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

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3.8 Reptiles

REPTILES SYNOPSIS

The United States Department of the Navy (Navy) considered all potential stressors that reptiles could potentially be exposed to from the Proposed Action. The following conclusions have been reached for the Preferred Alternative (Alternative 1):

- Acoustic: Navy training and testing activities have the potential to expose reptiles to multiple types of acoustic stressors, including sonars, other transducers, air guns, pile driving, and vessel, aircraft, and weapons noise. Reptiles could be affected by only a limited portion of acoustic stressors because reptiles have limited hearing abilities. Exposures to sound-producing activities present risks that could range from hearing loss, auditory masking, physiological stress, and changes in behavior; however, no injurious impacts are predicted due to exposure to any acoustic stressor. Because the number of sea turtles potentially impacted by sound-producing activities is small, population-level effects are unlikely. Few, if any impacts on crocodilians or terrapins are anticipated from acoustic stressors because of the location of training activities relative to crocodilian and terrapin habitats.
- Explosive: Explosions in the water or near the water's surface present a risk to reptiles located in close proximity to the explosion, because the shock waves produced by explosives could cause injury or result in the death. If further away from the explosion, impulsive, broadband sounds introduced into the marine environment may cause hearing loss, auditory masking, physiological stress, or changes in behavior. Sea turtles would be exposed to explosive stressors in the nearshore and offshore portions of the Study Area, while crocodilians and terrapins would be exposed to explosive stressors at two inshore training and testing locations. One loggerhead sea turtle mortality is predicted. Because the number of sea turtles potentially impacted by explosives is small, population-level effects are unlikely. It is unlikely that crocodilians and terrapins would be in close proximity to inshore explosions because they would likely, if present, flee the area in response to other stressors (e.g., vessel noise, visual stimulus). Also, the types of explosives are small limpet mine charges, which limits the area where crocodilians and terrapins could be exposed to injurious impacts from explosives. Because inshore explosives training activities would impact few, if any, crocodilians or terrapins, population-level effects are unlikely.
- Energy: Navy training and testing activities have the potential to expose reptiles to multiple energy stressors in offshore and inshore training and testing locations. The likelihood and magnitude of energy impacts depends on the proximity of a reptile to energy stressors. Based on the relatively weak strength of the electromagnetic field created by Navy activities, impacts on sea turtle migrating behaviors and navigational patterns are not anticipated. Potential impacts from high-energy lasers would only result for sea turtles directly struck by the laser beam. Statistical probability analyses demonstrate with a high level of certainty that no sea turtles would be struck by a high-energy laser. Activities that generate

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REPTILES SYNOPSIS

electromagnetic fields would occur in inshore habitats potentially inhabited by crocodilians and terrapins; however, no measureable impacts on individuals would be expected to occur. Activities using high-energy lasers would not occur in inshore training and testing locations. Energy stressors associated with Navy training and testing activities are temporary and localized in nature, and based on patchy distribution of reptiles, impacts on individual reptiles are unlikely and no impacts on populations are anticipated.

- Physical Disturbance and Strike: Vessels, in-water devices, and seafloor devices present a risk for collision with sea turtles, particularly in coastal areas where densities are higher. Strike potential by expended materials is statistically small. Because of the low numbers of sea turtles potentially impacted by activities that may potentially cause a physical disturbance and strike, population-level effects are unlikely. Activities that use vessels, in-water devices, and seafloor devices would occur in habitats used by crocodilians and terrapins. Activities that expend materials would also occur in inshore habitats inhabited by crocodilians and terrapins; however, interactions with materials would not likely occur, and no impacts on individual crocodilians and terrapins are expected if a reptile encountered expended material. Because of the low numbers of crocodilians and terrapins potentially impacted by activities that may potentially cause a physical disturbance and strike, population-level effects are unlikely.
- Entanglement: Sea turtles could be exposed to multiple entanglement stressors in inshore and offshore training and testing locations. The potential for impacts is dependent on the physical properties of the expended materials and the likelihood that a sea turtle would encounter a potential entanglement stressor and then become entangled in it. Physical characteristics of wires and cables, decelerators/parachutes, and biodegradable polymers combined with the sparse distribution of these items throughout the Study Area indicates a very low potential for sea turtles to encounter and become entangled in them. Long-term impacts on individual sea turtles and sea turtle populations from entanglement stressors associated with Navy training and testing activities are not anticipated. Entanglement stressors are not anticipated to impact crocodilians or terrapins because activities that expend materials that present a potential entanglement risk would not co-occur with crocodilian or terrapin habitats.
- Ingestion: Navy training and testing activities have the potential to expose reptiles to multiple ingestion stressors and associated impacts in inshore and offshore training and testing locations. The likelihood and magnitude of impacts depends on the physical properties of the military expended items and the feeding behaviors of the particular species of reptiles that occur in specific areas where potentially ingestible items are used. Adverse impacts from ingestion of military expended materials would be limited to the unlikely event

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REPTILES SYNOPSIS

that a sea turtle, crocodilian, or terrapin would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The likelihood that a reptile would encounter and subsequently ingest a military expended item associated with Navy training and testing activities is considered low. Long-term consequences to reptile populations from ingestion stressors associated with Navy training and testing activities are not anticipated.

- Secondary: Reptiles could be exposed to multiple secondary stressors (indirect stressors to habitat or prey) associated with Navy training and testing activities in the Study Area. In-water explosions have the potential to injure or kill prey species that sea turtles feed on within a small area affected by the blast; however, impacts would not substantially impact prey availability for sea turtles, crocodilians, or terrapins. Explosion byproducts and unexploded munitions would have no meaningful effect on water or sediment quality; therefore, they are not considered to be secondary stressors for reptiles. Metals are introduced into the water and sediments from multiple types of military expended materials. Available research indicates metal contamination is very localized and that bioaccumulation resulting from munitions would not occur. Several Navy training and testing activities introduce chemicals into offshore and inshore environments that are potentially harmful in concentration; however, through rapid dilution, toxic concentrations are unlikely to be encountered by sea turtles, crocodilians, or terrapins. Furthermore, bioconcentration or bioaccumulation of chemicals introduced by Navy activities to levels that would significantly alter water quality and degrade sea turtle habitat has not been documented. Secondary stressors from Navy training and testing activities in the Study Area are not expected to have long-term impacts on sea turtle populations. Secondary stressors discussed above would overlap with crocodilian and terrapin habitats at inshore training locations. As with sea turtles, toxic concentrations of chemicals and munitions constituents are unlikely to be encountered by crocodilians and terrapins; therefore, bioconcentration or bioaccumulation of chemicals introduced by Navy activities would not likely alter water quality, degrade habitats, or reduce prey availability. Any indirect stressors to habitat or prey from training and testing activities are anticipated to be negligible, and no population-level impacts are anticipated.

3.8.1 INTRODUCTION

This section provides a brief introduction to reptiles that occur within the boundaries of the Study Area and whose distribution may overlap with stressors associated with the Proposed Action. The National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) share jurisdictional responsibility for sea turtles under the Endangered Species Act (ESA). USFWS has responsibility in the terrestrial environment (e.g., nesting beaches), while NMFS has responsibility in the marine environment. Jurisdictional management of the crocodilian species included in this analysis is the responsibility of the USFWS.

Sea turtles considered in this analysis are found in coastal waters and on nesting beaches of the United States (U.S.) Atlantic Coast, Gulf of Mexico, Caribbean Sea, and in open ocean areas.[1] These species include green sea turtles (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), leatherback turtle (*Dermochelys coriacea*), and loggerhead turtle (*Caretta caretta*). The American crocodile (*Crocodylus acutus*) and American alligator (*Alligator mississippiensis*) belong to group of reptiles called crocodilians. The American crocodile inhabits coastal areas of south Florida where they are at the northern extreme of their range. American alligators range throughout the southeastern U.S., in estuaries and freshwater habitats along rivers and lakes. The diamondback terrapin (*Malaclemys terrapin*) is also found in nearshore and inshore waters along the Atlantic and Gulf coasts. All of the sea turtles analyzed in this document are ESA listed, along with the American crocodile. The American alligator is listed under the ESA classification of "threatened due to similarity of appearance" to the American crocodile. The diamondback terrapin is not ESA listed. Each species is discussed further in Section 3.8.2 (Affected Environment).

3.8.2 Affected Environment

3.8.2.1 General Background

All reptiles are ectotherms, commonly referred to as "cold-blooded" animals that have adopted different strategies to use external sources of heat to regulate body temperature. Within the Atlantic Fleet Training and Testing (AFTT) Study Area, sea turtles, crocodilians, and diamondback terrapins are analyzed for potential impacts.

Sea turtles are highly migratory, long-lived reptiles that occur throughout the open-ocean and coastal regions of the Study Area. Generally, sea turtles are distributed throughout tropical to subtropical latitudes, with some species extending into temperate seasonal foraging grounds. In general, sea turtles spend most of their time at sea, with female turtles returning to land to nest. Habitat and distribution vary depending on species and life stages, and is discussed further in the species profiles and summarized in the following sections.

Crocodilians are also long-lived reptiles whose life spans can exceed 40 years in the wild. Crocodilians control their body temperature by basking in the sun or moving to areas with warmer or cooler air and water temperatures. The American crocodile inhabits freshwater wetland habitats, including rivers, lakes, and reservoirs, and can also be found in brackish environments such as estuaries and swamps (Fishman et al., 2009). It occurs within the Study Area in coastal portions of the Caribbean and in Florida. The alligator is found throughout the southeastern United States, from the Carolinas to Texas. Unlike American crocodiles, American alligators lack lingual salt glands and are therefore unable to remove excess salt from their bodies (Nifong & Silliman, 2017). Gardner et al. (2016) predictively modeled alligator occurrence in North Carolina and found a strong negative relationship between water salinity

[1] The olive ridley sea turtle (*Lepidochelys olivacea*) was considered for inclusion in this document, but because its occurrence in the Study Area is extralimital (outside the species' normal range), the species will not be analyzed. Western Atlantic olive ridley sea turtle populations are centered near Suriname/French Guiana and Brazil. Occurrences as far north as Puerto Rico, the Dominican Republic, and Cuba are considered rare. Between 1999 and 2001, three individuals were reported in coastal south Florida; however, all were strandings (Foley et al., 2003). Currently, there are no olive ridley nesting beaches in the eastern United States, and there are no known feeding, breeding, or migration areas within the Study Area; therefore, there does not appear to be a nexus between olive ridley sea turtles and Navy training and testing activities.

and alligator occurrence and abundance. Throughout their range, American alligators are usually found in freshwater wetland habitats, in slow-moving rivers, or in the brackish waters of swamps, marshes, and lakes. Neither species occurs in offshore oceanic waters.

Diamondback terrapins can be found along the eastern and gulf coasts of the United States, from Cape Cod (Massachusetts) to Texas. They are most common in salt marshes and shallow bays. They are usually found in brackish water and occasionally travel out into the open ocean. However, they cannot tolerate full-strength salty water for long periods of time, or they may dehydrate.

Additional species profiles and information on the biology, life history, species distribution, and conservation of reptile species can also be found on the following organizations:

- NMFS Office of Protected Resources (includes sea turtle species distribution maps),
- USFWS Ecological Services Field Office and Region Offices (for sea turtle nesting habitat and general locations of nesting beaches),
- Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations (known as OBIS-SEAMAP) species profiles,
- International Union for Conservation of Nature, Marine Turtle Specialist Group, and
- State resource agencies (for sea turtle nesting information, status and management for American alligators and diamondback terrapins).

Detailed information about threats to these species and life history information can be found in the ESA listing documentation and their recovery plans (Federal Register 44 (244): 75074–75076, December 18, 1979; Federal Register 52 (107): 21059–21064, June 4, 1987; Federal Register 72 (53): 13027–13040, March 20, 2007).

3.8.2.1.1 Group Size

Sea turtles are generally solitary animals, but they tend to group during migrations and mating. Because they do not show territoriality, foraging areas often overlap. New hatchlings, which often emerge from nesting beaches in groups, are solitary until they are sexually mature (Bolten, 2003b; Bowen et al., 2004; James et al., 2005a; Schroeder et al., 2003).

Crocodiles and alligators are territorial, but will gather in groups as juveniles (as a defense against predators), and as adults when exhibiting courtship behavior and feeding (Hidalgo-Ruz et al., 2012; National Park Service, 2012). For both American crocodiles and American alligators, courtship and mating take place during the spring warming period (typically April and May), and nesting and egg-laying is initiated during the early part of the warm, wet summers (Briggs-Gonzalez et al., 2017; Vliet, 2001).

Diamondback terrapins may hibernate individually or hibernate together in large groups (Sheridan et al., 2010). Pfau and Roosenburg (2010) used harvesting records in the Chesapeake Bay to estimate that large hibernating groups may number as many as 200 individual diamondback terrapins.

3.8.2.1.2 Habitat Use

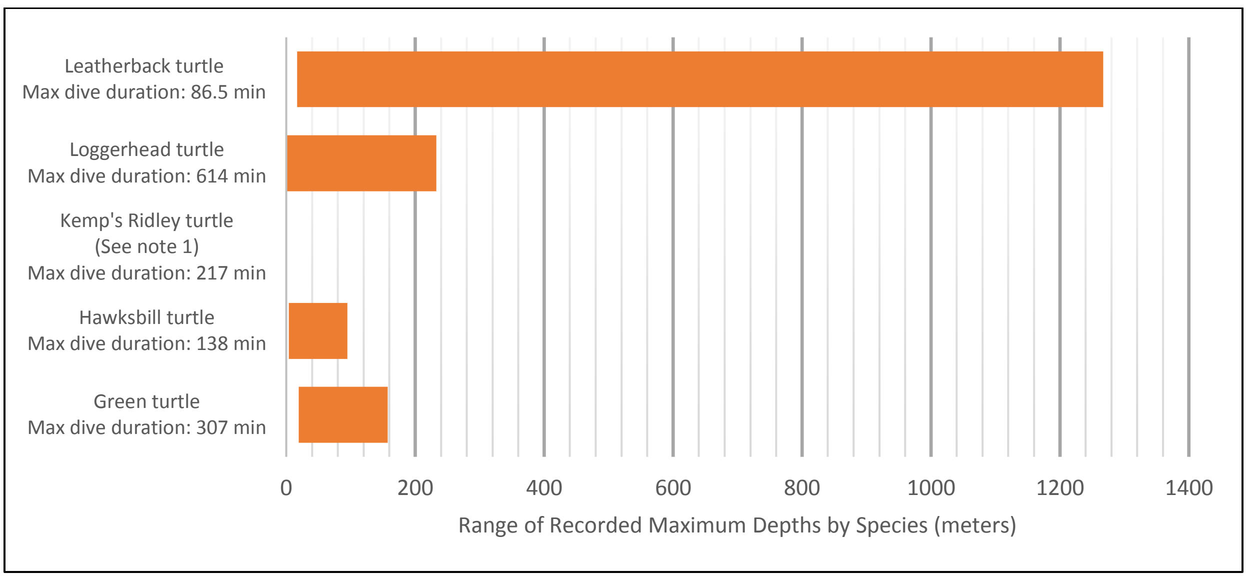
Sea turtles are dependent on beaches for nesting habitat, in locations that have sand deposits that are not inundated with tides or storm events prior to hatching. In the water, sea turtle habitat use is dependent on species and corresponds to dive behavior because of foraging and migration strategies, as well as behavior state (e.g., diving deep at night for resting purposes) (Hart et al., 2016).

Crocodiles and alligators depend on brackish and fresh water estuarine wetland types, where there is sufficient water to use as concealment for hunting and stalking of prey. Nesting habitats are on dry land, with eggs deposited in holes dug in soft mud and sediments (Britton, 2009).

Although diamondback terrapins are an aquatic turtle and spend the majority of their life in water, they do leave the water to bask and lay eggs. One biological advantage these turtles have acquired over time is the ability to survive in salt waters of variable salinities (Pfau & Roosenburg, 2010).

3.8.2.1.3 Dive Behavior

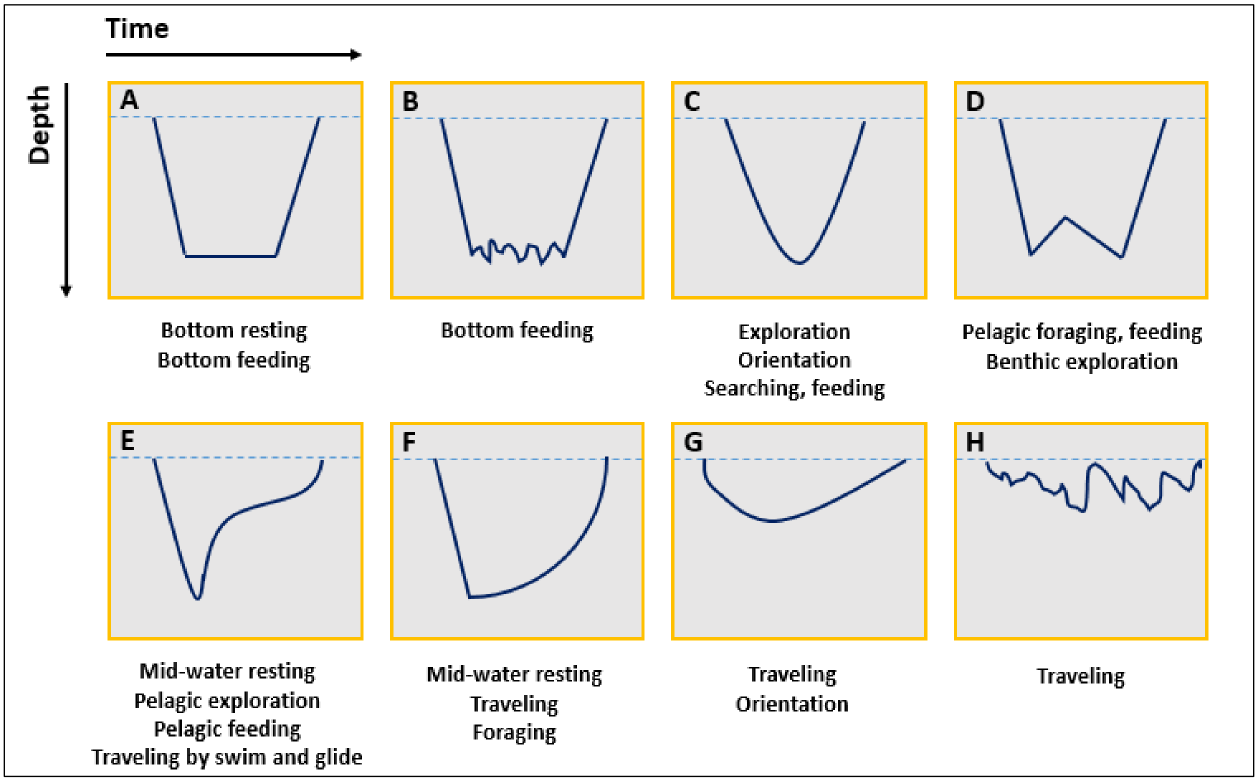
While the American crocodile, American alligator, and diamondback terrapin do submerge, they do not dive in the traditional sense; thus these species are not discussed in this section. Sea turtle dive depth and duration varies by species, the age of the animal, the location of the animal, and the activity (e.g., foraging, resting, and migrating). Dive durations are often a function of turtle size, with larger turtles being capable of diving to greater depths and for longer periods. The diving behavior of a particular species or individual has implications for mitigation, monitoring, and developing sound conservation strategies. In addition, their relative distribution through the water column is an important consideration when conducting acoustic exposure analyses. Methods of collecting dive behavior data over the years has varied in study design, configuration of electronic tags, parameters collected in the field, and data analyses. Collected data from 57 studies were published between 1986 and 2013, which summarized depths and durations of dives of datasets including an overall total of 538 sea turtles. Figure 3.8-1 presents the ranges of maximum dive depths for each sea turtle species found in the Study Area.



Sources: Hochscheid (2014); Sakamoto et al. (1993); (Rice & Balazs, 2008) ; Gitschlag (1996); Salmon et al. (2004)
Note: This figure shows the ranges of maximum dive depths and durations reported in the literature for the sea turtle species included in this analysis. Only one study was reviewed for Kemp's ridley turtle, which recorded depths of one juvenile Kemp's ridley turtle, and was not comparable to other data collected on other species.

Figure 3.8-1: Dive Depth and Duration Summaries for Sea Turtle Species

Hochscheid (2014) also collected information on generalized dive profiles, with correlations to specific activities, such as bottom resting, bottom feeding, orientation and exploration, pelagic foraging and feeding, mid-water resting, and traveling during migrations. Generalized dive profiles compiled from 11 different studies by Hochscheid (2014) show eight distinct profiles tied to specific activities. These profiles and activities are shown in Figure 3.8-2.



Sources: Hochscheid (2014); Rice and Balazs (2008), Sakamoto et al. (1993), Houghton et al. (2003), Fossette et al. (2007), Salmon et al. (2004), Hays et al. (2004); Southwood et al. (1999)

Note: Profiles A-H, as reported in the literature and compiled by Hochscheid (2014). The depth and time arrows indicate the axis variables, but the figure does not represent true proportions of depths and durations for the various profiles. In other words, the depths can vary greatly, but behavioral activity seems to dictate the shape of the profile. Profiles G and H have only been described for shallow dives (less than 5 m).

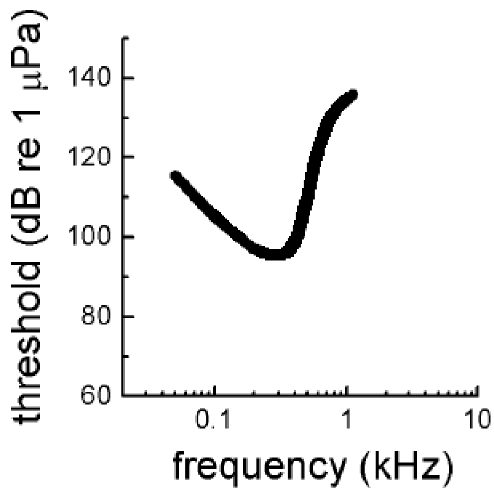
Figure 3.8-2: Generalized Dive Profiles and Activities Described for Sea Turtles

3.8.2.1.4 Hearing and Vocalization

3.8.2.1.4.1 Sea Turtles

Sea turtle ears are adapted for hearing underwater and in air, with auditory structures that receive sound via bone conduction (Lenhardt et al., 1985), via resonance of the middle ear cavity (Willis et al., 2013), or via standard tympanic middle ear path (Hetherington, 2008). Studies of hearing ability show that sea turtles' ranges of in-water hearing detection generally lie between 50 and 1600 hertz (Hz), with maximum sensitivity between 100 and 400 Hz, and that hearing sensitivity drops off rapidly at higher frequencies. Sea turtles are also limited to low-frequency hearing in-air, with hearing detection in juveniles possible between 50 and 800 Hz, with a maximum hearing sensitivity around 300 to 400 Hz (Bartol & Ketten, 2006; Piniak et al., 2016). Hearing abilities have primarily been studied with sub-adult, juvenile, and hatchling subjects in four sea turtle species, including green (Bartol & Ketten, 2006; Ketten & Moein-Bartol, 2006; Piniak et al., 2016; Ridgway et al., 1969), Kemp's ridley (Bartol & Ketten, 2006), loggerhead (Bartol et al., 1999; Lavender et al., 2014; Martin et al., 2012), and leatherback. Only one study examined the auditory capabilities of an adult sea turtle (Martin et al., 2012); the hearing range of the adult loggerhead turtle was similar to other measurements of juvenile and hatchling sea turtle hearing ranges.

Using existing data on sea turtle hearing sensitivity, the U.S. Department of the Navy (Navy) developed a composite sea turtle audiogram for underwater hearing (Figure 3.8-3), as described in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017).



Source: U.S. Department of the Navy (2017)
Notes: dB re 1 μPa: decibels referenced to 1 micropascal; kHz: kilohertz

Figure 3.8-3: Composite Underwater Audiogram for Sea Turtles

The role of underwater hearing in sea turtles is unclear. Sea turtles may use acoustic signals from their environment as guideposts during migration and as cues to identify their natal beaches (Lenhardt et al., 1983). However, they may rely more on other senses, such as vision and magnetic orientation, to interact with their environment (Avens, 2003; Narazaki et al., 2013).

Sea turtles are not known to vocalize underwater. Some sounds have been recorded during nesting activities ashore, including belch-like sounds and sighs (Mrosovsky, 1972), exhale/inhales, gular pumps, and grunts (Cook & Forrest, 2005) by nesting female leatherback turtles and low-frequency pulsed and harmonic sounds by leatherback embryos in eggs and hatchlings (Ferrara et al., 2014).

3.8.2.1.4.2 Crocodilians

Crocodilians (e.g., crocodiles and alligators), like other amphibious species, have both in-air and underwater hearing capabilities. However, crocodilians appear to be structurally adapted for detection of airborne sound based on the similarities between crocodilian and avian ear morphology and the corresponding auditory brainstem structures (Gleich & Manley, 2000). Crocodilians detect airborne sound via the tympanic membrane, while sounds in water appear to be detected via bone conduction (Higgs et al., 2002). Crocodilians have external muscular flaps both above and below the opening of the external auditory canal that reflexively close to seal off the canal when submerged and relax to open above/out of the water (Saunders et al., 2000; Shute & Bellairs, 1955).

The hearing ranges for crocodilians was observed to extend to higher frequencies in air than in water (Higgs et al., 2002). Crocodilians use hearing for prey detection and social communication, but also rely on good vision, scent, and touch for interacting with their environment (Grigg & Gans, 1993; Wever, 1971). With regard to sound production, crocodilian calls are typically low frequency, short, and repetitive. Adult calls include courtship bellows at the air-water interface with a notable in-water component (20–250 Hz); grunts (up to 1 kHz); hisses during threat displays, and coughs (Garrick et al., 1978; Vergne et al., 2009; Vliet, 1989). Hatchling and juvenile American alligators have a more restricted communication repertoire (Higgs et al., 2002). Sound production includes contact calls made when feeding or moving in groups and hisses or snarls when threatened (Bierman et al., 2014).

3.8.2.1.4.3 Terrapins

No definitive research is available to ascertain how terrapins use sound in the environment. Hearing may be used to locate food or mates, avoid predators, navigate, or communicate (Lester, 2013). Lester et al. (2012) determined that diamondback terrapins can hear a limited range of low-frequency tones less than 1,000 Hz. Terrapins responded to in-air sounds from 100 to 1,000 Hz, with the range of best hearing from 400 to 600 Hz with mean lowest threshold of 64 dB re 20 µPa SPL (Lester, 2013). In-water, terrapins responded to sounds from 50 to 800 Hz with mean lowest threshold of 86 dB re 1 µPa SPL (Lester, 2013).

3.8.2.1.5 General Threats

3.8.2.1.5.1 Water Quality

Sea Turtles

Water quality in sea turtle habitats can be affected by a wide range of activities. The potential for energy exploration and extraction activities to degrade nearshore and offshore habitats are discussed in Section 3.8.2.1.5.2 (Commercial Industries). Marine debris in sea turtle habitats is discussed in Section 3.8.2.1.5.6 (Marine Debris). Chemical pollution and impacts on water quality is also of great concern, although its effects on reptiles are just starting to be understood in marine organisms (Law et al., 2014; Ortmann et al., 2012). Oil and other chemical spills are a specific type of ocean contamination that can have damaging effects on some sea turtle and other marine reptile species directly through exposure to oil or chemicals and indirectly due to pollutants' impacts on prey and habitat quality. Ingested plastics, discussed in more detail in Section 3.8.2.1.5.6 (Marine Debris), can also release toxins, such as bisphenol-A (commonly known as "BPA") and phthalates, and organisms may absorb heavy metals from the ocean and release those into tissues (Fukuoka et al., 2016; Teuten et al., 2007). Life stage, geographic location relative to concentrations of pollutants, and feeding preference affects the severity of impacts on sea turtles associated with chemical pollution in the marine environment.

Crocodilians

For the American crocodile, the increase in salinity levels from fresh water input reductions may influence distributions in southern Florida (Mazzotti et al., 2016). One of the goals of the Comprehensive Everglades Restoration Plan is to restore historic freshwater flows through portions of the Everglades. Henry et al. (2016) modeled potential effects of restoring freshwater flows to the Everglades, predicting crocodile populations across south Florida decreasing approximately 3 percent after the restoration of flows compared to future conditions without restoration, but local increases up to 30 percent in the Joe Bay area near Taylor Slough, and local decreases up to 30 percent in the vicinity of Buttonwood Canal.

American alligators are often cited as indicators for water quality, in particular for heavy metal pollution (Brandt et al., 2016; Hodge, 2011). Fluctuations in water levels are a primary driver for alligator presence in inland freshwater systems (Brandt et al., 2016; Hidalgo-Ruz et al., 2012; National Park Service, 2012), along with lower salinities (Gardner et al., 2016; Nifong & Silliman, 2017).

Terrapins

Diamondback terrapins are also considered to be an indicator species for water quality (Pfau & Roosenburg, 2010). Although it is unclear how pollutants in terrapin habitats may impact individual terrapins and populations, studies on terrapins in polluted waters indicate that terrapins uptake pollutants into tissues, and higher abundances of terrapins are found in relatively higher quality waters than polluted waters within the same bay system. For example, Basile et al. (2011) measured fat content in diamondback terrapins for a number of contaminants, including persistent organic pollutants (e.g., polychlorinated biphenyls, polybrominated diphenyl ethers, chlorinated pesticides, and methyl-triclosan). This study was conducted by collecting fat biopsies on terrapins in Barnegat Bay in New Jersey, covering industrial areas and outfalls, as well as less polluted areas of the bay (e.g., Forsythe National Wildlife Refuge). Basile et al. (2011) found that terrapins closer to the industrial area had higher persistent organic pollutants in fat stores than terrapins further from sources of industrial pollution. Male terrapins had higher concentrations of pollutants in fat stores than females, while females had higher concentrations of persistent organic pollutants in plasma than males (Basile et al., 2011).

3.8.2.1.5.2 Commercial Industries

Sea Turtles

In offshore areas of the Study Area, bycatch from commercial fisheries is a primary threat to sea turtles. In U.S. fisheries, Finkbeiner et al. (2011) estimate that bycatch resulted in 71,000 sea turtle deaths per year prior to effective regulations that protect sea turtles (e.g., regulations adopted since the mid-1990s in different U.S. fisheries for turtle exclusion devices). Current mortality estimates are 94 percent lower (4,600 deaths) than pre-regulation estimates (Finkbeiner et al., 2011). One comprehensive study estimates that worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries around the world (Wallace et al., 2010a; Wallace et al., 2010b). Lewison et al. (2014) compared bycatch using three different gear types (longline, gillnet, and trawling nets) for sea turtles, marine mammals, and seabirds. Sea turtles were most susceptible to bycatch, with the Mediterranean and waters off the Atlantic coast of South America as the two highest fisheries reporting sea turtle mortalities (primarily through trawling) (Lewison et al., 2014). Offshore energy development, including oil and natural gas extraction in coastal and deep waters on the continental shelf, as well as renewable energy projects, can degrade habitats during pre-construction and operation phases (Bergström et al., 2014; Finkbeiner et al., 2011; Wright & Kyhn, 2015).

In nearshore areas, large-scale commercial exploitation also contributes to global decline in marine turtle populations. Currently, 42 countries and territories allow direct take of turtles and collectively take in excess of 42,000 turtles per year, the majority of which (greater than 80 percent) are green sea turtles (Humber et al., 2014). Illegal fishing for turtles and nest harvesting also continues to be a major cause of sea turtle mortality, both in countries that allow sea turtle take and in countries that outlaw the practice (Lam et al., 2011; Maison et al., 2010). For example, Humber et al. (2014) estimated that in Mexico, 65,000 sea turtles have been illegally harvested since 2000. The authors, however, noted a downward trend of legal and illegal direct takes of sea turtles over the past three decades—citing a greater than 40 percent decline in green sea turtle take since the 1980s, a greater than 60 percent decline in hawksbill and leatherback take, and a greater than 30 percent decline in loggerhead take (Humber et al., 2014).

Offshore energy development activities have likely led to negative consequences for sea turtle populations within the Study Area. The *Deepwater Horizon* spill in 2010, releasing 200 million gallons of crude oil into the Gulf of Mexico (Putman et al., 2015a), is anticipated to have long-term effects that persist for decades (National Marine Fisheries Service, 2011, 2014a). Prior to drilling operations, vessel traffic and seismic disturbances through exploration activities can degrade sea turtle coastal and open ocean foraging habitats. As of 2017, the global offshore wind industry had a current installed capacity of nearly 18,000 megawatts (Mills, et al. 2018) and is expected to grow to more than 37,000 megawatts by 2020 (Smith et al., 2015). Off of U.S. shores, approximately 20,000 megawatts of installed capacity is planned over the next few years, with most development occurring off the coasts of Massachusetts, New Jersey, Virginia, and North Carolina (Smith et al., 2015). Construction of offshore wind energy facilities in mid-Atlantic is likely to occur in warmer months, and sea turtles will be present during these periods (Williams et al., 2015). Onshore development can lead to nesting habitat loss or habitat degradation. Construction activities can facilitate erosion or inhibit natural sediment deposition to form beaches. Once facilities are operational, artificial lighting, noise, and other stressors can degrade nesting habitats (Seminoff et al., 2015).

Boat strike has been identified as one of the important mortality factors in several nearshore turtle habitats worldwide. Precise data are lacking for sea turtle mortalities directly caused by ship strikes; however, live and dead turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Hazel et al., 2007; Lutcavage et al., 1997). For example, scientists in Hawaii reported that 2.5 percent of green sea turtles found dead on the beaches between 1982 and 2003 had been killed by boat strike (Chaloupka et al., 2008), and in the Canary Islands, 23 percent of stranded sea turtles showed lesions from boat strikes or fishing gear (Oros et al., 2005). Denkinger et al. (2013) reports that boat strikes in the Galapagos Islands were most frequent at foraging sites close to a commercial and tourism port.

Crocodilians

American crocodiles and American alligators were widely hunted for their skins from 1920 to 1970, which led to significant population declines across all parts of the species range. Country-specific (e.g., the listing of the American crocodile as endangered in 1973 under the ESA) and international trade restrictions, along with the availability of legally obtained skins from other crocodilians, have significantly reduced commercial hunting in recent decades (Brandt et al., 2016; National Park Service, 2012; Thorbjarnarson et al., 2006). Regulated commercial use of captive reared crocodilians has relieved commercial exploitation for wild crocodilians. The American alligator population has expanded greatly throughout its historic range in wetlands of the southeastern United States (Brandt et al., 2016; National Park Service, 2012).

Oil spills that impact freshwater and estuarine habitats will alter important wetland ecological functions, such as removing sediments, nutrients, pesticides, metals, and other pollutants, and provide essential foundations for food chains for wildlife (Corn, 2010), including crocodilians. Oil spills that occur in or wash into these wetlands could reduce prey availability for both the American alligator and the American crocodile. For the American alligator, coastal oil pollution likely has only limited impacts because the highest abundance of alligators are found in inland freshwater systems (Corn, 2010). For American crocodiles, oil spills would have to occur within, or wash into, crocodile habitats in southern Florida for impacts to occur, and would likely be a significant and persistent inhibiting factor in American crocodile recovery.

Habitat destruction (through the filling in of wetlands and altering of hydrologic connectivity, water levels, and salinities) is the primary limiting factor on crocodilian recovery in the United States (Green et al., 2014; Mazzotti et al., 2007; Thorbjarnarson et al., 2006).

Terrapins

Commercial activities that threaten diamondback terrapins include commercial harvesting, bycatch mortality in crab pots, and pollution. Up until the beginning of the 20th century, diamondback terrapins were in great demand by gourmet restaurants in major metropolitan areas of the United States. (Pfau & Roosenburg, 2010). Dredging of shallow water habitats and scraping of hibernacula where terrapins congregate during the winter were the most effective forms of commercial harvesting. Commercial harvesting, as determined by test dredging, tended to capture more females than males, which likely severely reduced the reproductive potential for populations in terrapin fisheries. The commercial demand for terrapins generally subsided through the 20th century. However, there was an increase in terrapin exports to China from the United States in the late 1980s, but by 2007, all of the states within the diamondback terrapin range within the United States had prohibited commercial harvest of terrapins (Pfau & Roosenburg, 2010).

Roosenburg et al. (1997) studied crab pot use in the Chesapeake Bay and estimated that 15–78 percent of the local terrapin population can be captured in crab pots in a single year. Crab pots are designed with small entrances, which tend to capture smaller males rather than larger females. Because of the selective mortality of males in crab pots, Pfau and Roosenburg (2010) estimated that the terrapin sex ratio in the Chesapeake bay at one male to two, possibly three females. New crab traps with terrapin exclusions have greatly reduced terrapin bycatch (Lester, 2013; Pfau & Roosenburg, 2010; University of Georgia, 2017).

Oil spills in coastal areas directly impact diamondback terrapins by oiling and drowning the animals and indirectly by contaminating their nesting beaches (Pfau & Roosenburg, 2010). The short-term impacts of the oil spill from a leak in an underground oil pipeline near Chalk Point, Maryland, showed direct impacts on adult terrapins and decline in hatchling survivability where the oil leak polluted sand in a nesting location (Michel et al., 2001).

Residential and urban development restricts freshwater flow into swamps and estuaries, which may limit diamondback terrapin growth, survival, and abundance, and potentially impact diamondback terrapin habitats if spills reach estuaries and riverine areas (Basile et al., 2011).

3.8.2.1.5.3 Disease and Parasites

Fibropapillomatosis is a disease of sea turtles that results in the production of tumors, both external and internal, that are considered benign, but may obstruct crucial functions, such as swimming, feeding, sight, and buoyancy, and can lead to death (Balazs, 1986; Patrício et al., 2016). The disease was first noticed in 1928, and was not observed again until the 1970s (Day et al., 2016). The disease shows the highest prevalence among green sea turtles (Patrício et al., 2016), with rapid spread of the disease was recorded through the 1980s, becoming an endemic in both Florida and Hawaii in green sea turtle populations (Day et al., 2016; Work & Balazs, 2013). By 1995 the concentration of disease in the population reached its climax and has showed a decline in prevalence since (Patrício et al., 2016).

Edmonds et al. (2016) lists 16 parasites known to occur in sea turtles, with the most common and significant (in terms of impacts on health) being blood flukes and flatworms (Watson et al., 2017). Some of the common external parasites found on sea turtles include leeches and a number of different species that reside on the shell called epibiota (Glandon & Miller, 2016). Leeches are usually seen around where the flippers attach to the rest of the body. Parasitic isopods (e.g., sea lice) can attach themselves to sea turtle soft tissue on the outside and within the mouth (Foster & Gilmour, 2016).

The type and severity of disease in crocodilians and terrapins is poorly understood, and is not considered as a significant threat to species recovery (Florida Fish and Wildlife Conservation Commission, n.d.; Hackney, 2010; National Park Service, 2012; Savannah River Ecology Laboratory & Herpetology Program, 2012).

3.8.2.1.5.4 Invasive Species

Invasive species have been shown to have both harmful and beneficial impacts on sea turtles. Impacts on sea turtles associated with invasive species primarily concern nest predation and prey base. For example, feral hogs (*Sus scrofa*) have been known to destroy several sea turtle nests during a season on certain nesting beaches in Florida (Engeman et al., 2016). Engeman et al. (2016) noted nesting success after a successful implementation of a feral hog control program in Florida. In foraging grounds, sea turtles have been shown to adapt their foraging preferences for invasive seagrass and algae. Becking et al. (2014) showed green sea turtle foraging behavior shift to consumption of *Halophila stipulacea*, a rapidly spreading seagrass in the Caribbean. In Hawaii, green sea turtles in Kaneohe Bay have modified their diets over several decades to include seven non-native species (Spiny Seaweed, *Acanthophora spicifera; Hypnea musciformis, Gracilaria salicornia, Eucheuma denticulatum,* Graceful Red Weed*, Gracilaria tikvahiae;* Agar-agar*, Kappaphycus striatum;* and Elkhorn Sea Moss, *Kappaphycus alvarezii*), with non-native algae accounting for over 60 percent of turtle diet (Russell & Balazs, 2015).

Burmese pythons (*Python bivitattus*) are large generalist predators that have established an expanding breeding population in Florida (Walters et al., 2016). Introduced pythons present a direct threat to the American alligator and American crocodile through predation, where predation of alligators up to 2 m in length have been reported (Dorcas et al., 2012). Introduced pythons were thought to be primarily restricted to freshwater habitats in Florida, but Hart et al. (2012) has shown salt water tolerance in newly-hatched pythons, which may increase the risk for American crocodiles and terrapins. Introduced pythons can also negatively impact crocodilians and terrapins through competition for food. Dorcas et al. (2012) noted severe declines in mammals attributed to python population increases, which remove a small, but significant prey base for alligators and crocodiles.

Draud et al. (2004) and Pfau and Roosenburg (2010) noted that terrapin nests and hatchlings are vulnerable to predation from non-native rats and ants, along with other native terrestrial and avian predators. In addition, invasive vegetation can severely impact wetlands when made vulnerable by high amounts of disturbance. *Phragmites australis*, an invasive emergent marsh reed, is rapidly expanding in coastal wetlands of the United States, particularly brackish wetlands, which likely degrades terrapin nesting areas. Cook (2016) found that *Phragmites australis* can alter vegetation structure, soil temperature, and moisture in nesting locations, which may limit preferred nesting habitats (replacing sparsely vegetated sandy locations with thick stands of *Phragmites australis*), potentially skew sex ratios towards males, and reduce nesting success through the encroachment of root systems into nests.

3.8.2.1.5.5 Climate Change

Sea turtles, crocodilians, and terrapins are particularly susceptible to climate change effects because their life history, physiology, and behavior are extremely sensitive to environmental temperatures (Fuentes et al., 2013; Green et al., 2014; Hart & Lee, 2006; University of Georgia, 2017; Wheatley et al., 2012). Climate change models predict sea level rise and increased intensity of storms and hurricanes in tropical sea turtle nesting areas (Patino-Martinez et al., 2008), as well as coastal areas of the United States where crocodilians and terrapins may nest (Frost et al., 2017). These factors could significantly increase beach inundation and erosion, thus affecting water content of sea turtle, crocodilian, and terrapin nesting beaches and potentially inundating nests (Pike et al., 2015). Climate change may negatively impact reptiles in multiple ways and at all life stages. These impacts may include the potential loss of nesting beaches due to sea level rise and increasingly intense storm surge (Patino-Martinez et al., 2008), feminization of populations from elevated nest temperatures (and skewing populations to more females than males unless nesting shifts to northward cooler beaches) (Reneker & Kamel, 2016) (Pfau & Roosenburg, 2010), decreased reproductive success (Hawkes et al., 2006; Laloë et al., 2016; Pike, 2014), shifts in reproductive periodicity and latitudinal ranges (Pike, 2014), disruption of hatchling dispersal and migration, and indirect effects to food availability (Witt et al., 2010). Erosion, water contaminants, and sea level rise may further increase vulnerability of nesting sites for both the American crocodile and American alligator (Mazzotti et al., 2007; Mazzotti et al., 2016; Savannah River Ecology Laboratory & Herpetology Program, 2012), as well as the diamondback terrapin. Short-term effects on aquatic reptiles and their habitat also include the potential impacts caused by increased hurricane occurrence and intensity (Elsey et al., 2006; Elsey & Woodward, 2010). American alligators are likely less affected by coastal impacts associated with climate change because they occur in freshwater systems further inland (Eversole et al., 2015).

Adaption strategies to protect coastal infrastructure are an anticipated response to rising sea levels. These activities may include shoreline stabilization projects and infrastructure hardening, which could contribute to the loss of nesting habitat. Shoreline stabilization may hold in place beach sediments in a specific location; however, the disruption of onshore currents can reduce the beach replenishment of sediments further away (Boyer et al., 1999; Fish et al., 2008).

3.8.2.1.5.6 Marine Debris

Debris in offshore and inshore waters present ingestion and entanglement risks for sea turtles, crocodilians, and terrapins. Ingestion of marine debris can cause mortality or injury to sea turtles. The United Nations Environment Program estimates that approximately 6.4 million tons of anthropogenic debris enters the marine environment every year (United Nations Environmental Program, 2005). This estimate, however, does not account for cataclysmic events, such as the 2011 Japanese tsunami estimated to have generated 1.5 million tons of floating debris (Murray et al., 2015). Plastic is the primary type of debris found in marine and coastal environments, and plastics are the most common type of marine debris ingested by sea turtles (Schuyler et al., 2014). Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherback turtles to have ingested various types of plastic (Mrosovsky et al., 2009), and Narazaki et al. (2013) noted an observation of a loggerhead exhibiting hunting behavior on approach to a plastic bag, possibly mistaking the bag for a jelly fish. Even small amounts of plastic ingestion can cause an obstruction in a sea turtle's digestive track and mortality (Balazs et al., 1994; Bjorndal, 1997), and hatchlings are at risk for ingesting small plastic fragments. Ingested plastics can also release toxins, such as bisphenol-A (commonly known as "BPA") and phthalates, or absorb heavy metals from the ocean and release those into tissues (Fukuoka et al., 2016; Teuten et al., 2007). Life stage and feeding preference affects the likelihood of ingestion. Turtles living in oceanic or coastal environments and feeding in the open ocean or on the seafloor may encounter different types and densities of debris, and may therefore have different probabilities of ingesting debris. In 2014, Schuyler et al. (2014) reviewed 37 studies of debris ingestion by sea turtles, showing that young oceanic sea turtles are more likely to ingest debris (particularly plastic), and that green and loggerhead turtles were significantly more likely to ingest debris than other sea turtle species.

