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

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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):

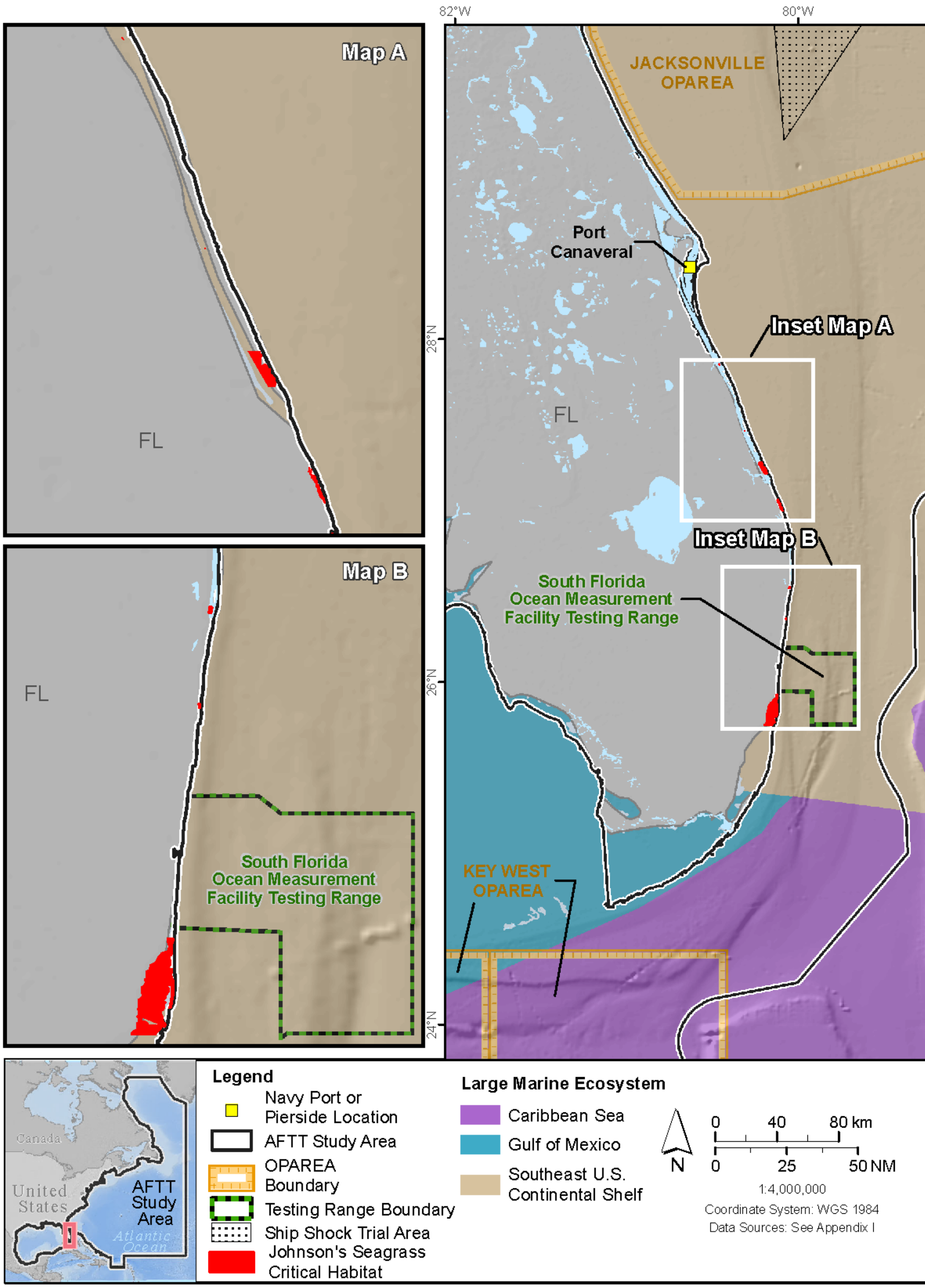
- locations with populations that have persisted for 10 years,
- locations with persistent flowering plant populations,
- locations at the northern and southern range limits of the species,
- locations with unique genetic diversity, and
- locations with a documented high abundance of Johnson's seagrass 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

