface of the seafloor could cause some limited damage to portions of plants through the crushing, abrasion, or snagging and tearing of thalli by the tracks of the crawler, but this would occur within a very small area (approximately 2 ft. wide) and is not expected to remove the holdfasts or rhizomes of plants, or to alter the substrate for longer than a single tidal cycle.

Seafloor devices installed in shallow water habitats under Alternative 1 testing activities would pose a negligible risk to vegetation because the effects would be generally limited to damage to portions of plants which would regrow within a fairly short time (weeks to months); and the underlying substrate conditions that influence the growth of vegetation would be briefly if at all affected. Population- or community-level impacts are unlikely because of the small, local impact areas, the frequency of testing activities, and the wider geographic distribution of seagrasses and macroalgae in and adjacent to range complexes and testing ranges.

The Navy will implement mitigation to avoid potential impacts from seafloor devices on seafloor resources in mitigation areas within the South Florida Ocean Measurement Facility, as discussed in Section 5.4.1 (Mitigation Areas for Seafloor Resources). For example, the Navy will use 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 to avoid impacts on shallow-water coral reefs and live hard bottom. This mitigation will consequently help avoid potential impacts on vegetation that occurs in these areas.

For the reasons discussed above, Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 1 would have no effect on Johnson's seagrass or its designated critical habitat.

3.3.3.4.4.2 Impacts from Seafloor Devices Under Alternative 2

Impacts from Seafloor Devices Under Alternative 2 for Training Activities

The use of seafloor devices for training activities under Alternative 2 would be nearly identical, in terms of locations and number of activities, to those occurring under Alternative 1 (refer to Tables 3.0-34 and 3.0-35). As detailed in Appendix F (Military Expended Material and Direct Strike Impact Analysis, Tables F-10, F-11, F-13), the overwhelming majority of bottom-placed devices used in training activities are recovered mine shapes. The total number of activities using seafloor devices would increase by 80 (0.1 percent) over the course of 5 years under Alternative 2, most of the difference being in the more frequent use of inland waters under Alternative 2 (60 more events over the course of 5 years than under Alternative 1) (Tables 3.0-34 and 3.0-35). Activities at some locations (e.g., Port Canaveral) may have a greater potential to overlap seagrass beds (Figure 3.3-3). As discussed under Alternative 1, these activities would have localized, temporary impacts. With the relatively infrequent use of bay and harbor locations under both alternatives, the difference in impacts between Alternatives 1 and 2 would be minor and inconsequential.

For the reasons discussed above pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

Impacts from Seafloor Devices Under Alternative 2 for Testing Activities

The use of seafloor devices for testing activities under Alternative 2 would increase by approximately 5 percent over the 5-year period under Alternative 2 (refer to Table 3.0-34). The difference is due to the greater number of activities under Alternative 2 in the Virginia Capes Range Complex and at NSWC Panama City Testing Range. Neither location overlaps the distribution of the ESA-listed Johnson's seagrass, so there would be no difference between alternatives in the effect to this species.

As discussed under Alternative 1, these activities would have localized, temporary impacts. While there would be incrementally greater temporary impacts to vegetation under Alternative 2, the difference is considered minor and inconsequential.

For the reasons discussed above, pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 2 would have no effect on Johnson's seagrass or its designated critical habitat.

3.3.3.4.4.3 Impacts from Seafloor Devices Under the No Action Alternative

Impacts from Seafloor Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various physical disturbance and strike stressors (e.g., seafloor devices) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.3.3.4.5 Impacts from Pile Driving

The effects of pile driving on vegetation would be limited to non-acoustic effects, i.e. substrate disturbance and the possible removal of relatively small amounts of vegetation during pile installation and removal. It is assumed that pile driving would occur in soft-bottom habitats with unconsolidated sediments that would allow pile installation and removal at a fairly rapid pace (Section 3.0.3.3.1.3, Pile Driving). Such areas are not expected to support appreciable amounts of vegetation. However, both micro- and macroalgae colonize hard substrate quickly and would be removed when the pilings are removed (yet there would be no net loss of vegetation). Therefore, pile driving would have no impact to vegetation and will not be analyzed further in this section.