Ribic et al. (2010) documented regional differences in amounts and long-term trends of marine debris (land-based and ocean-based) along the U.S. Atlantic coast, while indexing debris amounts with population growth and fisheries activity. Based on their analysis, Ribic et al. (2010) concluded that the vast majority of marine debris was either land-based (38 percent), general-source debris (42 percent), or ocean-based (20 percent) recreational and commercial sources (Ribic et al., 2010); no items of military origin were differentiated. The inland portions along the southeast Atlantic coast contributed the lowest amounts of debris despite a 19 percent increase in coastal population from 1997 through 2007. The northeast Atlantic coast also contributed low amounts of marine debris, although the coastal population increased by 8 percent. Most of the marine debris inputs along the U.S. Atlantic coast was sourced from inland portions of the mid-Atlantic. With a 10 percent population increase, the types of debris included heavy land-based and general-source debris loads. Where fisheries were stable, ocean-based debris either stayed steady or declined.

Because of the limited overlap of crocodilian habitats and marine debris, marine debris as an entanglement or ingestion hazard for the American crocodile and American alligator is not likely a concern for crocodilian conservation. There is one reported mortality of an estuarine crocodile (*Crocodylus porosus*) in Australia entangled by plastic marine debris (Ceccarelli, 2009); however, Platt and Thorbjarnarson et al. (2006) suggested that accidental drowning in monofilament fishing nets was likely a significant source of mortality for American crocodiles in Belize in conservation areas where poaching is not likely to occur. Outside of conservation areas in Belize, the authors found that poaching was a major cause of crocodile deaths, in addition to drownings in derelict and active fishing nets. Terrapin drowning events are most often associated with bycatch in crab pots (Roosenburg et al., 1997) as well as derelict crab traps (Bilkovic et al., 2014); however, marine debris in estuarine environments likely pose an entanglement hazard for diamondback terrapins.

3.8.2.2 Endangered Species Act-Listed Species

As shown in Table 3.8-1, there are seven species of reptiles listed as Endangered or Threatened under the ESA in the Study Area. Life history descriptions of these species are provided in more detail in the following sections.

Table 3.8-1: Current Regulatory Status and Presence of Endangered Species Act-Listed Reptiles in the Study Area

Species Name and Regulatory Status			Presence in Study Area		
Common Name	**Scientific Name**	**Endangered Species Act Status**	**Open Ocean**	**Large Marine Ecosystem**	**Inshore Waters**
Family Cheloniidae (hard-shelled sea turtles)					
Green Turtle (North Atlantic DPS, South Atlantic DPS)	*Chelonia mydas*	Threatened[1]	North Atlantic Subtropical Gyre, Gulf Stream	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Chesapeake Bay, Narragansett Bay, Kings Bay, Port Canaveral, St. Andrew Bay, Corpus Christi Bay
Hawksbill Turtle	*Eretmochelys imbricata*	Endangered[2]	North Atlantic Subtropical Gyre, Gulf Stream	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	NA
Kemp's Ridley Turtle	*Lepidochelys kempii*	Endangered	North Atlantic Subtropical Gyre, Gulf Stream	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico	Narragansett Bay, Chesapeake Bay, Corpus Christi Bay
Loggerhead Turtle (Northwest Atlantic Ocean DPS)	*Caretta caretta*	Threatened/ Endangered[3]	North Atlantic Subtropical Gyre, Gulf Stream	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Narragansett Bay, Chesapeake Bay, St. Andrew Bay, Kings Bay, Port Canaveral

Table 3.8-1: Current Regulatory Status and Presence of Endangered Species Act-Listed Reptiles in the Study Area (continued)

Species Name and Regulatory Status			Presence in Study Area		
Common Name	**Scientific Name**	**Endangered Species Act Status**	**Open Ocean**	**Large Marine Ecosystem**	**Inshore waters**
Family Dermochelyidae (leatherback sea turtle)					
Leatherback Turtle	*Dermochelys coriacea*	Endangered	North Atlantic Subtropical Gyre, Gulf Stream	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Narragansett Bay, Chesapeake Bay, Port Canaveral
Family Crocodylidae (true crocodiles)					
American Crocodile	*Crocodylus acutus*	Threatened	NA	Southeast U.S. Continental Shelf, Gulf of Mexico	NA
American Alligator	*Alligator mississippiensis*	Threatened due to similarity of appearance[4]	NA	Southeast U.S. Continental Shelf, Gulf of Mexico	Kings Bay, Port Canaveral, St. Andrew Bay, Corpus Christi Bay

[1] On April 6, 2016, the NMFS and USFWS listed the Central West Pacific, Central South Pacific, and Mediterranean distinct population segments as endangered, while listing the other eight distinct population segments (Central North Pacific, East Indian-West Pacific, East Pacific, North Atlantic, North Indian, South Atlantic, Southwest Indian, and Southwest Pacific) as threatened. The AFTT Study Area shares portions of the geographic extents identified for the North Atlantic distinct population segment, including breeding populations along the U.S. Atlantic and Gulf of Mexico coasts.

[2] Hawksbills have been recorded in the Study Area rarely; occurrence in the Northeast U.S. Continental Shelf Large Marine Ecosystem is extralimital (outside of their normal range).

[3] On September 22, 2011, the NMFS and USFWS listed the North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea distinct population segments of the loggerhead sea turtle as endangered under the ESA, while the other four distinct population segments (the Southeast Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean) are listed as threatened. The AFTT Study Area shares portions of the geographic extents identified for the Northwest Atlantic Ocean distinct population segment.

[4] The American alligator is listed under the Endangered Species Act (ESA) classification of "threatened due to similarity of appearance" to the American crocodile.

Sources: 81 Federal Register 20057, 35 Federal Register 18319, 35 Federal Register 8491, 43 Federal Register 32800, 76 Federal Register 58868

Note: NA = not applicable

3.8.2.2.1 Green Turtle (*Chelonia mydas*)

3.8.2.2.1.1 Status and Management

The green sea turtle was first listed under the ESA in 1978. In 2016, the NMFS and USFWS reclassified the species into 11 "distinct population segments," which maintains federal protections while providing a more tailored approach for managers to address specific threats facing different populations (see the NMFS and USFWS Final Rule published on April 6, 2016). The geographic areas that include these distinct population segments are: (1) North Atlantic Ocean, (2) Mediterranean Sea, (3) South Atlantic Ocean, (4) Southwest Indian Ocean, (5) North Indian Ocean, (6) East Indian Ocean – West Pacific Ocean, (7) Central West Pacific Ocean, (8) Southwest Pacific Ocean, (9) Central South Pacific Ocean, (10) Central North Pacific Ocean, and (11) East Pacific Ocean.

Only the North Atlantic distinct population segment (which was listed as threatened) is within the Study Area and is discussed further in the document. It should be noted, however, that North Atlantic green sea turtle populations have minimal mixing (gene flow) with the South Atlantic regions and no mixing with the Mediterranean region, and juvenile turtles from the North Atlantic may occasionally use south Atlantic or Mediterranean foraging grounds (Seminoff et al., 2015).

Critical habitat is designated within the Study Area (Figure 3.8-4). In 1998, critical habitat was designated for green sea turtles in coastal waters around Culebra Island, Puerto Rico, from the mean high water line seaward to three nautical miles (NM) to include Culebra's outlying Keys (63 *Federal Register* 46693). The essential physical and biological features of this critical habitat include (1) seagrass beds, which provide valuable foraging habitat; (2) coastal waters of Culebra, which serve as a developmental habitat and support juvenile, subadult, and adult green sea turtle populations; and (3) coral reefs and other topographic features that provide shelter (63 *Federal Register* 46693). Puerto Rico's Culebra Island, where the NMFS and USFWS designated Critical Habitat for green sea turtles, supports important habitat for juveniles, subadults, and a small population of adults. Green turtles are most abundant at Culebrita, Mosquito Bay, Puerto Manglar, and Tamarindo Grande, probably due to the presence of dense seagrass beds in those areas (Collazo et al., 1992; Patrício et al., 2016; Patrício et al., 2014). Higher concentrations and abundance in other locations throughout the green sea turtle range also support dense marine vegetation used as foraging grounds (Patrício et al., 2014; Seminoff et al., 2015).

3.8.2.2.1.2 Habitat and Geographic Range

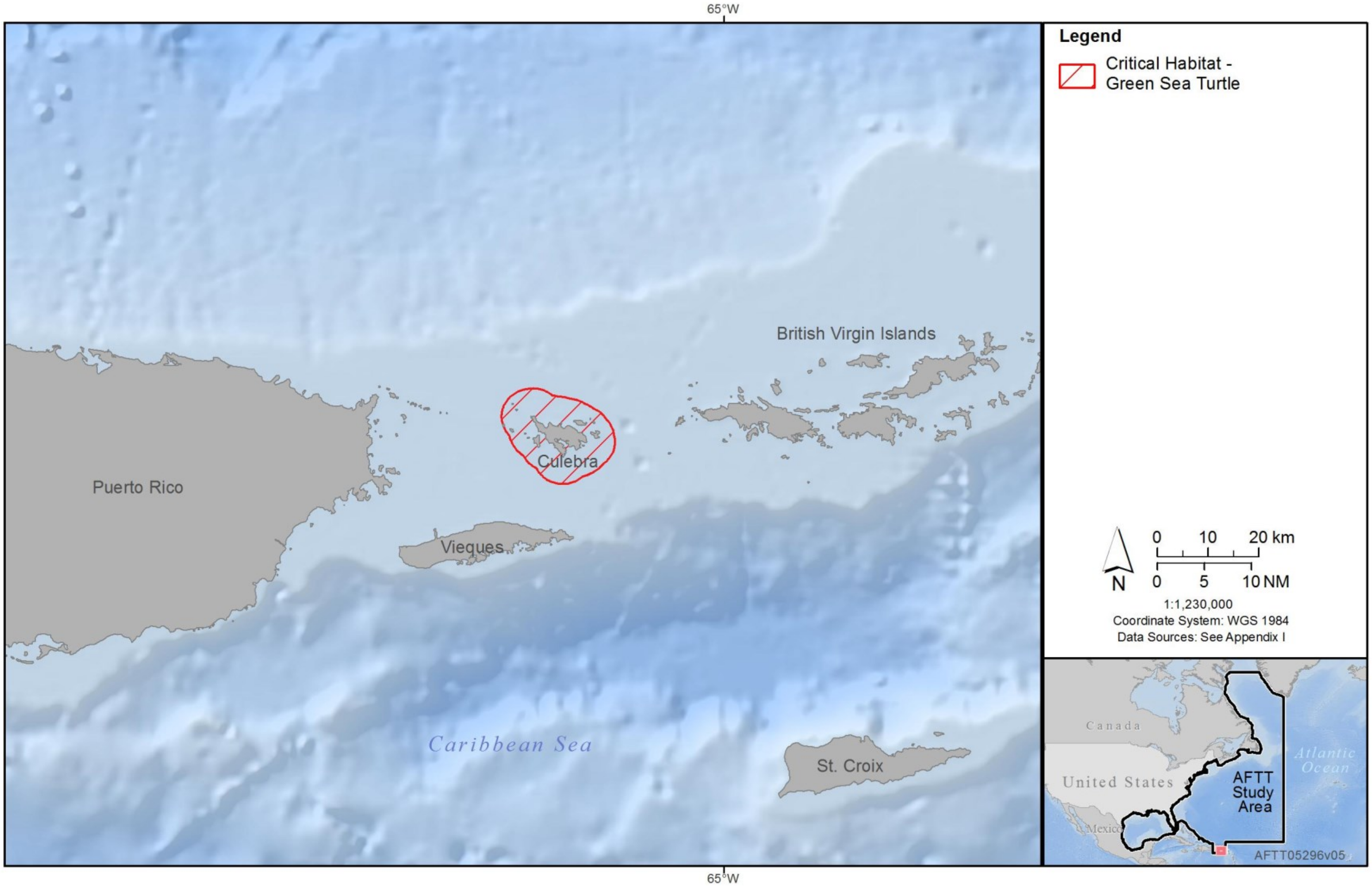
The green sea turtle is distributed worldwide across tropical and subtropical coastal waters generally between 45 degrees (°) north and 40° south. After emerging from the nest, green sea turtle hatchlings swim to offshore areas where they float passively in major current systems; however, laboratory and modeling studies suggest that dispersal trajectories might also be shaped by active swimming (Christiansen et al., 2016; Putman & Mansfield, 2015). Post-hatchling green sea turtles forage and develop in floating *Sargassum* habitats of the open ocean. At the juvenile stage (estimated at five to six years), they leave the open-ocean habitat and retreat to protected lagoons and open coastal areas that are rich in seagrass or marine algae (Bresette et al., 2006), where they will spend most of their lives (Bjorndal & Bolten, 1988). The optimal developmental habitats for late juveniles and foraging habitats for adults are warm shallow waters (3–5 m), with abundant submerged aquatic vegetation and close to nearshore reefs or rocky areas (Holloway-Adkins, 2006; Seminoff et al., 2002; Seminoff et al., 2015). Climate change and ocean warming trends may impact the habitat and range of this species over time (Fuentes et al., 2013). These impacts apply to all sea turtle species and are discussed in Section 3.8.2.1.5.5 (Climate Change).

Four regions within the North Atlantic distinct population segment support nesting concentrations: Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), United States (Florida), and Cuba. The highest concentration of nesting is in Tortuguero, and in Mexico, where nesting occurs primarily along the Yucatan Peninsula. Most green sea turtle nesting occurs in along the Atlantic coast of eastern central Florida, with smaller concentrations along the Gulf coast and Florida Keys. In Cuba, nesting primarily occurs on the extreme western tip of the country and on islands off the southern shore of Cuba. Nesting also occurs in the Bahamas, Belize, Cayman Islands, Dominican Republic, Haiti, Honduras, Jamaica, Nicaragua, Panama, Puerto Rico, Turks and Caicos Islands, North Carolina, South Carolina, Georgia, Texas, and Virginia.

Green sea turtles are known to live in the open-ocean waters of the Gulf Stream and North Atlantic Gyre during the first five to six years of life, but little is known about preferred habitat or general distribution during this life phase beyond the information presented in the introduction to this resource. Although information on migratory routes within this area is limited, recent research has shown that juvenile green sea turtles have the ability to migrate independently of ocean currents (directional and active swimming) to access productive foraging grounds (Christiansen et al., 2016; Putman & Mansfield, 2015; Ribic et al., 2010). The main source of information on distribution in the Study Area comes from U.S. fisheries bycatch. Green turtle post-hatchling and juvenile foraging grounds in the North Atlantic range from coral or nearshore reefs and seagrass beds, to inshore bays and estuaries (Bresette et al., 1998; Plotkin & Amos, 1998). In the western North Atlantic, juvenile green sea turtles forage as far north as Cape Cod Bay, Massachusetts; as far east as Bermuda; and throughout the Caribbean. However, foraging adults are only found from the southernmost reach of the Florida peninsula (Witherington & Hirama, 2006).

As ocean temperatures increase in the spring, green sea turtles migrate from southeastern U.S. waters to the estuarine habitats of Long Island Sound, Peconic Bay, Chesapeake Bay, and possibly Nantucket Sound, where an abundance of algae and eelgrass occurs. Peak occurrence in the Northeast U.S. Continental Shelf Large Marine Ecosystem is likely in September (Berry et al., 2000). During nonbreeding periods, adult and juvenile distributions may overlap in coastal feeding areas (Hirth, 1997; Weishampel et al., 2006).

Juveniles use the estuarine and nearshore waters of central Florida throughout the year, including Pensacola Bay, St. Joseph Bay, Charlotte Harbor, Cedar Keys, Homosassa Springs, Crystal River, and Tampa Bay (Lamont et al., 2015; Langhamer et al., 2016; Renaud et al., 1995; Seminoff et al., 2015). In the northern Gulf of Mexico, green sea turtles prefer the coastal habitats of southern Texas (e.g., lagoons, channels, inlets, bays) where seagrass beds and macroalgae are abundant, including Texas' Laguna Madre (Renaud et al., 1995). As water temperatures rise from April to June, green sea turtle numbers increase in the continental shelf waters of the Gulf of Mexico Large Marine Ecosystem, off Galveston Bay, and in those waters associated with the continental shelf break northeast of Corpus Christi. Green sea turtles found in these deeper waters are likely adults migrating from resident foraging grounds to distant nesting grounds (Meylan, 1995). The sparse sighting records in Louisiana and Texas waters, as well as nesting records on the southern Texas coast, indicate that green sea turtles are found in the northwestern Gulf of Mexico during spring but in far fewer numbers than in the northeastern Gulf.



Note: AFTT: Atlantic Fleet Training and Testing

Figure 3.8-4: Critical Habitat Designated for the Green Sea Turtles in the Study Area

3.8.2.2.1.3 Population Trends

Green turtle nesting has shown an exponential increase over the past 29 years, with nests reported along the Florida panhandle, Florida Gulf coast, Florida Atlantic coast, Georgia, Alabama, South Carolina, North Carolina, and Texas, along with the wider Caribbean, Yucatan Coast of Mexico, Suriname, and Isla Trindade (Brazil) (Florida Fish and Wildlife Conservation Commission, 2017; Seminoff et al., 2015). A green sea turtle nested at Cape Henlopen State Park in Delaware in August 2011, which was the first green sea turtle nesting ever observed north of Virginia (Murray, 2011). While nesting abundance has been monitored at these sites for decades, in-water abundance in the Gulf of Mexico or along the Atlantic coast remains unavailable (Seminoff et al., 2015). Adult and juvenile males and females from nesting colonies in the Yucatan Peninsula (Mexico), Aves Island (Venezuela), Galibi Reserve (Suriname), and Isla Trindade (Brazil) could also occur in the waters of the Study Area.

The Marine Turtle Specialist Group (under the International Union for Conservation of Nature's Species Survival Commission) conducted a worldwide analysis of the green sea turtle population based on 32 index nesting sites around the world (Seminoff & Marine Turtle Specialist Group Green Turtle Task Force, 2004). The analysis concluded there has been a 48–65 percent decline in the number of females nesting annually over the past 100 to 150 years. About 80 percent of nesting in the Western Atlantic Ocean occurs at Tortuguero, Costa Rica (Seminoff et al., 2015).

Generally, nesting trends in the Western Atlantic Ocean are stable to increasing and are increasing in Florida, as shown by annual total nest counts for green sea turtles on Florida's index beaches (27 out of 215 nesting beaches selected to monitor long-term nesting trends). Green turtle nest counts in Florida have increased by a factor of 80 since counts began in 1989 (Florida Fish and Wildlife Conservation Commission, 2017). In 2017, green turtle nest counts on the 27 core index beaches reached a new record high with almost 39,000 nests recorded. Green turtles set record highs in 2011, 2013, 2015, and 2017. The nest count in 2017 was almost 40 percent higher than the 2015 previous record. Nesting green turtles tend to follow a two-year reproductive cycle. Typically, there are wide year-to-year fluctuations in the number of nests recorded (Florida Fish and Wildlife Conservation Commission, 2017).

Although these data appear to present an encouraging global outlook, datasets for fewer than half of these sites (9 of 23) document a time span of longer than 20 years, which limits the strength of the data. A standard timeframe of data that would be necessary to properly assess population trends is three generations, which for the green sea turtle is between 100 and 150 years. Consequently, the impact of changes in juvenile recruitment that occurred four decades ago may not yet be manifested in changes in nesting abundance (Seminoff et al., 2015).

3.8.2.2.1.4 Predator and Prey Interactions

The green sea turtle is the only species of sea turtle that, as an adult, primarily consumes plants and other types of vegetation (Mortimer, 1995; Nagaoka et al., 2012). While primarily herbivorous, a green sea turtle's diet changes substantially throughout its life. Very young green sea turtles are omnivorous (Bjorndal, 1997). Salmon et al. (2004) reported that post-hatchling green sea turtles were found to feed near the surface on seagrasses or at shallow depths on comb jellies and unidentified gelatinous eggs off the coast of southeastern Florida. Nagaoka et al. (2012) analyzed 50 incidentally caught juvenile green sea turtles in Brazil and determined that juveniles consumed an omnivorous diet, including terrestrial plants (floating in the water), algae, invertebrates, and seagrass. Black mangrove leaves were of the greatest importance to diet at this location (adjacent to a black mangrove forest). Sampson and Giraldo (2014) observed opportunistic foraging of tunicates (a type of filter-feeding marine invertebrate) by green sea turtles in the eastern tropical Pacific. Pelagic juveniles smaller than 8–10 inches (in.) in length eat worms, young crustaceans, aquatic insects, grasses, and algae (Bjorndal, 1997). After settling in coastal juvenile developmental habitat at 8–10 in. in length, they eat mostly mangrove leaves, seagrass and algae (Balazs et al., 1994; Nagaoka et al., 2012). Research indicates that green sea turtles in the open-ocean environment, and even in coastal waters, also consume jellyfish, sponges, and sea pens (Hatase et al., 2006; Seminoff et al., 2015). Fukuoka et al. (2016) also noted that juvenile green sea turtles were at higher risk to marine debris ingestion, likely due to the resemblance of small pieces of debris to omnivorous dietary items.

The loss of eggs to land-based predators such as mammals, snakes, crabs, and ants occurs on some nesting beaches. As with other sea turtles, hatchlings may be preyed on by birds and fish. Sharks are the primary nonhuman predators of juvenile and adult green sea turtles at sea (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Seminoff et al., 2015).

3.8.2.2.1.5 Species-Specific Threats

In addition to the general threats described previously in Section 3.8.2.1.5 (General Threats), damage to seagrass beds and declines in seagrass distribution can reduce foraging habitat for green sea turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Seminoff et al., 2015). Green sea turtles are susceptible to the disease fibropapillomatosis, which causes tumor-like growths (fibropapillomas) resulting in reduced vision, disorientation, blindness, physical obstruction to swimming and feeding, increased susceptibility to parasites, and increased susceptibility to entanglement (Balazs, 1986; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Patrício et al., 2016; Work & Balazs, 2013). Some populations (e.g., the Florida population) have begun to show resistance to the disease, but it remains an issue for others, such as Pacific populations, and Hawaii's green sea turtles in particular (Chaloupka et al., 2009; Seminoff et al., 2015). Patrício et al. (2016) noted that fibropapillomatosis recovery was likely in a resident population in Puerto Rico, with tumor regression occurring within three years of formation. Other factors, such as increased stressors and selection of healthy turtles during illegal poaching activities may increase susceptibility of turtles (Patrício et al., 2016).

3.8.2.2.2 Hawksbill Sea Turtle (*Eretmochelys imbricata*)

3.8.2.2.2.1 Status and Management

The hawksbill turtle is listed as endangered under the ESA (35 *Federal Register* 8491). While the current listing as a single global population remains valid, data may support separating populations at least by ocean basin under the distinct population segment policy (National Marine Fisheries Service & U. S. Fish and Wildlife Service, 2007). The most recent status review document was released in 2013 by the NMFS and USFWS (National Marine Fisheries Service, 2013a).

Critical habitat has been designated in the Study Area, as shown in Figure 3.8-5. Critical habitat for hawksbill terrestrial nesting areas was designated in Puerto Rico in 1982. This designation includes portions of Mona Island, Culebra Island, Cayo Norte, and Island Culebrita, from the mean high tide line to a point 150 meters (m) from shore. Critical marine habitat was also designated in 1998 for the coastal waters surrounding Mona and Monito Islands, Puerto Rico, from the mean high water line seaward to 3 NM (National Marine Fisheries Service, 2013a). Critical habitat includes (1) coral reefs for food and shelter and (2) nesting beaches. The essential physical and biological features of coral reefs support a large, long-term juvenile hawksbill population, in addition to subadults and adults. The types of sponges that hawksbills prefer for food are found on the reefs around these islands. Reef ledges and caves also provide resting areas and protection from predators. Nesting beaches on Mona Island support the largest population of nesting hawksbill turtles in the U.S. Caribbean (National Marine Fisheries Service, 2013a).

3.8.2.2.2.2 Habitat and Geographic Range

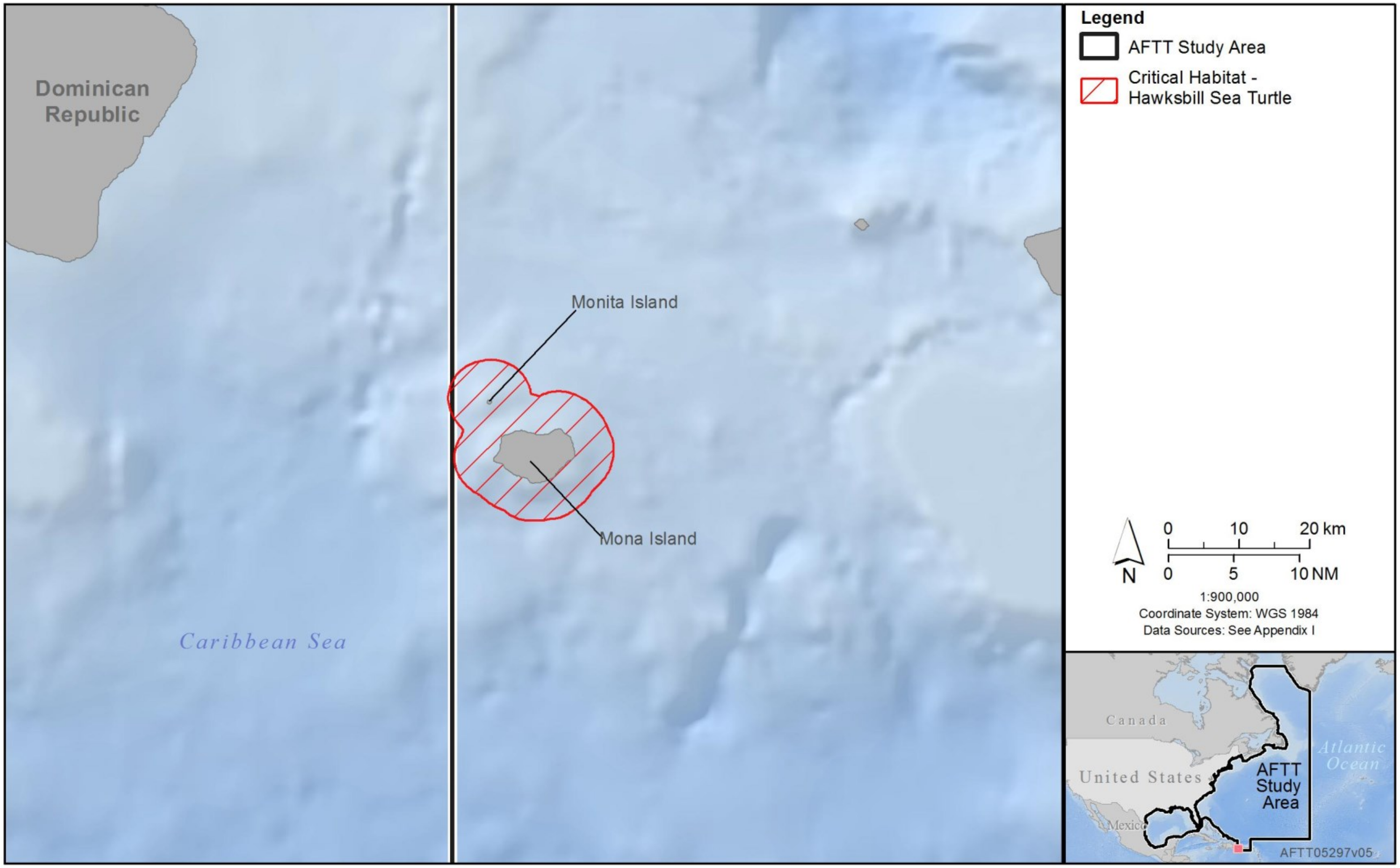
The hawksbill is the most tropical of the world's sea turtles, rarely occurring above 35° north or below 30° south (Witzell, 1983). While hawksbills are known to occasionally migrate long distances in the open ocean, they are primarily found in coastal habitats and use nearshore areas more exclusively than other sea turtles. Hatchlings in the AFTT Study Area are believed to occupy open-ocean waters, associating themselves with surface algal mats in the Atlantic Ocean (Parker, 1995; Witherington & Hirama, 2006; Witzell, 1983). Juveniles leave the open-ocean habitat after three to four years and settle in coastal foraging areas, typically coral reefs but occasionally seagrass beds, algal beds, mangrove bays, and creeks (Mortimer & Donnelly, 2008).

Less is known about the hawksbill's oceanic stage, but it is thought that neonates live in the oceanic zone where water depths are greater than 200 m. Distribution in the oceanic zone may be influenced by surface gyres (Leon & Bjorndal, 2002; National Marine Fisheries Service, 2013a).

Juveniles and adults share the same foraging areas, including tropical nearshore waters associated with coral reefs, hard bottoms, or estuaries with mangroves (Musick & Limpus, 1997). In nearshore habitats, resting areas for late juvenile and adult hawksbills are typically in deeper waters, such as sandy bottoms at the base of a reef flat (Houghton et al., 2003). As they mature into adults, hawksbills move to deeper habitats and may forage to depths greater than 90 m. During this stage, hawksbills are seldom found in waters beyond the continental or insular shelf unless they are in transit between distant foraging and nesting grounds (Renaud et al., 1996). Ledges and caves of coral reefs provide shelter for resting hawksbills during both day and night, where an individual often inhabits the same resting spot. Hawksbills are also found around rocky outcrops and high-energy shoals, where sponges are abundant, and in mangrove-fringed bays and estuaries. Female hawksbills return to their natal beach every two to three years to nest at night, every 14—16 days during the nesting season.

In the Caribbean Sea and Gulf of Mexico Large Marine Ecosystems, the principal nesting season is from June to November (Hillis, 1990), with only rare nesting activity in Florida, which is restricted to Volusia, Martin, Palm Beach, Broward, Miami-Dade, and Monroe Counties (Meylan et al., 2006; National Marine Fisheries Service, 2013a). Throughout their range, hawksbill turtles typically nest in low densities; aggregations of nesting activity that usually include approximately 20 nests, but can exceed a few hundred nests in some locations (National Marine Fisheries Service, 2013a).

The greatest hawksbill turtle numbers in the southeastern United States are found off the coast of southern Florida. There, hawksbills are documented from winter to summer from Palm Beach, Broward, and Dade Counties to the Florida Keys, and to coastal waters just northwest of Tampa Bay, where the northernmost stranding records typically occur. Foraging juveniles and adults settle on coral reef and hard-bottom habitats off southern Florida throughout the year (Musick & Limpus, 1997). Hawksbill turtle sightings in waters off the Florida panhandle, Alabama, Mississippi, Louisiana, and Texas (Rester & Condrey, 1996; Witzell, 1983), though rare, are likely of early juveniles born on nesting beaches in Mexico that have drifted north with the dominant currents (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1993).



Note: AFTT: Atlantic Fleet Training and Testing

Figure 3.8-5: Critical Habitat Designation for the Hawksbill Sea Turtle within the Study Area

3.8.2.2.2.3 Population Trends

Since the last five-year status review for hawksbill turtles (National Marine Fisheries Service & U. S. Fish and Wildlife Service, 2007), recent information on nesting populations in the eastern Pacific and the Nicaragua nesting population in the western Caribbean appears to have improved (National Marine Fisheries Service, 2013a). Global trends and distribution, however, have remained the same. An estimated 22,004–29,035 turtles nest each year in the Atlantic, Indian, and Pacific oceans; of these, 3,626–6,108 occur in the Atlantic Ocean alone. Historical population trends showed overall declines for the 20- to 100-year period of evaluation. Among the 88 sites worldwide for which historic trends could be assessed, 63 (72 percent) showed a decline. Shorter-term population trends, however, show more increases at some nesting sites, particularly in the north Atlantic and Pacific Oceans with 10 (24 percent) increasing, 3 (7 percent) stable, and 28 (68 percent) decreasing (National Marine Fisheries Service, 2013a).

3.8.2.2.2.4 Predator and Prey Interactions

Hawksbill turtles have a varying diet and feeding habitat preference throughout different lifestages. Post-hatchling hawksbills feed on floating habitats (e.g., *Sargassum*) in the open ocean (Bresette et al., 1998; Plotkin & Amos, 1998; Van Houtan et al., 2016). During the later juvenile stage, hawksbills are considered omnivorous, feeding on sponges, sea squirts, algae, molluscs, crustaceans, jellyfish, and other aquatic invertebrates (Bjorndal, 1997). Older juveniles and adults are more specialized, feeding primarily on sponges, which compose as much as 95 percent of their diet in some locations (Meylan, 1988; Witzell, 1983). As adults, Hawksbill turtles fill a unique ecological niche in marine and coastal ecosystems, supporting the natural functions of coral reefs by keeping sponge populations in check (Hill, 1998; Leon & Bjorndal, 2002). Feeding on sponges helps to control populations of sponges that may otherwise compete for space with reef-building corals (Hill, 1998; Leon & Bjorndal, 2002).

The loss of hawksbill eggs to predators such as feral pigs, mongoose, rats, snakes, crabs, and ants is a severe problem on some nesting beaches. As with other sea turtles, hatchlings may be preyed on by birds and fish. Sharks are the primary nonhuman predators of juvenile and adult hawksbills at sea (National Ocean Service, 2016; Southern California Marine Institute, 2016).

3.8.2.2.2.5 Species-Specific Threats

In addition to the general threats described in Section 3.8.2.1.5 (General Threats), the greatest threat to hawksbills is harvest for commercial and subsistence use. Direct harvest of eggs and nesting adult females from beaches, as well as direct hunting of turtles in foraging areas, continues in many countries. International trade of tortoise shells is thought to be the most important factor endangering the species worldwide. The second-most significant threat to hawksbill sea turtles is loss of nesting habitat caused by the expansion of human populations in coastal areas of the world, as well as the increased destruction or modification of coastal ecosystems to support tourism (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998a). Coastal pollution as a result of increased development degrades water quality, particularly coral reefs, which are primary foraging areas for hawksbills. Due to their preference for nearshore areas, hawksbills are particularly susceptible to nearshore fisheries gear such as drift nets, entanglement in gill nets, and capture on fish hooks of fishermen (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1993; National Marine Fisheries Service, 2013a).

3.8.2.2.3 Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

3.8.2.2.3.1 Status and Management

The Kemp's ridley sea turtle is listed as a single population and is classified as endangered under the ESA (35 *Federal Register* 18319). The most recent status review was released in 2015 by the USFWS and NMFS (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2015). There is no critical habitat currently designated for this species. In 2010, the USFWS and NMFS received a petition to designate critical habitat on nesting beaches in Texas and along gulf coast states. The petition is still under consideration, and no proposed rule on the establishment of critical habitat has been released by either agency.

3.8.2.2.3.2 Habitat and Geographic Range

Kemp's ridley turtle nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico. Nesting also occurs in Veracruz, and a few historical records exist for Campeche, Mexico. Since 1978, the U.S. National Park Service, in partnership with USFWS, NMFS, Texas Parks and Wildlife Department, and the Instituto Nacional de Pesca (a Mexican federal agency), has led an effort to increase Kemp's ridley turtle nesting at Padre Island National Seashore, south Texas, to form a secondary nesting colony to safeguard against extinction (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011). Occasional nesting has been reported from Florida, Alabama, Georgia, South Carolina, North Carolina, with the furthest north nesting occurring in Virginia (in 2012 and 2014) (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2015). Shaver et al. (2016) has noted that the known nesting range for the Kemp's ridley turtle has expanded since the late 1980s, possibly due to "head start" releases in Florida. Head starting is an accepted conservation intervention involving captive rearing and release of sea turtles, but the range expansion may also be associated with increased nesting numbers (Shaver et al., 2016).

Habitats frequently used by Kemp's ridley sea turtles in U.S. waters are warm-temperate to subtropical sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters, where their preferred food, the blue crab, is abundant (Lutcavage & Musick, 1985). The general migration pattern of females begins with travel through relatively shallow migratory corridors toward the nesting beach in the late winter in order to arrive at the nesting beach by early spring. Males and females can loop along the U.S. continental shelf large marine ecosystem in the spring, and back down the southeast U.S. continental shelf in the fall. From nesting beaches in the Gulf of Mexico, the migratory corridor traverses neritic areas of the Mexico and U.S. Gulf coasts with a mean water depth of 26 m approximately 20 kilometers (km) from the coast, occurring in late May through August with a peak in June (Shaver et al., 2016). Kemp's ridley turtles that headed north and east traveled as far as the waters off southwest Florida; however, waters off the upper Texas coast through Mississippi, especially off Louisiana, appear to be a "hotspot" as turtles returned to the area to forage over multiple years (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2015).

Evidence suggests that post-hatchling and small juvenile Kemp's ridley sea turtles, similar to loggerhead and green sea turtles of the same region, forage and develop in floating *Sargassum* habitats of the North Atlantic Ocean. Juveniles migrate to habitats along the U.S. Atlantic continental shelf from Florida to New England (Morreale & Standora, 1998; Peña, 2006) at around two years of age. A tag study funded by the U.S. Navy and completed by Barco and Lockhart (2015) indicates that waters off of Norfolk Naval Base and the Chesapeake Bay may be foraging grounds while juveniles are in transit along the Atlantic coast. Migrating juvenile Kemp's ridleys travel along coastal corridors generally shallower than 50 m in bottom depth (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011). Suitable developmental habitats are seagrass beds and mud bottoms in waters of less than 10 m bottom depth and with sea surface temperatures between 72 degrees Fahrenheit (°F) and 90°F (22 degrees Celsius [°C] and 32°C) (Coyne et al., 2000).

Important year-round developmental habitats in the northern Gulf of Mexico include the western coast of Florida (particularly the Cedar Keys area), the eastern coast of Alabama, and the mouth of the Mississippi River (Lazell, 1980; Lutcavage & Musick, 1985; Weber, 1995). Coastal waters off western Louisiana and eastern Texas also provide adequate habitats for bottom feeding. Verkaik et al. (2016) found strong site fidelity within and between years to the Mississippi Sound during spring, summer, and fall for juvenile Kemp's ridley turtles. During the winter, turtles migrated to the nearshore waters of Louisiana.

As adults, many turtles remain in the Gulf of Mexico Large Marine Ecosystem, with only occasional occurrence in the Atlantic Ocean (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011). While the understanding of adult males' distribution and habitat usage is limited, satellite telemetry of males caught near Padre Island, Texas, indicates that they do not migrate, remaining year-round in nearshore waters of less than 50 m. Many of the post-nesting females from Rancho Nuevo migrate north to areas offshore of Texas and Louisiana (Marquez, 1994). Farther south, some post-nesting females migrate from Rancho Nuevo to the northern and western Yucatán Peninsula in the Southern Gulf of Mexico, which contains important seasonal foraging sites for adult females—specifically the Bay of Campeche (Marquez, 1994; Márquez, 1990; Pritchard & Marquez, 1973).

3.8.2.2.3.3 Population Trends

The earliest estimate of population size was derived from analyzing archival film footage of a large arribada (mass nesting) event in 1947 and other life history information of the Kemp's ridley turtle. From these data sources and the analysis of the raw footage, Gonzalez (2011) suggest that the Kemp's ridley population during and prior to the 1947 nesting season was relatively robust, with the estimated number of nests exceeding 121,000. The lowest point in the decline of Kemp's ridleys occurred in 1985 (approximately 700 nests), representing a 99 percent decline in the number of nests compared to the 1947 estimate. Although the Kemp's ridley population has shown increases since 1985, the rate of recovery has declined in recent years. In 2010, Kemp's ridley nesting showed a steep decline (35 percent) followed by some recovery to 2009 levels, with other declines in 2013 and 2014 (Caillouet et al., 2016; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2015; Shaver et al., 2016). The numbers of Kemp's ridley sea turtle nests counted along Texas beaches have increased from 2015 (159 nests) to 2016 (186 nests) and 2017 (353 nests) (Shaver, 2018).

Subadult and adult females were presumed to have suffered a high mortality rate in 2009, which has manifested in a 40 percent decline in nesting activity in Mexico and Texas. The causes of this mortality event and the ramifications for population recovery and growth rates are still being analyzed (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2015).

3.8.2.2.3.4 Predator and Prey Interactions

Kemp's ridley sea turtles feed primarily on crabs but are also known to prey on molluscs, shrimp, fish, jellyfish, and plant material (Frick et al., 1999; Marquez, 1994; Seney, 2016). Plant material, primarily macroalgae, is likely consumed incidentally with invertebrate prey items (Seney, 2016). Blue crabs and spider crabs are important prey species for the Kemp's ridley (Keinath et al., 1987; Lutcavage & Musick, 1985; Seney, 2016). They may also feed on shrimp fishery bycatch (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1993), and Servis et al. (2015) noted instances of fish and horseshoe crab predation, indicating that Kemp's ridley turtles may opportunistically feed to supplement their diet.

Major predators of Kemp's ridley sea turtle eggs and hatchlings on nesting beaches include raccoons, dogs, feral pigs, skunks, badgers, and fire ants. Predatory fishes such as jackfish and redfish may feed on hatchlings at sea. Sharks are the primary predator of juvenile and adult Kemp's ridley sea turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011).

3.8.2.2.3.5 Species-Specific Threats

Because the Kemp's ridley turtle is very range limited, the general threats facing sea turtles described previously may increase impacts on this species. For example, energy extraction and development in the Gulf of Mexico are a particular threat to Kemp's ridley sea turtles because most of the nesting activity occurs there (Shaver & Caillouet, 1998). Kemp's ridley sea turtles periodically strand on beaches in Mexico covered in crude oil, and most of the turtles found injured and dead following the *Deepwater Horizon* oil spill were Kemp's ridley sea turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011; Wilkin et al., 2017). It should be noted that the dramatic reversal of an increasing nesting trend in the Gulf of Mexico followed the *Deepwater Horizon*, and the removal of a cohort of Kemp's ridleys that would be sexually mature now may be responsible for declines shown in 2013 and 2014 (Caillouet et al., 2016; Putman et al., 2015a). Shrimp trawling in the southeastern U.S. Atlantic and Gulf of Mexico was once a significant threat to Kemp's ridleys; however, the use of turtle excluder devices and the general decline of shrimp fishing in recent years have greatly reduced mortality levels (Caillouet et al., 2008; Nance et al., 2012). Vehicle activity on sea turtle nesting beaches can also disrupt the nesting process, crush nests, and create ruts and ridges in the sand that pose obstacles to turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011). Beach vehicular driving is permitted on most beaches in Texas, where adult turtles and hatchlings have been crushed by passing vehicles, as well as on some beaches in Mexico.

3.8.2.2.4 Loggerhead Turtle (*Caretta caretta*)

3.8.2.2.4.1 Status and Management

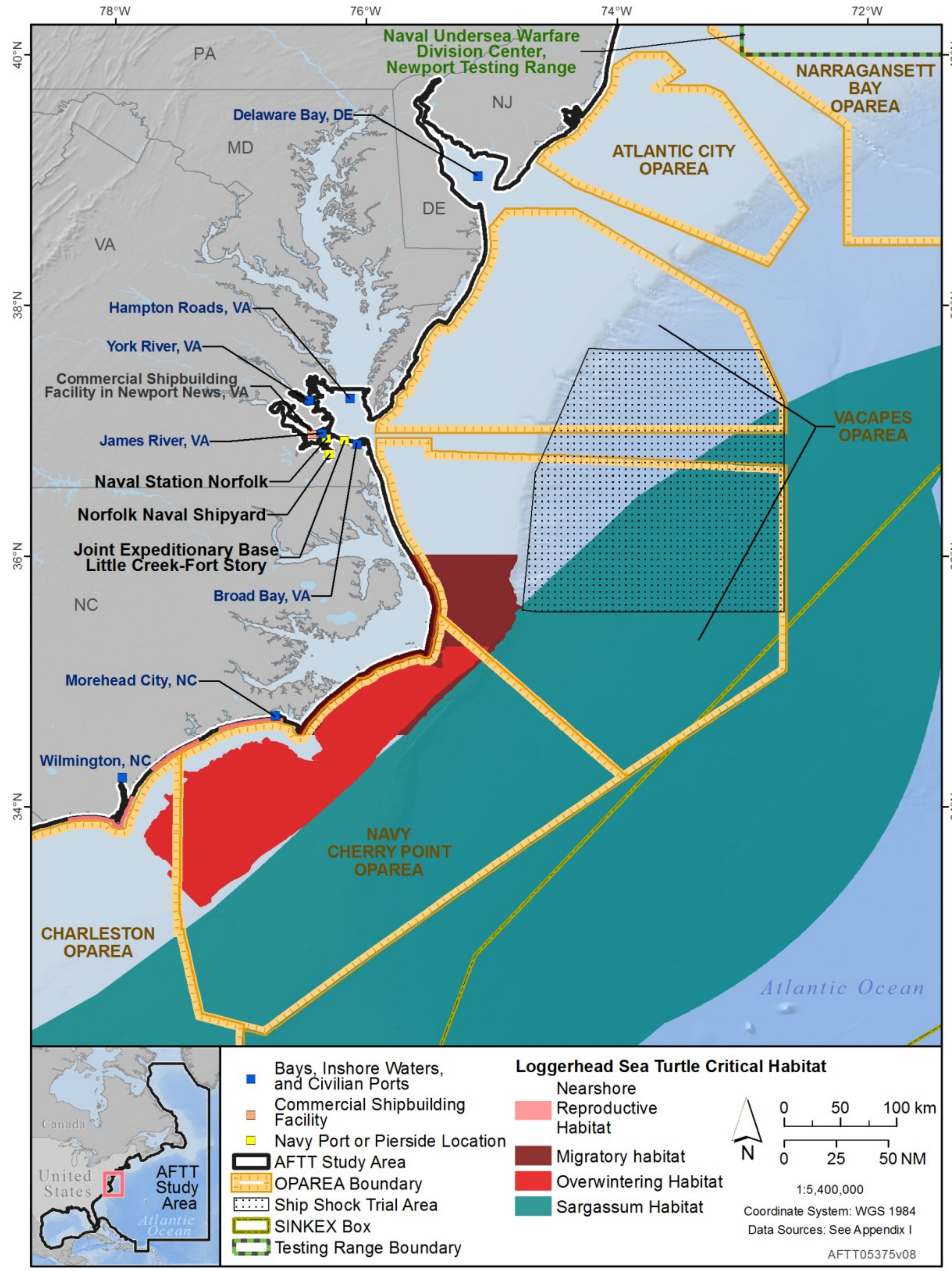
In 2009, a status review conducted for the loggerhead (the first turtle species subjected to a complete stock analysis) identified nine distinct population segments within the global population (Conant et al., 2009). In a September 2011 rulemaking, the NMFS and USFWS listed five of these distinct population segments as endangered and kept four as threatened under the ESA, effective as of October 24, 2011 (76 Federal Register 58868). The North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea distinct population segments of the loggerhead sea turtle are classified as endangered under the ESA, and the Southeast Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean distinct population segments are classified as threatened. The Northwest Atlantic Ocean distinct population segment is the only one that occurs entirely within the Study Area; however, loggerheads from other distinct population segments may occur rarely within the Study Area. For example, mixing likely occurs, rarely, with South Atlantic loggerheads enabling a limited amount of gene flow between these two distinct population segments (National Marine Fisheries Service, 2010; Tucker et al., 2014). Critical Habitat has been designated within the Study Area, and is shown in Figure 3.8-6 (for critical habitat along the mid-Atlantic coast), Figure 3.8-7 (for critical habitat along southeast Atlantic states), and Figure 3.8-8 (for critical habitat in the Gulf of Mexico).