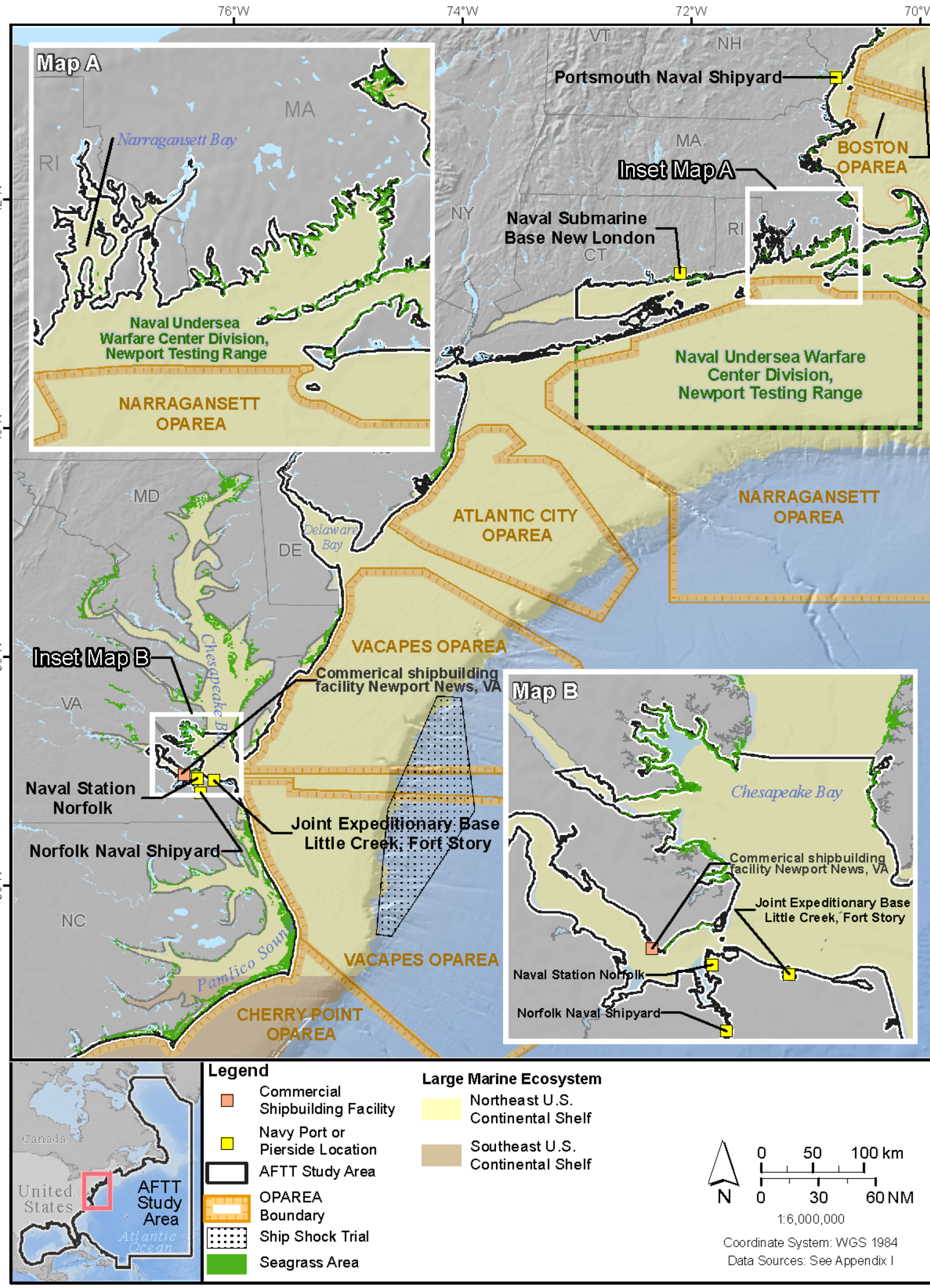
Seagrasses are unique among flowering plants in their ability to grow submerged in shallow marine environments. Seagrasses grow predominantly in shallow, subtidal, or intertidal sediments sheltered from wave action in estuaries, lagoons, and bays (Phillips & Meñez, 1988) and can extend over a large area 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

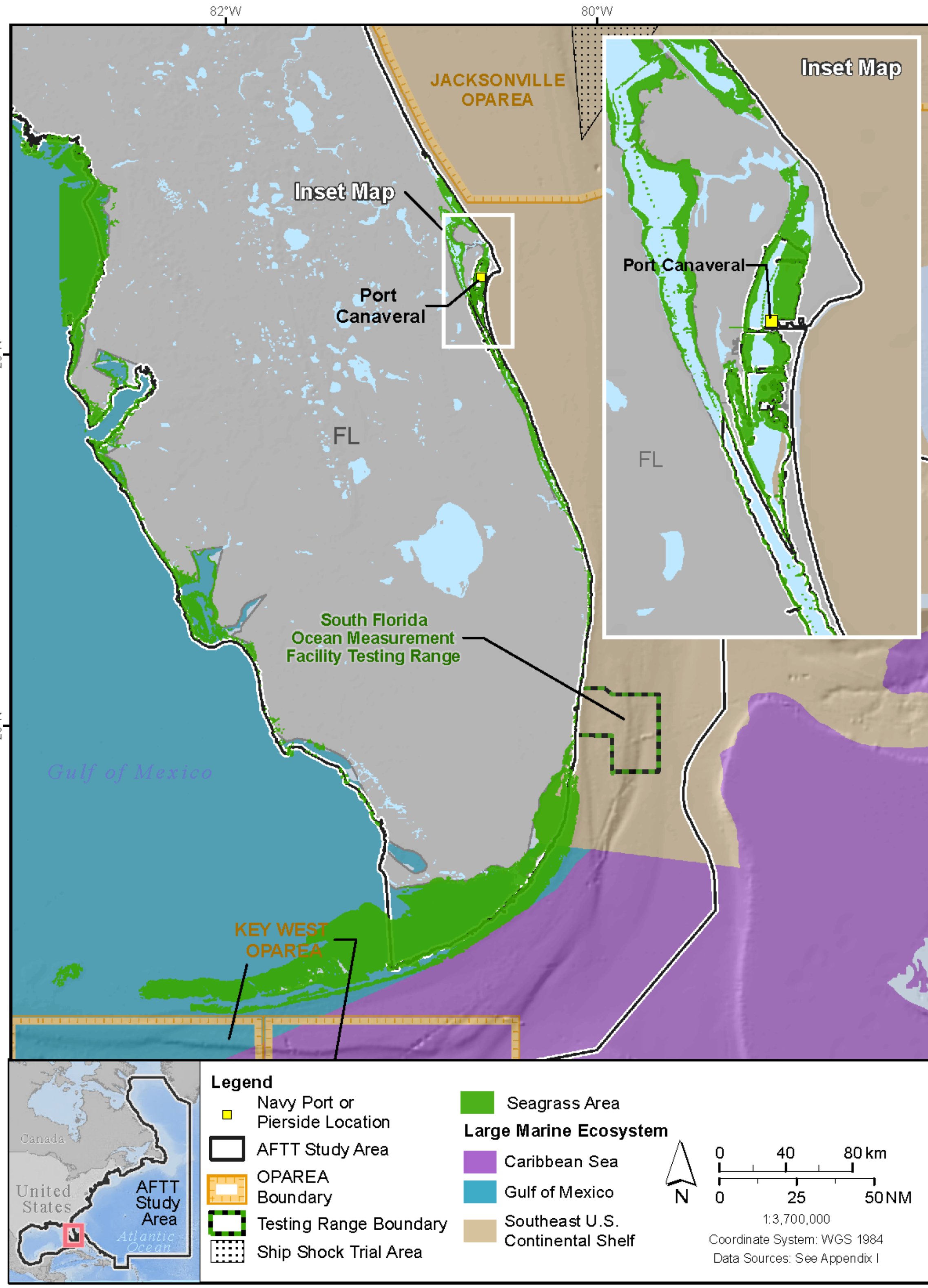
Seagrass Species	*Presence in the Study Area*[1]
Clover grass (*Halophila baillonii*)	Gulf of Mexico, Caribbean Sea
Eelgrass (*Zostera marina*)	West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf
Engelmann's seagrass (*Halophila engelmannii*)	Southeast U.S. 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)