3.3.3.5 Entanglement Stressors

Entanglement stressors associated with Navy training and testing activities are described in Section 3.0.3.3.5 (Entanglement Stressors). Expended materials that have the potential to cause entanglement generally sink to the bottom or drift ashore, and thereby could come into contact with macroalgae or seagrasses, possibly abrading or breaking plants, but such effects would be isolated, very small in scale, and temporary as the vegetation would regrow. No effects on the productivity or distribution of vegetation are anticipated. The likelihood of entanglement stressors drifting ashore and damaging plants of the ESA-listed Johnson's seagrass is extremely remote. Pursuant to the ESA, potential entanglement stressors associated with training and testing activities would have no effect on Johnson's seagrass or its designated critical habitat.

3.3.3.6 Ingestion Stressors

Ingestion stressors associated with Navy training and testing activities are described in Section 3.0.3.3.6 (Ingestion Stressors). Ingestion stressors will not impact vegetation due to the photosynthetic nature of vegetation and are not discussed further in this section.

3.3.3.7 Secondary Stressors

This section analyzes potential impacts on marine vegetation exposed to stressors indirectly through impacts on habitat and prey availability.

3.3.3.7.1 Impacts on Habitat

Section 3.2 (Sediments and Water Quality) and Section 3.5 (Habitats) considered the impacts on marine sediments and water quality and abiotic habitats from explosives and explosion by-products, metals, chemicals other than explosives, and other materials (marine markers, flares, chaff, targets, and miscellaneous components of other materials). One example of a local impact on water quality could be an increase in cyanobacteria associated with munitions deposits in marine sediments. Cyanobacteria may proliferate when iron is introduced to the marine environment, and this proliferation can negatively affect adjacent habitats by releasing toxins and can create hypoxic conditions. Introducing iron into the marine environment from munitions or infrastructure is not known to cause toxic red tide events; rather, these harmful events are more associated with natural causes (e.g., upwelling) and the effects of other human activities (e.g., agricultural runoff and other coastal pollution) (Hayes et al., 2007).

The analysis included in Section 3.2 (Sediments and Water Quality) determined that neither state nor federal standards or guidelines for sediments nor water quality would be violated by the No Action Alternative, Alternative 1, or Alternative 2. Because of these conditions, population-level impacts on marine vegetation are likely to not be detectable and therefore inconsequential. Therefore, because these standards and guidelines are structured to protect human health and the environment, and the proposed activities do not violate them, no indirect impacts are anticipated on vegetation from the No Action Alternative or by training and testing activities proposed by Alternative 1 or Alternative 2.

The analysis included in Section 3.5 (Habitats) determined that, for Alternative 1 and Alternative 2, impacts to abiotic substrates from military expended materials and explosives would amount to much less than 0.01 percent of each substrate type, resulting in little impact on the ability of substrates to support biological communities (including attached vegetation). The No Action Alternative would eliminate these impacts. The indirect impact due to substrate would be relatively minor and inconsequential because of the small areas of the seafloor that would be affected and the temporary nature of the impact. Substrate would be disturbed, but not removed, and hence would be available for recolonization.

The Navy will implement mitigation (e.g., not conducting gunnery activities within a specified distance of shallow-water coral reefs) to avoid potential impacts from explosives and physical disturbance and strike stressors on seafloor resources in mitigation areas throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). Mitigation will consequently help avoid potential secondary impacts on vegetation habitat within shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks.

3.3.3.7.2 Impacts on Prey Availability

Prey availability as a stressor is not applicable to vegetation and will not be analyzed further in this section. Impacts from the No Action Alternative or by training and testing activities proposed by Alternative 1 or Alternative 2 on prey availability are analyzed in the respective prey sections, such as invertebrates and fishes; see Sections 3.4 (Invertebrates) and 3.6 (Fishes) respectively.

Therefore, based on the information provided in these sub sections, secondary stressors would not have an impact on vegetation.

3.3.4 SUMMARY OF POTENTIAL IMPACTS ON VEGETATION

Exposures to physical disturbance and strike stressors occur primarily within the range complexes and testing ranges associated with the Study Area. The Navy identified and analyzed five physical disturbance or strike substressors that have potential to impact vegetation: vessel strikes, in-water device strikes, military expended material strikes, seafloor device strikes, and use of explosives. Vessels and in-water devices may impact vegetation by striking or disturbing vegetation on the sea surface or seafloor. Marie algae could be temporarily disturbed if struck by moving vessels and in-water devices or by the propeller action of transiting vessels.