Specific areas designated as critical habitat include 38 occupied marine areas within the range of the Northwest Atlantic Ocean distinct population segment of loggerhead turtles (79 *Federal Register* 39856). In order to characterize different use patterns and concentrations both seasonally and geographically, the NMFS named five different habitat types that comprise the critical habitat designation, which include (1) nearshore reproductive habitat (portions of nearshore waters adjacent to nesting beaches used by females and hatchlings to egress to open-water environments), (2) winter habitats (warm waters south of Cape Hatteras where juveniles and adults tend to concentrate during winter months), (3) breeding habitats (areas with high concentrations of both male and female adults during the breeding season in proximity to Florida migratory corridor and nesting grounds), (4) constricted migratory habitat (migratory corridors restricted in width), (5) *Sargassum* habitat (juvenile loggerhead developmental habitats where *Sargassum* supports adequate prey abundance and cover) (National Marine Fisheries Service, 2014b). Physical and biological features that support the five habitat types summarized above for loggerhead sea turtle conservation include oceanic conditions that would concentrate certain life-stage loggerheads together at different locations and in different seasons. The USFWS designated approximately 685 miles of nesting beaches (in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi) in a separate rulemaking (79 *Federal Register* 51264), which is also shown on Figure 3.8-6, Figure 3.8-7, and Figure 3.8-8.

None of these critical habitat areas include Department of Defense areas of Marine Corps Base Camp Lejeune (Onslow Beach), Cape Canaveral Air Force Station, Patrick Air Force Base, and Eglin Air Force Base, which are exempt from critical habitat designation because their Integrated Natural Resources Management Plans incorporate measures that provide a benefit for the conservation of the loggerhead sea turtle.

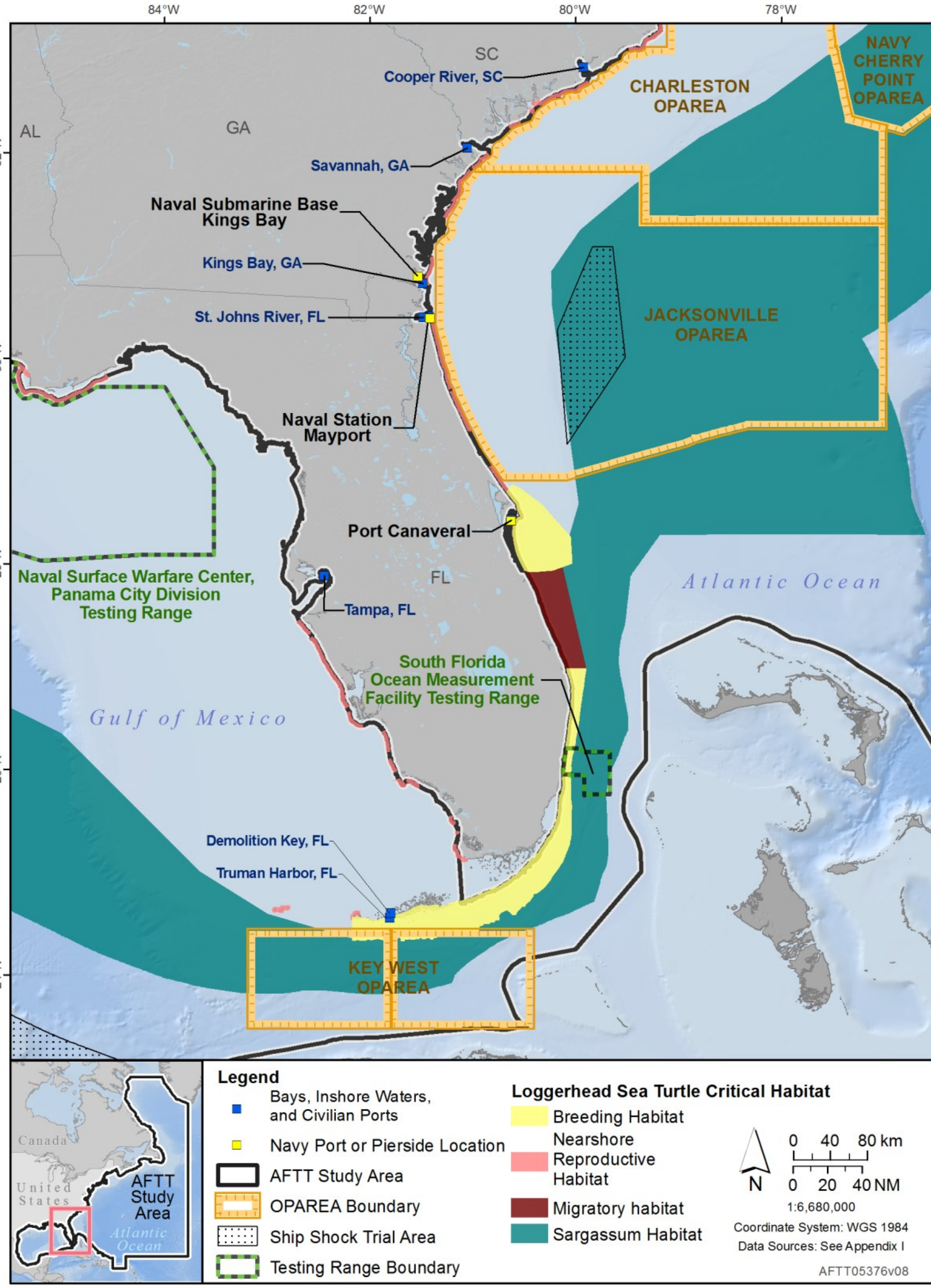
3.8.2.2.4.2 Habitat and Geographic Range

Loggerhead turtles occur in U.S. waters in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Chapman & Seminoff, 2016; Dodd, 1988). Loggerheads typically nest on beaches close to reef formations and in close proximity to warm currents (Dodd, 1988), preferring beaches facing the ocean or along narrow bays (National Marine Fisheries Service, 2014b; Reece et al., 2013). Nesting in the Study Area occurs from April through September, with a peak in June and July (Dodd, 1988; Weishampel et al., 2006; Williams-Walls et al., 1983). Large nesting colonies exist in Florida, with more limited nesting along the Gulf coast and north through Virginia. At emergence, hatchlings swim to offshore currents and remain in the open ocean, often associating with floating mats of *Sargassum* (Carr, 1986, 1987; Witherington & Hirama, 2006). Nesting activity within the North Atlantic Ocean distinct population segment include the eastern Bahamas, southwestern Cuba, the eastern Caribbean Islands, and numerous locations from the Yucatán Peninsula to Virginia (Conant et al., 2009; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2007; National Marine Fisheries Service, 2010). Within the United States, the highest concentration of loggerhead nesting occurs in Florida, discussed in more detail in Section 3.8.2.2.4.3 (Population Trends), with additional nesting reported in Texas, Alabama, Georgia, North Carolina, and Virginia. Genetic studies indicate that, although females routinely return to natal beaches, males may breed with females from multiple populations and facilitate gene flow (Bowen et al., 2005).



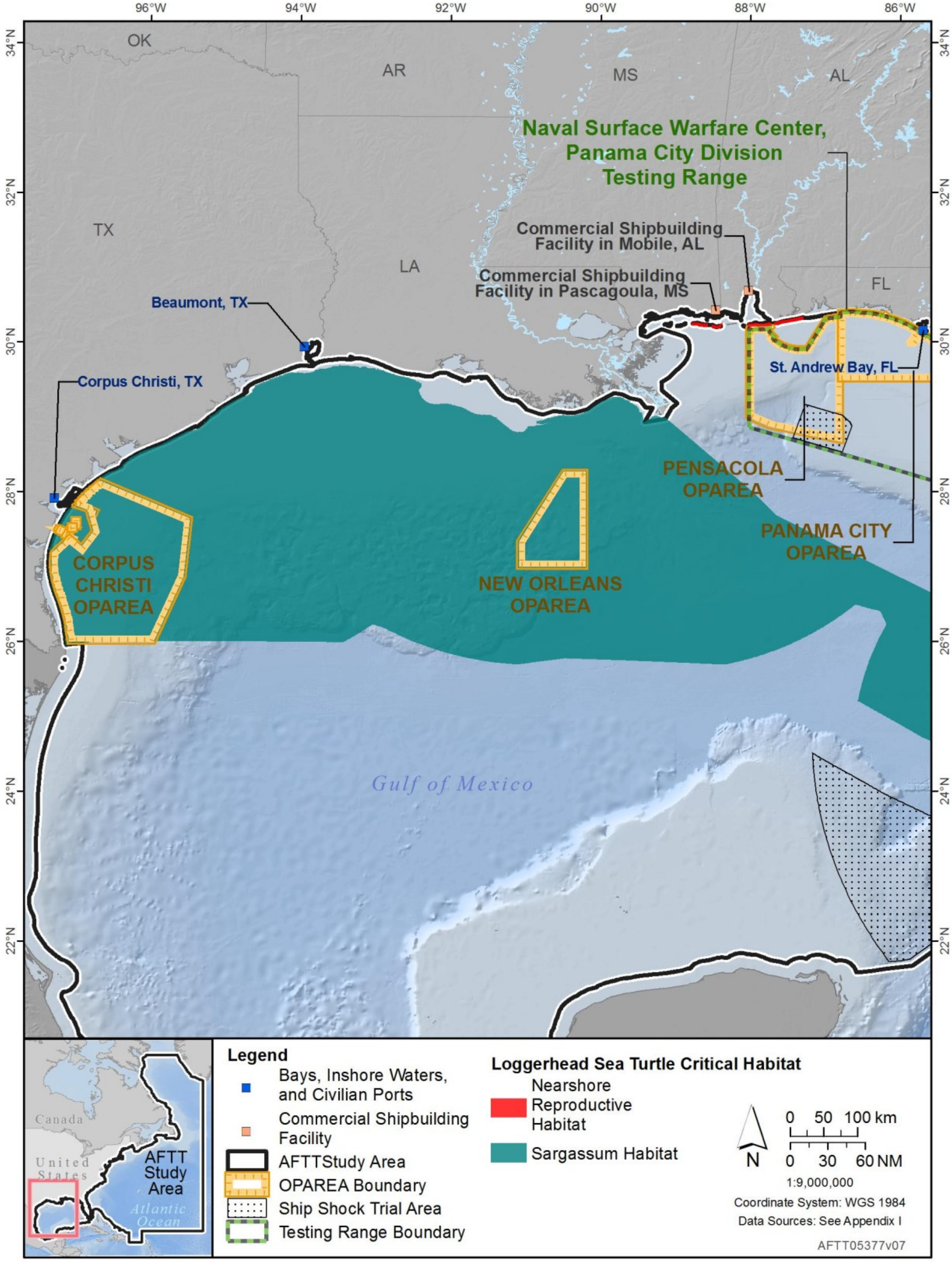
Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

Figure 3.8-6: Critical Habitat Designation for the Loggerhead Turtle within the Study Area: Mid-Atlantic



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

Figure 3.8-7: Critical Habitat Designation for the Loggerhead Turtle within the Study Area: Southeast



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

Figure 3.8-8: Critical Habitat Designation for the Loggerhead Turtle within the Study Area: Gulf of Mexico

Migration between oceanic and nearshore habitats occurs during the juvenile stage as turtles move seasonally from open-ocean current systems to nearshore foraging areas (Bolten, 2003a; Mansfield, 2006). After reaching a length of 40 centimeters (cm) (Carr, 1987), early juvenile loggerheads make a transoceanic crossing, swimming back to nearshore feeding grounds near their beach of origin in the western Atlantic Ocean (Bowen et al., 2004; Musick & Limpus, 1997). Juveniles are frequently observed in developmental habitats, including coastal inlets, sounds, bays, estuaries, and lagoons with depths less than 100 m (Hopkins-Murphy et al., 2003). Based on growth rate estimates, the duration of the open-ocean juvenile stage for North Atlantic loggerhead sea turtles is estimated to be 8.2 years (Bjorndal et al., 2000).

Juvenile loggerhead sea turtles inhabit offshore waters in the North Atlantic Ocean. These offshore habitats provide juveniles with an abundance of prey and sheltered locations where they can rest (Rosman et al., 1987). Loggerheads are generally observed in the northern extent of their range during the summer, in shallow water habitats with large expanses of open-ocean access. This summer distribution extends into the Gulf of Maine and waters over the Scotian Shelf, with some individuals venturing as far north as Newfoundland (Arendt et al., 2012; Bolten et al., 1992; National Marine Fisheries Service, 2010; Witherington & Hirama, 2006). Juveniles also use the strong current of the North Atlantic Gyre to move from developmental nursery habitats to later developmental habitats, and to and from adult foraging, nesting, and breeding habitats (Bolten et al., 1998; Musick & Limpus, 1997). Small bottom-feeding juveniles in Delaware Bay are the predominant loggerhead size class found along the northeast and mid-Atlantic U.S. coast, while adults inhabit the entire continental shelf area (Hopkins-Murphy et al., 2003). Long Island Sound, Cape Cod Bay, and Chesapeake Bay are the most frequently used juvenile developmental habitats along the Northeast U.S. Continental Shelf Large Marine Ecosystem (Mansfield, 2006).

Navy-funded aerial surveys and stranding data suggest that this species is the most abundant sea turtle species using Chesapeake Bay and waters off of Cape Hatteras (Andrady, 2011; Barco & Lockhart, 2015; Burt et al., 2014; National Oceanic and Atmospheric Administration, 2015; Swingle et al., 2016). Abundances in these waters were highest in the spring relative to summer and fall, with no presence in winter (Burt et al., 2014). Core Sound and Pamlico Sound, North Carolina, on the border between the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems, represent important developmental habitat for juvenile loggerheads (Epperly et al., 1995a). Although these habitats are also used by greens and Kemp's ridleys, loggerheads are the most abundant sea turtle species within the summer developmental habitats of North Carolina (Epperly et al., 1995a; Epperly et al., 1995b; Epperly et al., 1995c). In a sampling study from 2004 to 2007, juveniles were the most abundant age group among loggerheads found in the Charleston, South Carolina, shipping channel between May and August (Arendt et al., 2012). Immature loggerhead sea turtles may occupy coastal feeding grounds for 20 years before their first reproductive migration (Bjorndal et al., 2001; Putman et al., 2015b).

Sub-adult and adult loggerhead turtles tend to inhabit deeper offshore feeding areas along the western Atlantic coast, from mid-Florida to New Jersey (Hopkins-Murphy et al., 2003; Roberts et al., 2005). As late juveniles and adults, loggerhead sea turtles most often occur on the continental shelf and along the shelf break of the U.S. Atlantic and Gulf coasts, as well as in coastal estuaries and bays (Putman et al., 2015b). Hawkes et al. (2006) found that adult females forage predominantly in shallow coastal waters along the U.S. Atlantic coast less than 100 m deep, likely exploiting bottom-dwelling prey.

As water temperatures drop from October to December, most loggerheads emigrate from their summer developmental habitats and eventually return to warmer waters south of Cape Hatteras, where they spend the winter (Morreale & Standora, 1998). From a southwestern Florida nesting location, Tucker et al. (2014) tracked nine loggerheads over multiple nesting seasons, showing five distinct winter migration destinations—islands in the Caribbean, Florida Keys, West Florida Shelf, northern Gulf of Mexico, and Yucatan Peninsula. Bovery and Wyneken (2015) analyzed seasonal variation in sea turtle density and abundance off southeastern Florida, and found that loggerheads were the most frequently sighted species, with increased sightings in spring. Turtles were often found in coastal waters that were west of the Florida Current (approximately 20 km offshore).

Griffin et al. (2013) offered a conceptual model of foraging strategies, as shown by tagged loggerhead turtles from Georgia, South Carolina, and North Carolina nesting beaches. These strategies included seasonal strategies and year-round strategies, with summer prevalence in waters north of Cape Hatteras along neritic habitats to Cape Canaveral, Florida, with winter foraging occurring further out on the mid to outer continental shelf. Large juvenile and adult loggerhead turtles are captured or observed along Florida's Atlantic coast year-round (Bovery & Wyneken, 2015; Pajuelo et al., 2016). As stated previously, loggerheads were the highest occurring sea turtle species within the AFTT Study Area, with higher occurrences in spring (Bovery & Wyneken, 2015).

3.8.2.2.4.3 Population Trends

There are at least five demographically independent loggerhead sea turtle nesting groups or subpopulations of the Northwest Atlantic Ocean: (1) the Northern Recovery Unit, from the Florida-Georgia border to southern Virginia; (2) the Peninsular Florida Recovery Unit, along Florida's Atlantic coast to Key West; (3) the Dry Tortugas Recovery Unit, encompassing all islands west of Key West; (4) the Northern Gulf of Mexico Recovery Unit, from the Florida panhandle through Texas; and (5) the Greater Caribbean Recovery Unit, from Mexico through French Guiana, the Bahamas, and the Lesser and Greater Antilles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2008).

Annual total nest counts for loggerhead sea turtles on Florida's index beaches (27 beaches identified as a subset for measuring long-term nesting trends) fluctuate widely, and scientists do not yet understand fully what drives these changes. A detailed analysis of Florida's long-term loggerhead nesting data from 1989 to 2017 shows three distinct phases. Following a 52 percent increase between 1989 and 1998, nest counts declined sharply (53 percent) over nearly a decade (1998–2007). However, annual nest counts showed a strong increase (65 percent) through 2017. Overall, nest counts in Florida over the monitoring period (1989–2017) increased by approximately 19 percent (Florida Fish and Wildlife Conservation Commission, 2017).

3.8.2.2.4.4 Predator and Prey Interactions

Loggerhead sea turtles are primarily carnivorous in both open ocean and nearshore habitats, although they also consume some algae (Bjorndal, 1997), Diet varies by age class (Godley et al., 1998) and by specializing in specific prey groups dependent on location. For post hatchlings that tend to be grouped in masses of *Sargassum* and other floating habitats, various diet analyses of gut contents show parts of *Sargassum*, zooplankton, jellyfish, larval shrimp and crabs, and gastropods (Burkholder et al., 2004; Carr & Meylan, 1980; Richardson & McGillvary, 1991). Both juveniles and adults forage in coastal habitats, where they feed primarily on the bottom, although they also capture prey throughout the water column (Bjorndal, 2003). Adult loggerheads feed on a variety of bottom-dwelling animals, such as crabs, shrimp, sea urchins, sponges, and fish. They have powerful jaws that enable them to feed on hard-shelled prey, such as whelks and conch. During migration through the open sea, they eat jellyfish, molluscs, flying fish, and squid (Briscoe et al., 2016; Fukuoka et al., 2016; Pajuelo et al., 2016).

Common predators of eggs and hatchlings on nesting beaches are ghost crabs, raccoons, feral pigs, foxes, coyotes, armadillos, and fire ants (Campbell, 2016; Dodd, 1988; Engeman et al., 2016). Eriksson and Burton (2003) has shown that management interventions for feral pigs and raccoons can significantly increase nest success in Florida, one of the main nesting concentrations of loggerheads. Arroyo-Arce et al. (2017) documented an apparently rare instance of a jaguar (*Panthera onca*) in 2014 predating a loggerhead turtle at Tortuguero National Park, Costa Rica, while the turtle was on the beach. In the water, hatchlings are susceptible to predation by birds and fish. Sharks are the primary predator of juvenile and adult loggerhead sea turtles (Fergusson et al., 2000).

3.8.2.2.4.5 Species-Specific Threats

In addition to the general threats described previously, mortality associated with shrimp trawls has been a substantial threat to large juvenile and subadult loggerheads because these trawls operate in the nearshore habitats commonly used by this species. Although shrimping nets have been modified with turtle excluder devices to allow sea turtles to escape, the overall effectiveness of these devices has been difficult to assess (Bugoni et al., 2008). Shrimp trawl fisheries account for the highest number of loggerhead sea turtle fishery mortalities; however, loggerheads are also captured and killed in trawls, traps and pots, longlines, and dredges. Along the Atlantic coast of the United States, NMFS estimated that almost 163,000 loggerhead sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with 3,948 of those sea turtles dying as a result of their capture. Each year, several hundred loggerhead sea turtles are also captured in herring, mackerel, squid, butterfish, and monkfish fisheries; pound net fisheries, summer flounder, and scup fisheries; Atlantic pelagic longline fisheries; and gillnet fisheries in Pamlico Sound. Combined, these fisheries capture about 2,000 loggerhead sea turtles each year. Although most are released alive, about 700 turtles are killed annually.

Vehicle use on sea turtle nesting beaches is also an issue for loggerheads. Vehicles are allowed on some beaches in Florida, Georgia, North Carolina, Virginia, and Texas. Vehicles can run over and kill hatchlings or nesting adult turtles on the beach, disrupt the nesting process, create ruts in the sand that impede turtle movement, and crush nests (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2008).

3.8.2.2.5 Leatherback Sea Turtle (*Dermochelys coriacea*)

3.8.2.2.5.1 Status and Management

The leatherback sea turtle is listed as a single population and is classified as endangered under the ESA (35 *Federal Register* 8491). Although USFWS and NMFS believe the current listing is valid, preliminary information indicates an analysis and review of the species should be conducted under the distinct population segment policy (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b). Recent information on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies) have led to an increased understanding and refinement of the global stock structure. Leatherback sea turtles from nesting stocks originating throughout the Atlantic have the potential to be within the offshore portions of the Study Area, but only two of these—the Florida genetic stock and the Northern Caribbean genetic stock—nest on beaches in the jurisdiction of the United States.

Critical habitat has been designated in the Study Area for this species (Figure 3.8-9). In 1978, critical habitat was designated for the leatherback's terrestrial environment on St. Croix Island at Sandy Point because of its importance as a nesting habitat (43 *Federal Register* 43688). In 1979, critical habitat was designated for the waters next to Sandy Point, St. Croix, up to and including the waters from the

100-fathom curve shoreward to the mean high tide line (44 *Federal Register* 17710). The essential physical and biological feature of this critical habitat is its function as an important courtship and mating area adjacent to the nesting beach.

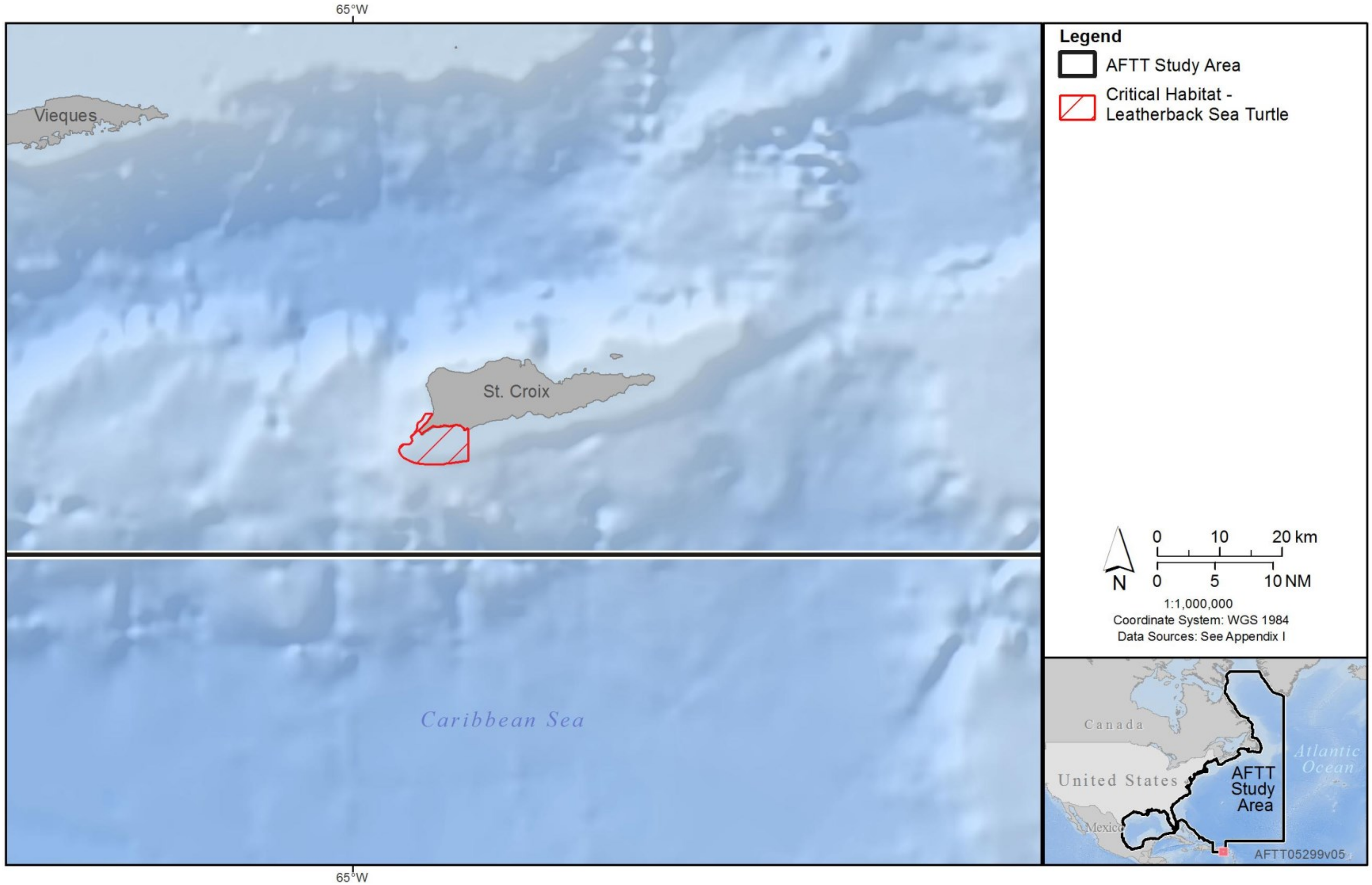
3.8.2.2.5.2 Habitat and Geographic Range

The leatherback turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b).

Important nesting areas in the western Atlantic Ocean occur in Florida, St. Croix, Puerto Rico, Costa Rica, Panama, Colombia, Trinidad and Tobago, Guyana, Suriname, French Guiana, and southern Brazil (Brautigam & Eckert, 2006; Márquez, 1990; Spotila et al., 1996). Other minor nesting beaches are scattered throughout the Caribbean, Brazil, and Venezuela (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b). Leatherback nesting season begins and ends a few months earlier than that of the other sea turtle species that nest in the Study Area, beginning in March in the more northern nesting habitats (e.g., Florida) and continues in more southern nesting habitats (e.g., Puerto Rico). Females remain in the general vicinity of the nesting habitat between nestings, with total residence in the nesting and inter-nesting habitat lasting up to four months. Horrocks et al. (2016) tagged over 3,100 female leatherbacks in the Caribbean Sea and found that females traveled an average of 160 km between nesting events within the same season. Migrations between nesting seasons were typically to the north towards more temperate latitudes, which support high densities of jellyfish prey in the summer.

In the Atlantic Ocean, equatorial waters appear to be a barrier between breeding populations. In the northwestern Atlantic Ocean, post-nesting female migrations appear to be restricted to north of the equator, but the migration routes vary (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b). Leatherbacks made round-trip migrations from where they started through the North Atlantic Ocean heading northwest to fertile foraging areas off the Gulf of Maine, Canada, and Gulf of Mexico; others crossed the ocean to areas off Western Europe and Africa; while others spent time between northern and equatorial waters. These data support earlier studies that found adults and subadults captured in waters off Nova Scotia stayed in waters north of the Equator (James et al., 2005a; James et al., 2005b; James et al., 2006).

Limited information is available on the habitats used by post-hatchling and early juvenile leatherback sea turtles because these age classes are entirely oceanic (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1992). These life stages are restricted to waters warmer than 79°F (26°C); consequently, much time is spent in the tropics (Eckert, 2002). They are not considered to associate with *Sargassum* or other flotsam, as is the case for all other sea turtle species (Horrocks, 1987; Johnson, 1989). Upwelling areas, such as equatorial convergence zones, serve as nursery grounds for post-hatchling and early juvenile leatherback sea turtles because these areas provide a high biomass of prey (Musick & Limpus, 1997).



Note: AFTT: Atlantic Fleet Training and Testing

Figure 3.8-9: Critical Habitat Designation for the Leatherback Sea Turtle within the Study Area

Late juvenile and adult leatherback sea turtles are known to range from mid-ocean to the continental shelf and nearshore waters (Barco & Lockhart, 2015; Grant & Ferrell, 1993; Schroeder & Thompson, 1987; Shoop & Kenney, 1992). Although leatherbacks were observed annually in Chesapeake Bay, they were not common and unevenly distributed. Juvenile and adult foraging habitats include both coastal and offshore feeding areas in temperate waters and offshore feeding areas in tropical waters. Leatherbacks have been shown to travel shorter distances at slower rates and increased diving rates in areas of high prey abundance, which is related to seasonal availability of prey (Wallace et al., 2015). Leatherback sea turtles mate in waters adjacent to nesting beaches and along migratory corridors (Cummings et al., 2016; Figgener et al., 2016).

3.8.2.2.5.3 Population Trends

Population trends for leatherback turtles in Florida show increases, with leatherback populations north of Florida being a stable population (National Marine Fisheries Service, 2013b; Stewart et al., 2014). This increase has coincided with an upsurge in the Caribbean population. Sporadic nesting also occurs in Georgia, South Carolina, as far north as North Carolina (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1992; Rabon et al., 2003; Schwartz, 1989), and in the Gulf of Mexico on the Florida panhandle. One of the most globally important stocks of leatherback turtles, the Southern Caribbean Stock, nests in French Guiana, Guyana, Suriname, and Trinidad but migrates and forages throughout the North Atlantic. The Western Caribbean stock of the Central American coast also migrates through the Study Area en route to North Atlantic foraging grounds. Nesting populations in southern Florida, Culebra, Puerto Rico, and the U.S. Virgin Islands are believed to be increasing due to heightened protection and monitoring of the nesting habitat over the past 30 years (National Marine Fisheries Service, 2011; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b; Turtle Expert Working Group, 2007).

The Florida nesting stock comes ashore primarily along the east coast of Florida. In the 1980s, fewer than 100 nests per year were reported. Based on data extrapolated from the index nesting beach surveys, nesting activity has shown an annual growth rate of 1 percent between 1989 and 2005 (National Marine Fisheries Service, 2013b). Larger growth rates (10.2 percent increases per year) in nesting activity in this area have been shown from 68 Florida beaches since 1979 (Stewart et al., 2011; Stewart et al., 2014). Florida statewide nesting reports show nesting numbers fluctuating between 896 nests and 1,712 nests during a five-year period between 2011 and 2015. Surveyors counted 205 leatherback nests on the 27 core index beaches in 2017 in Florida, which represents the lowest number of nests reported since 2006. While green turtle nest numbers on Florida's index beaches continue to rise, leatherback nest numbers have been declining since 2014 (Florida Fish and Wildlife Conservation Commission, 2017).

3.8.2.2.5.4 Predator and Prey Interactions

Leatherbacks lack the crushing chewing plates characteristic of hard-shelled sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied open-ocean prey such as jellyfish and salps. Leatherback sea turtles feed throughout the water column (Davenport, 1988; Eckert et al., 1989; Eisenberg & Frazier, 1983; Grant & Ferrell, 1993; James et al., 2005b; James et al., 2005c; Salmon et al., 2004). Leatherback prey is predominantly jellyfish (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b; Wallace et al., 2015).In Atlantic Canada, leatherbacks feed on jellyfish of *Cyanea* spp. and *Aurelia* spp. (James & Herman, 2001; Votier et al., 2011). In North Carolina and Georgia, turtles feed on cannonball jellies (*Stomolophus meleagris*) (Frick et al., 1999; Grant & Ferrell, 1993). Patterns in feeding behavior off St. Croix, U.S. Virgin Islands, over a 24-hour period suggest an interaction between leatherback diving and vertical movements of the deep scattering layer (a horizontal zone of planktonic organisms), with more frequent and shallower dives at night compared with fewer and deeper day dives (Eckert et al., 1989). Research in the feeding grounds of Georgia (Frick et al., 1999), North Carolina (Grant & Ferrell, 1993), and Atlantic Canada (James & Herman, 2001) has documented leatherbacks foraging on jellyfish at the surface.

Predators of leatherback nests are common to other sea turtle species (e.g., terrestrial mammals and invertebrates). Burns et al. (2016) found that nesting female leatherbacks expend a significant amount of time and energy, despite increased risk of direct predation while on land, to obscure nests. After laying nests and covering with sand, the female's return to the ocean is not linear, and is likely an attempt at decoy behavior as a further measure to protect the clutch. In the water, hatchlings are susceptible to predation by birds and fish. Sharks are the primary predator of juvenile and adult leatherback sea turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b).

3.8.2.2.5.5 Species-Specific Threats

In addition to the general threats to sea turtles described previously, bycatch in commercial fisheries is a particular threat to leatherback sea turtles. Incidental capture in longline and coastal gillnet fisheries has caused a substantial number of leatherback sea turtle deaths, likely because leatherback sea turtles dive to depths targeted by longline fishermen and are less maneuverable than other sea turtle species. Shrimp trawls in the Gulf of Mexico have been estimated to capture about 3,000 leatherback sea turtles, with 80 of those sea turtles dying as a result (Finkbeiner et al., 2011; Wallace et al., 2010b). Along the Atlantic coast of the United States, NMFS estimated that about 800 leatherback sea turtles are captured in pelagic longline fisheries, bottom longline, and drift gillnet fisheries for sharks as well as lobster, deep-sea red crab, Jonah crab, dolphin fish and wahoo, and Pamlico Sound gillnet fisheries. Although most of these turtles are released alive, these fisheries kill about 300 leatherback sea turtles each year (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b; Stewart et al., 2016). Harvest of leatherback sea turtle eggs and adult turtles continues to be a threat in many parts of the world (Humber et al., 2014). Lastly, climate change may impact leatherbacks in ways different from other sea turtle species because their distribution is so closely associated with jellyfish aggregations (which are affected by changing ocean temperatures and dynamics) (Pike, 2014). Robinson et al. (2013) suggest that climate change impacts are contributing to the Pacific leatherback population declines through a shifting of nesting dates to increase stressor exposure. The observed mean nesting date shifts in the Atlantic leatherback genetic stocks, in contrast to Pacific populations, may increase resiliency of Atlantic leatherbacks to climate-related impacts.

3.8.2.2.6 American Crocodile (*Crocodylus acutus*)

3.8.2.2.6.1 Status and Management

The American crocodile occurs within the jurisdictional boundaries of many different countries and is distributed in primarily coastal waters throughout the Caribbean Sea and on the Pacific coast of Central and South America from Mexico to Ecuador (Thorbjarnarson et al., 2006). Population declines have been attributed to loss of habitat and extensive poaching for their hides (U.S. Fish and Wildlife Service, 2010). The Florida population marks the northern extent of this species' range and is classified as a distinct population segment due to its genetic isolation (U.S. Fish and Wildlife Service, 2010). The American crocodile was listed as endangered under the ESA throughout its range in 1979 (44 *Federal Register*

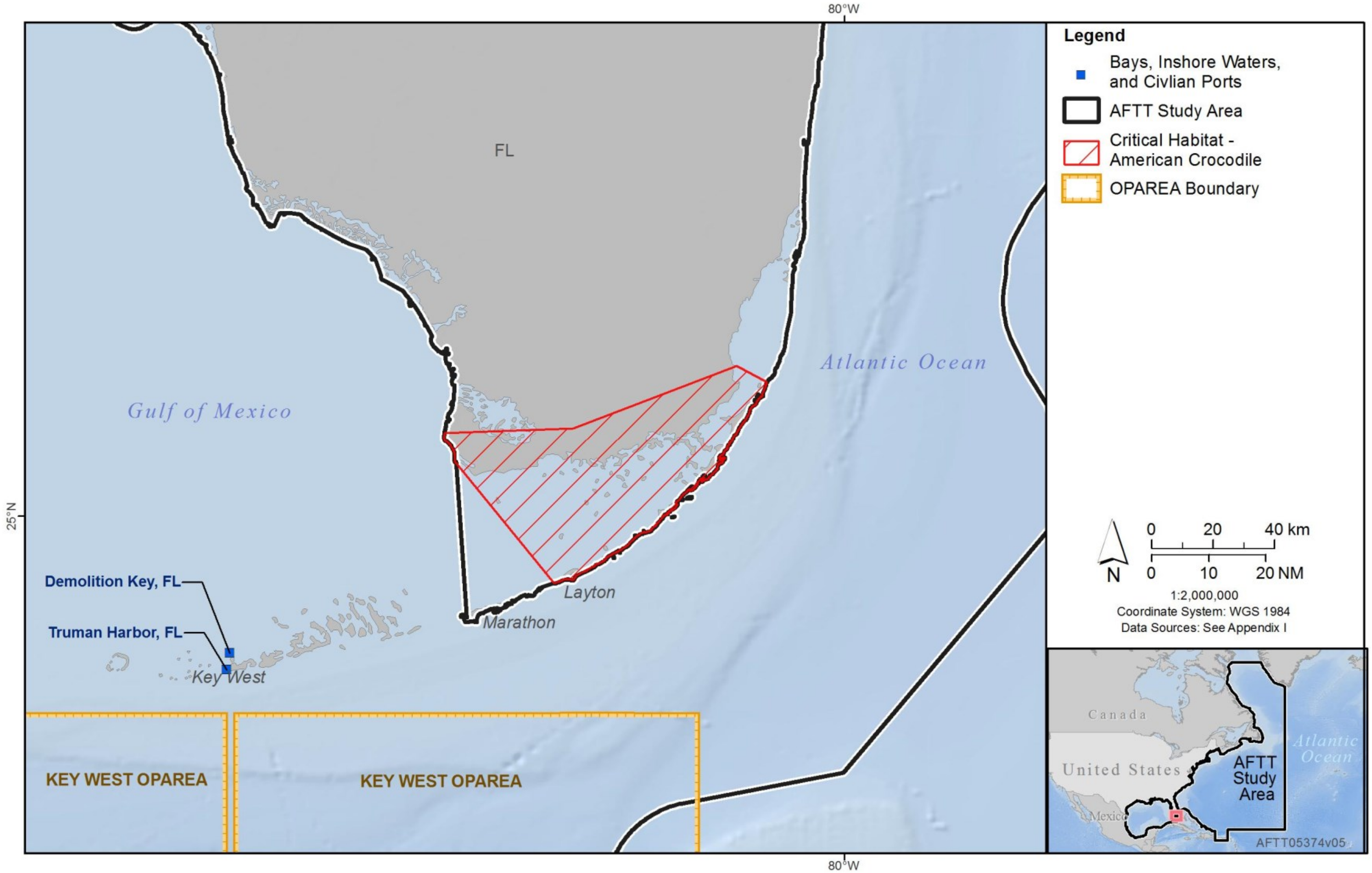
17710). In 2007, the Florida population of American crocodiles was reclassified as a distinct population segment and was designated as threatened under the ESA; the population outside of Florida remains listed as endangered under the ESA. Critical habitat was designated for the Florida population in 1976 and was slightly modified in 1977 to include a more accurate map of the habitat (41 *Federal Register* 41914, 44 *Federal Register* 75074) (Figure 3.8-10). The essential physical and biological feature of this critical habitat is Florida Bay and its associated brackish marshes, swamps, creeks, and canals because the crocodile population is concentrated in these waters, and all known breeding females inhabit and nest here (41 *Federal Register* 41914).

3.8.2.2.6.2 Habitat and Geographic Range

The American crocodile is typically found in fresh or brackish coastal habitats, including, but not limited to rivers, ponds, lagoons, and mangrove swamps (Mazzotti et al., 2007; Mazzotti, 2014; Wheatley et al., 2012). American crocodiles generally occur in water with salinities less than 20 parts per thousand; however, they possess salt lingual glands allowing them to excrete excess salt (Cherkiss et al., 2014; Wheatley et al., 2012) and occasionally inhabit more saline environments (e.g., Florida Bay) (Wheatley et al., 2012). Most crocodile sightings in more saline water are females attending nest sites, hatchlings at nest sites, or juveniles presumably avoiding adults (Mazzotti et al., 2007). Females construct nests on elevated, well-drained sites near the water such as ditch banks and beaches. In the United States, artificial nesting sites within berms along canal banks provide nearly ideal nesting conditions because they are elevated, well drained, and near relatively deep, low-to-intermediate salinity water (Mazzotti et al., 2007). These artificial nesting habitats appear to be compensating for natural habitat elsewhere in Florida and account for much of the increase in nesting documented since 1975.

The American crocodile is known to inhabit inshore marine waters and is not predisposed to travel across the open ocean (Cherkiss et al., 2014). Instead, they prefer calm warm waters with minimal wave action, and most frequently occur in sheltered, mangrove-lined estuaries (Mazzotti, 1983). No available evidence suggests that crocodiles cross the Florida Straits; therefore, this species is not expected to occur in offshore areas within the Study Area. The American crocodile, however, can travel long distances in nearshore environments. For example, Cherkiss et al. (2014) tracked an individual American crocodile over a 14-year period. The crocodile was originally marked in Homestead, Florida, as a young-of-the-year in 1999, and was later recaptured multiple times more than 388 km away along the southwest coast of Florida. After several relocations and numerous sightings, this individual returned the same canal system in which it was first captured.

Within the United States, distribution is limited to the southern tip of mainland Florida and the Florida Keys, which represents the northern extent of its range. The American crocodile range appears to be expanding (Mazzotti et al., 2007) (70 *Federal Register* 15052). Regular nesting occurs within Biscayne Bay on Florida's east coast, on the border between the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, and there is evidence that the species is expanding its current range to occupy portions of its historic range within the Florida Keys (Mazzotti et al., 2007). Most nesting occurs in the Everglades National Park, the cooling water discharge canal of the Turkey Point Power Plant (Homestead, Florida), and Crocodile Lake National Wildlife Refuge in the Gulf of Mexico Large Marine Ecosystem (Mazzotti et al., 2007). Currently, few crocodiles are found north of Biscayne Bay on the Atlantic Coast of Florida, or north of Sanibel Island on Florida's gulf coast. However, sightings have occurred in the coastal counties of mainland Florida from as far north as Indian River County on the Atlantic coast and Sarasota County on the Gulf coast (72 *Federal Register* 13027) and Lee County on the west coast (Green et al., 2014; U.S. Fish and Wildlife Service, 2010; Wheatley et al., 2012).



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

Figure 3.8-10: Critical Habitat Designation for the American Crocodile within the Study Area

3.8.2.2.6.3 Population Trends

In 1976, the American crocodile population in Florida was estimated to be between 200 and 300 individuals (40 *Federal Register* 58308), with only 10–20 breeding females estimated in 1975 (40 *Federal Register* 58308). An estimated 20 nests were laid in Florida in 1975. As a result of conservation measures, including habitat protection, the number of nests increased to 85 in 2004 (Mazzotti et al., 2007). The most recent population estimate, provided by the Florida Fish and Wildlife Commission, estimates the current Florida population of crocodiles to range between 1,500 and 2,000 adults, with an estimated 100 nests per year occurring in Florida (Florida Fish and Wildlife Conservation Commission, n.d.). The species is gradually recovering in the United States, but survey data from Central and South America are relatively poor. The Florida population of the American crocodile has increased, and its distribution has expanded, since it was listed as endangered.

Increased sightings of crocodiles on the airfield at the Naval Air Station Key West has initiated interest in having surveys for crocodiles performed on station. The Navy is currently monitoring occurrences of American crocodiles at Naval Air Station Key West. In 2014, 21 American crocodiles (along with one American alligator and two indistinguishable eye shines) were identified at the air station. Nesting may also occur on the coastal portions of the air station (Mazzotti, 2014). During 2016 spotlight surveys (occurring in January, April, June, and August), a total of seven crocodiles and one alligator were observed at Naval Air Station Key West. No nesting activity was observed on the Naval Air Station Key West properties.

3.8.2.2.6.4 Predator and Prey Interactions

The American crocodile typically forages from shortly before sunset to shortly after sunrise (U.S. Fish and Wildlife Service, 2010). During these times, crocodiles feed on any prey items that can be caught and overpowered (Mazzotti et al., 2007). Adults feed on fish, crabs, birds, turtles, snakes, and small mammals, while young feed on aquatic invertebrates and small fish.

Fire ants are predators of crocodile eggs. Crocodile hatchlings may be preyed on by large fish, birds, other large reptiles and amphibians, or even other crocodiles. Larger juvenile and adult crocodiles have no known natural predators (Mazzotti et al., 2007).