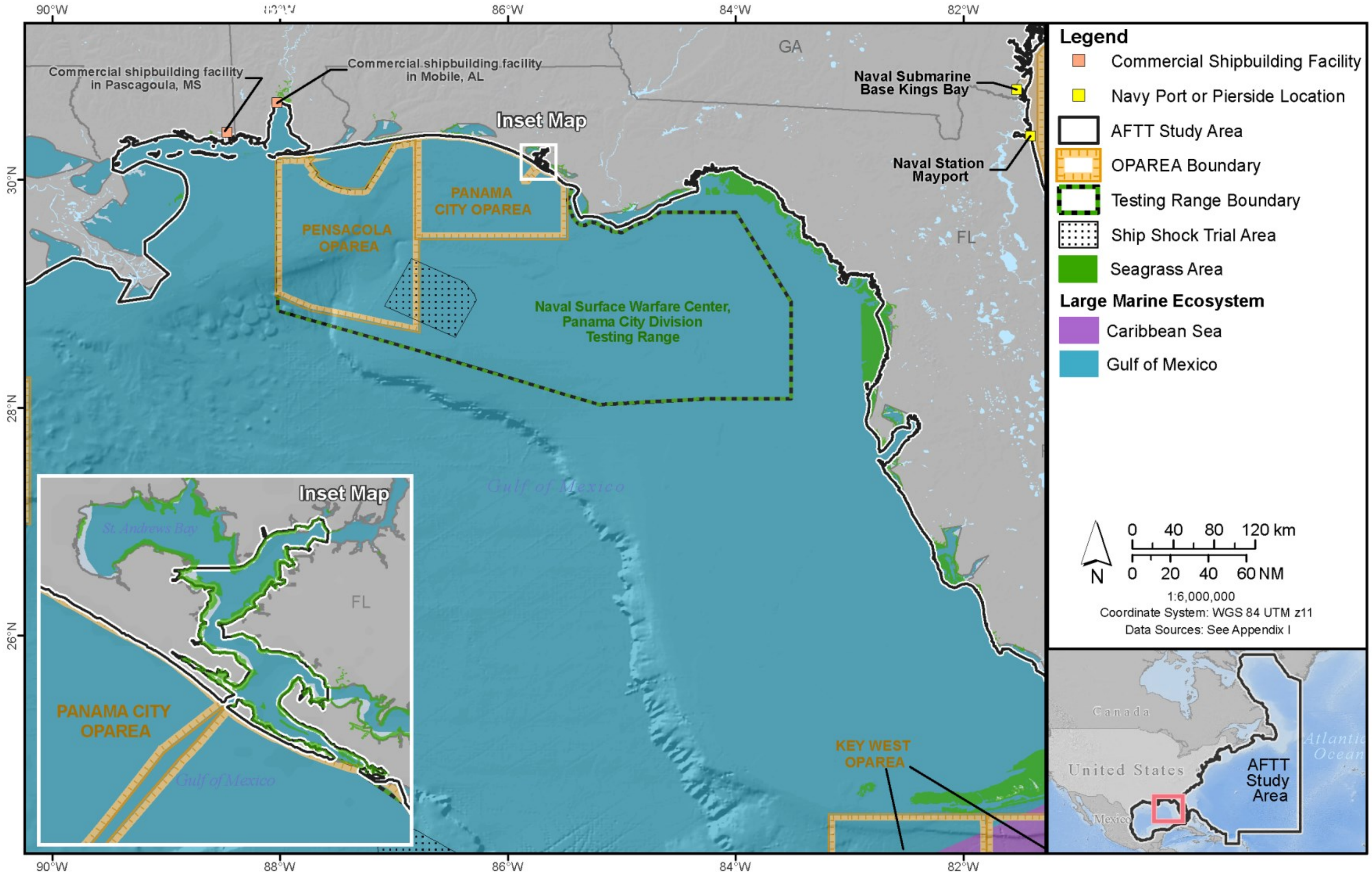
Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

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.