Vegetation may be temporarily disturbed if struck by military expended materials. This type of disturbance would not likely differ from conditions created by waves or rough weather. If enough military expended materials land on algal mats, the mats can sink. The likelihood is low that mats would accumulate enough material to cause sinking from military activities, as military expended materials are dispersed widely through an activity area. Seafloor device operation, installation, or removal could impact vegetation by physically removing portions of plants, crushing, temporarily increasing the turbidity (sediment suspended in the water) of waters nearby, or increasing shading which may interfere with photosynthesis. The potential for an explosion to injure or destroy vegetation would depend on the amount of vegetation present, the number of munitions used, and their net explosive weight. In areas where vegetation and locations for explosions overlap, vegetation on the surface of the water, in the water column, or rooted in the seafloor may be impacted.

The net impact of physical disturbance and strike stressors on vegetation is expected to be negligible, based on (1) the implementation of mitigation; (2) the quick recovery of most vegetation types from holdfasts or rhizomes that are unlikely to be removed by the activities; and (3) the short-term nature of most activities and local disturbances of the surface water, with some temporary increase in suspended sediment in shallow areas.

Activities described in this EIS/OEIS that have potential impacts on vegetation are widely dispersed, affecting a very small portion of the vegetation Study Area at any given time. The stressors that have potential impacts on marine vegetation include physical disturbances or strikes (vessels and in-water devices, military expended materials, seafloor devices, and explosives) and secondary. Unlike mobile organisms, vegetation cannot flee from stressors once exposed. The major taxonomic groups comprising vegetation in the Study Area would experience localized, temporary impacts, from stressors having the potential to physically damage or disperse individual plants or patches of vegetation. Impacted areas are expected to recover in a short time through regrowth, reproduction, and passive dispersal by currents, without measurable population-level effects to distribution, abundance, or productivity.

3.3.4.1 Combined Impacts of All Stressors Under Alternative 1

Activities described in this EIS/OEIS under Alternative 1 that have potential impacts on marine vegetation are widely dispersed, and not all stressors would occur simultaneously in a given location. The stressors that have potential impacts on marine vegetation include physical disturbances or strikes (vessel and in-water devices, military expended materials, explosives, and seafloor devices). Unlike mobile organisms, vegetation cannot flee from stressors once exposed. *Sargassum* is the type of marine vegetation most likely to be exposed to multiple stressors in combination because it occurs in large expanses and because more activities and the associated stressors occur at the surface than on the bottom. Discrete areas of the Study Area (mainly within off-shore areas with depths mostly greater than 85 ft. in portions of range complexes and testing ranges) could experience higher levels of activity involving multiple stressors, which could result in a higher potential risk for impacts on *Sargassum* within those areas. The potential for seagrasses and attached macroalgae to be exposed to multiple stressors would be low because activities are not concentrated in areas with depths less than 85 ft. or in inland waters where seagrasses are concentrated. Furthermore, relatively few activities involve explosions on the bottom. The combined impacts of all stressors would not be expected to impact marine vegetation populations because: (1) activities involving more than one stressor are generally short in duration, (2) such activities are dispersed throughout the Study Area, and (3) activities are generally scheduled where previous activities have occurred; e.g., Underwater Detonation areas in Key West that do not overlap mapped seagrass beds. The aggregate effect on marine vegetation would not observably differ from existing conditions.

3.3.4.2 Combined Impacts of All Stressors Under Alternative 2

Activities described in this EIS/OEIS under Alternative 2 that have potential impacts on marine vegetation are widely dispersed, and not all stressors would occur simultaneously in a given location. The stressors that have potential impacts on marine vegetation include physical disturbances or strikes (vessel and in-water devices, military expended materials, explosives, and seafloor devices). Combined Impacts of all stressors under Alternative 2 would similar to those under Alternative 1.

3.3.4.3 Combined Impacts of All Stressors Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various stressors would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.3.5 Endangered Species Act Determinations

Pursuant to the ESA, Navy training and testing activities would have no effect on Johnson's seagrass or its designated critical habitat because the proposed action does not have any elements with the potential to modify such habitat.

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