3.8.2.2.6.5 Species-Specific Threats

Habitat loss is a primary threat to the American crocodile (U.S. Fish and Wildlife Service, 2010). Development in coastal areas of Florida diminishes American crocodile habitat and restricts the species' breeding range. Erosion or sea level rise may further increase vulnerability of nesting sites. In addition to direct habitat loss, alteration of habitat is a concern. Urban and residential development restricts freshwater flow into swamps and estuaries, which may limit crocodile growth, survival, and abundance (Mazzotti et al., 2007). Collisions with automobiles are also a documented cause of mortality in Florida's southernmost Miami-Dade and Monroe Counties (Mazzotti et al., 2007). Cold weather has also been cited as a primary constraint on American crocodile recovery and expansion into suitable habitats within this species' historic range. For example, a 2010 freeze in south Florida resulted in a mass die off of reptiles and fish, including more than 150 American crocodiles (Mazzotti et al., 2016).

The introduction in Florida of Nile crocodiles (*Crocodulus niloticus*), confirmed recently through genetic analyses, presents threats to the American crocodile (Rochford et al., 2016). As a competitor for prey and habitat, the Nile crocodile can also likely predate smaller American crocodiles. In addition, many crocodilian species are already known to hybridize in captivity and where their native ranges overlap in the wild (e.g., Cuban crocodile [*Crocodulus rhombifer*]), which can degrade the genetic integrity of the American crocodile (Weaver et al., 2008). Because of similarity of appearance, Nile crocodile persecution by humans would likely include accidental poaching of American crocodiles (Rochford et al., 2016). Burmese pythons, as discussed previously in Section 3.8.2.1.5.4 (Invasive Species), may prey upon juvenile and small adult crocodiles and compete for crocodile prey base. Hart et al. (2012) have shown salt water tolerance in newly hatched pythons, which may increase the predation risk of American crocodiles and increase competition for crocodile prey base.

3.8.2.2.7 American Alligator (*Alligator mississippiensis*)

3.8.2.2.7.1 Status and Management

American alligator populations began to decline in the late 1800s, when unregulated hunting for the hides became prevalent, with population numbers close to extinction in some areas (Savannah River Ecology Laboratory & Herpetology Program, 2012). A hunting ban in the 1950s and other recovery efforts allowed the species to rebound (52 *Federal Register* 21059). American alligators were listed as an endangered species in 1967 under a law that preceded the ESA of 1973 (National Park Service, 2012). No critical habitat has been designated for this species. Federal legislation in the 1970s and 1980s, including the ESA and amendments to the Lacey Act in 1981, ensured the alligators' protection, and eventually their comeback. In 1987, the alligator was declared "no longer biologically threatened or endangered" (52 *Federal Register* 21059). However, to ensure protections to the American crocodile and other endangered crocodilians, the American alligator is listed under the ESA classification of "threatened due to similarity of appearance" to the American crocodile (52 *Federal Register* 21059). Accordingly, federal agencies are no longer required to consult with USFWS pursuant to section 7 of the ESA. Hunting and trade of the American alligator are now permitted and regulated by USFWS (National Park Service, 2012; Savannah River Ecology Laboratory & Herpetology Program, 2012).

3.8.2.2.7.2 Habitat and Geographic Range

The American alligator resides along the southeastern coast of the United States from North Carolina south through Florida and westward to the Texas coast (Elsey & Woodward, 2010). The American alligator's primary habitats are freshwater swamps and marshes but may also include lakes, canals, ponds, reservoirs, and rivers. As alligators lack lingual salt glands, the species has a limited capacity to tolerate highly saline environments (Mazzotti & Dunson, 1989). In coastal areas, alligators move between freshwater and estuarine waters. Size and sex influences the habitat that alligators reside in; adult males generally prefer deep, open water within coastal water bodies, while adult females prefer coastal open water habitats only during the spring breeding season. After the breeding season, adult females prefer to move to lake and marsh edges during nesting and hatching seasons (Savannah River Ecology Laboratory & Herpetology Program, 2012). After juveniles have hatched, they remain with the female for up to a year or more for protection during this vulnerable life stage (National Park Service, 2012; Savannah River Ecology Laboratory & Herpetology Program, 2012). Smaller alligators prefer wetlands with dense vegetation for protection and prey advantage (Savannah River Ecology Laboratory & Herpetology Program, 2012).

3.8.2.2.7.3 Population and Abundance

Following state and federal management of this species, alligator populations have rebounded to an estimated total in the millions of individuals (Savannah River Ecology Laboratory & Herpetology Program, 2012). The Navy is currently monitoring occurrences of American alligators at Naval Air Station Key West. In 2014, one American alligator (along with 21 American crocodiles and two indistinguishable eye shines) was identified at the air station. During 2016 spotlight surveys (occurring in January, April, June, and August), one alligator was observed at Naval Air Station Key West. No nesting activity was observed on the Naval Air Station Key West properties. Nesting may also occur on the coastal portions of the air station (Mazzotti et al., 2016).

3.8.2.2.7.4 Predator and Prey Interactions

American alligators are opportunistic carnivores. Adults eat a variety of animals, including large fish, turtles, snakes, birds, and small mammals. Hatchlings and smaller alligators eat insects, crayfish, snails and other invertebrates, small fish, and amphibians (Savannah River Ecology Laboratory & Herpetology Program, 2012).

Alligator eggs are often preyed upon by raccoons, opossums, skunks, feral pigs, and other terrestrial nest predators. Similarly, young alligators are preyed upon by raccoons, crabs, large snakes, turtles, birds, and even fish (Savannah River Ecology Laboratory & Herpetology Program, 2012).

3.8.2.2.7.5 Species-Specific Threats

State-level management programs, including managed harvesting, have not appeared to impact alligator populations. Alligators, however, appear to be sensitive to water quality parameters (e.g., salinity, temperature, and contaminants such as heavy metals and pharmaceuticals), as well as prey availability (Hidalgo-Ruz et al., 2012).

3.8.2.3 Species Not Listed under the Endangered Species Act

3.8.2.3.1 Diamondback terrapin (*Malaclemys terrapin*)

3.8.2.3.1.1 Status and Management

The diamondback terrapin is a widely distributed species that is native to the brackish coastal tidal marshes of the eastern and southern United States. This includes the states of Alabama, Connecticut, Delaware, Florida, Georgia, Louisiana, Maryland, Massachusetts, Mississippi, New Jersey, New York, North Carolina, Rhode Island, South Carolina, Texas, and Virginia. Population declines of this species are typically local and due to crab trap mortality and vehicle strikes on land. Several states have laws/regulations requiring that crab pot traps be fitted with exclusion or escape mechanisms to prevent bycatch of terrapins. The diamondback terrapin is not ESA listed, but is state listed in Massachusetts as Threatened. All U.S. states within this species' range (except New York) have designated this species as a Species of Greatest Conservation Need (U.S. Fish and Wildlife Service, 2013).

3.8.2.3.1.2 Habitat and Geographic Range

Typical habitat of the diamondback terrapin includes coastal swamps, estuaries, lagoons, tidal creeks, mangroves, and salt marshes with salinities ranging from 0 to 35 parts per thousand. Diamondback terrapins have salt glands around their eyes, allowing them to secrete excess salt from their blood, and survive in salty environments (University of Georgia, 2017). Although diamondback terrapins are found in brackish water, periodic access to freshwater is required for long-term health. Diamondback terrapins play an important role in coastal saltwater marsh ecosystems by aiding in seed dispersal, controlling insect and snail populations, and contributing to other ecological services (e.g., removing suspended sediments and contaminants in water) through perpetuating eelgrass spread (Pfau & Roosenburg, 2010).

Although diamondback terrapins are an aquatic turtle and spend the majority of their life in water, they do leave the water to bask and lay eggs (University of Georgia, 2017). During the cold winter months, diamondbacks hibernate in the mud at the bottom of tidal creeks. Nesting females wander considerable distances on land before nesting. Nests are usually laid in sand dunes or scrub vegetation near the ocean. Eggs are typically laid in late May through August and generally take 50–80 days to hatch.

The distribution of diamondback terrapins is best described as discontinuous along the approximately 5,000 km of coastline between Cape Cod, Massachusetts, and Corpus Christi, Texas (Pfau & Roosenburg, 2010). Throughout this distribution, there are seven defined subspecies of the diamondback terrapin based primarily on differences in carapace morphology and skin coloring (Hart & Lee, 2006). The subspecies are listed below:

- Carolina diamondback terrapin (*Malaclemys terrapin centrata*)
- Texas diamondback terrapin (*Malaclemys terrapin littoralis*)
- Ornate diamondback terrapin (*Malaclemys terrapin macrospilota*)
- Mississippi diamondback terrapin (*Malaclemys terrapin pileata*)
- Mangrove diamondback terrapin (*Malaclemys terrapin rhizophorarum*)
- Eastern Florida diamondback terrapin (*Malaclemys terrapin tequesta*)
- Northern diamondback terrapin (*Malaclemys terrapin terrapin*)

Despite this extensive distribution, its zone of occurrence is very linear and in places fragmented, resulting in a relatively small total area of occupancy (Hart & Lee, 2006).

Population Trends

Terrapins have a long history of exploitation by humans, who harvested them for food for decades (University of Georgia, 2017). The current population size of diamondback terrapins in the United States is unknown, but estimated to be over 100,000 individuals. Most diamondback terrapin populations range from stable to declining.

3.8.2.3.1.4 Predator Prey Interactions

Diamondback terrapins feed on shrimp, clams, barnacles, crabs, mussels and other marine invertebrates. Juveniles prey on insects and small crustaceans. Most notably, adults feed on salt marsh periwinkle (*Littoraria irrorata*), a snail that feeds on salt marsh cord grass. By feeding on the periwinkles, the diamondback terrapins control the populations of periwinkles and prevent them from overgrazing cord grasses (U.S. Fish and Wildlife Service, 2013). Nests, hatchlings, and sometimes adults are eaten by raccoons, foxes, rats and many species of birds, especially crows and gulls, which significantly impacts juvenile population numbers.

3.8.2.3.1.5 Species-Specific Threats

The species has declined significantly from historic levels, in part due to 19th and 20th century harvesting as gourmet food. Harvesting of turtles and eggs is no longer a primary threat to this species. In the states of South Carolina and Maryland, there have been significant local declines due to crab trap mortality and vehicle (car and boat) strikes. Additionally, a decline in the population of females is consistent with the increased mortality of nesting females from vehicle strikes while searching for nesting sites on land (U.S. Fish and Wildlife Service, 2013). Additional threats include loss of nesting habitat (erosion, land subsidence and shoreline hardening, residential development), nest and hatchling predation, and water quality degradation.

3.8.3 Environmental Consequences

This section evaluates how, and to what degree, the activities described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions) potentially impact reptiles known to occur within the Study Area. Tables 2.6-1 through 2.6-4 present proposed typical training and testing activity locations for each alternative (including number of events). General characteristics of all U.S. Navy stressors were introduced in Section 3.0.3.3 (Identifying Stressors for Analysis), and living resources' general susceptibilities to stressors were introduced in Section 3.0.3.6 (Biological Resource Methods). The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors analyzed for reptiles are:

- **Acoustic** (sonar and other transducers; air guns; pile driving; vessel noise; aircraft noise; and weapon noise)
- **Explosive** (explosions in-air, explosions in-water)
- **Energy** (in-water electromagnetic devices; high-energy lasers
- **Physical disturbance and strikes** (vessels and in-water devices; military expended materials; seafloor devices; pile driving)
- **Entanglement** (wires and cables; decelerators/parachutes; biodegradable polymers)
- **Ingestion** (military expended materials – munitions; military expended materials other than munitions)
- **Secondary stressors** (impacts on habitat; impacts on prey availability)

The analysis includes consideration of the mitigation that the Navy will implement to avoid potential impacts on sea turtles from acoustic, explosive, and physical disturbance and strike stressors. Mitigation was coordinated with NMFS and the USFWS through the consultation process. Details of the Navy's mitigation are provided in Chapter 5 (Mitigation).

3.8.3.1 Acoustic Stressors

The analysis of effects to reptiles follows the concepts outlined in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). This section begins with a summary of relevant data regarding acoustic impacts on reptiles in Section 3.8.3.1.1 (Background). This is followed by an analysis of estimated impacts on reptiles due to specific Navy acoustic stressors (sonar and other transducers, air guns, pile driving, vessel noise, aircraft noise, and weapon noise). Additional explanations of the acoustic terms and sound energy concepts used in this section are found in Appendix D (Acoustic and Explosive Concepts). Studies of the effects of sound on aquatic reptiles are limited; therefore, where necessary, knowledge of impacts on other species from acoustic stressors is used to assess impacts on sea turtles, crocodilians, and terrapins.

3.8.3.1.1 Background

The sections below include a survey and synthesis of best-available-science published in peer-reviewed journals, technical reports, and other scientific sources pertinent to impacts on reptiles potentially resulting from Navy training and testing activities. Reptiles could be exposed to a range of impacts depending on the sound source and context of the exposure. Exposures to sound-producing activities may result in auditory or non-auditory trauma, hearing loss resulting in temporary or permanent hearing threshold shift, auditory masking, physiological stress, or changes in behavior.

3.8.3.1.1.1 Injury

The high peak pressures close to some non-explosive impulsive underwater sound sources, such as air guns and impact pile driving, may be injurious, although there are no reported instances of injury to reptiles caused by these sources. A Working Group organized under the American National Standards Institute-Accredited Standards Committee S3, Subcommittee 1, Animal Bioacoustics, developed sound exposure guidelines for fish and sea turtles (Popper et al., 2014), hereafter referred to as the *ANSI Sound Exposure Guidelines*. Lacking any data on non-auditory sea turtle injuries due to non-explosive impulsive sounds, such as air guns and impact pile driving, the working group conservatively recommended that non-auditory injury could be analyzed using data from fish. The data show that fish would be resilient to injury to the non-explosive impulsive sound sources analyzed in this EIS/OEIS. Therefore, it is assumed that sea turtles, crocodilians, and terrapins would be as well. Additionally, sea turtle shells may protect against non-auditory injury due to exposures to high peak pressures (Popper et al., 2014), which can also be assumed for terrapins.

Lacking any data on non-auditory sea turtle injuries due to sonars, the working group also estimated the risk to sea turtles from low-frequency sonar to be low and mid-frequency sonar to be non-existent. Due to similarity in hearing, it is assumed that this would be the case for crocodilians and terrapins, as well.

As discussed in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities, specifically Section 3.0.3.6.1.1, Injury), mechanisms for non-auditory injury due to acoustic exposure have been hypothesized for diving breath-hold animals. Acoustically induced bubble formation, rectified diffusion, and acoustic resonance of air cavities are considered for their similarity to pathologies observed in marine mammals stranded coincident with sonar exposures but were found to not be likely causal mechanisms (Section 3.7.3.1.1.1, Injury), and findings are applicable to reptiles.

Nitrogen decompression due to modifications to dive behavior has never been observed in sea turtles. Sea turtles are thought to deal with nitrogen loads in their blood and other tissues, caused by gas exchange from the lungs under conditions of high ambient pressure during diving, through anatomical, behavioral, and physiological adaptations (Lutcavage & Lutz, 1997). Although diving sea turtles experience gas supersaturation, gas embolism has only been observed in sea turtles bycaught in fisheries (Garcia-Parraga et al., 2014). Therefore, nitrogen decompression due to changes in diving behavior is not considered a potential consequence to diving reptiles.

3.8.3.1.1.2 Hearing Loss and Auditory Injury

Exposure to intense sound may result in hearing loss, typically quantified as threshold shift, which persists after cessation of the noise exposure. Threshold shift is a loss of hearing sensitivity at an affected frequency of hearing. This noise-induced hearing loss may manifest as temporary threshold shift (TTS), if hearing thresholds recover over time, or permanent threshold shift (PTS), if hearing thresholds do not recover to pre-exposure thresholds. Because studies on inducing threshold shift in reptiles are very limited (e.g., alligator lizards; Dew et al., 1993; Henry & Mulroy, 1995), are not sufficient to estimate PTS and TTS onset thresholds, and have not been conducted on any of the reptiles present in the Study Area, auditory threshold shift in reptiles is considered to be consistent with general knowledge about noise-induced hearing loss described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Because there are no data on auditory effects on sea turtles, the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) do not include numeric sound exposure thresholds for auditory effects on sea turtles. Rather, the guidelines qualitatively estimate that sea turtles are less likely to incur TTS or PTS with increasing distance from various sound sources. The guidelines also suggest that data from fishes may be more relevant than data from marine mammals when estimating impacts on sea turtles, because, in general, fish hearing range is more similar to the limited hearing range of sea turtles. As shown in Section 3.8.2.1.4.1 (Hearing and Vocalization – Sea Turtles), sea turtle hearing is most sensitive around 100 to 400 Hz in-water, is limited over 1 kHz, and is much less sensitive than that of any marine mammal. Therefore, sound exposures from most mid-frequency and all high-frequency sound sources are not anticipated to affect sea turtle hearing, and sea turtles are likely only susceptible to auditory impacts when exposed to very high levels of sound within their limited hearing range.

Crocodilians and terrapins also have a limited hearing range, as described in Sections 3.8.2.1.4.2 (Hearing and Vocalization – Crocodilians) and 3.8.2.1.4.3 (Hearing and Vocalization – Terrapins), with best underwater hearing in the low frequencies, below 1 kHz, suitable for detecting low-frequency broadband vocalizations and sounds caused by prey movement. It is assumed that crocodilian and terrapin susceptibility to auditory impacts would be similar to that of sea turtles.

3.8.3.1.1.3 Physiological Stress

A stress response is a suite of physiological changes meant to help an organism mitigate the impact of a stressor. If the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the animal (e.g., decreased immune function, decreased reproduction). Physiological stress is typically analyzed by measuring stress hormones, other biochemical markers, or vital signs. Physiological stress has been measured for sea turtles or crocodilians during nesting (Flower et al., 2015; Valverde et al., 1999), capture and handling (Flower et al., 2015; Gregory & Schmid, 2001; Jessop et al., 2003; Lance et al., 2004), and when caught in entanglement nets (Hoopes et al., 2000; Snoddy et al., 2009) and trawls (Stabenau et al., 1991). However, the stress caused by acoustic exposure has not been studied for reptiles. Therefore, the stress response in reptiles in the Study Area due to acoustic exposures is considered to be consistent with general knowledge about physiological stress responses described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Marine animals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, nesting, and interactions with predators all contribute to stress. Anthropogenic sound-producing activities have the potential to provide additional stressors beyond those that naturally occur.

Due to the limited information about acoustically induced stress responses, the Navy conservatively assumes in its effects analysis that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

3.8.3.1.1.4 Masking

As described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), auditory masking occurs when one sound, distinguished as the “noise,” interferes with the detection or recognition of another sound or limits the distance over which other biologically relevant sounds, including those produced by prey, predators, or conspecifics, can be detected. Masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity. Any sound above ambient noise and within an animal’s hearing range may potentially cause masking.

Compared to other marine animals, such as marine mammals, that are highly adapted to use sound in the marine environment, marine reptile hearing is limited to lower frequencies and is less sensitive. Because marine reptiles likely use their hearing to detect broadband low-frequency sounds in their environment, the potential for masking would be limited to certain similar sound exposures. Only continuous human-generated sounds that have a significant low-frequency component, are not brief in duration, and are of sufficient received level could create a meaningful masking situation (e.g., vibratory pile extraction or proximate vessel noise). Other intermittent, short-duration sound sources with low-frequency components (e.g., air guns or low-frequency sonars) would have more limited potential for masking depending on duty cycle.

There is evidence that reptiles may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al., 2013), magnetic orientation (Avens, 2003; Putman et al., 2015b), and scent (Shine et al., 2004). Any effect of masking may be mediated by reliance on other environmental inputs.

3.8.3.1.1.5 Behavioral Reactions

Behavioral responses fall into two major categories: alterations in natural behavior patterns and avoidance. These types of reactions are not mutually exclusive and reactions may be combinations of behaviors or a sequence of behaviors. As described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), the response of a reptile to an anthropogenic sound would likely depend on the frequency, duration, temporal pattern, and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Distance from the sound source and whether it is perceived as approaching or moving away may also affect the way a reptile responds to a sound.

Reptiles may detect sources below 2 kHz but likely have limited hearing ability above 1 kHz. They likely detect most broadband sources (including air guns, pile driving, and vessel noise) and low-frequency sonars, so they may respond to these sources. Because auditory abilities for sea turtles and terrapins are poor above 1 kHz, detection and consequent reaction to any mid-frequency source is unlikely. Crocodilians have a slightly higher hearing range, but with best sensitivity around 800 Hz, they are assumed to have similar auditory abilities and reactions to sources below 2 kHz.

In the *ANSI Sound Exposure Guidelines* (Popper et al., 2014), qualitative risk factors were developed to assess the potential for sea turtles to respond to various underwater sound sources. The guidelines state that there is a low likelihood that sea turtles would respond within tens of meters of low-frequency sonars, and that it is highly unlikely that sea turtles would respond to mid-frequency sources. The risk that sea turtles would respond to other broadband sources, such as shipping, air guns, and pile driving, is considered high within tens of meters of the sound source, but moderate to low at farther distances. For this analysis, it is assumed that these guidelines would also apply to crocodilians and terrapins.

<u>Behavioral Reactions to Impulsive Sound Sources</u>

There are limited studies of reptile responses to sounds from impulsive sound sources, and all data come from sea turtles exposed to seismic air guns. These exposures consist of multiple air gun shots, either in close proximity or over long durations, so it is likely that observed responses may over-estimate responses to single or short-duration impulsive exposures. Studies of responses to air guns are used to inform reptile responses to other impulsive sounds (impact pile driving and some weapon noise).

O'Hara and Wilcox (1990) attempted to create a sound barrier at the end of a canal using seismic air guns. They reported that loggerhead turtles kept in a 300 m by 45 m enclosure in a 10 m deep canal maintained a minimum standoff range of 30 m from air guns fired simultaneously at intervals of 15 seconds, with strongest sound components within the 25–1,000 hertz frequency range. McCauley et al. (2000) estimated that the received sound pressure level (SPL) at which turtles avoided sound in the O'Hara and Wilcox (1990) experiment was 175–176 decibels referenced to 1 micropascal (dB re 1 µPa).

Moein Bartol et al. (1995) investigated the use of air guns to repel juvenile loggerhead sea turtles from hopper dredges. Sound frequencies of the air guns ranged from 100 to 1,000 Hz at three source SPLs: 175, 177, and 179 dB re 1 µPa. The turtles avoided the air guns during the initial exposures (mean range of 24 m), but additional exposures on the same day and several days afterward did not elicit avoidance behavior that was statistically significant. They concluded that this was likely due to habituation.

McCauley et al. (2000) exposed a caged green and a caged loggerhead sea turtle to an approaching-departing single air gun to gauge behavioral responses. The trials showed that above a received SPL of 166 dB re 1 µPa, the turtles noticeably increased their swimming activity compared to nonoperational periods, with swimming time increasing as air gun SPLs increased during approach. Above 175 dB re 1 µPa, behavior became more erratic, possibly indicating the turtles were in an agitated state. The authors noted that the point at which the turtles showed more erratic behavior and exhibited possible agitation would be expected to approximate the point at which active avoidance to air guns would occur for unrestrained turtles.

No obvious avoidance reactions by free-ranging sea turtles, such as swimming away, were observed during a multi-month seismic survey using air gun arrays, although fewer sea turtles were observed when the seismic air guns were active than when they were inactive (Weir, 2007). The author noted that sea state and the time of day affected both air gun operations and sea turtle surface basking behavior, making it difficult to draw conclusions from the data. However, DeRuiter and Doukara (2012) noted several possible startle or avoidance reactions to a seismic air gun array in the Mediterranean by loggerhead turtles that had been motionlessly basking at the water surface.

Behavioral Reactions to Sonar and Other Transducers

Studies of reptile responses to underwater non-impulsive sounds are limited. All data are from studies with sea turtles. Lenhardt (1994) used very low-frequency vibrations (< 100 Hz) coupled to a shallow tank to elicit swimming behavior responses by two loggerhead sea turtles. Watwood et al. (2016) tagged green sea turtles with acoustic transponders and monitored them using acoustic telemetry arrays in Port Canaveral, Florida. Sea turtles were monitored before, during, and after a routine pier-side submarine sonar test that utilized typical source levels, signals, and duty cycle. No significant long-term displacement was demonstrated by the sea turtles in this study. The authors note that Port Canaveral is an urban marine habitat and that resident sea turtles may be less likely to respond than naïve populations.

3.8.3.1.1.6 Long-Term Consequences

For the reptiles present in the Study Area, long-term consequences to individuals and populations due to acoustic exposures have not been studied. Therefore, long-term consequences to reptiles due to acoustic exposures are considered following Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

The long-term consequences due to individual behavioral reactions and short-term (seconds to minutes) instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies. It is more likely that any long-term consequences to an individual would be a result of costs accumulated over a season, year, or life stage due to multiple behavioral or stress responses resulting from exposures to multiple stressors over significant periods of time. Conversely, some reptiles may habituate to or become tolerant of repeated acoustic exposures over time, learning to ignore a stimulus that in the past did not accompany any overt threat. For example, loggerhead sea turtles exposed to air guns with a source SPL of 179 dB re 1 µPa initially exhibited avoidance reactions. However, they may have habituated to the sound source after multiple exposures since a habituation behavior was retained when exposures were separated by several days (Moein Bartol et al., 1995). Intermittent exposures are assumed to be less likely to have lasting consequences.

3.8.3.1.2 Impacts from Sonar and Other Transducers

Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. Use of sonar and other transducers would typically be transient and temporary. General categories of sonar systems are described in Section 3.0.3.3.1 (Acoustic Stressors); only those sources within the hearing range of reptiles (<2 kHz) in the Study Area are considered.

Sonar-induced acoustic resonance and bubble formation phenomena are very unlikely to occur under realistic conditions, as discussed in Section 3.8.3.1.1.1 (Injury). Non-auditory injury (i.e., other than PTS) and mortality from sonar and other transducers is so unlikely as to be discountable under normal conditions and is therefore not considered further in this analysis.

The most probable impacts from exposure to sonar and other transducers are PTS, TTS, behavioral reactions, masking, and physiological stress (Sections 3.8.3.1.1.2, Hearing Loss and Auditory Injury; 3.8.3.1.1.3, Physiological Stress; 3.8.3.1.1.4, Masking; and 3.8.3.1.1.5, Behavioral Reactions).

Activities involving sonar and other transducers would not occur in areas inhabited by the ESA-listed American crocodile, thus potential impacts are limited to sea turtles, alligators, and terrapins.

3.8.3.1.2.1 Methods for Analyzing Impacts from Sonar and Other Transducers

Potential impacts considered are hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior. The Navy performed a quantitative analysis to estimate the number of times that sea turtles could be affected by sonar and other transducers used during Navy training and testing activities. The Navy's quantitative analysis to determine impacts to sea turtles and marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. The steps of this quantitative analysis are described in Section 3.0.1.2 (Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals), which takes into account:

- criteria and thresholds used to predict impacts from sonar and other transducers (see below);
- the density and spatial distribution of sea turtles; and
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation when estimating the received sound level on the animals.

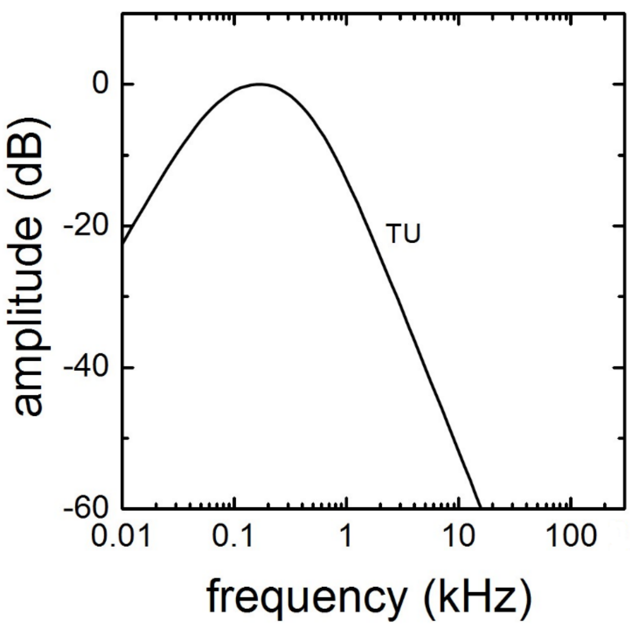
A further detailed explanation of this analysis is provided in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing (U.S. Department of the Navy, 2018).* Since crocodilians and terrapins have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that crocodilians and terrapins would react similarly to sonar and other transducers as sea turtles.

<u>Criteria and Thresholds Used to Predict Impacts from Sonar and Other Transducers</u>

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used. Auditory weighting functions are mathematical functions that adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges with less or no auditory sensitivity. The adjusted received sound level is referred to as a weighted received sound level.

The auditory weighting function for sea turtles is shown in Figure 3.8-11. The derivation of this weighting function is described in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017). The frequencies around the top portion of the function, where the amplitude is closest to zero, are emphasized, while the frequencies below and above this range (where amplitude declines) are de-emphasized, when summing acoustic energy received by a sea turtle.



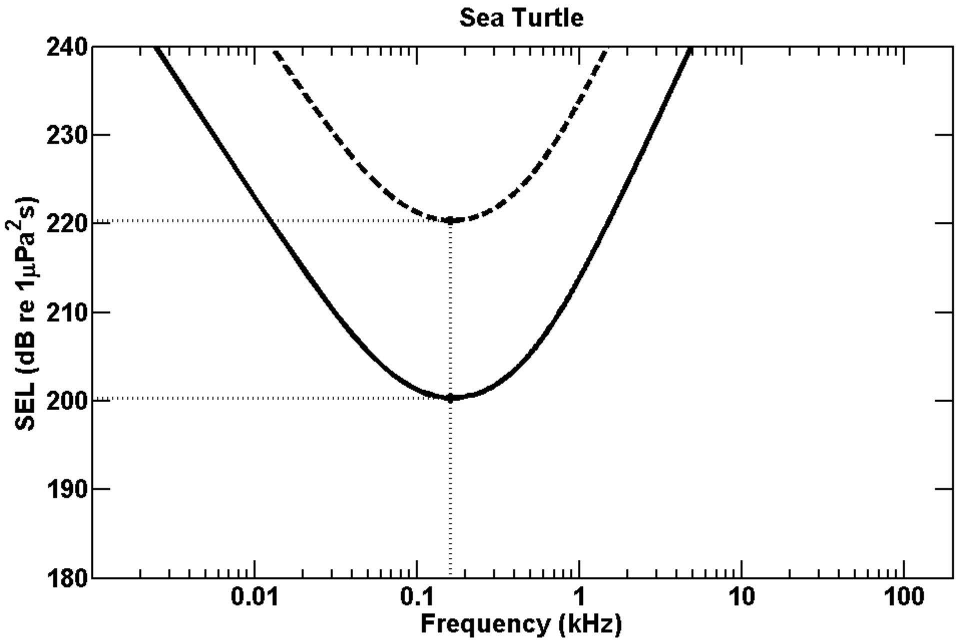
Source: U.S. Department of the Navy (2017)
Notes: dB: decibels; kHz: kilohertz; TU: sea turtle species group

Figure 3.8-11: Auditory Weighting Function for Sea Turtles

Hearing Loss from Sonar and Other Transducers

No studies of hearing loss have been conducted on sea turtles. Therefore, sea turtle susceptibility to hearing loss due to an acoustic exposure is evaluated using knowledge about sea turtle hearing abilities in combination with non-impulsive auditory effect data from other species (marine mammals and fish).

This yields sea turtle exposure functions, shown in Figure 3.8-12, which are mathematical functions that relate the sound exposure levels (SELs) for onset of PTS or TTS to the frequency of the sonar sound exposure. The derivation of the sea turtle exposure functions are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017).



Source: U.S. Department of the Navy (2017)
Note: dB re 1 μPa²s: decibels referenced to 1 micropascal second squared; kHz: kilohertz. The solid black curve is the exposure function for TTS and the dashed black curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL thresholds at the most-sensitive frequency for TTS (200 dB) and PTS (220 dB).

Figure 3.8-12: TTS and PTS Exposure Functions for Sonar and Other Transducers

Accounting for Mitigation

The Navy implements mitigation measures (described in Chapter 5, Mitigation) that would reduce the probability or severity of any potential impacts during activities that use sonar and other transducers, including the power-down or shut-down (i.e., power-off) of sonar when a sea turtle is observed in the mitigation zone. The mitigation zones for active sonar activities were designed to avoid the potential for sea turtles to be exposed to levels of sound that could result in auditory injury (i.e., PTS) from active sonar to the maximum extent practicable. The mitigation zones encompass the estimated ranges to injury (including PTS) for a given sonar exposure. Therefore, the impact analysis quantifies the potential for mitigation to reduce the risk of PTS. Two factors are considered when quantifying the effectiveness of mitigation: (1) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., active sonar) allows for observation of the mitigation zone prior to and during the activity; and (2) the sightability of each species that may be present in the mitigation zone, which is determined by species-specific characteristics and the viewing platform. A detailed explanation of the analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation is feasible, some model-estimated PTS is considered mitigated to the level of TTS. The impact analysis does not analyze the potential for mitigation to reduce TTS or behavioral effects, even though mitigation could also reduce the likelihood of these effects. In practice, mitigation also protects all unobserved (below the surface) animals in the vicinity, including other species, in addition to the observed animal. However, the analysis assumes that only animals sighted at the water surface would be protected by the applied mitigation. The analysis, therefore, does not capture the protection afforded to all marine species that may be near or within the mitigation zone.

The ability to observe the range to PTS was estimated for each training or testing event. The ability of Navy Lookouts to detect sea turtles in or approaching the mitigation zone is dependent on the animal's presence at the surface and the characteristics of the animal that influence its sightability (such as size or surface active behavior). The behaviors and characteristics of some species may make them easier to detect. Environmental conditions under which the training or testing activity could take place are also considered such as the sea surface conditions, weather (e.g., fog or rain), and day versus night.

3.8.3.1.2.2 Impact Ranges for Sonar and Other Transducers

Because sea turtle hearing range is limited to a narrow range of frequencies and thresholds for auditory impacts are relatively high, there are very few sonar sources that could potentially result in exposures exceeding the sea turtle PTS and TTS thresholds. Therefore, the range to auditory effects for most sources, such as the representative bin of LF5, in sea turtle hearing range is zero. Ranges would be greater (i.e., up to tens of meters) for sonars and other transducers with higher source levels; however, specific ranges cannot be provided in an unclassified document.

Ranges to auditory effects are not calculated for crocodilians or terrapins. Due to similarity in hearing and for purposes of this analysis, crocodilians and terrapins are assumed to have similar ranges to auditory impacts as sea turtles.

Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts to sea turtles from sonars and other transducers are discussed below in Sections 3.8.3.1.2.3 (Impacts from Sonar and Other Transducers under Alternative 1) and 3.8.3.1.2.4 (Impacts from Sonar and Other Active Sources under Alternative 2). The detailed analysis of potential impacts estimated for individual species from exposure to sonar for training and testing activities under Alternative 1 and Alternative 2 are presented in the figures below. The figures below provide the estimated impacts per region, per activity, and by effect (e.g., TTS and PTS). There is a potential for impacts to occur anywhere within the Study Area where sound from sonar and the species overlap, although only Regions or Activity Categories where 0.5 percent of the impacts or greater are estimated to occur are graphically represented on the figures below. All (i.e., grand total) estimated impacts for that species are included in the bar plots, regardless of region or category.

Note that the numbers of activities planned can vary from year-to-year. Results are presented for a "maximum sonar use year". The number of hours these sonars would be operated are described in Section 3.0.3.3.1 (Acoustic Stressors). Potential impacts to crocodilians and terrapins are analyzed qualitatively.

3.8.3.1.2.3 Impacts from Sonar and Other Transducers under Alternative 1

Impacts from Sonar and Other Transducers under Alternative 1 for Training Activities

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during training under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities using sonars and other transducers would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Use of sonar and other transducers would typically be transient and temporary.

Under Alternative 1, the number of major training exercises and civilian port defense activities would fluctuate each year to account for the natural variation of training cycles and deployment schedules. Some unit-level anti-submarine warfare training requirements would be met through synthetic training in conjunction with other training exercises. Training activities using low-frequency sonar and other transducers within reptile hearing range (<2 kHz) could occur throughout the Study Area in areas potentially inhabited by sea turtles, alligators, and terrapins, although use would generally occur within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives). Use of low-frequency sonars during training activities would be greatest in the Jacksonville Range Complex and Chesapeake Bay.

The quantitative analysis, using the number of hours of sonar and other transducers for a maximum year of training activities under Alternative 1, predicts that no sea turtles of any species are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause TTS or PTS. Only a limited number of sonars and other transducers with frequencies within the range of reptile hearing (<2 kHz) and high source levels have the potential to cause TTS and PTS.

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1–10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within its limited hearing range if it is close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. Use of sonar and other transducers would typically be transient and temporary, and there is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses.

Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most low-frequency sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a reptile to detect these sources and limit the potential for masking of broadband, continuous environmental sounds. In addition, broadband sources within sea turtle hearing range, such as countermeasures used during anti-submarine warfare, would typically be used in off-shore areas and some inshore areas, but not in nearshore areas where detection of beaches or concentrated vessel traffic is relevant for the masking of biologically relevant sounds to reptiles.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

The use of sonar and other transducers during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. For loggerhead turtle designated critical habitat (79 *Federal Register* 39855), the use of sonar and other transducers have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from military activity. However, impacts, if any, on this habitat would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features, and would not prevent a turtle from migrating as these activities are not continuous and most sources are outside of sea turtle hearing range. The physical and biological features identified for the nearshore reproductive, wintering, breeding, and *Sargassum* habitats (National Marine Fisheries Service, 2014b) would not be impacted by the use of sonar and other transducers during training activities.

It is reasonable to assume that crocodilians and terrapins use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Within their respective geographic ranges, alligators and terrapins could potentially be exposed to sonar and other transducers in the inshore regions of the Study Area during training activities, as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Sonar use is not proposed in the nearshore and inshore areas of south Florida known to be inhabited by the ESA-listed American crocodile or in designated American crocodile critical habitat in the Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of sonar and other transducers during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, and leatherback turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile critical habitat. The use of sonar and other transducers during training activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Sonar and Other Transducers under Alternative 1 for Testing Activities

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during testing under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities using sonars and other transducers would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions).

Under Alternative 1, the number of testing activities would fluctuate annually. Testing activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives). In particular, low-frequency sources during testing activities occur in some coastal waters such as Bath, Maine, Groton, Connecticut; Newport, Rhode Island; the Naval Undersea Warfare Center Division, Newport Testing Range; Narragansett, Rhode Island; Norfolk, Virginia; Kings Bay, Georgia; Mayport, Florida; Port Canaveral, Florida; offshore of Fort Pierce, Florida; South Florida Ocean Measurement Facility; Naval Surface Warfare Center, Panama City Division Testing Range; Pascagoula, Mississippi; as well as in any of the range complexes throughout the Study Area. Low-frequency sources are operated more frequently under testing activities than during training activities. Therefore, although the general impacts from sonar and other transducers under testing would be similar in severity to those described during training, there may be slightly more impacts under testing activities.

The quantitative analysis, using the number of hours of sonar and other transducers for a maximum year of testing activities, predicts that no green or hawksbill sea turtles are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause TTS or PTS under Alternative 1. The quantitative analysis also predicts that a small number of Kemp's ridley, leatherback, and loggerhead turtles may be exposed to levels of sound from sonars or other transducers that could cause TTS. The locations and types of testing activities that would most likely contribute to these impacts are shown in Figure 3.8-13, Figure 3.8-14, and Figure 3.8-15 for Kemp's ridley, leatherback, and loggerhead turtles, respectively. Most impacts are predicted to occur in the Northeast Range Complexes, with fewer impacts in the Jacksonville Range Complex. Fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category.

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No impacts during training are estimated for this species. No PTS is estimated for this species. No impacts are estimated from training. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-13: Kemp's Ridley Turtle Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No impacts during training are estimated for this species. No PTS is estimated for this species. No impacts are estimated from training. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-14: Leatherback Sea Turtle Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No impacts during training are estimated for this species. No PTS is estimated for this species. No impacts are estimated from training. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-15: Loggerhead Sea Turtle Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing under Alternative 1

Only a limited number of sonars and other transducers with frequencies within the range of reptile hearing (<2 kHz) and high source levels have the potential to cause TTS and PTS. Any impact to hearing could reduce the distance over which a reptile detects environmental cues, such as the sound of waves or the presence of a vessel or predator. Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, and conducting pierside sonar testing during daylight hours at Port Canaveral, Florida and Kings Bay, Georgia, as discussed in Section 5.3.2 (Acoustic Stressors).

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1–10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within their limited hearing range if they are close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. There is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses or TTS.

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a sea turtle to detect these sources and limit the potential for masking of broadband, continuous environmental sounds.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

The use of sonar and other transducers during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. For loggerhead turtle designated critical habitat, the use of sonar and other transducers have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing “noise pollution” from military activity (79 *Federal Register* 39855). However, impacts, if any, on this habitat would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features, and would not prevent a turtle from migrating as these activities are not continuous and most sources are outside of sea turtle hearing range. The physical and biological features identified for the nearshore reproductive, wintering, breeding, and *Sargassum* habitats (National Marine Fisheries Service, 2014b) would not be impacted by the use of sonar and other transducers during testing activities.

It is reasonable to assume that crocodilians and terrapins use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Within their respective geographic ranges, alligators and terrapins could potentially be exposed to sonar and other transducers in the inshore regions of the Study Area during testing activities, as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). No sonar use is proposed in the inshore or nearshore areas of south Florida known to be inhabited by the ESA-listed American crocodile, including designated American crocodile critical habitat in the Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of sonar and other transducers during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp’s ridley, leatherback, and loggerhead turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile critical habitat since the use of sonar and other transducers during testing activities. The use of sonar and other transducers during testing activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.2.4 Impacts from Sonar and Other Active Sources under Alternative 2

Impacts from Sonar and Other Transducers under Alternative 2 for Training Activities

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during training under Alternative 2 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities using sonars and other transducers would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions).

Under Alternative 2, the maximum number of major training exercises could occur every year, an additional major training exercise would be conducted in the Gulf of Mexico Range Complex annually, and only the number of civilian port defense activities would fluctuate annually. In addition, all unit level anti-submarine warfare tracking exercise – ship activities would be completed through individual events conducted at sea, rather than through leveraging other anti-submarine warfare training exercises or synthetically. This would result in an increase of sonar use compared to Alternative 1, including sources within reptile hearing range. Training activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives). Use of sonars associated with anti-submarine warfare would be greatest in the Jacksonville and Virginia Capes Range Complexes. The limited number of sources within sea turtle hearing range would also typically be used in the areas described above.

The quantitative analysis predicts that no sea turtles of any species are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause TTS or PTS during a maximum year of training activities under Alternative 2. Although there would be an increase in sonar use compared to Alternative 1, the potential for and type of impacts on reptiles would be the similar. This is because reptiles are capable of detecting only a limited number of sonars due to their limited hearing range.

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1 to 10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within their limited hearing range if they are close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. Use of sonar and other transducers would typically be transient and temporary, and there is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses.

Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most low-frequency sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a reptile to detect these sources and limit the potential for masking of broadband, continuous environmental sounds.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

The use of sonar and other transducers during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. For loggerhead turtle designated critical habitat, the use of sonar and other transducers have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing “noise pollution” from military activity (79 *Federal Register* 39855). However, impacts, if any, on this habitat would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features, and would not prevent a turtle from migrating as these activities are not continuous and most sources are outside of sea turtle hearing range. The physical and biological features of the nearshore reproductive, wintering, breeding, and *Sargassum* habitats (National Marine Fisheries Service, 2014b) would not be impacted by the use of sonar and other transducers during training activities.

It is reasonable to assume that crocodilians and terrapins use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Within their respective geographic ranges, alligators and terrapins could potentially be exposed to sonar and other transducers in the inshore regions of the Study Area during testing activities, as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). No sonar use is proposed in the inshore or nearshore areas of south Florida known to be inhabited by the ESA-listed American crocodile, including designated American crocodile critical habitat in the Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of sonar and other transducers during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp’s ridley, loggerhead, and leatherback sea turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle or American crocodile critical habitat. The use of sonar and other transducers during training activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions.

Impacts from Sonar and Other Transducers under Alternative 2 for Testing Activities

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during testing under Alternative 2 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities using sonars and other transducers would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions).

Under Alternative 2, the maximum number of nearly all testing activities would occur every year. This would result in an increase of sonar use compared to Alternative 1, including sources within reptile hearing range. Testing activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives).

The quantitative analysis predicts that no green or hawksbill sea turtles are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause PTS or TTS during testing activities under Alternative 2. The quantitative analysis also predicts that a small number of Kemp's ridley, loggerhead, and leatherback turtles may be exposed to levels of sound from sonars or other transducers that could cause TTS during testing activities under Alternative 2. The locations and types of testing activities that would most likely contribute to these impacts are shown in Figure 3.8-16, Figure 3.8-17, and Figure 3.8-18 for Kemp's ridley, leatherback, and loggerhead turtles, respectively. Most impacts are predicted to occur in the Northeast Range Complexes. Fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category.

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No impacts during training are estimated for this species. No PTS is estimated for this species. No impacts are estimated from training. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-16: Kemp's Ridley Turtle Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No impacts during training are estimated for this species. No PTS is estimated for this species. No impacts are estimated from training. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-17: Leatherback Sea Turtle Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No impacts during training are estimated for this species. No PTS is estimated for this species. No impacts are estimated from training. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-18: Loggerhead Sea Turtle Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing under Alternative 2

Only a limited number of sonars and other transducers with frequencies within the range of reptile hearing (<2 kHz) and high source levels have the potential to cause TTS and PTS. Any impact to hearing could reduce the distance over which a reptile detects environmental cues, such as the sound of waves or the presence of a vessel or predator. Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, and conducting pierside sonar testing during daylight hours at Port Canaveral, Florida and Kings Bay, Georgia, as discussed in Section 5.3.2 (Acoustic Stressors).