<u>Impacts from Vessels and In-Water Devices Under Alternative 1 for Testing Activities</u>

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.

References

Adey, W. H., & L. A. C. Hayek. (2011). Elucidating marine biogeography with Macrophytes: Quantitative analysis of the north Atlantic supports the thermogeographic model and demonstrates a distinct subarctic region in the northwestern Atlantic. *Northeastern Naturalist, 18*(8), 1–128.

Arnold, T., C. Mealey, H. Leahey, A. W. Miller, J. M. Hall-Spencer, M. Milazzo, & K. Maers. (2012). Ocean acidification and the loss of phenolic substances in marine plants. *PLoS ONE, 7*(4), e35107–e35107.

Bedinger, L. A., S. S. Bell, & C. J. Dawes. (2013). Rhizophytic Algal Communities of Shallow, Coastal Habitats in Florida: Components Above and Below the Sediment Surface. *Bulletin of Marine Science, 89*(2), 437–461.

Benham, C. F., S. G. Beavis, R. A. Hendry, & E. L. Jackson. (2016). Growth effects of shading and sedimentation in two tropical seagrass species: Implications for port management and impact assessment. *Elsevier*, 1–10.

Blaber, S. J., D. P. Cyrus, J. J. Albaret, C. V. Ching, J. W. Day, M. Elliott, M. S. Fonseca, D. E. Hoss, J. Orensanz, & I. C. Potter. (2000). Effects of fishing on the structure and functioning of estuarine and nearshore ecosystems. *ICES Journal of Marine Sciences, 57*, 590–613.

Bozek, C., & D. Burdick. (2005). Impacts of seawalls on saltmarsh plant communities in the Great Bay Estuary, New Hampshire USA. *Wetlands Ecology and Management, 13*, 553–568.

Butler, J. N., B. F. Morris, J. Cadwallader, & A. W. Stoner. (1983). *Studies of Sargassum and the Sargassum Community*: Bermuda Biological Station for Research, Inc.

Byrnes, J. E., D. C. Reed, B. J. Cardinale, K. C. Cavanaugh, S. J. Holbrooks, & R. J. Schmitts. (2011). Climate-driven increases in storm frequency simplify kelp forest food webs. *Global Change Biology, 17*, 2513–2525.

Caceres, C., F. G. Taboada, J. Hofer, & R. Anadon. (2013). Phytoplankton Growth and Microzooplankton Grazing in the Subtropical Northeast Atlantic. *PLoS ONE, 8*(7).

Castro, P., & M. E. Huber. (2000). Marine prokaryotes, protists, fungi, and plants *Marine Biology* (3rd ed., pp. 83–103). McGraw-Hill.

Coelho, C., R. Silva, F. Veloso-Gomes, & F. Taveira-Pinto. (2009). Potential effects of climate change on northwest Portuguese coastal zones. *ICES Journal of Marine Sciences, 66*, 1497–1508.

Coston-Clements, L., L. R. Settle, D. E. Hoss, & F. A. Cross. (1991). *Utilization of the Sargassum habitat by marine invertebrates and vertebrates—A review*. National Oceanic and Atmospheric Administration.

Crain, C. M., B. S. Halpern, M. W. Beck, & C. V. Kappel. (2009). Understanding and Managing Human Threats to the Coastal Marine Environment. In R. S. Ostfeld & W. H. Schlesinger (Eds.), *The Year in Ecology and Conservation Biology, 2009* (pp. 39–62). Oxford, UK: Blackwell Publishing.

Creed, J. C., R. C. Phillips, & B. I. Van Tussenbroek. (2003). The Seagrasses of the Caribbean. In E. P. Green & F. T. Short (Eds.), *World Atlas of Seagrasses* (pp. 234–242). Berkeley, CA: University of California Press.

Culbertson, J. B., I. Valiela, M. Pickart, E. E. Peacock, & C. M. Reddy. (2008). Long-term consequences of residual petroleum on salt marsh grass. *Journal of Applied Ecology, 45*(4), 1284–1292.

Dawes, C. J., J. Andorfer, C. Rose, C. Uranowski, & N. Ehringer. (1997). Regrowth of the seagrass, *Thalassia testudinum,* into propeller scars. *Aquatic Botany, 59*(1–2), 139–155.

Dawes, C. J. (1998). *Marine Botany* (2nd ed.). New York, NY: John Wiley and Sons, Inc.

Dennison, W., R. Orth, K. Moore, J. Stevenson, V. Carter, S. Kollar, P. Bergstrom, & R. Batiuk. (1993). Assessing Water Quality with Submersed Aquatic Vegetation. *Bioscience, 43*(2), 86–94.

Doney, S. C., M. Ruckelshaus, D. J. Emmett, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, & L. D. Talley. (2012). Climate change impacts on marine ecosystems. *Annual Review of Marine Science, 4*(1), 11–37.

Doyle, E., & J. Franks. (2015). Sargassum Fact Sheet. In G. a. C. F. Institute (Ed.).

Egan, B., & C. Yarish. (1988). The distbution of the genus *Laminaria* (Phaeophyta) at its southern limit in the western Atlantic Ocean. *Botanica Marina, 31*, 155–161.

Egan, B., & C. Yarish. (1990). Productivity and life history of *Laminaria longicruris* at its southern limit in the Western Atlantic Ocean. *Marine Ecology Progress Series, 67*, 263–273.

Eiseman, N. J., & C. McMillan. (1980). A new species of seagrass, *Halophila johnsonii*, from the Atlantic coast of Florida. *Aquatic Botany, 9*, 15–19.

Ellison, A., E. Farnsworth, & G. Moore. (2007a). *Avicennia germinans*. *International Union for Conservation of Nature 2010. International Union for Conservation of Nature Red List of Threatened Species. Version 2010.4.* Retrieved from http://www.iucnredlist.org/apps/redlist/details/178811/0

Ellison, A., E. Farnsworth, & G. Moore. (2007b). *Rhizophora mangle*. *International Union for Conservation of Nature 2010. International Union for Conservation of Nature Red List of Threatened Species. Version 2010.4.* Retrieved from http://www.iucnredlist.org/apps/redlist/details/178851/0

Ellison, A., E. Farnsworth, & G. Moore. (2007c). *Laguncularia racemosa*. *International Union for Conservation of Nature 2010. International Union for Conservation of Nature Red List of Threatened Species. Version 2010.4.* Retrieved from http://www.iucnredlist.org/apps/redlist/details/178798/0

Feller, I. C., C. E. Lovelock, U. Berger, K. L. McKee, S. B. Joye, & M. C. Ball. (2010). Biocomplexity in mangrove ecosystems. *Annual Review of Marine Science, 2*(1), 395–417.

Ferguson, R. L., & L. L. Wood. (1994). *Rooted Vascular Beds in the Albemarle-Pamlico Estuarine System*. Environmental Protection Agency, National Marine Fisheries Service.

Florida Department of Environmental Protection. (2010a). *Seagrasses*. Florida Department of Environmental Protection.

Florida Department of Environmental Protection. (2010b). *Site-Specific Information in Support of Establishing Numeric Nutrient Criteria for St. Andrew Bay Florida*. Tallahassee, FL.

Florida Fish and Wildlife Conservation Commission-Fish and Wildlife Research Institute. (2012). Marine Resources Geographic Information System. Retrieved from http://ocean.floridamarine.org/mrgis/

Fonseca, M., & A. Malhorta. (2012). *Boat wakes and their influence on erosion in the Atlantic Intracoastal Waterway, North Carolina*. Beaufort, NC.

Fonseca, M. S., W. J. Kenworthy, & G. W. Thayer. (1998). *Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters*. (NOAA's Coastal Ocean Program Decision Analysis Series No. 12). Silver Spring, MD: National Oceanic and Atmospheric Administration, Coastal Ocean Office.

Fourqurean, J. W., M. J. Durako, M. O. Hall, & L. N. Hefty. (2002). Seagrass distribution in South Florida: A multi-agency coordinated monitoring program. In J. W. Porter & K. G. Porter (Eds.), *The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook* (pp. 497–522). Boca Raton, FL: CRC Press.

Francour, P., A. Ganteaume, & M. Poulain. (1999). Effects of boat anchoring in *Posidonia oceanica* seagrass beds in the Port-Cros National Park (north-western Mediterranean Sea). *Aquatic Conservation: Marine and Freshwater Ecosystems, 9*(4), 391–400.

Galbraith, H., R. Jones, R. Park, J. Clough, S. Herrod-Julius, B. Harrington, & G. Page. (2005). *Global Climate Change and Sea Level Rise: Potential Losses of Intertidal Habitat for Shorebirds*.

Garrison, T. (2004). *Essentials of Oceanography* (3rd ed.). Pacific Grove, CA: Brooks/Cole-Thomas Learning.

Gower, J., C. Hu, G. Borstad, & S. King. (2006). Ocean color satellites show extensive lines of floating *Sargassum* in the Gulf of Mexico. *IEEE Transactions on Geoscience and Remote Sensing, 44*(12), 3619–3625.

Gower, J., & S. King. (2008). Satellite images show the movement of floating Sargassum in the Gulf of Mexico and Atlantic Ocean. *Nature Precedings*.

Gower, J., E. Young, & S. King. (2013). Satellite images suggest a new Sargassum source region in 2011. *Remote Sensing Letters, 4*(8), 764–773.

Green, E. P., & F. T. Short. (2003). World Atlas of Seagrasses (pp. 298). Berkeley, CA: University of California Press.

Gulf of Mexico Fishery Management Council. (2010). *Species Listed in the Fishery Management Plans of the Gulf of Mexico Fishery Management Council*.

Gulf of Mexico Program. (2004). *Seagrass Habitat in the Northern Gulf of Mexico: Degradation, Conservation and Restoration of a Valuable Resource*. (855-R-04-001). United States Environmental Protection Agency.

Harley, C. D., A. R. Hughes, K. M. Hultgren, B. G. Miner, C. J. B. Sorte, C. S. Thomber, L. F. Rodriguez, T. L., & S. L. Willaims. (2006). The impacts of climate change in coastal marine systems. *Ecology letters, 9*, 228–242.

Hayes, M. O., R. Hoff, J. Michel, D. Scholz, & G. Shigenaka. (1992). *An Introduction to Coastal Habitats and Biological Resources for Oil Spill Response*. Seattle, WA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Hazardous Materials Response and Assessment Division.

Hayes, P. K., N. A. El Semary, & P. Sanchez-Baracaldo. (2007). The taxonomy of cyanobacteria: Molecular insights into a difficult problem. In J. Brodie & J. Lewis (Eds.), *Unravelling the Algae: The Past, Present, and Future of Algal Systematics* (pp. 93–102). Boca Raton, FL: CRC Press.