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1–10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within their limited hearing range if they are close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. There is no evidence to suggest that any behavioral response would persist after the sound exposure ends. It is assumed that a stress response could accompany any behavioral responses or TTS.

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a sea turtle to detect these sources and limit the potential for masking of broadband, continuous environmental sounds.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

The use of sonar and other transducers during testing activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands, respectively. For loggerhead turtle-designated critical habitat (79 *Federal Register* 39855), the use of sonar and other transducers have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from military activity. However, impacts, if any, on this habitat would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features, and would not prevent a turtle from migrating as these activities are not continuous and most sources are outside of sea turtle hearing range. The physical and biological features of the nearshore reproductive, wintering, breeding, and *Sargassum* habitats (National Marine Fisheries Service, 2014b) would not be impacted by the use of sonar and other transducers during testing activities.

It is reasonable to assume that crocodilians and terrapins use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Within their respective geographic ranges, alligators and terrapins could potentially be exposed to sonar and other transducers in the inshore regions of the Study Area during testing activities, as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). No sonar use is proposed in the inshore or nearshore areas of south Florida known to be inhabited by the ESA-listed American crocodile, including designated American crocodile critical habitat in the Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of sonar and other transducers during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile habitat. The use of sonar and other transducers during testing activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions.

3.8.3.1.2.5 Impacts from Sonar and Other Transducers 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 acoustic stressors (e.g., sonar and other transducers) 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.

3.8.3.1.3 Impacts from Air Guns

Air guns use bursts of pressurized air to create broadband, impulsive sounds. Any use of air guns would typically be transient and temporary. Section 3.0.3.3.1.2 (Air Guns) provides additional details on the use and acoustic characteristics of the small air guns used in these activities. Because no use of air guns is proposed in known crocodilian habitat, the remainder of the analysis of impacts from air guns focuses on sea turtles and terrapins.

3.8.3.1.3.1 Methods for Analyzing Impacts from Air Guns

Potential impacts considered are hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior. The Navy's quantitative analysis to determine impacts to sea turtles and marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. The steps of this quantitative analysis are described in Section 3.0.1.2 (Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals), which takes into account:

- criteria and thresholds used to predict impacts from air guns (see below);
- the density and spatial distribution of sea turtle; and
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation when estimating the received sound level on the animals

A further detailed explanation of this analysis is provided in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing (U.S. Department of the Navy, 2018).*Since terrapins have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that terrapins could react similarly to air guns as sea turtles.

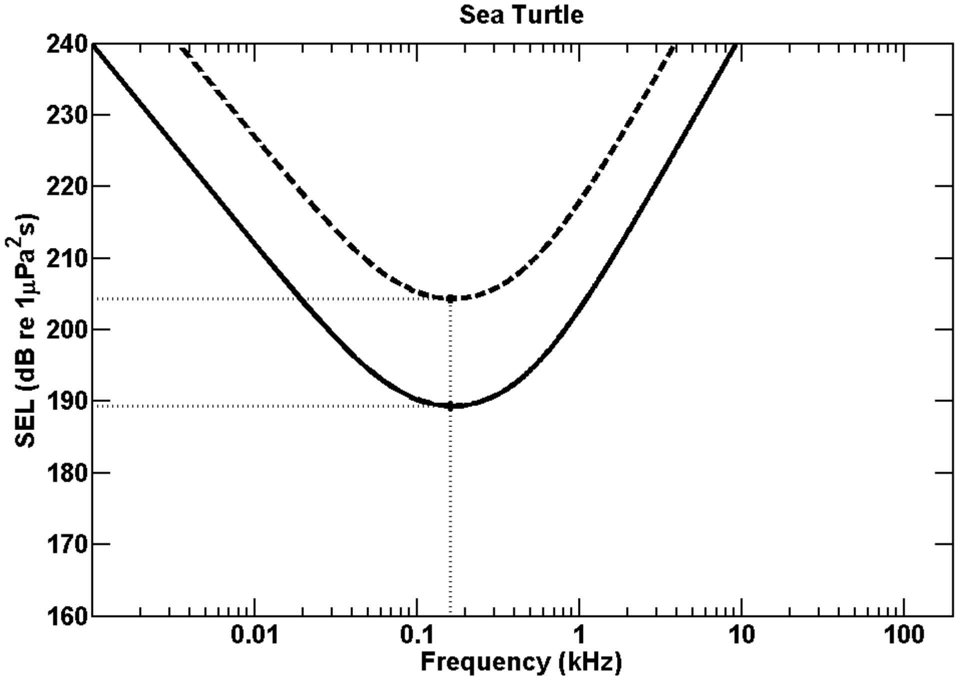
<u>Criteria and Thresholds used to Predict Impacts on Sea Turtles from Air Guns</u>

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used. The auditory weighting function for sea turtles presented above in Section 3.8.3.1.2.1 (Methods for Analyzing Impacts from Sonar and Other Transducers) is also used in the quantitative assessment of auditory impacts due to air guns.

Hearing Loss from Air Guns

No studies of hearing loss have been conducted on sea turtles. Therefore, sea turtle susceptibility to hearing loss due to an air gun exposure is evaluated using knowledge about sea turtle hearing abilities in combination with auditory effect data from other species (marine mammals and fish). This yields sea turtle exposure functions, shown in Figure 3.8-19, which are mathematical functions that relate the SELs for onset of PTS or TTS to the frequency of the underwater impulsive sound exposure. The derivation of the sea turtle impulsive exposure functions are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017).



Notes: kHz: kilohertz; SEL: Sound Exposure Level, dB re 1 μPa²s: decibels referenced to 1 micropascal squared second. The solid black curve is the exposure function for TTS onset and the dashed black curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL thresholds and most-sensitive frequency for TTS and PTS.

Figure 3.8-19: TTS and PTS Exposure Functions for Impulsive Sounds

For impulsive sounds, hearing loss in other species has also been observed to be related to the unweighted peak pressure of a received sound. Because this data does not exist for sea turtles, unweighted peak pressure thresholds for PTS and TTS were developed by applying relationships observed between impulsive peak pressure TTS thresholds and auditory sensitivity in marine mammals to sea turtles. This results in dual-metric hearing loss criteria for sea turtles for impulsive sound exposure: the SEL-based exposure functions in Figure 3.8-18 and the peak pressure thresholds in Table 3.8-2. The derivation of the sea turtle impulsive peak pressure PTS and TTS thresholds are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017).

Table 3.8-2: PTS and TTS Peak Pressure Thresholds for Sea Turtles Exposed to Impulsive Sounds

Auditory Effect	*Unweighted Peak Pressure Threshold*
TTS	226 dB re 1 μPa SPL peak
PTS	232 dB re 1 μPa SPL peak

Notes: dB re I μPa = decibels referenced to 1 micropascal,
PTS: permanent threshold shift, TTS: temporary threshold shift,
SPL: sound pressure level

3.8.3.1.3.2 Impact Ranges for Air Guns

Ranges to the onset of PTS or TTS for the air guns used in Navy activities are shown in Table 3.8-3. The majority of air gun activities occur offshore and involve the use of a single shot or 10 shots. Fewer activities are conducted pierside and could use up to a maximum of 100 shots. The following ranges are based on the SEL metrics for PTS and TTS for 100 firing of an air gun, a conservative estimate of the number of air gun firings that could occur over a single exposure duration at a single location. Ranges based on the peak pressure metrics for PTS and TTS for firings of an air gun, regardless of number of firings, are zero meters.

Table 3.8-3: Ranges to Permanent Threshold Shift and Temporary Threshold Shift for Sea Turtles Exposed to 100 Air Gun Firings

Range (m)	
PTS	***TTS***
13	100

3.8.3.1.3.3 Impacts from Air Guns under Alternative 1

Impacts from Air Guns under Alternative 1 for Training Activities

Training activities under Alternative 1 do not include the use of air guns.

Impacts from Air Guns under Alternative 1 for Testing Activities

Characteristics of air guns and the number of times they would be operated during testing under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities using air guns would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Under Alternative 1, small air guns (12–60 cubic inches) would be fired pierside at the Naval Undersea Warfare Center Division, Newport Testing Range, and at off-shore locations typically in the Northeast, Virginia Capes, and Gulf of Mexico Range Complexes.

These small air guns lack large pressures that could cause non-auditory injuries. The broadband impulsive sounds produced by these small air guns could only cause PTS and TTS for sea turtles within a short distance. Considering that an air gun would be shut down if a sea turtle was sighted in the mitigation zone as described in Chapter 5 (Mitigation), any TTS is highly unlikely. The quantitative analysis, for a maximum year of air gun testing activities, predicts that no sea turtles of any species are likely to be exposed to the received levels of sound from air guns during testing activities, in their hearing range, that could cause TTS or PTS.

The working group that prepared the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) provide parametric descriptors of sea turtle behavioral responses to air guns. Popper et al. (2014) estimate the risk of sea turtles responding to air guns is high, moderate, and low while at near (tens of meters), intermediate (hundreds of meters), and far (thousands of meters) distances from the source, respectively. Based on the few studies of sea turtle reactions to air guns, any behavioral reactions to air gun firings may be to increase swim speed or avoid the air gun. McCauley et al. (2000) estimated that sea turtles would begin to exhibit avoidance behavior when the received level of air gun firings was around 175 dB re 1 µPa, based on several studies of sea turtle exposures to air guns. The few studies of sea turtle reactions to sounds suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. There is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses.

Sea turtles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. Due to the low duration of an individual air gun shot, approximately 0.1 second, and the low duty cycle of sequential shots, the potential for masking from these small air guns would be low. Additionally, the pierside air gun use would only occur several times a year and would use a limited number of air gun shots, limiting any masking, while the use of small air guns in off-shore waters would not interfere with detection of sounds in shore environments.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

The use of air guns during testing activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands, respectively. Loggerhead turtle habitat would not be impacted by air gun use during testing activities.

It is reasonable to assume that terrapins use their hearing similarly to sea turtles and that the types of impacts on these species would be similar to impacts on sea turtles. Air guns within reptile hearing range are not likely to be used in nearshore locations where crocodilians could be present, however terrapins may be present in Newport, Rhode Island where pierside air gun activities occur. Due to the similarity in hearing between terrapins and sea turtles, the low frequency of air gun use, and the low duration of shots, impacts, if any, are assumed to parallel those described above for sea turtles. No air gun use is proposed in the areas known to be inhabited by alligators or the ESA-listed American crocodile, including designated American crocodile critical habitat in Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of air guns during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; would have no effect on the ESA-listed American crocodile. The use of air guns would have no effect on green, hawksbill, leatherback, or loggerhead turtle critical habitat or on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.3.4 Impacts from Air Guns under Alternative 2

Impacts from Air Guns under Alternative 2 for Training Activities

Training activities under Alternative 2 do not include the use of air guns.

Impacts from Air Guns under Alternative 2 for Testing Activities

The number and locations of air gun testing activities planned under Alternative 2 are identical to those planned under Alternative 1; therefore, the estimated impacts would be identical. Considering the factors described under Alternative 1 and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. It is reasonable to assume that terrapins use their hearing similarly to sea turtles and that the types of impacts on these species would be similar to impacts on sea turtles. Air guns within reptile hearing range are not likely to be used in nearshore locations where crocodilians could be present, however terrapins may be present in Newport, Rhode Island where pierside air gun activities occur. Due to the similarity in hearing between terrapins and sea turtles, the low frequency of air gun use, and the low duration of shots, impacts, if any, are assumed to parallel those described above for sea turtles. No air gun use is proposed in the areas known to be inhabited by alligators or the ESA-listed American crocodile, including designated American crocodile critical habitat in Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of air guns during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; would have no effect on the ESA-listed American crocodile; and would have no effect on green, hawksbill, loggerhead, or leatherback turtle critical habitat or on American crocodile critical habitat.

3.8.3.1.3.5 Impacts from Air Guns 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 acoustic stressors (e.g., air guns) 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.

3.8.3.1.4 Impacts from Pile Driving

Sea turtles could be exposed to sounds from impact pile driving and vibratory pile extraction during the construction and removal phases of the Elevated Causeway System. This training activity involves the use of an impact hammer to drive 24 in. steel piles into the sediment to support an elevated causeway to the shore and a vibratory hammer to later remove the piles that support the causeway structure. Section 3.0.3.3.1.3 (Pile Driving) provides additional details on pile driving activities and the noise levels measured from a prior elevated causeway installation and removal.

Because no pile driving or vibratory extraction is proposed in known crocodilian or terrapin habitat, the remainder of the analysis of impacts from pile driving focuses on sea turtles.

3.8.3.1.4.1 Methods for Analyzing Impacts from Pile Driving

Potential impacts considered are hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior.

The Navy's quantitative analysis to determine impacts on sea turtles and marine mammals for pile driving produces initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. The steps of this quantitative analysis are described in Section 3.0.1.2 (Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals), which takes into account:

- criteria and thresholds used to predict impacts from pile driving (see below); and
- the density and spatial distribution of sea turtles.

A further detailed explanation of this analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018).

Criteria and Thresholds used to Predict Impacts on Sea Turtles from Pile Driving

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used. The auditory weighting function for sea turtles presented above in Section 3.8.3.1.2.1 (Methods for Analyzing Impacts from Sonar and Other Transducers) is also used in the quantitative assessment of auditory impacts due to pile driving.

Hearing Loss from Pile Driving

Because impact pile driving produces impulsive noise, the criteria used to assess the onset of TTS and PTS are identical to those used for air guns, as described in Section 3.8.3.1.3.1 (Methods for Analyzing Impacts from Air Guns).

Because vibratory pile extraction produces continuous, non-impulsive noise, the criteria used to assess the onset of TTS and PTS due to exposure to sonars are used to assess auditory impacts on sea turtles, as described in Section 3.8.3.1.2.1 (Methods for Analyzing Impacts from Sonar and Other Transducers).

Modeling of Pile Driving Noise

Underwater noise effects from pile driving and vibratory pile extraction were modeled using actual measures of impact pile driving and vibratory removal during construction of an elevated causeway (Illingworth and Rodkin, 2015, 2017). A conservative estimate of spreading loss of sound in shallow coastal waters (i.e., transmission loss = $16.5 * \text{Log}_{10}$ [radius]) was applied based on spreading loss observed in actual measurements. Inputs used in the model are provided in Section 3.0.3.3.1.3 (Pile Driving), including source levels, the number of strikes required to drive a pile and the duration of vibratory removal for a pile, the number of piles driven or removed per day, and the number of days of pile driving and removal.

3.8.3.1.4.2 Impact Ranges for Pile Driving

The ranges to the onset of TTS and PTS for sea turtles exposed to impact pile driving are shown in Table 3.8-4. The ranges to effect are short due to sea turtles' relatively high thresholds for any auditory impacts compared to the source levels of the impact pile driving conducted during Navy training.

Table 3.8-4: Ranges to PTS and TTS Sea Turtles Exposed to Impact Pile Driving

Type of Activity	*PTS (m)*	*TTS (m)*
Impact Pile Driving (single pile)	2	19

Notes: PTS: permanent threshold shift, TTS: temporary threshold shift. Calculations for ranges to TTS and PTS assume a sound exposure level accumulated over a duration of one minute, after which time an animal is assumed to avoid the immediate area.

Because vibratory pile extraction has a low source level, it is not possible for a sea turtle to experience PTS or TTS, even if exposed to a full day of pile removal.

3.8.3.1.4.3 Impacts from Pile Driving under Alternative 1

Impacts from Pile Driving under Alternative 1 for Training Activities

Characteristics of pile driving (impact and vibratory extraction) and the number of times pile driving for the elevated causeway system would occur during training under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with pile driving would be conducted as described in Chapter 2

(Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). This activity would take place nearshore and within the surf zone, up to two times per year, once at Joint Expeditionary Base Little Creek/Fort Story, Virginia, and once at Marine Corps Base Camp Lejeune, North Carolina.

Impulses from the impact hammer strikes are broadband, within the hearing range of sea turtles, and carry most of their energy in the lower frequencies. The quantitative analysis, for a maximum duration of pile driving activities during training activities, predicts that no sea turtles of any species are likely to be exposed to the received levels of sound, in their hearing range, that could cause TTS or PTS.

The impulse from impact pile driving can also travel through the bottom sediment, potentially disturbing sea turtles that may be present near the bottom. Any impacts on sea turtles may be reduced by soft starts. As discussed in Section 2.3.3.14 (Pile Driving Safety), as a standard operating procedure, the Navy performs soft starts at reduced energy during an initial set of strikes from an impact hammer. Soft starts may “warn” sea turtles and cause them to move away from the sound source before impact pile driving increases to full operating capacity. Soft starts were not considered when calculating the number of sea turtles that could be impacted, nor was the possibility that a sea turtle would avoid the construction area.

Sound produced from a vibratory hammer is broadband, continuous noise that is produced at a much lower level than impact driving. The quantitative analysis estimates that no sea turtles could be exposed to levels of vibratory pile extraction that could cause TTS or PTS. To further avoid the potential for impacts, the Navy will implement mitigation for pile driving that includes ceasing impact pile driving or vibratory pile extraction if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

The working group that prepared the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) provide parametric descriptors of sea turtle behavioral responses to impact pile driving. Popper et al. (2014) estimate the risk of sea turtles responding to impact pile driving is high, moderate, and low while at near (tens of meters), intermediate (hundreds of meters), and far (thousands of meters) distances from the source respectively. Based on prior observations of sea turtle reactions to sound, if a behavioral reaction were to occur, the responses could include increases in swim speed, change of position in the water column, or avoidance of the sound. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. It is assumed that a stress response could accompany any behavioral response or TTS.

Sea turtles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. Despite the short duration of each impulse from an impact pile driving strike, the rate of impulses has the potential to result in some auditory masking of shore sounds or broadband vessel noise for sea turtles. Vibratory pile extraction is more likely than impact pile driving to cause masking of continuous broadband environmental sounds; however, due to its low source level, the masking effect would only be relevant in a small area around the vibratory pile extraction activity. These coastal areas tend to have high ambient noise levels due to natural (breaking waves) and anthropogenic sources. For both types of activities, masking would only occur during the brief periods of time during which pile driving or removal is actively occurring, approximately less than two hours per day for two weeks in any year.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

Hawksbill turtles are considered extralimital north of Florida, and would not occur near pile driving activities. Additionally, pile driving during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. Loggerhead turtle habitat would not be impacted by pile driving use during training activities. No pile driving activities will occur in the areas known to be inhabited by the ESA-listed American crocodile, including designated American crocodile critical habitat in Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the pile driving and extraction during training under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; would have no effect on the ESA-listed American crocodile; and would have no effect on green, hawksbill, leatherback, or loggerhead turtle critical habitat or on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Pile Driving under Alternative 1 for Testing Activities

Testing activities under Alternative 1 do not include the use of pile driving (impact or vibratory).

3.8.3.1.4.4 Impacts from Pile Driving under Alternative 2

Impacts from Pile Driving under Alternative 2 for Training Activities

Pile driving training activities planned under Alternative 2 are identical to those planned under Alternative 1; therefore, the estimated impacts would be identical. Considering the factors described under Alternative 1 and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

Pursuant to the ESA, the pile driving and removal during training under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, and leatherback sea turtles; would have no effect on the ESA-listed American crocodile; and would have no effect on green, hawksbill, loggerhead, or leatherback sea turtle critical habitat or on American crocodile critical habitat.

Impacts from Pile Driving under Alternative 2 for Testing Activities

Testing activities under Alternative 2 do not include the use of pile driving (impact or vibratory).

3.8.3.1.4.5 Impacts from Pile Driving 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 acoustic stressors (e.g., pile driving) 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.

3.8.3.1.5 Impacts from Vessel Noise

The characteristics of noise produced by Navy vessels and their overall contribution to vessel noise in the Study Area are described in Section 3.0.3.3.1.4 (Vessel Noise). Navy vessels make up a very small percentage of the overall traffic, and, because most Navy ships are quieter than similar-sized commercial vessels, naval vessel noise contributes a very small portion of radiated noise in Navy operating areas (Mintz & Filadelfo, 2011; Mintz, 2012). Even during major training exercises, when a higher number of Navy vessels are at sea, the Navy vessel contribution to overall ship radiated noise is very small. Navy ships make up only 20 percent of total ship traffic in the AFTT Study Area (Mintz, 2016). In terms of anthropogenic noise, Navy ships would contribute a correspondingly smaller amount of vessel noise compared to more common commercial shipping and boating (Mintz, 2012; Mintz & Filadelfo, 2011).

3.8.3.1.5.1 Methods for Analyzing Impacts from Vessel Noise

Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior. The source levels of vessels are below the level of sound that would cause hearing loss for sea turtles.

There is little information on assessing behavioral responses of sea turtles to vessels. Sea turtles have been both observed to respond (DeRuiter & Doukara, 2012) and not respond (Weir, 2007) during seismic surveys, although any reaction could have been due to the active firing of air gun arrays, ship noise, ship presence, or some combination thereof. Lacking data that assesses sea turtle reactions solely to vessel noise, the *ANSI Sound Exposure Guidelines* suggest that the relative risk of a sea turtle behaviorally responding to a continuous noise, such as vessel noise, is high when near a source (tens of meters), moderate when at an intermediate distance (hundreds of meters), and low at farther distances. These recommendations did not consider source level. While it is reasonable to assume that sea turtles may exhibit some behavioral response to vessels, numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls that may have been exacerbated by a sea turtle surfacing reaction or lack of reaction to vessels (Hazel et al., 2007; Lutcavage et al., 1997).

Since crocodilians and terrapins have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that crocodilians and terrapins would react similarly to vessel noise as sea turtles.

3.8.3.1.5.2 Impacts from Vessel Noise under Alternative 1

Impacts from Vessel Noise under Alternative 1 for Training Activities

Characteristics of Navy vessel noise are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with vessel noise would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Vessel movements involve transits to and from ports to various locations within the Study Area, and many ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels), as well as unmanned vehicles. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. A study of Navy vessel traffic found that traffic was heaviest just offshore of Norfolk and Jacksonville, as well as along the coastal waters between the two ports (Mintz & Filadelfo, 2011; Mintz, 2012).

Surface combatant ships (e.g., destroyers, guided missile cruisers, and littoral combat ships) and submarines especially are designed to be quiet to evade enemy detection. Reptiles exposed to these Navy vessels may not respond at all or exhibit brief startle dive reactions, if, for example, basking on the surface near a passing vessel. Even for louder vessels, such as Navy oilers, it is not clear that reptiles would typically exhibit any reaction other than a brief startle and avoidance reaction, if they react at all. Any of these short-term reactions to vessels are not likely to disrupt important behavioral patterns more than for a brief moment. The size and severity of these impacts would be insignificant, and not rise to the level of measurable impacts. Acoustic masking, especially from larger, non-combatant vessels, is possible. Vessels produce continuous broadband noise, with larger vessels producing sound that is dominant in the lower frequencies where reptile hearing is most sensitive, as described in Section 3.0.3.3.1.4 (Vessel Noise) (Mintz & Filadelfo, 2011; Richardson et al., 1995; Urick, 1983). Smaller vessels emit more energy in higher frequencies, much of which would not be detectable by reptiles. Sea turtles and terrapins most likely use sound to detect nearby broadband, continuous low-frequency environmental sounds, such as the sounds of waves crashing on the beach, so vessel noise in those habitats may cause more meaningful masking. However, most vessel use would be in harbors or in transit to offshore areas, limiting masking impacts on sea turtles in many shore areas. Crocodilians use low-frequency sounds for vocalization during various behaviors, and any potential for masking impacts would be limited to inshore environments for short durations during vessel transit. Existing high ambient noise levels in ports and harbors with non-Navy vessel traffic and in shipping lanes with large commercial vessel traffic would limit the potential for masking by naval vessels in those areas. In offshore areas with lower ambient noise, the duration of any masking effects in a particular location would depend on the time in transit by a vessel through an area. Because sea turtles and terrapins appear to rely on senses other than hearing for in-water foraging and navigation, any impact of temporary masking is likely minor or inconsequential. Hazel et al. (2007) noted in one study that green sea turtles did not have time to react to vessels moving at speeds of about 10 knots, but reacted frequently to vessels at speeds of about two knots. Detection, therefore, was suggested to be based on the turtle's ability to see rather than hear an oncoming vessel.

Vessel noise during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands, respectively. For loggerhead turtle critical habitat (79 *Federal Register* 39855), vessel noise during training activities would have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from shipping or military activity. The impacts on this habitat would be considered insignificant with no discernible impact on the conservation function of the physical and biological features as activity would not prevent a turtle from migrating due to the transient nature of vessels. The physical and biological features of the nearshore reproductive, wintering, breeding, and *Sargassum* habitats (National Marine Fisheries Service, 2014b) would not be impacted by vessel noise during training activities.

It is reasonable to assume that crocodilians and terrapins use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Within their respective geographic ranges, crocodilians and terrapins could potentially be exposed to vessel noise in the inshore regions of the Study Area during training activities, as described in Appendix A (Navy Activity Descriptions). Navy vessel presence would be unlikely in ESA-listed American crocodile habitat, which consists of shallow nearshore habitat in southern Florida; however, it is possible that American crocodiles could be occasionally exposed to Navy vessel noise, mostly from smaller support vessels. Vessel noise produced during training activities would not impact critical habitat in the Florida Bay, which encompasses creeks, canals, and swamps.

Because impacts on individual sea turtles, crocodilians, or terrapins, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle, crocodilian, or terrapin populations.

Pursuant to the ESA, vessel noise produced during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles and the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or on American crocodile critical habitat. Vessel noise during training activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast. The Navy has consulted with NMFS and USFWS as required by section 7(a)(2) of the ESA.

Impacts from Vessel Noise under Alternative 1 for Testing Activities

Characteristics of Navy vessel noise are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with vessel noise would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Testing activities under Alternative 1 include vessel movement during many events. Because many testing activities would use the same or similar vessels as Navy training events, the general locations and types of effects due to vessel noise described above for training would be similar for many testing activities. In addition, smaller vessels would typically be used on Navy testing ranges. Navy vessel noise would continue to be a minor contributor to overall radiated vessel noise in the exclusive economic zone.

Reptiles are likely able to detect low-frequency components of broadband continuous vessel noise which may elicit masking, physiological stress, or behavioral reactions, including avoidance behavior. The size and severity of these impacts would be insignificant, and not rise to the level of measurable impacts. Because impacts on individual sea turtles, crocodilians, and terrapins, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle, crocodilian, or terrapin populations.

Pursuant to the ESA, vessel noise produced during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles, and the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or on American crocodile critical habitat. Vessel noise produced during testing activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions. The Navy has consulted with NMFS and USFWS as required by section 7(a)(2) of the ESA.

3.8.3.1.5.3 Impacts from Vessel Noise under Alternative 2

Impacts from Vessel Noise under Alternative 2 for Training Activities

While there would be an increase in the amount of at-sea vessel time during training under Alternative 2, the general locations and types of effects due to vessel noise would be the same as described in Alternative 1. Therefore, the general locations and types of effects due to vessel noise described above for training under Alternative 1 would be similar under Alternative 2. Navy vessel noise would continue to be a minor contributor to overall radiated vessel noise in the exclusive economic zone.

Reptiles are likely able to detect low-frequency components of broadband continuous vessel noise which may elicit masking, physiological stress, or behavioral reactions, including avoidance behavior. The size and severity of these impacts would be insignificant, and not rise to the level of measurable impacts. Because impacts on individual sea turtles, crocodilians, and terrapins, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle, crocodilian, or terrapin populations.

Pursuant to the ESA, vessel noise produced during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles and the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or on American crocodile critical habitat. Vessel noise produced during training activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions.

Impacts from Vessel Noise under Alternative 2 for Testing Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), testing activities under Alternative 2 include vessel movement during many events. The difference in vessel noise contributed by testing activities under Alternative 2 compared to Alternative 1 is so small as to not be discernable. Therefore, the general locations and types of effects due to vessel noise described above for testing under Alternative 1 would be the same under Alternative 2. Navy vessel noise would continue to be a minor contributor to overall radiated vessel noise in the exclusive economic zone.

Reptiles are likely able to detect low-frequency components of broadband continuous vessel noise which may elicit masking, physiological stress, or behavioral reactions, including avoidance behavior. The size and severity of these impacts would be insignificant, and not rise to the level of measurable impacts. Because impacts on individual sea turtles, crocodilians, and terrapins if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle, crocodilian, or terrapin populations.

Pursuant to the ESA, vessel noise produced during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles and the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile critical habitat. Vessel noise produced during testing activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions.

3.8.3.1.5.4 Impacts from Vessel Noise 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 acoustic stressors (e.g., vessel noise) 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.

3.8.3.1.6 Impacts from Aircraft Noise

Fixed and rotary-wing aircraft are used during a variety of training and testing activities throughout the Study Area. Aircraft produce extensive airborne noise from either turbofan or turbojet engines. Rotary-wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al., 2003). An infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Fixed-wing aircraft would pass quickly overhead, while rotary-wing aircraft (e.g., helicopters) may hover at lower altitudes for longer durations. A description of aircraft noise produced during Navy activities is provided in Section 3.0.3.3.1.5 (Aircraft Noise), including estimates of underwater noise produced by certain flight activities. Aircraft flights during training would be most concentrated within the offshore waters of the Virginia Capes, Navy Cherry Point, Jacksonville, and Key West Range Complexes. The use of aircrafts during training activities would also occur within several inshore water locations, but would be concentrated within the James Rivers and tributaries; Lower Chesapeake Bay; Kings Bay, Georgia; and Port Canaveral, Florida.

Most in-air sound would be reflected at the air-water interface. Depending on atmospheric conditions, in-air sound can refract upwards, limiting the sound energy that reaches the water surface. This is especially true for sounds produced at higher altitudes. Underwater sounds from aircraft would be strongest just below the surface and directly under the aircraft. Any sound that does enter the water only does so within a narrow cone below the sound source that would move with the aircraft. For the common situation of a hovering helicopter, the sound pressure level in water would be about 125 dB re

1 µPa for an H-60 helicopter hovering at 50 ft. For an example fixed-wing flight, the sound pressure underwater would be about 128 dB re 1 µPa for an F/A-18 traveling at 250 knots at 3,000 ft. altitude. Most air combat maneuver activities would occur at higher altitudes. Supersonic aircraft, if flying at low altitudes, could generate an airborne sonic boom that may be sensed by reptiles while at the surface, or as a low-level impulsive sound underwater.

3.8.3.1.6.1 Methods for Analyzing Impacts from Aircraft Noise

The amount of sound entering the ocean from aircraft would be very limited in duration, sound level, and affected area. For those reasons, impacts on sea turtles and other aquatic reptiles from aircraft have not been studied. Due to the low level of sound that could enter the water from aircraft, hearing loss is not further considered as a potential effect. Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior.

There is little information with which to assess behavioral responses of reptiles to aircraft. The *ANSI Sound Exposure Guidelines* for sea turtles did not consider this acoustic stressor (Popper et al., 2014). For this analysis, the Navy assumes that some animals at or near the water surface may exhibit startle reactions to certain aircraft noise if aircraft altitude is low. This could mean a hovering helicopter, for which the sight of the aircraft and water turbulence could also cause a response, or a low-flying or super-sonic aircraft generating enough noise to be briefly detectable underwater or at the air-water interface. Because any fixed-wing or missile overflight would be brief, the risk of masking any sounds relevant to reptiles is very low.

Since crocodilians and terrapins have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that crocodilians and terrapins would react similarly to aircraft noise as sea turtles.

3.8.3.1.6.2 Impacts from Aircraft Noise under Alternative 1

<u>**Impacts from Aircraft Noise under Alternative 1 for Training Activities**</u>

Characteristics of aircraft noise are described in Section 3.0.3.3.1 (Acoustic Stressors), and the number of training activities that include aircraft under Alternative 1 are shown in Section 3.0.3.3.4.4 (Aircraft). Training activities with aircraft would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Aircraft noise would usually occur adjacent to Navy airfields, installations, and in special use airspace within Navy range complexes. Aircraft flights during training would be most concentrated within the Virginia Capes, Navy Cherry Point, Jacksonville, and Key West Range Complexes.

Reptiles may respond to both the physical presence and to the noise generated by aircraft, making it difficult to attribute causation to one or the other stimulus. In addition to noise produced, all low-flying aircraft make shadows, which can cause animals at the surface to react. Helicopters may also produce strong downdrafts, a vertical flow of air that becomes a surface wind, which can also affect an animal's behavior at or near the surface.

In most cases, exposure of a reptile to fixed-wing aircraft presence and noise would be brief as the aircraft quickly passes overhead. Animals would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. Supersonic flight at sea would not be conducted over crocodilian or terrapin habitats, and is typically conducted at altitudes exceeding 30,000 ft., limiting the number of occurrences of supersonic flight being audible at the water surface. Because most overflight exposures from fixed-wing aircraft or transiting helicopters would be brief and aircraft noise would be at low received levels, only startle reactions, if any, are expected in response to low altitude flights. Similarly, the brief duration of most overflight exposures would limit any potential for masking of relevant sounds.

Daytime and nighttime activities involving helicopters may occur for extended periods of time, up to a couple of hours in some areas. During these activities, helicopters would typically transit throughout an area and may hover over the water. Longer activity durations and periods of time where helicopters hover may increase the potential for behavioral reactions, startle reactions, and physiological stress. Low-altitude flights of helicopters during some activities, which often occur under 100 ft. altitude, may elicit a stronger startle response due to the proximity of a helicopter to the water; the slower airspeed and longer exposure duration; and the downdraft created by a helicopter's rotor.

Most fixed-wing aircraft and helicopter activities are transient in nature, although helicopters could also hover for extended periods. The likelihood that a sea turtle, crocodilian, or terrapin would occur or remain at the surface while an aircraft or helicopter transits directly overhead would be low. Helicopters that hover in a fixed location for an extended period of time could increase the potential for exposure. However, impacts from training and testing activities would be highly localized and concentrated in space and duration.

Behavioral reactions, startle reactions, and physiological stress due to aircraft noise, including hovering helicopters, are likely to be brief and minor, if they occur at all. Sea turtle reactions to aircraft noise have not been studied like marine mammals. For marine mammals, aircraft noise would cause only small temporary changes in behavior. Since reptile hearing is less sensitive than marine mammals, conservatively, it is likely that sea turtles, crocodilians, and terrapins could exhibit temporary changes in behavior to aircraft noise as well. The size and severity of these impacts would be insignificant, and not rise to the level of measurable impacts.

Aircraft noise during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. Loggerhead turtle critical habitat would not be affected by aircraft noise above the water.

It is reasonable to assume that crocodilians and terrapins use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Within their respective geographic ranges, crocodilians and terrapins could potentially be exposed to aircraft noise in the inshore regions of the Study Area during training activities, as described in Appendix A (Navy Activity Descriptions). Navy aircraft presence would be unlikely in American crocodile habitat, which consists of shallow nearshore habitat in southern Florida; however, it is possible that American crocodiles could be occasionally exposed to Navy aircraft noise. Aircraft noise would not impact American crocodile critical habitat in Florida Bay which encompasses creeks, canals, and swamps.

Because impacts on individual sea turtles, crocodilians, or terrapins, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle, crocodilian, or terrapin populations.

Pursuant to the ESA, aircraft noise produced during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles and the ESA-listed American crocodile. Aircraft noise during training activities would have no effect on green, hawksbill, leatherback, or loggerhead turtle critical habitat or American crocodile critical habitat. The Navy has consulted with NMFS and USFWS as required by section 7(a)(2) of the ESA.

Impacts from Aircraft Noise under Alternative 1 for Testing Activities

Characteristics of aircraft noise are described in Section 3.0.3.3.1 (Acoustic Stressors) and the number of testing activities with aircraft under Alternative 1 are shown in Section 3.0.3.3.4.4 (Aircraft). Testing activities using aircraft would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Aircraft overflights would usually occur adjacent to Navy airfields, installations, and in special use airspace within Navy range complexes. Testing activities with aircraft would be most concentrated within the offshore waters of the Northeast, Navy Cherry Point, Virginia Capes, and Jacksonville Range Complexes.

Testing activities under Alternative 1 use aircraft during numerous events. Because many testing activities would use the same or similar aircraft as Navy training events in the same general locations, the types of effects due to aircraft noise described above for training would be similar for many testing activities. Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Pursuant to the ESA, aircraft noise produced during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles and the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback or loggerhead turtle critical habitat or American crocodile critical habitat. The Navy has consulted with NMFS and USFWS as required by section 7(a)(2) of the ESA.

3.8.3.1.6.3 Impacts from Aircraft Noise under Alternative 2

Impacts from Aircraft Noise under Alternative 2 for Training Activities

There would be a minor increase in aircraft noise during training activities under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for training under Alternative 1. Because impacts on individual sea turtles, crocodilians, or terrapins, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle, crocodilian, or terrapin populations.

Pursuant to the ESA, aircraft noise produced during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles and the ESA-listed American crocodile; and would have no effect on green, hawksbill, leatherback, or loggerhead turtle critical habitat or on American crocodile critical habitat.

Impacts from Aircraft Noise under Alternative 2 for Testing Activities

There would be a minor increase in aircraft noise under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for testing under Alternative 1. Impacts on individual sea turtles, crocodilians, or terrapins, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle, crocodilian, or terrapin populations.

Pursuant to the ESA, aircraft noise produced during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, and leatherback turtles and the ESA-listed American crocodile. Aircraft noise produced during testing activities would have no effect on green, hawksbill, leatherback, or loggerhead turtle critical habitat or on American crocodile critical habitat.

3.8.3.1.6.4 Impacts from Aircraft Noise 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 acoustic stressors (e.g., aircraft noise) 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.

3.8.3.1.7 Impacts from Weapon Noise

Reptiles may be exposed to sounds caused by the firing of weapons, objects in flight, and inert impact of non-explosive munitions on the water's surface, which are described in Section 3.0.3.3.1.6 (Weapon Noise). In general, these are impulsive sounds generated in close vicinity to or at the water surface, with the exception of items that are launched underwater. The noise generated from firing a weapon include muzzle blast and a crack sound due to a low amplitude shock wave generated by a supersonic projectile flying through the air. Most in-air sound would be reflected at the air-water interface. Underwater sounds would be strongest just below the surface and directly under the firing point. Any sound that enters the water only does so within a narrow cone below the firing point or path of the projectile. Vibration from the blast propagating through a ship's hull, the sound generated by the impact of an object with the water surface, and the sound generated by launching an object underwater are other sources of impulsive sound in the water. Sound due to missile and target launches is typically at a maximum at initiation of the booster rocket and rapidly fades as the missile or target travels downrange.

3.8.3.1.7.1 Methods for Analyzing Impacts from Weapon Noise

The amount of sound entering the ocean from weapon firing, projectile travel, and inert objects hitting the water would be very limited in duration and affected area. Sound levels could be relatively high directly beneath a gun blast, but even in the worst-case scenario of a naval large caliber gun fired at the lowest elevation angle, sound levels in the water directly below the blast (about 200 db re 1 μPa SPL peak; see Yagla & Stiegler, 2003) are substantially lower than necessary to cause hearing loss in a sea turtle. Similarly, situations in which inert objects hitting the water, even at high speeds, could hypothetically generate sound sufficient to cause hearing loss within a short distance would be very rare. Therefore, hearing loss is not further considered as a potential effect. Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior.

Since crocodilians and terrapins have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that crocodilians and terrapins would react similarly to weapon noise as sea turtles.

3.8.3.1.7.2 Impacts from Weapon Noise under Alternative 1

<u>Impacts from Weapon Noise under Alternative 1 for Training Activities</u>

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapon noise are described in Section 3.0.3.3.1.6 (Weapon Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for training under Alternative 1 are shown in Section 3.0.3.3.4.2 (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapon noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.8.3.2 (Explosive Stressors).

Weapon training would occur in the range complexes, with greatest use of most types of munitions in the Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes. Most activities involving large-caliber naval gunfire or the launching of targets, missiles, bombs, or other munitions are conducted more than 12 NM from shore, but could potentially occur in the Panama City OPAREA and the Naval Surface Warfare Center Panama City Testing Range. Small- and medium-caliber weapon firing could occur throughout the Study Area. Only small-caliber weapons are used within inshore waters. Navy training activities in the inshore waters occur in several locations along the Atlantic coast as described in Section 3.0.3.3.4.2 (Military Expended Materials), with the highest concentration occurring in the James River and tributaries in Virginia. Other locations include the Lower Chesapeake Bay; Cooper River, South Carolina; Port Canaveral, Florida; and Narragansett, Rhode Island.

All of these sounds would be brief, lasting from less than a second for a blast or inert impact to few seconds for other launch and object travel sounds. Most incidents of impulsive sounds produced by weapon firing, launch, or inert object impacts would be single events, with the exception of gunfire activities. It is expected that these sounds may elicit brief startle reactions or diving, with avoidance being more likely with the repeated exposure to sounds during gunfire events. It is assumed that, similar to air gun exposures, reptile behavioral responses would cease following the exposure event and the risk of a corresponding, sustained stress response would be low. Similarly, exposures to impulsive noise caused by these activities would be so brief that risk of masking relevant sounds would be low. These activities would not typically occur in nearshore habitats where sea turtles may use their limited hearing to sense broadband, coastal sounds. Behavioral reactions, startle reactions, and physiological stress due to weapon noise are likely to be brief and minor, if they occur at all due, to the low probability of co-occurrence between weapon activity and sea turtle individuals.

To further avoid the potential for impacts, the Navy will implement mitigation for weapon firing noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors). Also, activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles. This further reduces the likelihood of impacts on hatchling and pre-recruitment juveniles of all sea turtle species and leatherback turtles of all age classes since these species and age classes occur in open-ocean habitat where most of these activities would occur.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

Weapon training would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. For loggerhead critical habitat (79 *Federal Register* 39855), weapon noise during training activities would have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing “noise pollution” from military activity. The impacts on this habitat would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features as activity would not prevent a turtle from migrating, as weapon noise is brief in nature. The physical and biological features of the nearshore reproductive, wintering, breeding, and *Sargassum* habitats (National Marine Fisheries Service, 2014b) would not be impacted by weapon noise during training activities.

It is reasonable to assume that crocodilians and terrapins use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Within their respective geographic ranges, crocodilians and terrapins could potentially be exposed to weapon noise in some inshore waters of the Study Area during training activities, as described in Appendix A (Navy Activity Descriptions). Activities producing weapon noise would not occur in American crocodile habitat, which consists of shallow nearshore habitat in southern Florida. Weapon noise would not impact American crocodile critical habitat in Florida Bay which encompasses creeks, canals, and swamps. Because impacts on individual crocodilians and terrapins, if any, are expected to be minor and limited, long-term consequences to individuals or populations would not be expected.

Pursuant to the ESA, weapon noise produced during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile habitat. Weapon noise produced during training activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Weapon Noise under Alternative 1 for Testing Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapon noise are described in Section 3.0.3.3.1.6 (Weapon Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for testing under Alternative 1 are shown in Section 3.0.3.3.4.2 (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapon noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.8.3.2 (Explosive Stressors).

The general locations and types of effects due to weapon noise described above for training would be similar for many testing activities. Weapon testing would typically occur on the range complexes, with some activity also occurring on testing ranges. Most activities involving large-caliber naval gunfire or the launching of targets, missiles, bombs, or other munitions are conducted more than 12 NM from shore, but could potentially occur in the Panama City OPAREA and the Naval Surface Warfare Center Panama City Testing Range.

To further avoid the potential for impacts, the Navy will implement mitigation for weapon firing noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors). Also, activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles. This further reduces the likelihood of impacts on hatchling and pre-recruitment juveniles of all sea turtle species and leatherback turtles of all age classes since these species and age classes occur in open-ocean habitat where most of these activities would occur.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. No testing activities would use munitions in inshore waters, and thus would not overlap with or impact crocodilians or terrapins.

Weapon testing would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. For loggerhead critical habitat (79 *Federal Register* 39855), weapon noise during training activities would have a pathway to impact the physical and biological features of the constricted migratory habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from military activity. The impacts on this habitat would be considered insignificant, with no discernible impact on the conservation function of the physical and biological features as activity would not prevent a turtle from migrating, as weapon noise is brief in nature. The physical and biological features of the nearshore reproductive, wintering, breeding, and *Sargassum* habitats (National Marine Fisheries Service, 2014b) would not be impacted by weapon noise during testing activities.

Activities producing weapon noise would not occur in American crocodile habitat, which consists of shallow nearshore habitat in southern Florida. Weapon noise would not impact American crocodile critical habitat in Florida Bay which encompasses creeks, canals, and swamps.

Pursuant to the ESA, weapon noise produced during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback sea turtle critical habitat or American crocodile critical habitat. Weapon noise produced during testing activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.7.3 Impacts from Weapon Noise under Alternative 2

Impacts from Weapon Noise under Alternative 2 for Training Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapon noise are described in Section 3.0.3.3.1.6 (Weapon Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for training under Alternative 2 are shown in 3.0.3.3.4.2. (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapon noise. The noise produced by the detonation of explosive weapon is analyzed in Section 3.8.3.2 (Explosive Stressors).

There would be a minor increase in these activities under Alternative 2 compared to Alternative 1; however, the types of impacts and locations of impacts would be the same as those described for training under Alternative 1. To further avoid the potential for impacts, the Navy will implement mitigation for weapon firing noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors). Also, activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles. This further reduces the likelihood of impacts on hatchling and pre-recruitment juveniles of all sea turtle species and leatherback turtles of all age classes since these species and age classes occur in open-ocean habitat where most of these activities would occur. Because impacts on individual sea turtles, crocodilians, and terrapins, if any, are expected to be minor and limited, long-term consequences to individuals or populations are not expected.

Pursuant to the ESA, weapon noise produced during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile critical habitat. Weapon noise produced during training activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions.

Impacts from Weapon Noise under Alternative 2 for Testing Activities

Activities using weapon and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapon noise are described in Section 3.0.3.3.1.6 (Weapon Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for testing under Alternative 2 are shown in 3.0.3.3.4.2. (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapon noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.8.3.2 (Explosive Stressors).