Heck, K. L., Jr., G. Hays, & R. J. Orth. (2003). Critical evaluation of the nursery role hypothesis for seagrass meadows. *Marine Ecology Progress Series, 253*, 123–136.

Hemminga, M. A., & C. M. Duarte. (2000). Seagrasses in the human environment *Seagrass Ecology* (pp. 248–291). Cambridge, UK: Cambridge University Press.

Hoff, R., P. Hensel, E. C. Proffitt, P. Delgado, G. Shigenaka, R. Yender, R. Hoff, & A. J. Mearns. (2002). *Oil Spills in Mangroves: Planning & Response Considerations*. Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Ocean Service, Office of Response and Restoration.

Kenworthy, W. J., M. J. Durako, S. M. R. Fatemy, H. Valavi, & G. W. Thayer. (1993). Ecology of seagrasses in northeastern Saudi Arabia one year after the Gulf War oil spill. *Marine Pollution Bulletin, 27*, 213–222.

Knowlton, A. R., & S. D. Kraus. (2001). Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean. *Journal of Cetacean Resource Management, Special Issue 2*, 193–208.

Lehmköster, J. (2015). Climate change impacts on marine ecosystems. In T. Schröder (Ed.), *World Ocean Review* (pp. 102–117). Hamburg: maribus gGmbH.

Levinton, J. (2013a). Plankton *Marine Biology: Function, Biodiversity, Ecology* (4th ed., pp. 141–162). New York, NY: Oxford University Press.

Levinton, J. (2013b). Benthic microorganisms, seaweeds, and sea grasses *Marine Biology: Function, Biodiversity, Ecology* (4th ed., pp. 242–253). New York: Oxford University Press.

Levinton, J. (2013c). Seaweeds *Marine Biology: Function, Biodiversity, Ecology* (4th ed., pp. 246–252). New York, NY: Oxford University Press.

Levinton, J. (2013d). Environmental impacts of industrial activities and human populations *Marine Biology: Function, Biodiversity, Ecology* (4th ed., pp. 492–516). New York, NY: Oxford University Press.

Levinton, J. S. (2013e). *Marine Biology: Function, Biodiversity, Ecology* (Fourth ed.). New York, New York: Oxford University Press.

Liu, H., M. Chen, F. Zhu, & P. J. Harrison. (2016). Effect of Diatom Silica Content on Copepod Grazing, Growth and Reproduction. *Frontiers in Marine Science, 3*(89), 1–7.

Luning, K. (1990). Seaweeds: Their Environment, Biogeography, and Ecophysiology. In C. Yarish & H. Kirkman (Eds.), (pp. 527). New York, NY: John Wiley & Sons, Inc.

Mach, K. J., B. B. Hale, M. W. Denny, & D. V. Nelson. (2007). Death by small forces: A fracture and fatigue analysis of wave-swept macroalgae. *Journal of Experimental Biology, 210*(13).

Maffei, M. E. (2014). Magnetic field effects on plant growth, development, and evolution. *Frontiers in Plant Science, 5*(445), 1–15.

Maine Department of Marine Resources. (2014). *Fishery Management Plan for Rockweed (Ascophyllum nodosum)*.

Marret, F., & K. A. F. Zonneveld. (2003). Atlas of modern organic-walled dinoflagellate cyst distribution. *Review of Palaeobotany and Palynology, 125*(1–2), 1–200.

Martinez, B., F. Arenas, M. Rubal, S. Burgues, R. Esteban, I. Garcia-Plazaola, F. L. Figueroa, R. Pereira, L. Saldana, I. Sousa-Pinto, A. Trilla, & R. M. Viejo. (2012). Physical factors driving intertidal macroalgae distribution: physiological stress of a dominant fucoid at its southern limit. *Oecologia*.

Massachusetts Office of Coastal Zone Management. (2013). *Non-Native Seaweed in Massachusetts*. Boston, MA.

Mathieson, A. C., C. J. Dawes, E. J. Hehre, & L. G. Harris. (2009). Floristic studies of seaweeds from Cobscook Bay, Maine. *Northeastern Naturalist, 16*(Mo5), 1–48.

McHugh, D. J. (2003). *A Guide to the Seaweed Industry*. Food & Agriculture Organization.

Mearns, A. J., D. J. Reish, P. S. Oshida, T. Ginn, & M. A. Rempel-Hester. (2011). Effects of Pollution on Marine Organisms. *Water Environment Research, 83*(10), 1789–1852.

Michel, J., & N. Rutherford. (2013). *Oil Spills in Marshes: Planning and Response Considerations*.

Mitsch, W. J., J. G. Gosselink, C. J. Anderson, & L. Zhang. (2009). *Wetland Ecosystems*. Hoboken, NJ: John Wiley & Sons, Inc.

Narragansett Bay Estuary Program. (2010). *Rhode Island's Coastal Habitats*. Coastal Resources Management Council.

National Marine Fisheries Service. (2002). *Final Recovery Plan for Johnson's Seagrass (Halophia johnsonni)*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service. (2010). *Johnson's Seagrass (Halophila johnsonii)*. National Marine Fisheries Service Retrieved from http://www.nmfs.noaa.gov/pr/species/plants/johnsonsseagrass.htm.

Endangered and Threatened Species: Critical Habitat for the Northwest Atlantic Ocean Loggerhead Sea Turtle Distinct Population Segment (DPS) and Determination Regarding Critical Habitat for the North Pacific Ocean Loggerhead DPS; Final Rule (2014).