There would be a minor increase in these activities under Alternative 2 compared to Alternative 1; however, the types of impacts and locations of impacts would be the same as those described for testing under Alternative 1. To further avoid the potential for impacts, the Navy will implement mitigation for weapon firing noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors). Also, activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles. This further reduces the likelihood of impacts on hatchling and pre-recruitment juveniles of all sea turtle species and leatherback turtles of all age classes since these species and age classes occur in open-ocean habitat where most of these activities would occur. No testing activities would use munitions in inshore waters, and thus would not overlap with or impact crocodilians or terrapins.

Because impacts on individual sea turtles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any sea turtle populations. Pursuant to the ESA, weapon noise produced during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile critical habitat. Weapon noise produced during testing activities may affect loggerhead constricted migratory habitats in the mid-Atlantic and southeast regions.

3.8.3.1.7.4 Impacts from Weapon Noise 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 acoustic stressors (e.g., weapon noise) 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.

3.8.3.2 Explosive Stressors

Explosions in the water or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. But unlike other acoustic stressors, explosions release energy at a high rate producing a shock wave that can be injurious and even deadly. Therefore, explosive impacts on reptiles are discussed separately from other acoustic stressors, even though the analysis of explosive impacts will rely on data for sea turtle impacts due to impulsive sound exposure where appropriate.

Explosives are usually described by their net explosive weight, which accounts for the weight and type of explosive material. Additional explanation of the acoustic and explosive terms and sound energy concepts used in this section is found in Appendix D (Acoustic and Explosives Concepts).

This section begins with a summary of relevant data regarding explosive impacts on reptiles in Section 3.8.3.2.1 (Background). The ways in which an explosive exposure could result in immediate effects or lead to long-term consequences for an animal are explained in the Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), and the analysis in this section follows that framework. Studies of the effects of sound and explosives on reptiles are limited; therefore, where necessary, knowledge of explosive impacts to other species is used to assess impacts on reptiles, such as sea turtles, crocodilians, and terrapins.

3.8.3.2.1 Background

The sections below include a survey and synthesis of best available science published in peer-reviewed journals, technical reports, and other scientific sources pertinent to impacts on reptiles potentially resulting from Navy training and testing activities. Reptiles could be exposed to a range of impacts depending on the explosive source and context of the exposure. In addition to acoustic impacts including temporary or permanent hearing loss, auditory masking, physiological stress, or changes in behavior, potential impacts from an explosive exposure can include non-lethal injury and mortality.

3.8.3.2.1.1 Injury

Because direct studies of explosive impacts on reptiles have not been conducted, the below discussion of injurious effects is based on studies of other animals, generally mammals. The generalizations that can be made about in-water explosive injuries to other species should be applicable to reptiles, with consideration of the unique anatomy of sea turtles and terrapins. For example, it is unknown if the sea turtle shell may afford it some protection from internal injury.

If an animal is exposed to an explosive blast underwater, the likelihood of injury depends on the charge size, the geometry of the exposure (distance to the charge, depth of the animal and the charge), and the size of the animal. In general, an animal would be less susceptible to injury near the water surface because the pressure wave reflected from the water surface would interfere with the direct path pressure wave, reducing positive pressure exposure. However, rapid under-pressure caused by the negative surface-reflected pressure wave above an underwater detonation may create a zone of cavitation that may contribute to potential injury. In general, blast injury susceptibility would increase with depth, until normal lung collapse (due to increasing hydrostatic pressure) and increasing ambient pressures again reduce susceptibility. See Appendix D (Acoustic and Explosives Concepts) for an overview of explosive propagation and an explanation of explosive effects on gas cavities.

Primary blast injury is injury that results from the compression of a body exposed to a blast wave. This is usually observed as barotrauma of gas-containing structures (e.g., lung and gut) and structural damage to the auditory system (Greaves et al., 1943; Office of the Surgeon General, 1991; Richmond et al., 1973). The lungs are typically the first site to show any damage, while the solid organs (e.g., liver, spleen, and kidney) are more resistant to blast injury (Clark & Ward, 1943). Recoverable injuries would include slight lung injury, such as capillary interstitial bleeding, and contusions to the gastrointestinal tract. More severe injuries would significantly reduce fitness and likely cause death in the wild. Rupture of the lung may also introduce air into the vascular system, producing air emboli that can cause a stroke or heart attack by restricting oxygen delivery to critical organs. In this discussion, primary blast injury to auditory tissues is considered gross structural tissue injury distinct from noise-induced hearing loss, which is considered below in Section 3.8.3.2.1.2 (Hearing Loss).

Data on observed injuries to sea turtles from explosions is generally limited to animals found following explosive removal of offshore structures (Viada et al., 2008), which can attract sea turtles for feeding opportunities or shelter. Klima et al. (1988) observed a turtle mortality subsequent to an oil platform removal blast, although sufficient information was not available to determine the animal's exposure. Klima et al. (1988) also placed small sea turtles (less than seven kilograms) at varying distances from piling detonations. Some of the turtles were immediately knocked unconscious or exhibited vasodilation over the following weeks, but others at the same exposure distance exhibited no effects.

Incidental injuries to sea turtles due to military explosions have been documented in a few instances. In one incident, a single 1,200 pound (lb.) trinitrotoluene (TNT) underwater charge was detonated off Panama City, FL in 1981. The charge was detonated at a mid-water depth of 120 ft. Although details are limited, the following were recorded: at a distance of 500–700 ft., a 400 lb. sea turtle was killed; at 1,200 ft., a 200–300 lb. sea turtle experienced "minor" injury; and at 2,000 ft. a 200–300 lb. sea turtle was not injured (O'Keeffe & Young, 1984). In another incident, two "immature" green sea turtles (size unspecified) were killed when 100-150 ft. away from detonation of 20 lb. of C-4 in a shallow water environment.

For this analysis, it is assumed that these types of observations would also apply to crocodilians and terrapins. Results from limited experimental data suggest two explosive metrics are predictive of explosive injury: peak pressure and impulse.

Impulse as a Predictor of Explosive Injury

Without measurements of the explosive exposures in the above incidents, it is difficult to draw conclusions about what amount of explosive exposure would be injurious to aquatic reptiles. Studies of observed in-water explosive injuries showed that terrestrial mammals were more susceptible than comparably sized fish with swim bladders (Yelverton & Richmond, 1981), and that fish with swim bladders may have increased susceptibility to swim bladder oscillation injury depending on exposure geometry (Goertner, 1978; Wiley et al., 1981). Therefore, controlled tests with a variety of terrestrial mammals (mice, rats, dogs, pigs, sheep, and other species) are the best available data sources on actual injury to similar-sized animals due to underwater exposure to explosions.

In the early 1970s, the Lovelace Foundation for Medical Education and Research conducted a series of tests in an artificial pond to determine the effects of underwater explosions on mammals, with the goal of determining safe ranges for human divers. The resulting data were summarized in two reports (Richmond et al., 1973; Yelverton et al., 1973). Specific physiological observations for each test animal are documented in Richmond et al. (1973). Gas-containing internal organs, such as lungs and intestines, were the principle damage sites in submerged terrestrial mammals, consistent with earlier studies of mammal exposures to underwater explosions (Clark & Ward, 1943; Greaves et al., 1943).

In the Lovelace studies, acoustic impulse was found to be the metric most related to degree of injury, and size of an animal's gas-containing cavities was thought to play a role in blast injury susceptibility. The proportion of lung volume to overall body size is similar between sea turtles and terrestrial mammals, so the magnitude of lung damage in the tests may approximate the magnitude of injury to sea turtles when scaled for body size. Measurements of some shallower diving sea turtles (Hochscheid et al., 2007) show lung to body size ratios that are larger than terrestrial animals, whereas the lung to body mass ratio of the deeper diving leatherback sea turtle is smaller (Lutcavage et al., 1992). The use of test data with smaller lung to body ratios to set injury thresholds may result in a more conservative estimate of potential for damaging effects (i.e., lower thresholds) for animals with larger lung to body ratios.

For these shallow exposures of small terrestrial mammals (masses ranging from 3.4 to 50 kilograms) to underwater detonations, Richmond et al. (1973) reported that no blast injuries were observed when exposures were less than 6 lb. per square in. per millisecond (psi-ms) (40 pascal-seconds [Pa-s]), no instances of slight lung hemorrhage occurred below 20 psi-ms (140 Pa-s), and instances of no lung damage were observed in some exposures at higher levels up to 40 psi-ms (280 Pa-s). An impulse of 34 psi-ms (230 Pa-s) resulted in about 50 percent incidence of slight lung hemorrhage. About half of the animals had gastrointestinal tract contusions (with slight ulceration, i.e., some perforation of the mucosal layer) at exposures of 25–27 psi-ms (170–190 Pa-s). Lung injuries were found to be slightly more prevalent than gastrointestinal tract injuries for the same exposure.

The Lovelace subject animals were exposed near the water surface; therefore, depth effects were not discernible in this data set. In addition, this data set included only small terrestrial animals, whereas adult reptiles may be substantially larger and have respiratory structures adapted for the high pressures experienced at depth. Goertner (1982) examined how lung cavity size would affect susceptibility to blast injury by considering both size and depth in a bubble oscillation model of the lung, which is assumed to be applicable to reptiles as well for this analysis. Animal depth relates to injury susceptibility in two ways: injury is related to the relative increase in explosive pressure over hydrostatic pressure, and lung collapse with depth reduces the potential for air cavity oscillatory damage. The time period over which an impulse must be delivered to cause damage is assumed to be related to the natural oscillation period of an animal’s lung, which depends on lung size. Based on a study of green sea turtles, Berkson (1967) predicted sea turtle lung collapse would be complete around 80–160 m depth.

Peak Pressure as a Predictor of Explosive Trauma

High instantaneous peak pressures can cause damaging tissue distortion. Goertner (1982) suggested a peak overpressure gastrointestinal tract injury criterion because the size of gas bubbles in the gastrointestinal tract are variable, and their oscillation period could be short relative to primary blast wave exposure duration. The potential for gastrointestinal tract injury, therefore, may not be adequately modeled by the single oscillation bubble methodology used to estimate lung injury due to impulse. Like impulse, however, high instantaneous pressures may damage many parts of the body, but damage to the gastrointestinal tract is used as an indicator of any peak pressure-induced injury due to its vulnerability.

Older military reports documenting exposure of human divers to blasts generally describe peak pressure exposures around 100 lb. per square inch (psi) (237 dB re 1 µPa peak) to feel like a slight pressure or stinging sensation on skin, with no enduring effects (Christian & Gaspin, 1974). Around 200 psi, the shock wave felt like a blow to the head and chest. Data from the Lovelace Foundation experiments show instances of gastrointestinal tract contusions after exposures up to 1,147 psi peak pressure, while exposures of up to 588 psi peak pressure resulted in many instances of no observed gastrointestinal tract effects. The lowest exposure for which slight contusions to the gastrointestinal tract were reported was 237 dB re 1 µPa peak. As a vulnerable gas-containing organ, the gastrointestinal tract is vulnerable to both high peak pressure and high impulse, which may vary to differing extents due to blast exposure conditions (e.g., animal depth, distance from the charge). This likely explains the range of effects seen at similar peak pressure exposure levels and shows the utility of considering both peak pressure and impulse when analyzing the potential for injury due to explosions.

The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) recommended peak pressure guidelines for sea turtle injury from explosives. Lacking any direct data for sea turtles, these recommendations were based on fish data. Of the fish data available, the working group conservatively chose the study with the lowest peak pressures associated with fish mortality to set guidelines (Hubbs & Rechnitzer, 1952), and did not consider the Lovelace studies discussed above.

Fragmentation

Fragments produced by exploding munitions at or near the surface may present a high-speed strike hazard for an animal at or near the surface. In water, however, fragmentation velocities decrease rapidly due to drag (Swisdak & Montanaro, 1992). Because blast waves propagate efficiently through water, the range to injury from the blast wave would likely extend beyond the range of fragmentation risk.

3.8.3.2.1.2 Hearing Loss

An underwater explosion produces broadband, impulsive sound that can cause noise-induced hearing loss, typically quantified as threshold shift, which persists after cessation of the noise exposure. This noise-induced hearing loss may manifest as TTS or PTS. Because studies on inducing threshold shift in reptiles are very limited (e.g., alligator lizards: Dew et al., 1993; Henry & Mulroy, 1995) and have not been conducted on any of the reptiles present in the Study Area, auditory threshold shift in reptiles is considered to be consistent with general knowledge about noise-induced hearing loss described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Little is known about how sea turtles or terrapins use sound in their environment. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) do not suggest numeric sound exposure thresholds for auditory effects on sea turtles due to the lack of data. Rather, the guidelines qualitatively advise that sea turtles are less likely to incur TTS or PTS with increasing distance from an explosion. The guidelines also suggest that data from fishes may be more relevant than data from marine mammals when estimating auditory impacts on sea turtles, because, in general, fish hearing range is more similar to the limited hearing range of sea turtles. As shown in Section 3.8.2.1.4.1 (Hearing and Vocalization – Sea Turtles), sea turtle hearing is most sensitive around 100–400 Hz in-water, is limited over 1 kHz, and is much less sensitive than that of any marine mammal. The guidelines do not advise on crocodilians or terrapins, however hearing is most sensitive at low frequencies in these species as discussed in Section 3.8.2.1.4 (Hearing and Vocalization). For this analysis, it is assumed that hearing loss in crocodilians and terrapins would be similar to sea turtles.

3.8.3.2.1.3 Physiological Stress

A stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. If the magnitude and duration of the stress response is too great or too long, it can have negative consequences to the animal (e.g., decreased immune function, decreased reproduction). Physiological stress is typically analyzed by measuring stress hormones, other biochemical markers, or vital signs. Physiological stress has been measured for sea turtles during nesting (Flower et al., 2015; Valverde et al., 1999) and capture and handling (Flower et al., 2015; Gregory & Schmid, 2001), but the stress caused by acoustic exposure has not been studied for reptiles. Therefore, the stress response in reptiles in the Study Area due to acoustic exposures is considered to be consistent with general knowledge about physiological stress responses described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Marine animals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, nesting, and interactions with predators all contribute to stress. Anthropogenic sound-producing activities have the potential to provide additional stressors beyond those that naturally occur.

Due to the limited information about acoustically induced stress responses in reptiles, the Navy conservatively assumes in its effect analysis that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

3.8.3.2.1.4 Masking

As described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), auditory masking occurs when one sound, distinguished as the "noise," interferes with the detection or recognition of another sound or limits the distance over which other biologically relevant sounds can be detected. Masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity. Any unwanted sound above ambient noise and within an animal's hearing range may potentially cause masking that can interfere with an animal's ability to detect, understand, or recognize biologically relevant sounds of interest.

Masking occurs in all vertebrate groups and can effectively limit the distance over which an animal can communicate and detect biologically relevant sounds. The effect of masking has not been studied for marine reptiles. The potential for masking in reptiles would be limited to certain sound exposures due to their limited hearing range to broadband low-frequency sounds and lower sensitivity to noise in the marine environment. Only sounds that have a significant low-frequency component, are not of brief duration, and are of sufficient received level could create a meaningful masking situation. While explosions produce intense, broadband sounds with significant low-frequency content, these sounds are very brief with limited potential to mask relevant sounds.

There is evidence that reptiles may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al., 2013), magnetic orientation (Avens, 2003; Putman et al., 2015b), and scent (Shine et al., 2004). Any effect of masking may be mediated by reliance on other environmental inputs.

3.8.3.2.1.5 Behavioral Reactions

There are no observations of behavioral reactions by aquatic reptiles to exposure to explosive sounds and energy. Impulsive signals, particularly at close range, have a rapid rise time and higher instantaneous peak pressure than other signal types, making them more likely to cause startle responses or avoidance responses. Although explosive sources are more energetic than air guns, the few studies of sea turtles' responses to air guns may show the types of behavioral responses that sea turtles may have towards explosions. General research findings regarding behavioral reactions from sea turtles due to exposure to impulsive sounds, such as those associated with explosions, are discussed in detail in Behavioral Reactions to Impulsive Sound Sources under Section 3.8.3.1 (Acoustic Stressors). For this analysis, it is assumed that these guidelines would also apply to crocodilians and terrapins.

3.8.3.2.1.6 Long-Term Consequences

For reptiles present in the Study Area, long-term consequences to individuals and populations due to acoustic exposures have not been studied. Therefore, long-term consequences to reptiles due to explosive exposures are considered following Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Long-term consequences to a population are determined by examining changes in the population growth rate. Physical effects that could lead to a reduction in the population growth rate include mortality or injury, which could remove animals from the reproductive pool, and permanent hearing impairment, which could impact navigation. The long-term consequences due to individual behavioral reactions and short-term instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies. It is more likely that any long-term consequences to an individual would be a result of costs accumulated over a season, year, or life stage due to multiple behavioral or stress responses resulting from exposures to multiple stressors over significant periods of time. Conversely, some reptiles may habituate to or become tolerant of repeated acoustic exposures over time, learning to ignore a stimulus that in the past did not accompany any overt threat. For example, loggerhead sea turtles exposed to air guns with a source SPL of 179 dB re 1 µPa initially exhibited avoidance reactions. However, they may have habituated to the sound source after multiple exposures since a habituation behavior was retained when exposures were separated by several days (Moein Bartol et al., 1995). More research is needed to better understand the long-term consequences of human-made noise on reptiles, although intermittent exposures are assumed to be less likely to have lasting consequences.

3.8.3.2.2 Impacts from Explosives

This section analyzes the impacts on reptiles due to in-water explosions that result from Navy training and testing activities, synthesizing the background information presented above.

3.8.3.2.2.1 Methods for Analyzing Impacts from Explosives

Potential impacts considered are mortality, injury, hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior. The Navy's quantitative analysis to determine impacts to sea turtles and marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. The steps of this quantitative analysis are described in Section 3.0.1.2 (Navy's Quantitative Analysis to Determine Impacts to Sea Turtles and Marine Mammals), which takes into account:

- criteria and thresholds used to predict impacts from explosives (see below);
- the density and spatial distribution of sea turtles; and
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation and explosive energy when estimating the received sound level and pressure on the animals.

A further detailed explanation of this analysis is provided in the technical report titled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018).

Since crocodilians and terrapins have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that crocodilians and terrapins would react similarly to explosions as sea turtles.

Criteria and Thresholds used to Predict Impacts from Explosives

Mortality and Injury from Explosives

As discussed above in Section 3.8.3.2.1.1 (Injury), two metrics have been identified as predictive of injury: impulse and peak pressure. Peak pressure contributes to the "crack" or "stinging" sensation of a blast wave, compared to the "thump" associated with received impulse. Older military reports documenting exposure of human divers to blast exposure generally describe peak pressure exposures around 100 psi (237 dB re 1 µPa SPL peak) to feel like slight pressure or stinging sensation on skin, with no enduring effects (Christian & Gaspin, 1974).

Two sets of thresholds are provided for use in non-auditory injury assessment. The exposure thresholds are used to estimate the number of animals that may be affected during Navy training and testing activities (Table 3.8-5). The thresholds for the farthest range to effect are based on the received level at which 1 percent risk is predicted and are useful for assessing mitigation effectiveness. Increasing animal mass and increasing animal depth both increase the impulse thresholds (i.e., decrease susceptibility), whereas smaller mass and decreased animal depth reduce the impulse thresholds (i.e., increase susceptibility). For impact assessment, sea turtle populations are assumed to be 5 percent adult and 95 percent sub-adult. This adult to sub-adult population ratio is estimated from what is known about the population age structure for sea turtles. Sea turtles typically lay multiple clutches of 100 or more eggs with little parental investment and generally have low survival in early life. However, sea turtles that are able to survive past early life generally have high age-specific survival in later life.

Table 3.8-5: Criteria to Quantitatively Assess Non-Auditory Injury due to Underwater Explosions

Impact Category	Impact Threshold	Threshold for Farthest Range to Effect[2]
Mortality[1]	$144M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Injury[1]	$65.8\mathrm{M}^{1/3}\left(1+\frac{\mathrm{D}}{10.1}\right)^{1/6}$ Pa-s	$47.5\mathrm{M}^{1/3}\left(1+\frac{\mathrm{D}}{10.1}\right)^{1/6}$ Pa-s
	243 dB re 1 µPa SPL peak	237 dB re 1 µPa SPL peak

[1] Impulse delivered over 20% of the estimated lung resonance period. See U.S. Department of the Navy (2017).
[2] Threshold for 1% risk used to assess mitigation effectiveness.
Note: dB re 1 µPa = decibels referenced to 1 micropascal, SPL = sound pressure level

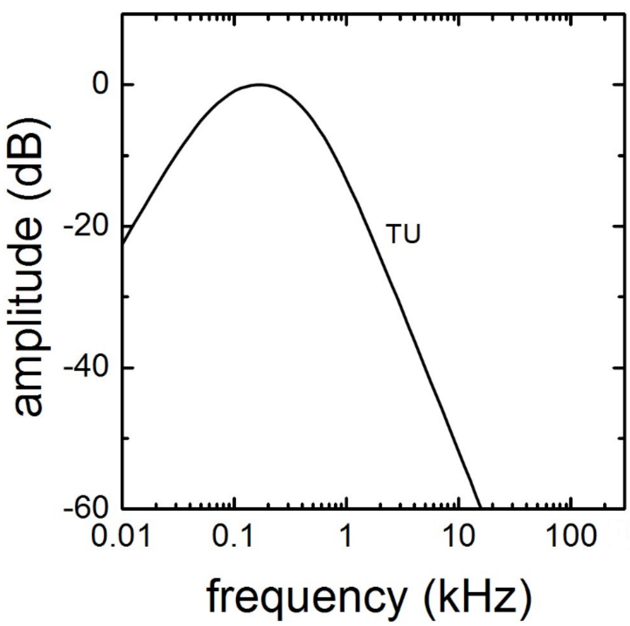
The derivation of these injury criteria and the species mass estimates are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017).

When explosive munitions (e.g., a bomb or missile) detonates, fragments of the weapon are thrown at high velocity from the detonation point, which can injure or kill sea turtles if they are struck. Risk of fragment injury reduces exponentially with distance as the fragment density is reduced. Fragments underwater tend to be larger than fragments produced by in-air explosions (Swisdak & Montanaro, 1992). Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat. On the other hand, the blast wave from an explosive detonation moves efficiently through the seawater. Because the ranges to mortality and injury due to exposure to the blast wave are likely to far exceed the zone where fragments could injure or kill an animal, the above thresholds are assumed to encompass risk due to fragmentation.

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used. Auditory weighting functions are mathematical functions that adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges with less or no auditory sensitivity. The adjusted received sound level is referred to as a weighted received sound level.

The auditory weighting function for sea turtles is shown in Figure 3.8-20. The derivation of this weighting function is described in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017). The frequencies around the top portion of the function, where the amplitude is closest to zero, are emphasized, while the frequencies below and above this range (where amplitude declines) are de-emphasized, when summing acoustic energy received by a sea turtle.

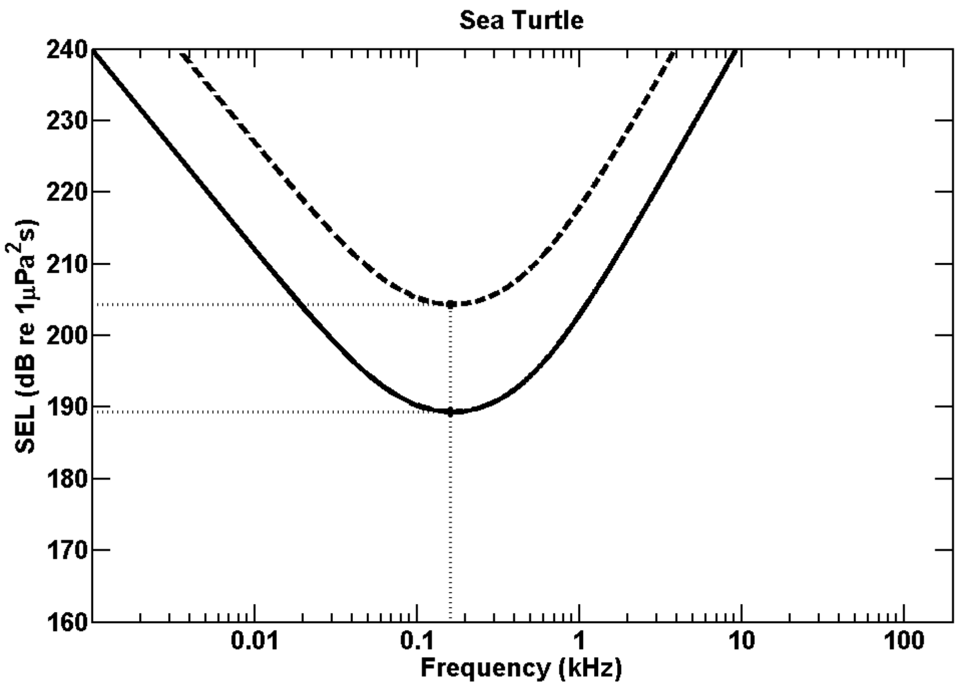


Source: U.S. Department of the Navy (2017)
Notes: dB: decibels; kHz: kilohertz; TU: sea turtle hearing group

Figure 3.8-20: Auditory Weighting Function for Sea Turtles

Hearing Loss from Explosives

No studies of hearing loss have been conducted on sea turtles. Therefore, sea turtle susceptibility to hearing loss due to an acoustic exposure is evaluated using knowledge about sea turtle hearing abilities in combination with non-impulsive auditory effect data from other species (marine mammals and fish). This yields sea turtle exposure functions, shown in Figure 3.8-21, which are mathematical functions that relate the SELs for onset of TTS or PTS to the frequency of the sonar sound exposure. The derivation of the sea turtle exposure functions are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017).



Notes: kHz: kilohertz; SEL: Sound Exposure Level, dB re 1 μPa²s = decibels referenced to 1 micropascal squared second. The solid black curve is the exposure function for TTS onset and the dashed black curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL thresholds and most-sensitive frequency for TTS and PTS.

Figure 3.8-21: TTS and PTS Exposure Functions for Impulsive Sounds

For impulsive sounds, hearing loss in other species has also been observed to be related to the unweighted peak pressure of a received sound. Because this data does not exist for sea turtles, unweighted peak pressure thresholds for TTS and PTS were developed by applying relationships observed between impulsive peak pressure TTS thresholds and auditory sensitivity in marine mammals to sea turtles. This results in dual-metric hearing loss criteria for sea turtles for impulsive sound exposure: the SEL-based exposure functions in Figure 3.8-21 and the peak pressure thresholds in Table 3.8-6. The derivation of the sea turtle impulsive peak pressure TTS and PTS thresholds are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017).

Table 3.8-6: TTS and PTS Peak Pressure Thresholds Derived for Sea Turtles Exposed to Impulsive Sounds

Auditory Effect	***Unweighted Peak Pressure Threshold***
TTS	226 dB re 1 μPa SPL peak
PTS	232 dB re 1 μPa SPL peak

Notes: dB re 1 μPa = decibels referenced to 1 micropascal, PTS = permanent threshold shift, SPL = sound pressure level, TTS = temporary threshold shift

Accounting for Mitigation

The Navy implements mitigation measures (described in Chapter 5, Mitigation) during explosive activities, including delaying detonations when a sea turtle or marine mammal is observed in the mitigation zone. The mitigation zones encompass the estimated ranges to mortality for a given explosive. Therefore, the impact analysis quantifies the potential for mitigation to reduce the risk of mortality due to exposure to explosives. Two factors are considered when quantifying the effectiveness of mitigation: (1) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., active sonar) allows for observation of the mitigation zone prior to and during the activity; and (2) the sightability of each species that may be present in the mitigation zone, which is determined by species-specific characteristics and the viewing platform. A detailed explanation of the analysis is provided in the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (U.S. Department of the Navy, 2018).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation is feasible, model-estimated mortality is considered mitigated to the level of injury. The impact analysis does not analyze the potential for mitigation to reduce TTS or behavioral effects, even though mitigation could also reduce the likelihood of these effects. In practice, mitigation also protects all unobserved (below the surface) animals in the vicinity, including other species, in addition to the observed animal. However, the analysis assumes that only animals sighted at the water surface would be protected by the applied mitigation. The analysis, therefore, does not capture the protection afforded to all marine species that may be near or within the mitigation zone.

3.8.3.2.2.2 Impact Ranges for Explosives

Ranges to effect (see Table 3.8-7 through Table 3.8-10) were developed in the Navy Acoustic Effects Model based on the thresholds for TTS, PTS, injury, and mortality discussed above.

Table 3.8-7: Ranges to Mortality for Sea Turtles Exposed to Explosives as a Function of Animal Mass[1]

Bin	*Animal Mass Intervals (kg)*[1,2]				
	10	***50***	***100***	***150***	***300***
E1	3 (2–3)	0 (0–2)	0 (0–0)	0 (0–0)	0 (0–0)
E2	4 (3–4)	2 (2–3)	1 (0–2)	1 (0–2)	0 (0–0)
E3	8 (6–10)	5 (4–6)	4 (3–4)	3 (3–4)	2 (2–2)
E4	14 (0–30)	9 (0–19)	7 (0–15)	6 (4–12)	5 (3–8)
E5	13 (11–30)	8 (7–15)	7 (6–12)	6 (5–10)	4 (4–7)
E6	18 (14–50)	12 (9–30)	10 (7–23)	8 (7–19)	6 (5–13)
E7	69 (55–85)	40 (35–45)	30 (25–35)	25 (24–30)	19 (18–21)
E8	47 (0–100)	30 (0–55)	23 (0–40)	20 (0–30)	16 (9–21)
E9	32 (30–55)	23 (22–25)	19 (18–20)	17 (16–18)	13 (12–13)
E10	59 (35–190)	26 (25–40)	24 (21–35)	21 (19–35)	16 (15–25)
E11	213 (180–400)	135 (120–210)	105 (100–170)	92 (85–140)	63 (55–100)
E12	133 (50–320)	46 (30–150)	27 (25–35)	25 (25–30)	20 (19–21)
E16	931 (800–1,025)	676 (600–850)	538 (525–550)	485 (470–500)	376 (370–390)
E17	1,359 (1,025–2,025)	1,077 (900–1,275)	929 (800–1,025)	841 (750–925)	728 (675–850)

[1] Ranges based on the mortality impact threshold (see Criteria and Thresholds Used to Predict Impacts from Explosives) in Section 3.8.3.2.2.1 (Methods for Analyzing Impacts from Explosives).

[2] Average distance (m) to mortality is depicted above the minimum and maximum distances which are in parentheses.

Table 3.8-8: Ranges to Non-Auditory Injury[1] (in meters) for Sea Turtles Exposed to Explosives as a Function of Animal Mass

Bin	*Animal Mass Intervals (kg)*[1,2]				
	10	*50*	*100*	*150*	*300*
E1	12 (11–13)	12 (11–13)	12 (11–13)	12 (11–13)	12 (11–13)
E2	15 (15–16)	15 (15–16)	15 (15–16)	15 (15–16)	15 (15–16)
E3	25 (25–40)	25 (25–40)	25 (25–40)	25 (25–40)	25 (25–40)
E4	30 (0–65)	30 (0–55)	30 (0–55)	30 (9–55)	30 (7–55)
E5	41 (30–70)	41 (30–70)	41 (30–70)	41 (30–70)	41 (30–70)
E6	53 (40–130)	53 (40–90)	53 (40–90)	53 (40–90)	53 (40–90)
E7	166 (110–190)	94 (75–110)	92 (75–110)	92 (75–110)	92 (75–110)
E8	107 (0–230)	88 (0–130)	88 (0–130)	88 (19–130)	88 (17–130)
E9	119 (90–300)	119 (90–140)	119 (90–130)	119 (90–130)	119 (90–130)
E10	169 (90–480)	139 (90–270)	139 (90–190)	139 (90–160)	139 (90–160)
E11	436 (310–1,275)	284 (230–525)	223 (190–500)	192 (170–500)	191 (170–500)
E12	300 (140–675)	188 (140–400)	188 (140–320)	188 (140–270)	188 (140–220)
E16	1,460 (1,275–2,025)	1,146 (975–1,775)	962 (825–1,775)	888 (775–1,775)	844 (650–1,775)
E17	2,520 (1,275–4,275)	1,751 (1,275–3,025)	1,442 (1,275–3,025)	1,414 (1,025–3,025)	1,414 (1,025–3,025)

[1] Ranges based on the injury impact threshold (see Criteria and Thresholds Used to Predict Impacts from Explosives) in Section 3.8.3.2.2.1 Methods for Analyzing Impacts from Explosives).

[2] Average distance (m) to non-auditory injury is depicted above the minimum and maximum distances, which are in parentheses. The ranges depicted are the further of the ranges for impulse or peak pressure thresholds for an explosive bin and animal mass interval combination.

Table 3.8-9: Peak Pressure Based Ranges to PTS and TTS for Sea Turtles Exposed to Explosives

Range to Effects for Explosives Bin: Sea Turtles[1]			
Bin	***Source Depth (m)***	***PTS***	***TTS***
E1	0.1	36 (30–60)	66 (50–100)
E2	0.1	44 (40–60)	70 (60–85)
E3	18.25	80 (80–110)	152 (140–230)
E4	15	111 (100–180)	220 (190–440)
	19.8	101 (100–110)	198 (190–250)
	198	85 (65–110)	181 (170–220)
E5	0.1	116 (75–140)	210 (100–250)
E6	0.1	144 (95–170)	257 (130–320)
	30	218 (160–450)	436 (300–1,275)
E7	15	321 (250–410)	660 (500–850)
E8	0.1	243 (130–320)	403 (190–525)
	45.75	334 (280–775)	696 (500–1,775)
	305	250 (210–310)	508 (490–625)
E9	0.1	350 (230–400)	563 (330–750)
E10	0.1	389 (180–925)	619 (320–1,275)
E11	18.5	715 (480–2,025)	1,350 (800–3,775)
	45.75	761 (525–1,775)	1,399 (925–3,525)
E12	0.1	510 (310–675)	797 (460–2,025)
E16	61	2,500 (1,275–5,775)	3,761 (1,275–9,275)
E17	61	3,097 (1,275–8,275)	4,735 (1,525–10,275)

[1]Average distance (m) to PTS and TTS are depicted above the minimum and maximum distances which are in parentheses. Values depict the maximum range produced by the peak pressure metric.

Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

Table 3.8-10: SEL Based Ranges to PTS and TTS for Sea Turtles Exposed to Explosives

Range to Effects for Explosives: Sea Turtles[1]				
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**
E1	0.1	1	0 (0–0)	0 (0–0)
		20	0 (0–0)	2 (2–4)
E2	0.1	1	0 (0–0)	0 (0–0)
		2	0 (0–0)	0 (0–0)
E3	18.25	1	3 (3–3)	17 (16–19)
		50	25 (23–25)	145 (130–220)
E4	15	1	5 (5–8)	41 (40–50)
		5	13 (12–17)	99 (90–110)
	19.8	2	7 (7–7)	50 (50–50)
	198	2	4 (0–7)	18 (0–35)
E5	0.1	25	6 (6–14)	41 (25–160)
E6	0.1	1	2 (2–3)	11 (10–15)
	30	1	16 (13–24)	129 (95–360)
E7	15	1	51 (45–55)	361 (330–390)
E8	0.1	1	6 (5–11)	60 (25–180)
	45.75	1	40 (40–65)	308 (260–725)
	305	1	15 (0–35)	128 (55–190)
E9	0.1	1	9 (9–20)	160 (40–350)
E10	0.1	1	15 (13–25)	207 (50–625)
E11	18.5	1	229 (170–440)	1,474 (750–4,025)
	45.75	1	179 (170–260)	1,143 (700–2,775)
E12	0.1	1	25 (18–120)	367 (80–900)

Table 3.8-10: SEL Based Ranges to PTS and TTS for Sea Turtles Exposed to Explosives (continued)

Range to Effects for Explosives: Sea Turtles[1]				
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**
E16	61	1	1,059 (900–1,525)	5,257 (1,525–10,525)
E17	61	1	1,869 (1,275–2,775)	13,443 (7,775–23,275)

[1] Average distance (m) to PTS and TTS are depicted above the minimum and maximum distances which are in parentheses. Values depict the maximum range produced by the SEL metric.

Notes: PTS = permanent threshold shift, TTS = temporary threshold shift

Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts to sea turtles from explosives as described in Section 3.8.3.2.2.1 (Methods for Analyzing Impacts from Explosives) are discussed below. Estimated numbers of potential impacts from the quantitative analysis for each species of sea turtle from exposure to explosive energy and sound for training and testing activities are presented below. The most likely regions and activity categories from which the impacts could occur are displayed in the figures for each species of sea turtle. Additionally, results of Ship Shock Trial are presented separately in the section for impacts due to testing. There is a potential for impacts to occur anywhere within the Study Area where sound and energy from explosives and the species overlap, although only areas or categories where 0.5 percent of the impact, or greater, are estimated to occur are graphically represented on the species specific figures below. All (i.e., grand total) estimated impacts are included in the graphics, regardless of region or category.

The numbers of activities planned can vary slightly from year-to-year. Results are presented for a maximum explosive use year; however, during most years, explosive use would be less resulting in fewer potential impacts. The number of explosives used are described in Section 3.0.3.3.2 (Explosive Stressors). Impacts to crocodilians and terrapins are discussed qualitatively below as appropriate.

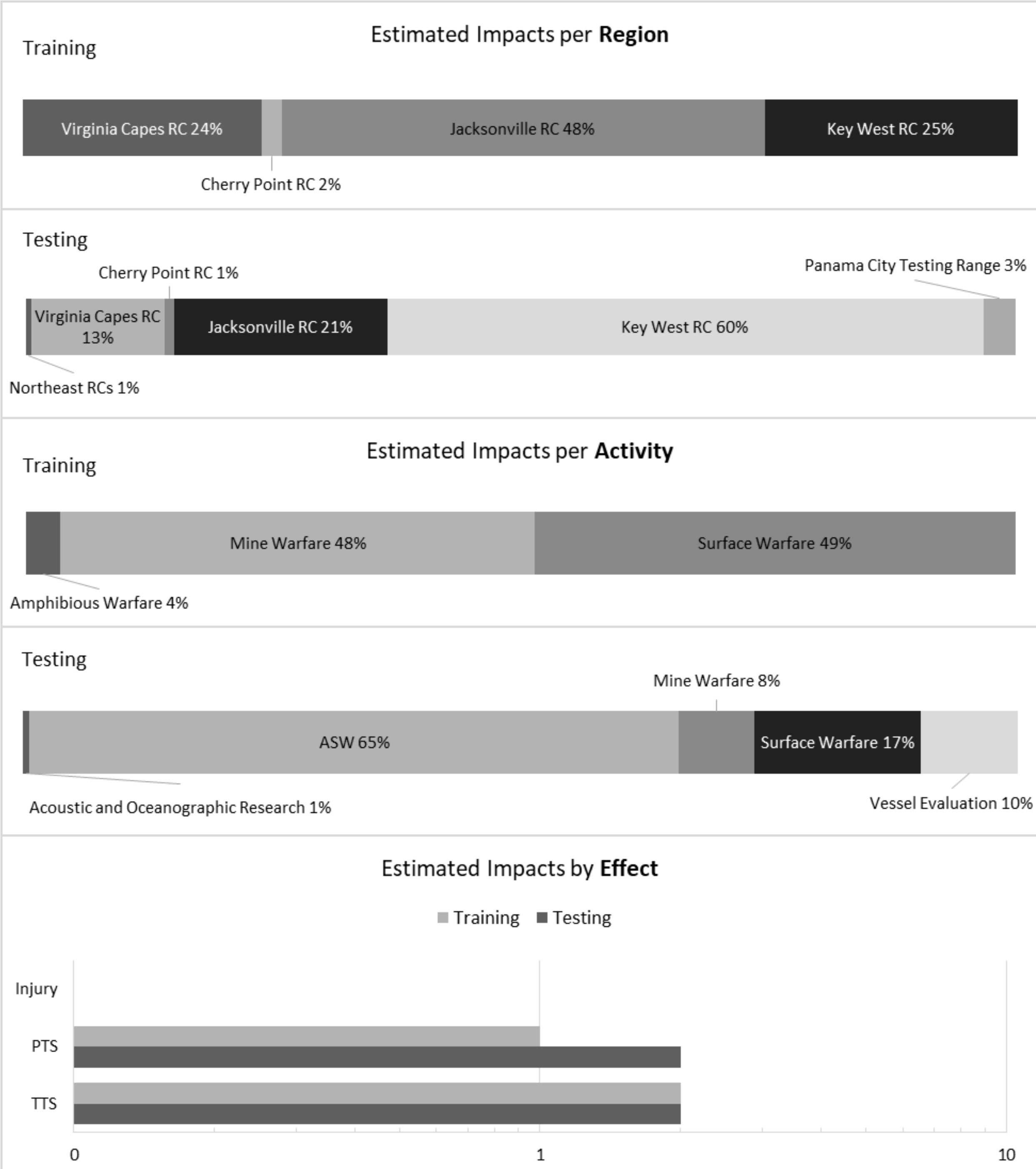
3.8.3.2.2.3 Impacts from Explosives under Alternative 1

Impacts from Explosives under Alternative 1 for Training Activities

Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during training under Alternative 1 are provided in Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during training under Alternative 1 are shown in Section 3.0.3.3.4.2 (Military Expended Materials). Under Alternative 1, there could be fluctuation in the amount of explosions that could occur annually, although potential impacts would be similar from year to year.

Training activities involving explosions would typically be conducted in the range complexes, with greater occurrence in the Virginia Capes and Jacksonville Range Complexes. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore.

The estimated impacts on sea turtles from explosives during training activities presented in Figure 3.8-22 through Figure 3.8-25 are for the maximum anticipated training year under Alternative 1 (for impact tables, see Appendix E, Acoustic Impact Tables). Under Alternative 1, it is possible that impacts would be slightly reduced in some years, as explosive use would fluctuate.



Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex.

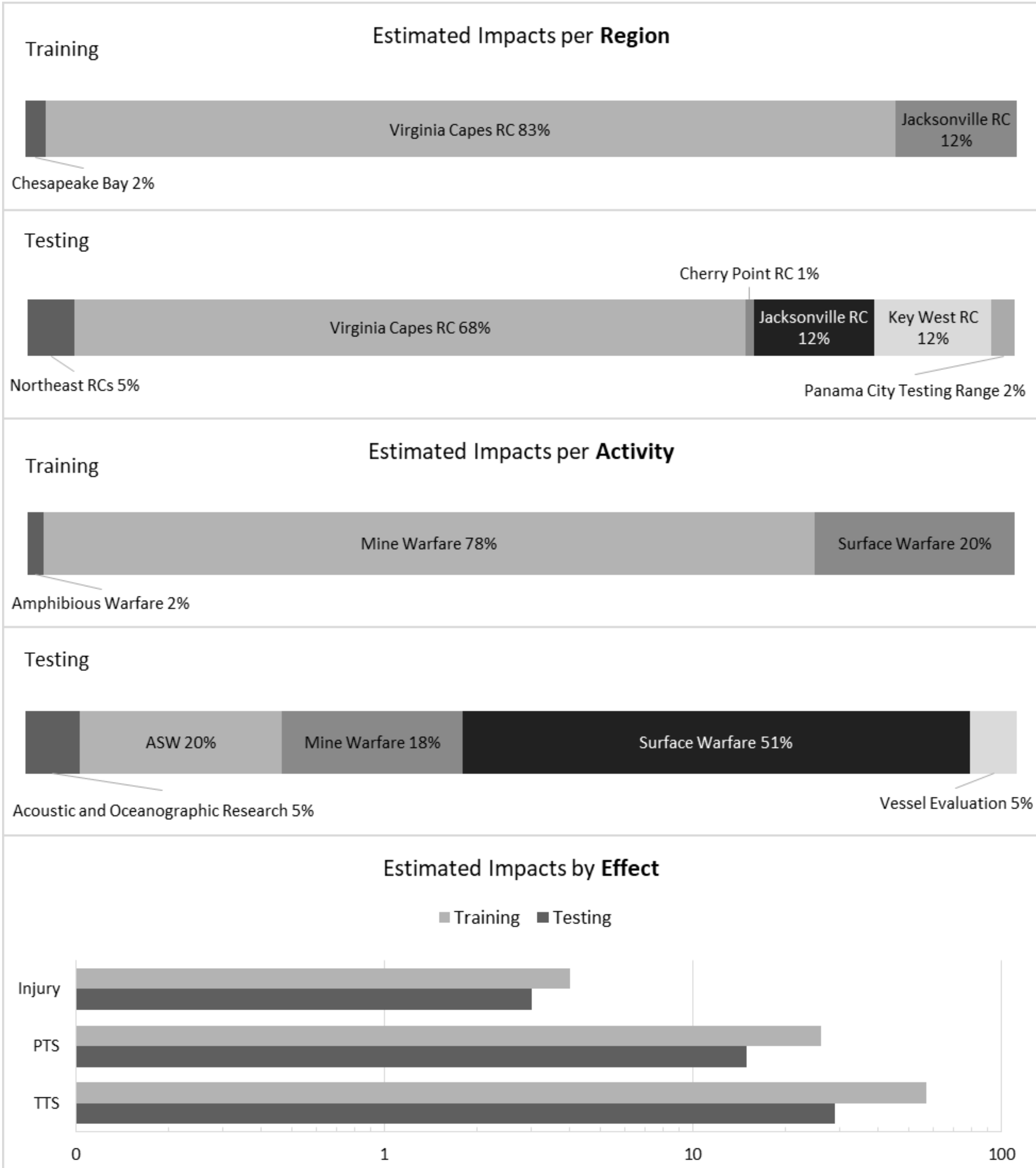
Figure 3.8-22: Green Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing under Alternative 1 (Excluding Full Ship Shock Trials)

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-23: Kemp's Ridley Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing under Alternative 1 (Excluding Full Ship Shock Trials)

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-24: Leatherback Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing under Alternative 1 (Excluding Full Ship Shock Trials)



Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-25: Loggerhead Turtle Impacts Estimated per Year from the Maximum Number of Explosions during Training and Testing under Alternative 1 (Excluding Full Ship Shock Trials)

As shown in the above estimates, the quantitative analysis estimates that a small number of green, Kemp's ridley, leatherback, and loggerhead turtles would be exposed to levels of explosive sound and energy that could cause TTS and PTS, some loggerhead turtles would be injured, and no sea turtles would be killed. The quantitative analysis predicts that no hawksbill sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury during training activities under Alternative 1. Fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category.

Threshold shifts and injuries could reduce the fitness of an individual animal, causing a reduction in foraging success, reproduction or increased susceptibility to predators. This reduction in fitness would be temporary for recoverable impacts, such as TTS. There could be long-term consequences to some individuals. However, no population-level impact is expected due to the low number of estimated injuries for any sea turtle species relative to total population size.

As discussed in Section 5.3.3 (Explosive Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb) if a sea turtle is observed in the mitigation zone whenever and wherever applicable activities occur. In addition to procedural mitigation, the Navy will implement mitigation within mitigation areas to: (1) avoid or reduce potential impacts from explosives on sea turtles in nearshore waters of the Navy Cherry Point Range Complex during nesting season (see Section 5.4.3, Mitigation Areas off the Mid-Atlantic and Southeastern United States), and (2) avoid or reduce potential impacts on seafloor resources throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). Mitigation for seafloor resources will help the Navy further avoid or reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, live hard-bottom, artificial reefs, submerged aquatic vegetation, and shipwrecks.

Reptile hearing is less sensitive than other marine animals (i.e., marine mammals), and the role of their underwater hearing is unclear. Reptiles' limited hearing range (<2 kHz) is most likely used to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach that may be important for identifying their habitat. Recovery from a hearing threshold shift begins almost immediately after the noise exposure ceases. A temporary threshold shift is expected to take a few minutes to a few days, depending on the severity of the initial shift, to fully recover (U.S. Department of the Navy, 2017). If any hearing loss remains after recovery, that remaining hearing threshold shift is permanent. Because explosions produce broadband sounds with low-frequency content, hearing loss due to explosive sound could occur across a sea turtle's very limited hearing range, reducing the distance over which relevant sounds, such as beach sounds, may be detected for the duration of the threshold shift.

Some reptiles may behaviorally respond to the sound of an explosive. A reptile's behavioral response to a single detonation or explosive cluster is expected to be limited to a short-term startle response, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (see Section 3.8.3.2.2.1, Methods for Analyzing Impacts from Explosives) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. Because the duration of most explosive events is brief, the potential for masking is low. In fact, the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions. This can also be assumed for crocodilians and terrapins.

A physiological stress response is assumed to accompany any injury, hearing loss, or behavioral reaction. A stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. While the stress response is a normal function for an animal dealing with natural stressors in their environment, chronic stress responses could reduce an individual's fitness. Due to the low number of estimated impacts, it is not likely that any reptile would experience repeated stress explosive impacts.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for sea turtle populations would not be expected.

The use of explosives during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. Explosives during training activities would have a pathway to impact the physical and biological features of the constricted migratory habitat and *Sargassum* habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from military activity (79 *Federal Register* 39855). The impacts on these habitats would be considered insignificant with no discernible impact on the conservation function of the physical and biological features as activity would not prevent a turtle from migrating, as explosions are brief in nature.

In addition to sea turtles, crocodilians and terrapins may overlap with explosions occurring in inshore areas. The only training activities involving explosions that would occur in ESA-listed American crocodile habitat involve the underwater detonation of small (2-lb.) charges in enclosed areas of Truman Harbor and Demolition Key in the Key West Range Complex. Alligators and terrapins may also be present in Truman Harbor and Demolition Key, and terrapins may be present in areas with detonations occurring in the inshore waters of the lower Chesapeake Bay. Impacts, if any, to crocodilians and terrapins would be low due to the low probability of occurrence and nature of the confined and restricted detonation locations. The use of explosives would not overlap with American crocodile critical habitat in Florida Bay, which encompasses creeks, canals, and swamps.

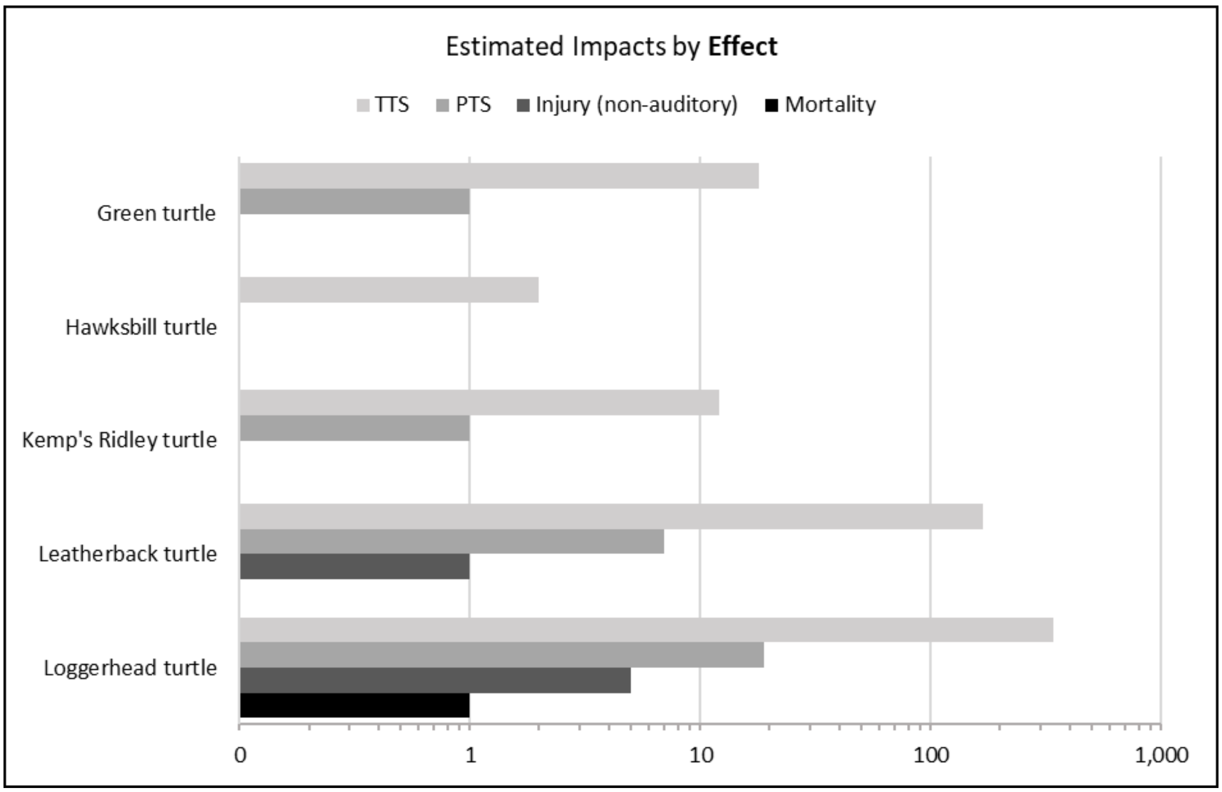
Pursuant to the ESA, the use of explosives during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles and the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle or American crocodile critical habitat. The use of explosives during training activities may affect loggerhead constricted migratory and *Sargassum* habitats in the mid-Atlantic and southeast regions. The Navy has consulted with NMFS and USFWS as required by section 7(a)(2) of the ESA.

Impacts from Explosives under Alternative 1 for Testing Activities

Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during testing under Alternative 1 are provided in Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during testing under Alternative 1 are shown in 3.0.3.3.4.2 (Military Expended Materials).

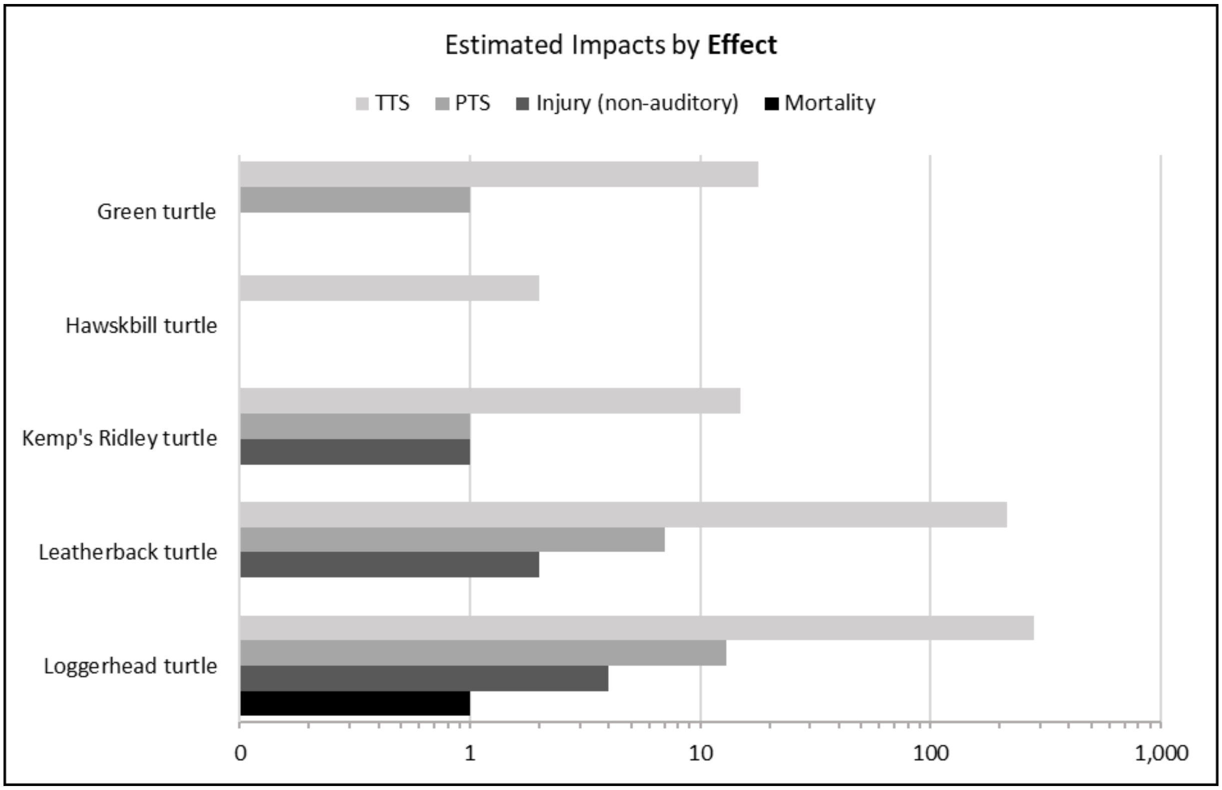
Under Alternative 1, the number of testing activities using explosives could fluctuate annually. Testing activities involving explosions would typically be conducted on range complexes and on testing ranges, and do not occur in inshore waters. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore. Very few activities would be conducted in the Naval Undersea Warfare Center Division, Newport Testing Range, and the Naval Surface Warfare Center Carderock Division, South Florida Ocean Measurement Facility Testing Range.

The estimated impacts on sea turtles from explosives during testing activities presented in Figure 3.8-22 through Figure 3.8-25 are for the maximum anticipated testing year under Alternative 1, excluding ship shock trials (for impact tables, see Appendix E, Acoustic Impact Tables). The estimated impacts on sea turtles from a small ship shock trial and a large ship shock trial are shown in Figure 3.8-26 and Figure 3.8-27. The results shown include the impacts due to all four separate detonations that constitute a single full ship shock trial. Small Ship Shock Trials could take place any season within the deep offshore water of the Virginia Capes Range Complex or in the spring, summer, or fall within the Jacksonville Range Complex and would occur up to three times over a 5-year period. The Large Ship Shock Trial could take place in the Jacksonville Range Complex during the spring, summer, or fall and during any season within the deep offshore water of the Virginia Capes or Gulf of Mexico Range Complexes. The Large Ship Shock Trial would occur once over five years. In addition, no ship shock trials would be conducted in the Jacksonville Range Complex between November and April due to North Atlantic right whale calving season. The estimated impacts shown are the worst case for each species in any season at any of the possible ship shock trial locations; therefore, they over-estimate the actual potential for impacts.



Note: As shown in the estimates above, the quantitative analysis estimates that one loggerhead turtle could be killed and a small number of loggerhead and leatherback turtles could be injured.

Figure 3.8-26: Estimated Impacts on Sea Turtles from a Small Ship Shock Trial under Alternative 1



Note: As shown in the estimates above, the quantitative analysis estimates that one loggerhead turtle could be killed and a small number of most other sea turtle species could be injured.

Figure 3.8-27: Estimated Impacts on Sea Turtles from a Large Ship Shock Trial under Alternative 1

As shown in the above estimates, the quantitative analysis estimates that a small number of green, Kemp's ridley, loggerhead, and leatherback turtles would be exposed to levels of explosive sound and energy that could cause TTS and PTS, some loggerhead sea turtles would be injured, and no sea turtles would be killed, excluding ship shock trials. The quantitative analysis predicts that no hawksbill sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury during testing activities under Alternative 1, excluding ship shock trials. In Figure 3.8-22 to Figure 3.8-25, fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category. Additionally, the quantitative analysis estimates that one loggerhead turtle could be killed during a small ship shock trial and one during a large ship shock trial (Figure 3.8-26 and Figure 3.8-27). All sea turtle species present in the Study Area could be exposed to levels of explosive sound and energy that could cause TTS or PTS, and only Kemp's, leatherback, or loggerhead turtles could be injured during small or large ship shock trials.

Threshold shifts and injuries could affect the fitness of an individual animal, causing a reduction in foraging success, reproduction, or increased susceptibility to predators. This reduction in fitness would be temporary for recoverable impacts, such as TTS, but there could be long-term consequences to some individuals. However, no population-level impact would occur due to the low number of estimated injuries for any sea turtle species relative to total population size.

As discussed in Section 5.3.3 (Explosive Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb) if a sea turtle is observed in the mitigation zone whenever and wherever applicable activities occur. Navy also implements additional procedural mitigation during sea turtle nesting season in the Naval Surface Warfare Center, Panama City Division Testing Range during line charge testing events. In addition to procedural mitigation, the Navy will implement mitigation within mitigation areas to: (1) avoid or reduce potential impacts from explosives on sea turtles in nearshore waters of the Navy Cherry Point Range Complex during nesting season (see Section 5.4.3, Mitigation Areas off the Mid-Atlantic and Southeastern United States), and (2) avoid or reduce potential impacts on seafloor resources throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). Mitigation for seafloor resources will help the Navy further avoid or reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, live hard-bottom, artificial reefs, submerged aquatic vegetation, and shipwrecks.

The Navy also develops detailed ship shock mitigation plans prior to conducting ship shock trials. Ship shock trial procedural mitigations include pre-activity observation for sea turtles and floating vegetation that may indicate the possible presence of sea turtles in a large mitigation zone around the ship shock trial location, with delay or re-location if the site is deemed environmentally unsuitable, as described in Section 5.3.3.11 (Ship Shock Trials). These mitigations would reduce the potential for some exposures to high levels of explosive sound and energy.

Reptile hearing is less sensitive than other marine animals (i.e., marine mammals), and the role of their underwater hearing is unclear. Reptiles' limited hearing range (<2 kHz) is most likely used to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach that may be important for identifying their habitat. Recovery from a hearing threshold shift begins almost immediately after the noise exposure ceases. A temporary threshold shift is expected to take a few minutes to a few days, depending on the severity of the initial shift, to fully recover. If any hearing loss remains after recovery, that remaining hearing threshold shift is permanent. Because explosions produce broadband sounds with low-frequency content, hearing loss due to explosives could occur across a sea turtle's very limited hearing range, reducing the distance over which relevant sounds, such as beach sounds, may be detected for the duration of the threshold shift.

Some reptiles may behaviorally respond to the sound of an explosive. A reptile's behavioral response to a single detonation or explosive cluster is expected to be limited to a short-term (seconds to minutes) startle response, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (Section 3.8.3.2.2.1, Methods for Analyzing Impacts from Explosives) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure.

A physiological stress response is assumed to accompany any injury, hearing loss, or behavioral reaction. A stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. While the stress response is a normal function for an animal dealing with natural stressors in their environment, chronic stress responses could reduce an individual's fitness. Due to the low number of estimated impacts, there is a low likelihood that a reptile would experience repeated stress responses due to explosive impacts. Because the duration of most explosive events is brief, the potential for masking is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for sea turtle populations would not be expected.

The use of explosives during testing activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. Explosives during training activities would have a pathway to impact the physical and biological features of the constricted migratory habitat and *Sargassum* habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from military activity (79 *Federal Register* 39855). The impacts on these habitats would be considered insignificant with no discernible impact on the conservation function of the physical and biological features as activity would not prevent a turtle from migrating, as explosions are brief in nature.

Explosives would not be used in crocodilian, including the ESA-listed American crocodile, or terrapin habitats during testing activities. Additionally, the use of explosives would not overlap with American crocodile critical habitat in Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of explosives during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or on American crocodile critical habitat. The use of explosives during testing activities may affect loggerhead constricted migratory and *Sargassum* habitats in the mid-Atlantic and southeast regions. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.2.2.4 Impacts from Explosives under Alternative 2

Impacts from Explosives under Alternative 2 for Training Activities

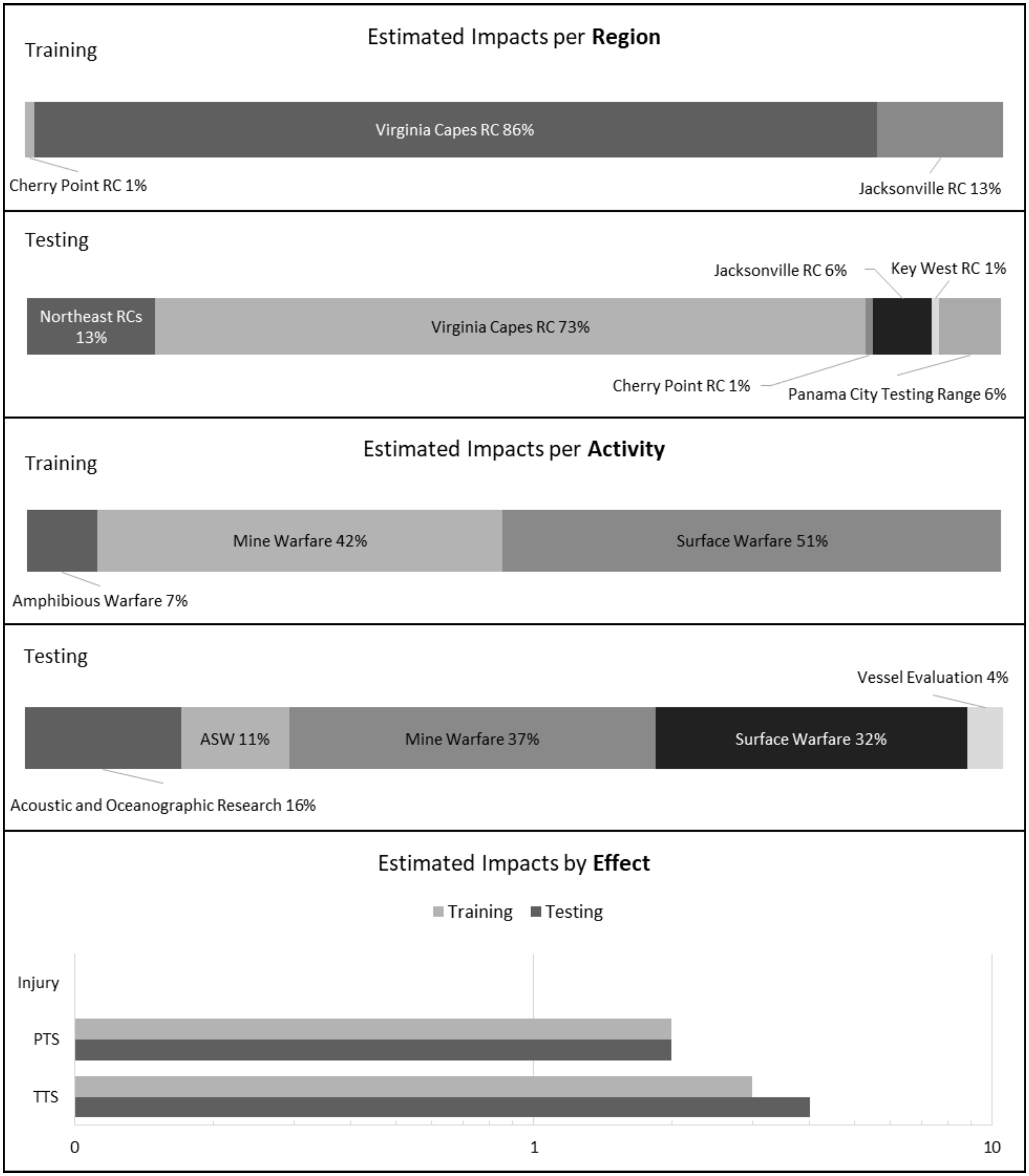
Under Alternative 2, the maximum number of training activities could occur every year. Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during training under Alternative 2 are provided in Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during training under Alternative 2 are shown in 3.0.3.3.4.2 (Military Expended Materials).

Training activities involving explosions would typically be conducted in the range complexes, with greater occurrence in the Virginia Capes and Jacksonville Range complexes. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore.

The estimated impacts on sea turtles from explosions during a maximum year of training under Alternative 2 are presented in Figure 3.8-28 to Figure 3.8-31. Estimated impacts for Alternative 2 are identical to those described in Section 3.8.3.2.2.3 (Impacts from Explosives Under Alternative 1).

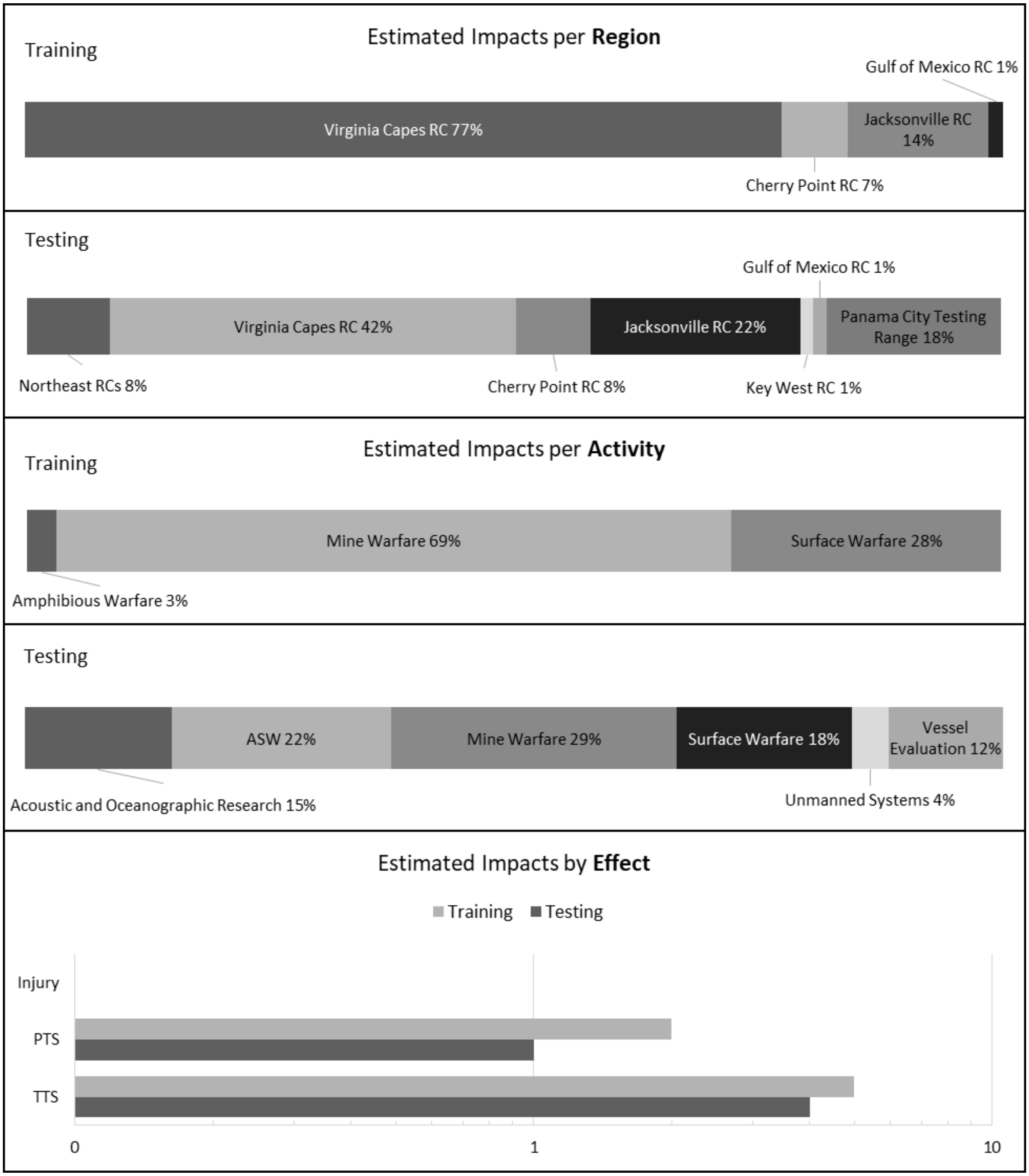
Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-28: Green Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing under Alternative 2 (Excluding Full Ship Shock Trials)



Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-29: Kemp's Ridley Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing under Alternative 2 (Excluding Full Ship Shock Trials)



Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-30: Leatherback Sea Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing under Alternative 2 (Excluding Full Ship Shock Trials)

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. ASW: Anti-Submarine Warfare; RC: Range Complex.

Figure 3.8-31: Loggerhead Sea Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing under Alternative 2 (Excluding Full Ship Shock Trials)

As shown in the above estimates, the quantitative analysis estimates that a small number of green, Kemp's ridley, leatherback, and loggerhead turtles would be exposed to levels of explosive sound and energy that could cause TTS and PTS, some loggerhead turtles would be injured, and no sea turtles would be killed. The quantitative analysis predicts that no hawksbill sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury during training activities under Alternative 2. Fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category.

Threshold shifts and injuries could reduce the fitness of an individual animal, causing a reduction in foraging success, reproduction, or increased susceptibility to predators. This reduction in fitness would be temporary for recoverable impacts, such as TTS, but there could be long-term consequences to some individuals. However, no population-level impact is expected due to the low number of estimated injuries for any sea turtle species relative to total population size.

As discussed in Section 5.3.3 (Explosive Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb) if a sea turtle is observed in the mitigation zone whenever and wherever applicable activities occur. In addition to procedural mitigation, the Navy will implement mitigation within mitigation areas to: (1) avoid or reduce potential impacts from explosives on sea turtles in nearshore waters of the Navy Cherry Point Range Complex during nesting season (see Section 5.4.3, Mitigation Areas off the Mid-Atlantic and Southeastern United States), and (2) avoid or reduce potential impacts on seafloor resources throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). Mitigation for seafloor resources will help the Navy further avoid or reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, live hard-bottom, artificial reefs, submerged aquatic vegetation, and shipwrecks.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for sea turtle population would not be expected.

The use of explosives during training activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. Explosives during training activities would have a pathway to impact the physical and biological features of the constricted migratory habitat and *Sargassum* habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from military activity (79 *Federal Register* 39855). The impacts on these habitats would be considered insignificant with no discernible impact on the conservation function of the physical and biological features as activity would not prevent a turtle from migrating, as explosions are brief in nature.

In addition to sea turtles, crocodilians and terrapins may overlap with explosions occurring in inshore areas. The only training activities involving explosions that would occur in ESA-listed American crocodile habitat involves the underwater detonation of small (2-lb.) charges in enclosed areas of Truman Harbor and Demolition Key in the Key West Range Complex. Alligators and terrapins may also be present in Truman Harbor and Demolition Key, and terrapins may be present in areas with detonations occurring in the inshore waters of the lower Chesapeake Bay. Impacts, if any, to crocodilians and terrapins would be low due to the low probability of occurrence and nature of the confined and restricted detonation locations. The use of explosives would not overlap with American crocodile critical habitat in Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of explosives during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and may affect the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback sea turtle critical habitat or on American crocodile critical habitat. The use of explosives during training activities may affect loggerhead constricted migratory and *Sargassum* habitats in the mid-Atlantic and southeast regions.

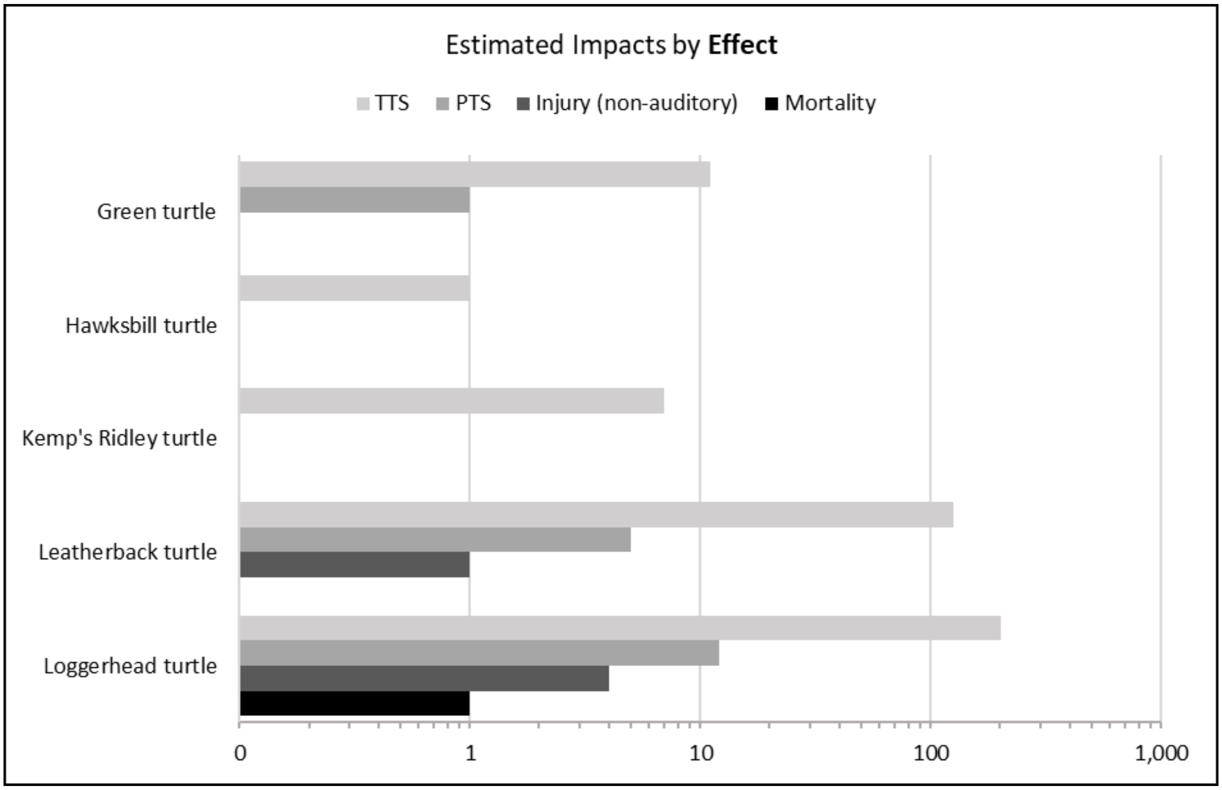
Impacts from Explosives under Alternative 2 for Testing Activities

Under Alternative 2, the maximum number of testing activities could occur every year. Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during testing under Alternative 2 are provided in Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during testing under Alternative 2 are shown in 3.0.3.3.4.2 (Military Expended Materials).

Testing activities involving explosions would typically be conducted on range complexes and on testing ranges, and do not occur in inshore waters. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore.

Annual use of explosives during testing under Alternative 2 is nearly identical to the maximum year of testing under Alternative 1. Therefore, estimated impacts under Alternative 2 are nearly identical to those described in Section 3.8.3.2.2.3 (Impacts from Explosives under Alternative 1).

The estimated impacts on sea turtles from explosives during testing activities presented in Figure 3.8-28 through Figure 3.8-31 are for the maximum anticipated testing year under Alternative 2, excluding ship shock trials (for impact tables, see Appendix E, Acoustic Impact Tables). The estimated impacts on sea turtles from a small ship shock trial are shown in Figure 3.8-32. No impacts were estimated for a large ship shock trial. Small ship shock trials could take place any season within the deep offshore water of the Virginia Capes Range Complex or in the spring, summer, or fall within the Jacksonville Range Complex and would occur up to three times over a five-year period. In addition, no ship shock trials would be conducted in the Jacksonville Range Complex between November and April due to North Atlantic right whale calving season. The estimated impacts shown are the worst case for each species in any season at any of the possible ship shock trial locations; therefore, they over-estimate the actual potential for impacts.



Note: As shown in the estimates above, the quantitative analysis estimates that one loggerhead turtle could be killed and a small number of loggerhead and leatherback turtle species could be injured.

Figure 3.8-32: Estimated Impacts on Sea Turtles from a Small Ship Shock Trial

As shown in Figure 3.8-28 through Figure 3.8-31, the quantitative analysis estimates that a small number of green, Kemp's ridley, leatherback, and loggerhead turtles would be exposed to levels of explosive sound and energy that could cause TTS and PTS, some loggerhead sea turtles would be injured, and no sea turtles would be killed, excluding ship shock trials. The quantitative analysis predicts that no hawksbill sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury during testing activities under Alternative 2, excluding ship shock trials. In Figure 3.8-28 to Figure 3.8-31, fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category. During a small ship shock trial, the quantitative analysis estimates that one loggerhead turtle could be killed (Figure 3.8-32). All sea turtle species present in the Study Area could be exposed to levels of explosive sound and energy that could cause TTS or PTS, and only leatherback or loggerhead turtles could be injured during a small ship shock trial.

Threshold shifts and injuries could affect the fitness of an individual animal, causing a reduction in foraging success, reproduction, or increased susceptibility to predators. This reduction in fitness would be temporary for recoverable impacts, such as TTS, but there could be long-term consequences to some individuals. However, no population-level impact would occur due to the low number of estimated injuries for any sea turtle species relative to total population size.

As discussed in Section 5.3.3 (Explosive Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb, ceasing explosive missile firing) if a sea turtle is observed in the mitigation zone whenever and wherever applicable activities occur. Navy also implements additional procedural mitigation during sea turtle nesting season in the Naval Surface Warfare Center, Panama City Division Testing Range during line charge testing events. In addition to procedural mitigation, the Navy will implement mitigation within mitigation areas to: (1) avoid or reduce potential impacts from explosives on sea turtles in nearshore waters of the Navy Cherry Point Range Complex during nesting season (see Section 5.4.3, Mitigation Areas off the Mid-Atlantic and Southeastern United States), and (2) avoid or reduce potential impacts on seafloor resources throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). Mitigation for seafloor resources will help the Navy further avoid or reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, live hard-bottom, artificial reefs, submerged aquatic vegetation, and shipwrecks.

The Navy also develops detailed ship shock mitigation plans prior to conducting ship shock trials. Ship shock trial procedural mitigations include pre-activity observation for sea turtles and floating vegetation that may indicate the possible presence of sea turtles in a large mitigation zone around the ship shock trial location, with delay or re-location if the site is deemed environmentally unsuitable, as described in Section 5.3 (Procedural Mitigation to be Implemented). These mitigations would reduce the potential for some exposures to high levels of explosive sound and energy.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences for sea turtle populations would not be expected.

The use of explosives during testing activities would not overlap with green, hawksbill, or leatherback turtle critical habitat around Culebra, Puerto Rico; Mona Island, Puerto Rico; and St. Croix Island, U.S. Virgin Islands respectively. Explosives during training activities would have a pathway to impact the physical and biological features of the constricted migratory habitat and *Sargassum* habitat in the mid-Atlantic and southeast regions by producing "noise pollution" from military activity (79 *Federal Register* 39855). The impacts on these habitats would be considered insignificant with no discernible impact on the conservation function of the physical and biological features as activity would not prevent a turtle from migrating, as explosions are brief in nature.

Explosives would not be used in crocodilian, including the ESA-listed American crocodile, or terrapin habitats during testing activities. The use of explosives would not overlap with American crocodile critical habitat in Florida Bay, which encompasses creeks, canals, and swamps.

Pursuant to the ESA, the use of explosives during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, and leatherback turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, or leatherback turtle critical habitat or American crocodile critical habitat. The use of explosives during testing activities may affect loggerhead constricted migratory and *Sargassum* habitats in the mid-Atlantic and southeast regions.

3.8.3.2.2.5 Impacts from Explosives under the No Action Alternative

Under the No-Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. 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.

3.8.3.3 Energy Stressors

This section analyzes the potential impacts of energy stressors used during training and testing activities within the Study Area. This section includes analysis of the potential impacts of: (1) in-water electromagnetic devices and (2) high-energy lasers. The potential for impact from electromagnetic energy created by kinetic energy weapons was determined to be low and contained on the surface vessel (Section 3.0.3.3.3.1, In-Water Electromagnetic Devices) and, therefore, will not be analyzed in this section. General discussion of impacts can also be found in Section 3.0.3.6.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities). Because energy stressors would not occur in habitats used by the American crocodile, the impacts that may potentially occur from energy stressors are limited to sea turtles, American alligators, and as diamondback terrapins.

3.8.3.3.1 Impacts from In-Water Electromagnetic Devices

For a discussion of the types of activities that create an electromagnetic field underwater, refer to Appendix B (Activity Stressor Matrices), and for information on locations and the number of activities proposed for each alternative, see Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices). The devices producing an electromagnetic field are towed or unmanned mine countermeasure systems. The electromagnetic field is produced to simulate a vessel's magnetic field. In an actual mine-clearing operation, the intent is that the electromagnetic field would trigger an enemy mine designed to sense a vessel's magnetic field.

Well over a century ago, electromagnetic fields were introduced into the marine environment within the Study Area from a wide variety of sources (e.g., power transmission cables), yet little is known about the potential impacts on marine life. There is consensus, however, that magnetic fields and other cues (e.g., visual cues), are important for sea turtle orientation and navigation (Lohmann et al., 1997; Putman et al., 2015b). Studies on behavioral responses to magnetic fields have been conducted on green and loggerhead sea turtles. Loggerheads were found to be sensitive to field intensities ranging from 0.005 to 4,000 microteslas, and green sea turtles were found to be sensitive to field intensities from 29.3 to 200 microteslas (Bureau of Ocean Energy Management, 2011). Because these data are the best available information, this analysis assumes that the responses would be similar for other sea turtle species. Sea turtles use geomagnetic fields to navigate at sea, and therefore changes in those fields could impact their movement patterns (Lohmann & Lohmann, 1996; Lohmann et al., 1997). Turtles in all life stages orient to the earth's magnetic field to position themselves in oceanic currents, and directional swimming presumably aided by magnetic orientation has been shown to occur in some sea turtles(Christiansen et al., 2016; Putman & Mansfield, 2015). This helps them locate seasonal feeding and breeding grounds and return to their nesting sites (Lohmann & Lohmann, 1996; Lohmann et al., 1997). Experiments show that sea turtles can detect changes in magnetic fields, which may cause them to deviate from their original direction (Lohmann & Lohmann, 1996; Lohmann et al., 1997). For example, Teuten et al. (2007) found that loggerhead hatchlings tested in a magnetic field of 52 microteslas swam eastward, and when the field was decreased to 43 microteslas, the hatchlings swam westward. Sea turtles also use nonmagnetic cues for navigation and migration, and these additional cues may compensate for variations in magnetic fields. Putman et al. (2015b) conducted experiments on loggerhead hatchlings and determined that electromagnetic fields may be more important for sea turtle navigation in areas that may constrain a turtle's ability to navigate (cold temperatures or displacement from a migration route). The findings of this study suggest that the magnetic orientation behavior of sea turtles is closely associated with ocean ecology and geomagnetic environment (Putman et al., 2015b).

Liboff (2015) determined that freshly hatched sea turtles are able to detect and use the local geomagnetic field as a reference point before embarking a post-hatchling migration. Liboff (2015) proposed that the information is transferred from the mother to the egg through some undetermined geomagnetic imprinting process (Liboff, 2015). Aspects of electromagnetic stressors that are applicable to marine organisms in general are described in Section 3.0.3.6.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

As stated in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), the static magnetic fields generated by electromagnetic devices used in training and testing activities are of relatively minute strength. The maximum strength of the magnetic field is approximately 2,300 microteslas, with the strength of the field decreasing further from the device. At a distance of 4 m from the source of a 2,300-microtesla magnetic field, the strength of the field is approximately 50 microteslas, which is within the range of the Earth's magnetic field (25 to 65 microteslas). At 8 m, the strength of the field is approximately 40 percent of the Earth's magnetic field, and only 10 percent at 24 m away from a 2,300 microtesla magnetic field at the source. At a distance of 200 m the magnetic field would be approximately 0.2 microteslas (U.S. Department of the Navy, 2005), which is less than 1 percent of the strength of the Earth's magnetic field. This is likely within the range of detection for sea turtle species, but at the lower end of the sensitivity range.

Sheridan (2010) confirmed high degrees of site fidelity among terrapins returning to natal beaches, along with low dispersal distances, suggesting that long-distance navigation is not required of terrapins, and they likely rely on other environmental cues (e.g., visual cues, shoreline shape, currents). Terrapins and alligators, however, like other reptiles (Brothers & Lohmann, 2015; Mathis & Moore, 1988; Putman et al., 2015b), likely detect electromagnetic fields and can use them in some degree for orientation. For inshore reptiles, however, other cues are likely more important.

3.8.3.3.1.1 Impacts from In-Water Electromagnetic Devices under Alternative 1

Impacts from In-Water Electromagnetic Devices under Alternative 1 for Training Activities

As discussed in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), offshore training activities that use in-water electromagnetic devices would occur within the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes (see Table 3.0-15). In addition, training activities that use in-water electromagnetic devices would occur within inshore waters surrounding Boston, Massachusetts; Earle, New Jersey; Delaware Bay, Delaware; Hampton Roads, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Savannah, Georgia; Kings Bay; Georgia; Mayport, Florida; Port Canaveral; Florida; Tampa, Florida; Beaumont, Texas; and Corpus Christi, Texas (see Table 3.0-23) In-water electromagnetic devices would be used in areas potentially inhabited by sea turtles, American alligators, and diamondback terrapins.

Sea turtles would be potentially exposed to electromagnetic fields in offshore areas and nearshore areas where electromagnetic devices are used. Sea turtles are expected to be highly dispersed in offshore waters, and co-occurrence with training events is unlikely even in the Navy Cherry Point Range Complex and Virginia Capes Range Complex where the density of training activities using in-water electromagnetic devices is the highest. If located in the immediate area (within about 200 m) where electromagnetic devices are being used, adult, sub-adult, juvenile, and hatchling sea turtles of all species could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential because of the low likelihood of a sea turtle occurring within 200 m of the device and the movement through the area of both the turtle and the device. In the event that an animal is exposed in these areas, a small behavioral disturbance (e.g., short disorientation) is unlikely to significantly impact an animal's behavior and fitness. Repeated exposures to animals are not anticipated as these offshore areas do not have resident animals year round. Given the very low number of events within inshore waters (see Table 3.0-23), the inshore water locations of where these devices would occur, and species' distribution, co-occurrence with individuals of any species is very unlikely, especially in northern inshore locations.

Potential impacts on sea turtles are not anticipated because any potential effects are likely limited to a few minor disturbances, which would be similar to natural stressors regularly occurring in the animal's life cycle. The electromagnetic devices used in training activities are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microteslas at 200 m from the source), (2) very localized potential impact area, and (3) temporary duration of the activities (hours). Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

American alligators may be exposed to electromagnetic fields in inshore training locations from North Carolina to Texas, while diamondback terrapins may be exposed to electromagnetic fields in all inshore training locations where electromagnetic devices are used under Alternative 1 (these locations are listed in Table 3.0-23). Electromagnetic fields generated by in-water training devices would likely have negligible effects on alligators and terrapins because of the (1) relatively low intensity of the magnetic fields generated (0.2 microteslas at 200 m from the source), (2) very localized potential impact area, (3) geography of inshore waters (e.g., mudflats, plants, islands, creeks) that likely further shield alligators and terrapins from electromagnetic fields, (4) temporary duration of the activities (hours), and (5) the reliance on other environmental cues for orientation. Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts for American alligators or diamondback terrapins.

Proposed training activities that use in-water electromagnetic devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that expend in-water electromagnetic devices would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas, but would occur in the following loggerhead sea turtle critical habitat year round: nearshore reproductive habitat, winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. In-water electromagnetic device use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the relatively weak strength of the electromagnetic fields created by these activities, the localized area potentially impacted by the electromagnetic fields, and the temporary duration of these activities.

Pursuant to the ESA, the use of electromagnetic devices during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and there would be no effect on

American crocodile critical habitat. The Navy has consulted with the NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from In-Water Electromagnetic Devices under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), under Alternative 1, offshore testing activities use in-water electromagnetic devices would occur within the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes, as well as the South Florida Ocean Measurement Facility, and the Naval Surface Warfare Center Panama City Testing Range (see Table 3.0-14). In addition, testing activities that use in-water electromagnetic devices would occur within inshore waters surrounding Little Creek, Virginia (see Table 3.0-15).

Only sea turtles and diamondback terrapins are analyzed for potential impacts for testing activities that use in-water electromagnetic devices under Alternative 1. For testing activities occurring within inshore waters near Little Creek, Virginia, most of the sea turtle species except the hawksbill sea turtle would be present. Given the limited location of where these devices would occur, and species' distribution in the area, which is limited to warmer months, co-occurrence with individuals is possible but unlikely in certain times of the year.