National Ocean Service. (2015, January 5). How far does light travel in the ocean? , Retrieved from http://oceanservice.noaa.gov/facts/light_travel.html

National Oceanic and Atmospheric Administration. (2011). State of the Coasts. Retrieved from http://stateofthecoast.noaa.gov/glossary.html

National Research Council. (2007). *Mitigating Shore Erosion Along Sheltered Coasts*. Washington, D.C.: The National Academies Press.

North Carolina Department of Environmental and Natural Resources. (2012). *North Carolina Submerged Aquatic Vegetation*. Retrieved from http://portal.ncdenr.org/web/apnep/sav-map.

Olsen, Y. S., M. Sanchez-Camacho, N. Marba, & C. M. Duarte. (2012). Mediterranean seagrass growth and demography responses to experimental warming. *Estuaries and Coasts, 35*(5), 1205–1213.

Orth, R., T. Carruthers, W. Dennison, C. Duarte, J. Fourqurean, K. Heck Jr., A. Hughes, G. Kendrick, W. Kenworthy, S. Olyarnik, F. Short, M. Waycott, & S. Williams. (2006). A Global Crisis for Seagrass Ecosystems. *Bioscience, 56*(12), 987–996.

Orth, R., S. Marion, K. Moore, & D. Wilcox. (2010). Eelgrass (*Zostera marina L.*) in the Chesapeake Bay Region of Mid-Atlantic Coast of the USA: Challenges in Conservation and Restoration. *Estuaries and Coasts, 33*, 139–150.

Orth, R. J., & K. A. Moore. (1988). Distribution of *Zostera marina* L. and *Ruppia maritima* L. sensu lato along depth gradients in the lower Chesapeake Bay, U.S.A. *Aquatic Botany, 32*(3), 291–305.

Parnell, K., S. McDonald, & A. Burke. (2007). Shoreline effects of vessel wakes, Marlborough Sounds, New Zealand. *Journal of Coastal Research*(Special Issue 50), 502–506.

Peckol, P., & R. Searles. (1984). Temporal and Spatial Patterns of Growth and Survival of Invertebrate and Algal Populations of a North Carolina Continental Shelf Community. *Estuarine and Coastal Shelf Science, 18*, 133–143.

Peckol, P., & J. Ramus. (1988). Abundances and physiological properties of deepwater seaweeds from Carolina outer continental shelf. *Journal of Experimental Marine Biology and Ecology, 115*(1), 25–40.

Peterson, C. H. (2001). The "Exxon Valdez" oil spill in Alaska: Acute, indirect and chronic effects on the ecosystem. In A. J. Southward, P. A. Tyler, C. M. Young & L. A. Fuiman (Eds.), *Advances in Marine Biology* (Vol. 39, pp. 1–103). San Diego, CA: Academic Press.

Phillips, R. C., & E. G. Meñez. (1988). Seagrasses. *Smithsonian Contributions to the Marine Sciences, 34*, 104.

Rabalais, N. N., R. E. Turner, & D. Scavia. (2002). Beyond science into policy: Gulf of Mexico hyposiz and the Mississippi River. *Bioscience, 52*(2).

Roskov, Y., L. Abucay, T. Orrell, D. Nicolson, T. Kunze, A. Culham, N. Bailly, P. Kirk, T. Bourgoin, R. E. DeWalt, W. Decock, & A. De Weaver. (2015). Species 2000 & ITIS Catalogue of Life, 2015 Annual Checklist. [Digital Resource]. ISSN 2405-8858. Retrieved July 6, 2015 http://www.catalogueoflife.org/annual-checklist/2015/

Ruggiero, M., & D. Gordon. (2015). ITIS Standard Report Page: Ochrophyta. Retrieved from http://www.itis.gov/servlet/SingleRpt/SingleRpt

Ruwa, R. K. (1996). Intertidal wetlands. In T. R. McClanahan & T. P. Young (Eds.), *East African Ecosystems and Their Conservation* (pp. 101–130). New York, NY: Oxford University Press.

Sargent, F. J., T. J. Leary, D. W. Crewz, & C. R. Kruer. (1995). *Scarring of Florida's Seagrasses: Assessment and Management Options*. Florida Department of Environmental Protection.

Schiel, D. R., J. R. Steinbeck, & M. S. Foster. (2004). Ten years of induced ocean warming causes comprehensive changes in marine benthic communities. *Ecology, 85*(7), 1833–1839.

Schoener, A., & G. T. Rowe. (1970). Pelagic *Sargassum* and its presence among the deep-sea benthos. *Deep-Sea Research, 17*, 923–925.

Short, F., T. Carruthers, W. Dennison, & M. Waycott. (2007). Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology, 350*, 3–21.

South Atlantic Fishery Management Council. (1998). *Final Habitat Plan for the South Atlantic Region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Coucil*. South Atlantic Fishery Management Council.

South Atlantic Fishery Management Council. (2002). *Fishery Management Plan for Pelagic Sargassum Habitat of the South Atlantic Region. Second Revised Final. Including a Final Environmental Impact Statement, Initial Regulatory Flexibility Analysis, Regulatory Impact Review, & Social Impact Assessment/Fishery Impact Statement*.

South Atlantic Fishery Management Council. (2009). *Fishery Ecosystem Plan of the South Atlantic Region: South Atlantic Habitats and Species*. Charleston, SC: South Atlantic Fishery Management Council.

Spalding, M., M. Taylor, C. Ravilious, F. Short, & E. Green. (2003). Global overview: The distribution and status of seagrasses. In E. P. Green & F. T. Short (Eds.), *World Atlas of Seagrasses* (pp. 5–26). Berkeley, CA: University of California Press.

Stedman, S., & T. Dahl. (2008). *Status and trends of wetlands in the coastal watersheds of the Eastern United States 1998 to 2004*.

Steneck, R. S., M. H. Graham, B. J. Bourque, D. Corbett, J. M. Erlandson, J. A. Estes, & M. J. Tegner. (2002). Kelp forest ecosystems: Biodiversity, stability, resilience and future. *Environmental Conservation, 29*(4), 436–459.

Stevenson, J., C. Piper, & N. Confer. (1979). *Decline of Submerged Plants in Chesapeake Bay*. Retrieved from https://www.fws.gov/chesapeakebay/savpage.htm.

Stevenson, J., L. Staver, & K. Staver. (1993). Water Quality Associated With Survival of Submersed Aquatic Vegetation Along an Estuarine Gradient. *Estuaries, 16*(2), 346–361.

Steward, J., & W. Green. (2007). Setting Load Limits for Nutrients and Suspended Solids Based upon Seagrass Depth-limit Targets. *Estuaries and Coasts, 30*(4), 657–670.

Thomsen, M., T. Wernberg, A. Engelen, F. Tuya, M. Vanderklift, M. Holmer, K. McGlathery, F. Arenas, J. Kotta, & B. Silliman. (2012). A Meta-Analysis of Seaweed Impacts on Seagrasses: Generalities and Knowledge Gaps. *PLoS ONE, 7*(1), 1–8.

Trono, G., & G. Tolentino. (1993). Studies on the Management of Sargassum (*Fucales, Phaeophyta*) Bed in Bolinao, Pangasinan, Phillipines. *The Korean Journal of Phycology, 8*(2), 249–257.

Twilley, R., W. Kemp, K. Staver, J. Stevenson, & W. Boynton. (1985). Nutrient enrichment of estuarine submersed vascular plant communities. 1. Algal growth and effects on production of plants and associated communities. *Marine Ecology - Progress Series, 23*, 179–191.

U.S. Geological Survey. (2003). *Predicting Future Mangrove Forest Migration in the Everglades Under Rising Sea Level*. (FS-030-03).

U.S. National Response Team. (2010). *What are the Effects of Oil on Seagrass?* : U.S. Environmental Protection Agency, Region IV Retrieved from http://www.nrt.org/production/NRT/RRTHome.nsf/resources/RRTIV-Pamphlets/$File/27_RRT4_Seagrass_Pamphlet.pdf.

Vadas, R. L., Sr., B. F. Beal, W. A. Wright, S. Nickl, & S. Emerson. (2004). Growth and productivity of sublittoral fringe kelps (*Laminaria longicruris*) Bach. Pyl. in Cobscook Bay, Maine. *Northeastern Naturalist, 11*(Special Issue 2), 143–162.

Virnstein, R. W., L. J. Morris, J. D. Miller, & R. Miller-Myers. (1997). *Distribution and abundance of Halophila johnsonii in the Indian River Lagoon*. Palatka, FL: St. Johns River Water Management District.

Virnstein, R. W., & L. M. Hall. (2009). Northern range extension of the seagrasses *Halophila johnsonii* and *Halophila decipiens* along the east coast of Florida, U.S.A. *Aquatic Botany, 90*(1), 89–92.

Virnstein, R. W., L.-A. C. Hayek, & L. J. Morris. (2009). Pulsating patches: A model for the spatial and temporal dynamics of the threatened seagrass, *Halophila johnsonii*. *Marine Ecology Progress Series, 385*, 97–109.

Watzin, M. C., & J. G. Gosselink. (1992). *The Fragile Fringe: Coastal Wetlands of the Continental United States*. Washington, DC: United States Dept. of the Interior, Fish and Wildlife Service Retrieved from http://nla.gov.au/nla.cat-vn3842373.

Waycott, M., C. M. Duarte, T. J. B. Carruthers, R. J. Orth, W. C. Dennison, S. Olyarnik, A. Calladine, J. W. Fourqurean, K. L. Heck, Jr., A. R. Hughes, G. A. Kendrick, W. J. Kenworthy, F. T. Short, & S. L.

Williams. (2009). Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Sciences, 106*(30), 12377–12381.

Willette, D., & R. Ambrose. (2012). Effects of the invasive seagrass Halophila stipulacea on the native seagrass, Syringodium filiforme, and associated fish and epibiota communities in the Eastern Caribbean. *Aquatic Botany, 103*, 74–82.

Williams, S. L., & J. E. Smith. (2007). A Global Review of the Distribution, Taxonomy, and Impacts of Introduced Seaweeds. *Annual Review of Ecology, Evolution, and Systematics, 38*(1), 327–359.

Wilson, C. J., P. S. Wilson, C. A. Greene, & K. H. Dunton. (2013). Seagrass meadows provide an acoustic refuge for estuarine fish. *Marine Ecology Progress Series, 472*, 117–128.

Woodward-Clyde Consultants. (1994). *Historical imagery inventory and seagrass assessment, Indian River Lagoon*. Melborne, FL: Indian River Lagoon National Estuary Program.

World Ocean Review. (2015). *Sustainable Use of Our Oceans - Making Ideas Work*. Hamburg, Germany: Maribus.

Zaitsev, Y. P. (1971). *Marine Neustonology*. Jerusalem: Israel Program for Scientific Translations.