Sea turtles would be potentially exposed to electromagnetic fields in offshore areas and nearshore areas where electromagnetic devices are used. Sea turtles are expected to be highly dispersed in offshore waters, and co-occurrence with testing events is unlikely within areas used for testing activities (e.g., Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes), even in areas where sea turtle density is likely the highest (Virginia Capes and Navy Cherry Point Range Complexes). If located in the immediate area (within about 200 m) where electromagnetic devices are being used, adult, sub-adult, juvenile, and hatchling sea turtles could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential because of the low likelihood of a sea turtle occurring within 200 m of the device and the movement through the area of both the turtle and the device. In addition, potential impacts on sea turtles are not anticipated because any potential effects are likely limited to a few minor disturbances, which would be similar to natural stressors regularly occurring in the animal's life cycle. The electromagnetic devices used in testing activities are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microteslas at 200 m from the source), (2) very localized potential impact area, and (3) temporary duration of the activities (hours). Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Diamondback terrapins may be exposed to electromagnetic fields in inshore waters around Little Creek, Virginia, where electromagnetic devices are used under Alternative 1. Electromagnetic fields generated by in-water testing devices would likely have negligible effects on terrapins because of the (1) relatively low intensity of the magnetic fields generated (0.2 microteslas at 200 m from the source), (2) very localized potential impact area, (3) geography of inshore waters (e.g., mudflats, plants, islands, creeks) that likely further shield terrapins from electromagnetic fields, (4) temporary duration of the activities (hours), and (5) the reliance on other environmental cues for orientation. Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts for diamondback terrapins.

Proposed testing activities that use in-water electromagnetic devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend in-water electromagnetic devices would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas, but would occur in the following loggerhead sea turtle critical habitat year round: nearshore reproductive habitat, winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. In-water electromagnetic device use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the relatively weak strength of the electromagnetic fields created by these activities, the localized area potentially impacted by the electromagnetic fields, and the temporary duration of these activities.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat. The Navy has consulted with the NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.3.1.2 Impacts from In-Water Electromagnetic Devices under Alternative 2

Impacts from In-Water Electromagnetic Devices under Alternative 2 for Training Activities

Because the locations, number of events, and potential effects associated with in-water electromagnetic devices would be the same under Alternatives 1 and 2, impacts experienced by sea turtles, American alligators, and diamondback terrapins from in-water electromagnetic devices use under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. Therefore, impacts associated with training activities under Alternative 2 are the same as Alternative 1.

Proposed training activities that use in-water electromagnetic devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that expend in-water electromagnetic devices would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas, but would occur in the following loggerhead sea turtle critical habitat year round: nearshore reproductive habitat, winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. In-water electromagnetic device use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the relatively weak strength of the electromagnetic fields created by these activities, the localized area potentially impacted by the electromagnetic fields, and the temporary duration of these activities.

Pursuant to the ESA, the use of electromagnetic devices during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and there would be no effect on American crocodile critical habitat.

Impacts from In-Water Electromagnetic Devices under Alternative 2 for Testing Activities

As discussed in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices) the locations, numbers of testing activities, and potential effects associated with in-water electromagnetic device use would be the same under Alternatives 1 and 2. Refer to Section 3.8.3.3.1.1 (Impacts from In-Water Electromagnetic Devices under Alternative 1) for a discussion of impacts on sea turtles and terrapins.

Proposed testing activities that use in-water electromagnetic devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend in-water electromagnetic devices would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas, but would occur in the following loggerhead sea turtle critical habitat year round: nearshore reproductive habitat, winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. In-water electromagnetic device use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the relatively weak strength of the electromagnetic fields created by these activities, the localized area potentially impacted by the electromagnetic fields, and the temporary duration of these activities.

Pursuant to the ESA, the use of electromagnetic devices during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and there would be no effect on American crocodile critical habitat.

3.8.3.3.1.3 Impacts from In-Water Electromagnetic Devices under the No Action Alternative

Impacts from In-Water Electromagnetic 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 energy stressors (e.g., in-water electromagnetic 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.

3.8.3.3.2 Impacts from In-Air Electromagnetic Devices

The use of in-air electromagnetic devices associated with Navy training and testing activities is not applicable to reptiles because in-air electromagnetic energy does not penetrate the ocean, nor will use of these devices be close enough in proximity to sea turtle nesting locations to have an effect on these animals. As a result, in-air electromagnetic devices will not be analyzed further in this section.

3.8.3.3.3 Impacts from High-Energy Lasers

As discussed in Section 3.0.3.3.3.3 (Lasers), high-energy laser weapons training and testing involves the use of up to 30 kilowatts of directed energy as a weapon against small surface vessels and airborne targets. These weapons systems are deployed from surface ships and helicopter to create small but critical failures in potential targets and used at short ranges from the target.

This section analyzes the potential impacts of high-energy lasers on sea turtles. As discussed in Section 3.0.3.3.3.3 (Lasers), high-energy laser weapons are designed to disable surface targets, rendering them immobile. High-energy lasers would only be used in open ocean areas for training and testing activities; therefore, crocodilian and terrapin species are not included in the analysis for potential impacts from high-energy lasers because they would not be located in areas where high-energy lasers would be used.

The primary concern for high-energy weapons training and testing is the potential for a sea turtle to be struck by a high-energy laser beam at or near the water's surface, which could result in injury or death, resulting from traumatic burns from the beam.

Sea turtles could be exposed to a laser only if the beam missed the target. Should the laser strike the sea surface, individual sea turtles at or near the surface could be exposed. The potential for exposure to a high energy laser beam decreases as the water depth increases. Because laser platforms are typically helicopters and ships, sea turtles at sea would likely transit away or submerge in response to other stressors, such as ship or aircraft noise, although some sea turtles would not exhibit a response to an oncoming vessel or aircraft, increasing the risk of contact with the laser beam.

3.8.3.3.3.1 Impacts from High-Energy Lasers under Alternative 1

Impacts from High-Energy Lasers under Alternative 1 for Training Activities

As discussed in Section 3.0.3.3.3.3 (Lasers), high-energy laser use associated with training activities would occur within the Virginia Capes and Jacksonville Range Complexes. For safety reasons, high energy lasers would not be used in nearshore or inshore training locations. Navy training activities have the potential to expose sea turtles that occur within these areas to this energy stressor.

Appendix F (Military Expended Materials and Direct Strike Impact Analyses) includes a conservative probability estimate for a direct laser strike on a sea turtle during training activities. The analysis is over-predictive and conservative in that it assumes: (1) that all sea turtles would be at or near the surface 100 percent of the time, and would not account for the duration of time a sea turtle would be diving; and (2) that sea turtles are stationary, which does not account for any movement or any potential avoidance of the training or testing activity in response to other stressors (e.g., vessel noise). Loggerhead sea turtles have the highest seasonal density within these areas where high-energy lasers would be used; therefore, for the sake of conservatively estimating the potential for direct strike of sea turtles by a high-energy laser, loggerheads are used as a proxy in the modeling for estimating impacts on all sea turtle species within the AFTT Study Area. As shown in Appendix F (Military Expended Materials and Direct Strike Impact Analyses) the probability for a direct strike on a sea turtle is extremely low. The modeling results show that 0.000008 loggerhead sea turtles would be exposed to a high-energy laser strike. Based on the assumptions used in the statistical probability analysis, there is a high level of certainty in the conclusion that no sea turtles of any species that occur in the Study Area would be struck by a high-energy laser. Potential impacts of exposure to high-energy lasers are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level sea turtles.

Proposed training activities that use high-energy lasers would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use high-energy lasers would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas or nearshore reproductive habitats, but would occur in the following loggerhead turtle critical habitat year round: winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. High-energy laser use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the directed energy of the laser, the dissipation of energy as water depth increases, and the temporary duration of the activities. (National Marine Fisheries Service, 2014b)

Pursuant to the ESA, the use of high-energy lasers during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with the NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from High-Energy Lasers under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.3.3 (Lasers), high-energy laser tests would occur within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Gulf of Mexico, and Key West Range Complexes. High-energy laser testing activities would also be conducted within the Naval Undersea Warfare Center, Newport Testing Range, South Florida Ocean Measurement Facility, and the Naval Surface Warfare Center Panama City Testing Range. Navy testing activities have the potential to expose sea turtles that occur within these locations to this energy stressor. The sea turtle species with the highest average seasonal density (loggerhead sea turtle) in the location with the greatest number of testing activities involving high-energy lasers under Alternative 1 (Virginia Capes Range Complex) was used in the probability analysis.

Appendix F (Military Expended Materials and Direct Strike Impact Analyses) includes a conservative probability estimate for a direct laser strike on a sea turtle during testing activities. Using the same methods and assumptions described above, the modeling results show that 0.000136 loggerhead sea turtles would be exposed to a high-energy laser strike. Based on the assumptions used in the statistical probability analysis, there is a high level of certainty in the conclusion that no sea turtle of any species that occur in the Study Area would be struck by a high-energy laser.

Proposed testing activities that use high-energy lasers would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that use high-energy lasers would not occur within nearshore reproductive habitats, but would occur in the following loggerhead turtle critical habitat year round: breeding areas, winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. High-energy laser use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the directed energy of the laser, the dissipation of energy as water depth increases, and the temporary duration of the activities.(National Marine Fisheries Service, 2014b)

Pursuant to the ESA, the use of high-energy lasers during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.3.3.2 Impacts from High-Energy Lasers under Alternative 2

Impacts from High-Energy Lasers under Alternative 2 for Training Activities

The locations, number of events, and potential effects associated with high-energy lasers would be the same under Alternatives 1 and 2. Refer to Section 3.8.3.3.3.1 (Impacts from High-Energy Lasers under Alternative 1) for a discussion of impacts on sea turtles.

Proposed training activities that use high-energy lasers would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use high-energy lasers would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas or nearshore reproductive habitats, but would occur in the following loggerhead turtle critical habitat year round: winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. High-energy laser use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the directed energy of the laser, the dissipation of energy as water depth increases, and the temporary duration of the activities.(National Marine Fisheries Service, 2014b)

Pursuant to the ESA, the use of high-energy lasers during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from High-Energy Lasers under Alternative 2 for Testing Activities

The locations, number of events, and potential effects associated with high-energy laser use would be the same under Alternatives 1 and 2. Refer to Section 3.8.3.3.3.1 (Impacts from High-Energy Lasers under Alternative 1) for a discussion of impacts on sea turtles.

Proposed testing activities that use high-energy lasers would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that use high-energy lasers would not occur within nearshore reproductive habitats, but would occur in the following loggerhead turtle critical habitat year round: breeding areas, winter areas, migration corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. High-energy laser use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the directed energy of the laser, the dissipation of energy as water depth increases, and the temporary duration of the activities.(National Marine Fisheries Service, 2014b)

Pursuant to the ESA, the use of high-energy lasers during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.3.3.3 Impacts from High-Energy Lasers under the No Action Alternative

Impacts from High-Energy Lasers under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training or testing activities in the AFTT Study Area. Various energy stressors (e.g., high-energy lasers) 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.

3.8.3.4 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts of the various types of physical disturbance and strike stressors used by Navy during training and testing activities within the Study Area. The physical disturbance and strike stressors that may impact reptiles and include: (1) Navy vessels and in-water devices; (2) military expended materials, including non-explosive practice munitions and fragments from high-explosive munitions; and (3) seafloor devices. General discussion of impacts can also be found in Section 3.0.3.6.3 (Conceptual Framework for Assessing Effects from Physical Disturbance or Strike).

The way a physical disturbance may affect a reptile would depend in part on the relative size of the object, the speed of the object, the location of the reptile in the water column, and the behavioral reaction of the sea turtle. It is not known at what point or through what combination of stimuli (visual, acoustic, or through detection in pressure changes) a reptile becomes aware of a vessel or other potential physical disturbances prior to reacting or being struck.

Like marine mammals, if a reptile reacts to physical disturbance, the individual must stop its activity and divert its attention in response to the stressor. The energetic costs of reacting to a stressor will depend on the specific situation, but one can assume that the caloric requirements of a response may reduce the amount of energy available for other biological functions.

For sea turtles who have resident home ranges near Navy activities, the relative concentration of Navy vessels would cause sea turtles to respond repeatedly to the exposure. This repeated response would interrupt normal daily routines (e.g., foraging activities) more often than resident near-shore turtles not near Navy installations or in open ocean areas where Navy vessel traffic is less concentrated, though animals may become habituated to repeated stimuli. If a strike does occur, the cost to the individual could range from slight injury to death.

Diamondback terrapins may be exposed to potential physical disturbance and strike hazards in all inshore training and testing locations. American alligators may be exposed in all inshore training and testing locations along the Atlantic coast from North Carolina to Florida, and along the Gulf coast from Florida to Texas. As with sea turtles, impacts of any potential strike of alligators or terrapins could range from slight injury to death. American crocodiles are not included in the analysis for physical disturbance and strike stressors because of the very low likelihood of a strike. Navy vessel presence would be unlikely in American crocodile habitat, which consists of shallow nearshore habitat in southern Florida; however, it is possible that American crocodiles could be occasionally exposed to Navy vessel noise, mostly from smaller support vessels (see Section 3.8.3.1.5, Impacts from Vessel Noise, for an analysis of acoustic stressor responses by crocodilians). Therefore, American crocodiles are not analyzed for potential impacts from physical disturbance and strike stressors.

3.8.3.4.1 Impacts from Vessels and In-Water Devices

Vessels

The majority of the training and testing activities under all alternatives involve some level of vessel activity. For a discussion on the types of activities that use vessels see Appendix B (Activity Stressor Matrices). Section 3.0.3.3.4.1 (Vessels and In-Water Devices) Table 3.0-17 provides a list of representative vessels used in training and testing activities, along with vessel lengths and speeds used in training and testing activities.

Within the AFTT Study Area, commercial traffic is heaviest in the nearshore waters, near major ports and in the shipping lanes along the entire United States East Coast and along the northern coast of the Gulf of Mexico while Navy vessel traffic is primarily concentrated between the mouth of the Chesapeake Bay, Virginia and Jacksonville, Florida (Mintz, 2012). An examination of vessel traffic within the AFTT Study Area determined that Navy vessel occurrence is two orders of magnitude lower than that of commercial traffic. The study also revealed that, while commercial traffic is relatively steady throughout the year, Navy vessel usage within the range complexes is episodic, based on specific exercises being conducted at different times of the year (Mintz, 2012); however, Navy vessel use within inshore waters occurs regularly and primarily consists of high-speed small vessel movements. These high-speed vessel movements in near shore and inshore waters present a relatively higher risk for strike (Hazel et al., 2007) because of the higher concentrations of sea turtles in these areas and the difficulty for vessel operators to avoid collisions in high-speed activities.

Strikes of sea turtles, American alligators, and diamondback terrapin could cause permanent injury or death from bleeding or other trauma, paralysis and subsequent drowning, infection, or inability to feed. Apart from the severity of the physical strike, the likelihood and rate of recovery from a strike may be influenced by the animal's age, reproductive state, and general condition. Much of what is written about recovery from vessel strikes is inferred from observing individuals some time after a strike.

Numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al., 2007; Lutcavage et al., 1997). Fresh wounds on some stranded animals may strongly suggest a vessel strike as the cause of death. The actual incidence of recovery versus death is not known, given available data. Any sea turtle species found in the Study Area can occur at or near the surface in open ocean and coastal areas, whether feeding or periodically surfacing to breathe.

Sea turtles spend a majority of their time submerged (Renaud & Carpenter, 1994; Sasso & Witzell, 2006), though Hazel et al. (2009) and Hazel et al. (2007) showed turtles staying within the top 3 m of water despite deeper water being available. Loggerhead turtles are the most abundant sea turtles found in the nearshore environment of the Study Area. Loggerheads, considered to be the most generalist of sea turtle species in terms of feeding and foraging behavior, apparently exhibit varied dive behavior that is linked to the quantity and quality of available resources. Leatherback turtles are more likely to feed at or near the surface in open ocean areas. It is important to note that leatherbacks can forage for jellyfish at depth but bring them to the surface to ingest (Benson et al., 2007; Fossette et al., 2007; James & Herman, 2001). Basking on the water's surface is common for all species within the Study Area as a strategy to thermoregulate, and the reduced activity associated with basking may pose higher risks for sea turtle strikes because of a likely reduced capacity to avoid cues. Green, hawksbill, loggerhead, and

Kemp's ridley sea turtles are more likely to forage nearshore, and although they may feed along the seafloor, they surface periodically to breathe while feeding and moving between near-shore habitats. Kemp's ridleys can spend extended periods foraging at depth, even in open ocean areas (Sasso & Witzell, 2006; Seney, 2016; Servis et al., 2015).

Smaller, faster vessels that operate in nearshore waters, where green, Kemp's ridley, loggerhead sea turtles can be more densely concentrated, pose a greater risk (Chaloupka et al., 2008). For example, sea turtle occurrence (e.g., Kemp's ridleys and loggerheads) increases in nearshore areas within Chesapeake Bay from late spring to early fall, most likely due to foraging (Barco & Lockhart, 2015). Other studies have shown that the potential for vessel strike increases in areas important for foraging sea turtles (Denkinger et al., 2013).

Vessels transiting in shallow waters to and from ports travel at slower speed and pose less risk of strikes to sea turtles (Hazel et al., 2007; Lutcavage et al., 1997). It should be noted that no known instances of vessel strikes to sea turtles by a Navy vessel have been reported for the Study Area.

The American alligator and diamondback terrapin are also subject to potential vessel strikes in inshore waters. The diamondback terrapin may be exposed to potential strike within all inshore training and testing locations, while the American alligator would be exposed to potential strike in inshore training and testing locations along the Atlantic coast from North Carolina to Florida, and along the Gulf Coast from Florida to Texas.

American alligators may exhibit avoidance behaviors in relatively open waters in the presence of recreational boating traffic. Lewis et al. (2014) observed that alligators avoided open waters of the Fort Worth Nature Center and Refuge located on the Trinity River in Texas, at least in part due to the presence of recreational boaters. Based off of field observations, Lewis et al. (2014) noted that both motorized and non-motorized boats commonly approached alligators, which may have resulted in alligators avoiding the open water where detection by boaters would have been more likely. Grant and Lewis (2010) noted in a study on spectacled caiman (*Caiman crocodilus*) in the Tortuguero region of Costa Rica found that increasing boat traffic associated with ecotourism, recreation, and local human population growth increased the likelihood of boat-collision–related injuries. Spectacled caiman were also frequently observed avoiding boats (Grant & Lewis, 2010). Grant and Lewis (2010) also noted that collisions with boats were more likely to occur in relatively more narrow channels where crocodilians had less maneuverable space within the channel to avoid the boat, as substantiated by observations of American crocodile scars on tails. With American alligator population increases in recent years (Savannah River Ecology Laboratory & Herpetology Program, 2012) and expansion into many parts of their historical range (Smith et al., 2016), incidents of collisions with boats will likely increase. However, alligators likely exhibit avoidance behaviors both in the presence of vessels and avoid areas with high amounts of recreational boat traffic.

Hearing sensitivities of terrapins have been shown to overlap with boat engine sounds. However, the lack of observed behavioral responses to approaching vessels can present strike risk to terrapins, particularly in high-density, small vessel recreation areas (Lester et al., 2012; Lester, 2013). Therefore, terrapins may be at relatively higher risk to potential strike compared to crocodilians where vessel traffic occurs, not because of an inability to hear approaching vessels, but because terrapins do not exhibit avoidance behaviors.

In-Water Devices

In-water devices are generally smaller (several inches to 111 ft.) than most Navy vessels. Devices that could pose a collision risk to reptiles are those operated at high speeds and are unmanned. For a discussion on the types of activities that use in-water devices see Appendix B (Activity Stressor Matrices), and for information on where in-water devices are used, and how many activities would occur under each alternative, see Section 3.0.3.3.4.1 (Vessels and In-Water Devices).

The Navy reviewed torpedo design features and a large number of previous anti-submarine warfare torpedo exercises to assess the potential of torpedo strikes on marine mammals, and its conclusions are also relevant to reptiles. The acoustic homing programs of Navy torpedoes are sophisticated and would not confuse the acoustic signature of a marine mammal with a submarine/target. It is reasonable to assume that acoustic signatures of sea turtles would also not be confused with a submarine or target. All exercise torpedoes are recovered and refurbished for eventual re-use. Review of the exercise torpedo records indicates there has never been an impact on a sea turtle or other reptile. In thousands of exercises in which torpedoes were fired or in-water devices used, there have been no recorded or reported instances of a marine species strike from a torpedo or any other in-water device.

Since some in-water devices are identical to support craft (typically less than 15 m in length), reptiles could respond to the physical presence of the device similar to how they respond to the physical presence of a vessel. Physical disturbance from the use of in-water devices is not expected to result in more than a momentary behavioral response. These responses would likely include avoidance behaviors (swimming away or diving) and cessation of normal activities (e.g., foraging). As with an approaching vessel, not all sea turtles would exhibit avoidance behaviors and therefore would be at higher risk of a strike.

In-water devices, such as unmanned underwater vehicles, that move slowly through the water are highly unlikely to strike reptiles because the animal could easily avoid the object. Towed devices are unlikely to strike a sea turtle because of the observers on the towing platform and other standard safety measures employed when towing in-water devices. Reptiles that occur in areas that overlap with in-water device use within the Study Area may encounter in-water devices. It is possible that reptiles may be disturbed by the presence of these activities, but any disturbance from the use of in-water devices is not expected to result in more than a temporary behavioral response.

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

Section 3.0.3.3.4.1 (Vessels and In-Water Devices) provides estimates of relative vessel and in-water device use and location throughout the Study Area. Under Alternative 1 the concentration of vessel and in-water device use and the manner in which the Navy trains and tests would remain consistent with the levels and types of activity undertaken in the AFTT Study Area over the last decade. Consequently, the Navy does not foresee any appreciable changes in the levels, frequency, or locations where vessels have been used over the last decade, and therefore the level at which physical disturbance and strikes are expected to occur is likely to remain consistent with the previous decade.

Impacts from Vessels and In-Water Devices under Alternative 1 for Training Activities

As indicated in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), most training activities involve large vessel movement. The potential for vessel strikes to reptiles are not associated with any specific training activity but rather a limited, sporadic, and accidental result of Navy ship movement within the Study Area, occurring in both offshore and inshore water areas. Vessel movement can be widely dispersed throughout the AFTT Study Area but for the most part occurs within the established range complexes and is more concentrated near naval ports, piers, and range areas. Training activities that include vessel movements in the offshore waters of the Study Area would primarily be conducted within the Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes, but would also be conducted within the Northeast, Key West, and Gulf of Mexico Range Complexes, as well as other offshore AFTT areas. Offshore vessel movements would be widely dispersed throughout the Study Area, but are more concentrated near ports, naval installations, range complexes and testing ranges. Large vessel movement primarily occurs within the U.S. Exclusive Economic Zone, with the majority of the traffic flowing between Naval Stations Norfolk and Mayport (see Table 3.0-18).

Vessel movements associated with training activities within inshore waters would occur within or near Boston, Massachusetts; Groton, Connecticut; Narragansett, Rhode Island; Earle, New Jersey; Delaware Bay, Delaware; James River and tributaries, Virginia; York River, Virginia; the Lower Chesapeake Bay, Virginia; Hampton Roads, Virginia; Norfolk, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Cooper River, South Carolina; Savannah, Georgia; Kings Bay, Georgia; Mayport, Florida; St. Johns River, Florida; Port Canaveral, Florida; Tampa, Florida; St. Andrew Bay, Florida; Beaumont, Texas, and Corpus Christi, Texas. In addition, high-speed small vessel movements would be conducted within inshore waters including and surrounding Narragansett Bay, Rhode Island; James River and tributaries, Virginia; York River, Virginia; the Lower Chesapeake Bay; Coopers River, South Carolina; Mayport, Florida; St. Johns River, Florida; Port Canaveral, Florida; and St. Andrew Bay, Florida (see Table 3.0-18 through Table 3.0-20).

As discussed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), in-water devices include unmanned surface vehicles, unmanned underwater vehicles, and towed devices. Under Alternative 1, offshore training activities involving the use of in-water devices would be conducted within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes, the Naval Surface Warfare Center Panama City Testing Range, and other offshore AFTT areas. Training activities that use in-water devices would also occur within inshore waters including and surrounding Boston, Massachusetts; Earle, New Jersey; Delaware Bay, Delaware; Hampton Roads, Virginia; the Lower Chesapeake Bay, Virginia; James River and tributaries, Virginia; York River, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Savannah, Georgia; Kings Bay, Georgia; Mayport, Florida; Port Canaveral, Florida; Tampa, Florida; St. Andrew Bay, Florida; Beaumont, Texas; and Corpus Christi, Texas.

Under Alternative 1 training activities, sea turtles may be exposed to strike risk in all inshore and offshore areas where vessels and in-water devices would operate. American alligators may be exposed to vessel strike at Morehead City, North Carolina; Cooper River, South Carolina; Savannah, Georgia; Kings Bay, Georgia; Mayport, Florida; St. Johns River, Florida; Port Canaveral, Florida; Tampa, Florida; St. Andrew Bay, Florida; Beaumont, Texas, and Corpus Christi, Texas. Diamondback terrapins may be exposed to strike at all inshore training locations.

Under Alternative 1, sea turtle, alligator, and terrapin strikes would most likely occur where there is a co-location of these reptile species, especially in high densities, and with high-speed vessel and in-water device training activities. Over the continental shelf, sea turtles are at risk of strikes because of greater densities of sea turtles and more frequent vessel movements relative to the open ocean. Therefore, sea turtle species that occur over the continental shelf and in inshore waters (e.g., estuaries), would therefore have a greater potential for impacts. This suggests that loggerhead sea turtles are likely the most at risk of vessel interactions and in-water devices under Alternative 1 in the open ocean, as well as within inshore waters where small and fast vessels conduct activities because this species is the most abundant in the Range Complexes and inshore waters (e.g., Lower Chesapeake Bay) that have the highest concentration of training activities involving vessel movement. There is not expected to be any predictable seasonal difference in Navy vessel use; therefore, impacts from vessels and in-water devices, including physical disturbance and potential for strike, would depend on each species' seasonal patterns of occurrence or degree of residency in the continental shelf and inshore waters portions of the AFTT Study Area. As previously indicated, any physical disturbance from vessel transit and use of in-water devices is not expected to result in more than a momentary behavioral response; however, an actual strike of a reptile would likely result in permanent injury, temporary injury that weakens a sea turtle's resilience to other natural and human-induced stressors, death. In-water devices have a very limited potential to strike a sea turtle, alligator, or terrapin because they either move slowly through the water column (e.g., most unmanned underwater vehicles) or are closely monitored by observers manning the towing platform (e.g., most towed devices).

Although the likelihood is low, a harmful interaction with a vessel or in-water device in the open ocean cannot be discounted. In addition, more frequent vessel movements would occur in nearshore and inshore waters where sea turtles may congregate. Sea turtles often congregate close to shorelines during the breeding season, where vessel traffic is denser (Schofield et al., 2010). Activities within these areas present a higher likelihood of vessel strike of a sea turtle. Any of the sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas or inshore waters, whether feeding, periodically surfacing to breathe, or basking (a behavior more common in cooler water and seasons). Leatherback turtles are more likely to feed at or near the surface in open ocean areas. Green, hawksbill, Kemp's ridley, and loggerhead turtles are more likely to forage nearshore, and although they may feed along the seafloor, they surface periodically to breathe while feeding and moving between nearshore habitats. These species, except for Hawksbill turtles, are distributed widely in all offshore portions of the Study Area.

The leatherback turtle is likely to be impacted by these activities, given its preference for open-ocean habitats and its feeding behavior (feed at the surface and throughout the water column) and prey (e.g., jellyfish). Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats, where they reside among *Sargassum* mats. Sea turtles are expected to be highly dispersed in deeper offshore waters and given the large area over which Navy vessels could potentially conduct training activities, the likelihood of co-occurrence is low, as well as the potential consequences.

Training activities that include vessel movements in the inshore waters of the Study Area occur on a more regular basis than the offshore activities, and often involve the vessels traveling at speeds greater than 10 knots (see Section 3.0.3.3.4.1, Vessels and In-Water Devices). Generally these inshore water activities are conducted in more confined waterways than activities occurring in the offshore waters, limiting maneuverability of the vessel, especially when trying to avoid a potential collision with a reptile. High-speed vessel movements further increase the potential risk of vessel strikes by reducing the available reaction time of both the animal and vessel operator to an impending strike. Hazel et al. (2007) noted in one study that green sea turtles did not have time to react to vessels moving at speeds of about 10 knots, but reacted frequently to vessels at speeds of about two knots. Detection, therefore, was suggested to be based on the turtle's ability to see rather than hear an oncoming vessel. Boat strike has been identified as one of the important mortality factors in several nearshore sea turtle habitats worldwide. Precise data are lacking for sea turtle mortalities directly caused by vessel strikes; however, live and dead turtles are often found with injuries indicative of collision with a vessel hull or propeller

(Hazel et al., 2007; Lutcavage et al., 1997). For example, Barco et al. (2016) found that out of the 60 fresh, dead loggerhead turtles that were examined from 2004 to 2013 in Virginia, 15 (25 percent) showed signs of vessel interactions. Scientists in Hawaii reported that 2.5 percent of green turtles found dead on the beaches between 1982 and 2003 had been killed by vessel strike (Chaloupka et al., 2008). Given the high amount of high-speed vessel movement hours, the inshore water locations of where these activities would occur (Table 3.0-20), and species' distribution throughout the Study Area, co-occurrence with individuals of loggerhead, green, Kemp's ridley, and leatherback turtles are very likely, especially in the Lower Chesapeake Bay, Virginia.

Any collision with a sea turtle would result in injury, and possible mortality, of an individual sea turtle. Under Alternative 1 training activities, the Navy will continue to implement procedural mitigation to avoid or reduce the potential for vessel and in-water device strike of sea turtles (see Section 5.3.4.1, Vessel Movement, and Section 5.3.4.2, Towed In-Water Devices). Within a mitigation zone of a vessel or in-water device, trained observers will relay sea turtle locations to the operators, who are required to change course (no course change would be implemented if the vessel's safety is threatened, the vessel is restricted in its ability to maneuver (e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.), or if the in-water device is operated autonomously. A mitigation zone size is not specified for sea turtles to allow flexibility based on vessel type and mission requirements (e.g., small boats operating in a narrow harbor).

Potential impacts of exposure to vessels may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of high-speed vessel hours in the inshore water locations, and the density of sea turtles in the area, the possibility of a strike to an individual of any species cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for all sea turtle species.

Strike potential in inshore training locations for American alligators under Alternative 1 training activities would likely range from minor survivable injuries to death of individual alligators. Based on avoidance behaviors, as shown in open water locations with motorized and non-motorized boat traffic, strike potential is likely reduced. Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of high-speed vessel hours in the inshore water locations, and the density of alligators in training locations, the possibility of a strike to an individual alligator cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for American alligators.

Strike potential in inshore training locations for the diamondback terrapin under Alternative 1 training activities would likely range from major injuries (because of the relatively small body mass and body type of terrapins) and death. Boat strikes are a significant concern in terrapin conservation efforts (Lester et al., 2012; Lester, 2013). Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual terrapin's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of high-speed vessel hours in the inshore water locations, and the density of terrapins in training locations, the possibility of a strike to an individual terrapin cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for diamondback terrapins.

Proposed training activities under Alternative 1 that use vessels and in-water devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use vessels and in-water devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Vessels have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b). For example, training activities that use vessels and in-water devices will not impact the prey species found in *Sargassum* habitat or the nearshore habitat conditions that are essential for nearshore reproductive habitat.

Pursuant to the ESA, the use of vessels and in-water devices during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Vessels and In-Water Devices under Alternative 1 for Testing Activities

As indicated in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), most of the testing activities involve large vessel movement. However, the number of activities that involve large vessel movements for testing is comparatively lower than the number of training activities. In addition, testing often occurs jointly with a training event, so it is likely that the testing activity would be conducted from a training vessel. Vessel movement in conjunction with testing activities could be widely dispersed throughout the Study Area, but would be concentrated near naval ports, piers, range complexes, testing ranges, and especially off the northeast U.S. coast, off south Florida, and in the Gulf of Mexico. Specifically, offshore testing activities that include vessels would be conducted within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes, the Naval Undersea Warfare Center, Newport Testing Range; South Florida Ocean Measurement Facility Testing Range; Naval Surface Warfare Center, Panama City Division Testing Range (see Table 3.0-18).

Propulsion testing, which sometimes include ships operating at speeds in excess of 30 knots, occur infrequently but may pose a higher strike risk for reptiles (and primarily sea turtles because this activity would be conducted in offshore waters). This activity requires some vessels to transit at high speeds to complete the testing activity. These activities would occur in the Northeast, Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes. However, there are just a few of these events proposed per year, so the increased risk is nominal compared to all vessel use proposed for testing activities under Alternative 1.

In addition, vessel movements associated with testing activities would occur within inshore waters surrounding Bath, Massachusetts; Portsmouth, New Hampshire; Newport, Rhode Island; Groton, Connecticut; Little Creek, Virginia; Norfolk, Virginia; Kings Bay, Georgia; Mayport, Florida; Port Canaveral, Florida; and Pascagoula, Mississippi (see Table 3.0-19).

Also, as discussed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), testing activities involving the use of in-water devices would occur in the AFTT Study Area at any time of year. Under Alternative 1, testing activities involving the use of in-water devices would be conducted throughout the AFTT Study Area, including the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of

Mexico Range Complexes, the Naval Undersea Warfare Center, Newport Testing Range, South Florida Ocean Measurement Facility, and the Naval Surface Warfare Center Panama City Testing Range.

As with training activities, sea turtle, alligator, or terrapin strikes resulting from testing activities would most likely occur where there is a co-location of these reptile species, especially in high densities, and with high-speed vessel and in-water device testing activities. Over the continental shelf, sea turtles are at risk of strikes because of greater densities of sea turtles and more frequent vessel movements relative to the open ocean. Therefore, sea turtle species that occur over the continental shelf and in inshore waters (e.g., estuaries), would therefore have a greater potential for impacts. Loggerhead sea turtles are likely the most at risk of vessel interactions under Alternative 1 in the open ocean, as well as within inshore waters where small and fast vessels conduct activities. There is not expected to be any predictable seasonal difference in Navy vessel use; therefore, impacts from vessels and in-water devices, including physical disturbance and potential for strike, would depend on each species' seasonal patterns of occurrence or degree of residency in the continental shelf portions of the AFTT Study Area. As previously indicated, any physical disturbance from vessel transit and use of in-water devices is not expected to result in more than a momentary behavioral response; however, an actual strike of a sea turtle would likely result in permanent injury, temporary injury that weakens a sea turtle's resilience to other natural and human-induced stressors, death. Although the likelihood is low, a harmful interaction with a vessel or in-water device cannot be discounted during a testing activity.

Any collision with a sea turtle would result in injury, and possible mortality, of an individual sea turtle. Under Alternative 1 testing activities, the Navy will continue to implement procedural mitigation to avoid or reduce the potential for vessel and in-water device strike of sea turtles (see Section 5.3.4.1, Vessel Movement, and Section 5.3.4.2, Towed In-Water Devices). Within a mitigation zone of a vessel or in-water device, trained observers will relay sea turtle locations to the operators, who are required to change course (no course change would be implemented if the vessel's safety is threatened, the vessel is restricted in its ability to maneuver (e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.), or if the in-water device is operated autonomously. A mitigation zone size is not specified for sea turtles to allow flexibility based on vessel type and mission requirements (e.g., small boats operating in a narrow harbor).

The leatherback turtle is likely to be impacted by testing activities using vessels and in-water devices, given its preference for open-ocean habitats and its feeding behavior (feed at the surface and throughout the water column) and prey (e.g., jellyfish). Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats, where they reside among *Sargassum* mats. Sea turtles are expected to be highly dispersed in deeper offshore waters; given the large area over which Navy vessels could potentially conduct testing activities, the likelihood of co-occurrence is low, as well as the potential consequences.

American alligators may be exposed to vessel strike during testing activities at inshore testing locations in Georgia, Florida, and Mississippi. Diamondback terrapins may be exposed to strike at all inshore testing locations along the Atlantic and Gulf coasts.

Strike potential in inshore testing locations for American alligators under Alternative 1 testing activities would likely range from minor survivable injuries to death of individual alligators. Based on avoidance behaviors, as shown in open-water locations with motorized and non-motorized boat traffic, strike potential is likely reduced. Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of testing activities involving vessel movement in inshore locations, and the density of alligators in testing locations, the possibility of a strike to an individual alligator cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for American alligators.

Strike potential in inshore testing locations for the diamondback terrapin under Alternative 1 testing activities would likely range from major injuries (because of the relatively small body mass and body type of terrapins) and death. Boat strikes are a significant concern in terrapin conservation efforts (Lester et al., 2012; Lester, 2013). Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual terrapin's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of testing activities involving vessel movement in inshore locations, and the density of terrapins in testing locations, the possibility of a strike to an individual terrapin cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for the diamondback terrapin.

Proposed testing activities under Alternative 1 that use vessels and in-water devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that use vessels and in-water devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Vessels have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b). For example, testing activities that use vessels and in-water devices will not impact the prey species found in *Sargassum* habitat or the nearshore habitat conditions that are essential for nearshore reproductive habitat.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

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

Impacts from Vessels and In-Water Devices under Alternative 2 for Training Activities

As shown in Tables 3.0-18–3.0-20 the locations of offshore training activities that use vessels are the same under Alternatives 1 and 2. However, the number of offshore training activities involving vessel movement would increase by approximately 2 percent annually and 3 percent over five years under Alternative 2. Similarly, the locations and annual numbers of training activities that include vessels within inshore waters of the AFTT Study Area would be the same under Alternatives 1 and 2. Even with the nominal increase in training activity levels described above, Navy training activities would remain consistent with the levels of activity and types activities undertaken in the AFTT Study Area over the last decade.

Similarly, Tables 3.0-22 and 3.0-23 show the locations of training activities within both offshore and inshore waters of the Study Area that use in-water devices area would be the same under Alternatives 1 and 2. In addition, the annual number of training activities occurring within inshore waters of the AFTT Study Area are identical between Alternatives 1 and 2. However, the number of offshore training activities that use in-water devices would increase by approximately 5 percent annually and 6 percent over five years (as with Alternative 1). This level of increased in-water device use would not appreciably change the potential for physical disturbance or strike of a sea turtle. Because the increase in activities under Alternative 2 over five years would be the same as with Alternative 1, impacts from training activities involving vessels and in-water devices under Alternative 2 would be similar to Alternative 1. Therefore, the analyses presented in Section 3.8.3.4.1.1 (Impacts from Vessels and In-Water Devices under Alternative 1) for training activities are applicable to training activities under Alternative 2.

Any collision with a sea turtle would result in injury, and possible mortality, of an individual sea turtle. Under Alternative 2 training activities, the Navy will continue to implement procedural mitigation to avoid or reduce the potential for vessel and in-water device strike of sea turtles (see Section 5.3.4.1, Vessel Movement, and Section 5.3.4.2, Towed In-Water Devices). Within a mitigation zone of a vessel or in-water device, trained observers will relay sea turtle locations to the operators, who are required to change course (no course change would be implemented if the vessel's safety is threatened, the vessel is restricted in its ability to maneuver (e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.), or if the in-water device is operated autonomously. A mitigation zone size is not specified for sea turtles to allow flexibility based on vessel type and mission requirements (e.g., small boats operating in a narrow harbor).

Strike potential in inshore training locations for American alligators under Alternative 2 training activities would likely range from minor survivable injuries to death of individual alligators. Based on avoidance behaviors, as shown in open water locations with motorized and non-motorized boat traffic, strike potential is likely reduced. Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of high-speed vessel hours in the inshore water locations, and the density of alligators in training locations, the possibility of a strike to an individual alligator cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for American alligators.

Strike potential in inshore training locations for the diamondback terrapin under Alternative 2 training activities would likely range from major injuries (because of the relatively small body mass and body type of terrapins) and death. Boat strikes are a significant concern in terrapin conservation efforts (Lester et al., 2012; Lester, 2013). Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual terrapin's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of high-speed vessel hours in the inshore water locations, and the density of terrapins in training locations, the possibility of a strike to an individual terrapin cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for diamondback terrapins.

The leatherback turtle is likely to be impacted by training activities that use vessels and in-water devices, given its preference for open-ocean habitats and its feeding behavior (feed at the surface and throughout the water column) and prey (e.g., jellyfish). Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats, where they reside among *Sargassum* mats. Sea turtles are expected to be highly dispersed in deeper offshore waters; given the large area over which

Navy vessels could potentially conduct training activities, the likelihood of co-occurrence is low, as well as the potential consequences.

Proposed training activities under Alternative 2 that use vessels and in-water devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use vessels and in-water devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Vessels have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b). For example, training activities that use vessels and in-water devices will not impact the prey species found in *Sargassum* habitat or the nearshore habitat conditions that are essential for nearshore reproductive habitat.

Pursuant to the ESA, the use of vessels and in-water devices during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from Vessels and In-Water Devices under Alternative 2 for Testing Activities

As shown in Tables 3.0-18 through 3.0-20, the locations of testing activities within offshore and inshore waters that involve vessel movement would be the same under Alternatives 1 and 2. In addition, the annual and five-year numbers of testing activities that involve vessel movements within inshore waters of the AFTT Study Area are identical under Alternatives 1 and 2. However, the number of offshore testing activities would increase by 0.3 percent annually and by approximately 7 percent over five years. As previously indicated the number of testing activities that involve vessels are much lower than the number of training activities. Furthermore, testing activities may be conducted simultaneously with a training event, using a training vessel. The proposed increase in offshore vessel use from testing activities under Alternative 2 would still be consistent with the levels of activity and types activities undertaken in the AFTT Study Area over the last decade.

In addition, Tables 3.0-22 and 3.0-23 show the locations and annual numbers of testing activities that use in-water devices are the same under Alternatives 1 and 2. However, the number of testing activities that use in-water devices would increase approximately 11 percent over five years. This slight level of increased use of in-water devices does not substantially change the potential for physical disturbance or strike of sea turtles, crocodilians, or terrapins. Therefore, impacts from testing activities involving vessels and in-water devices under Alternative 2 would be similar to Alternative 1 and the analyses presented in Section 3.8.3.4.1.1 (Impacts from Vessels and In-Water Devices under Alternative 1) for testing activities are applicable to testing activities under Alternative 2.

Any collision with a sea turtle would result in injury, and possible mortality, of an individual sea turtle. Under Alternative 2 testing activities, the Navy will continue to implement procedural mitigation to avoid or reduce the potential for vessel and in-water device strike of sea turtles (see Section 5.3.4.1, Vessel Movement, and Section 5.3.4.2, Towed In-Water Devices). Within a mitigation zone of a vessel or in-water device, trained observers will relay sea turtle locations to the operators, who are required to change course (no course change would be implemented if the vessel's safety is threatened, the vessel is restricted in its ability to maneuver (e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.), or if the in-water device is operated autonomously. A mitigation zone size is not specified for sea turtles to allow flexibility based on vessel type and mission requirements (e.g., small boats operating in a narrow harbor).

Strike potential in inshore testing locations for American alligators under Alternative 2 testing activities would likely range from minor survivable injuries to death of individual alligators. Based on avoidance behaviors, as shown in open-water locations with motorized and non-motorized boat traffic, strike potential is likely reduced. Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of testing activities involving vessel movement in inshore locations, the possibility of a strike to an individual alligator cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for American alligators.

Strike potential in inshore testing locations for the diamondback terrapin under Alternative 2 testing activities would likely range from major injuries (because of the relatively small body mass and body type of terrapins) and death. Boat strikes are a significant concern in terrapin conservation efforts (Lester et al., 2012; Lester, 2013). Potential impacts of exposure to vessels and in-water devices may result in substantial changes in an individual terrapin's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number of testing activities involving vessel movement in inshore locations, and the density of terrapins in testing locations, the possibility of a strike to an individual terrapin cannot be discounted. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for the diamondback terrapin.

The leatherback turtle is likely to be impacted by testing activities that use vessels and in-water devices, given its preference for open-ocean habitats and its feeding behavior (feed at the surface and throughout the water column) and prey (e.g., jellyfish). Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats, where they reside among *Sargassum* mats. Sea turtles are expected to be highly dispersed in deeper offshore waters; given the large area over which Navy vessels could potentially conduct testing activities, the likelihood of co-occurrence is low, as well as the potential consequences.

Navy testing activities that use vessels and in-water devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Vessels have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b). For example, testing activities that use vessels and in-water devices will not impact the prey species found in *Sargassum* habitat or the nearshore habitat conditions that are essential for nearshore reproductive habitat.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.4.1.3 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.

3.8.3.4.2 Impacts from Aircraft and Aerial Targets

Impacts from aircraft and aerial targets are not applicable to sea turtles, crocodilians, or terrapins because they do not occur in airborne environments and will not be analyzed further in this section. Refer to the Impacts from Military Expended Materials section (Section 3.8.3.4.3) for impacts from target fragments and the Acoustic Stressors section (Section 3.8.3.1) for potential disturbance from aircraft.

3.8.3.4.3 Impacts from Military Expended Materials

This section analyzes the strike potential to sea turtles from the following categories of military expended materials: (1) all sizes of non-explosive practice munitions; (2) fragments from high-explosive munitions; (3) expendable targets; and (4) expended materials other than munitions, such as sonobuoys, expended bathythermographs, and torpedo accessories.

For a discussion of the types of activities that use military expended materials refer to Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how much of each material is expended under each alternative, see Section 3.0.3.3.4.2 (Military Expended Materials). As described in Appendix F (Military Expended Materials and Direct Strike Impact Analyses), for physical disturbance and strike stressors as it relates to sea turtles, impacts from fragments from high-explosive munitions are included in the analysis presented in Section 3.8.3.2 (Explosive Stressors), and are not considered further in this section. These activities would occur in offshore and inshore training and testing locations that overlap with all species of sea turtles, American alligators, and diamondback terrapins. Because military expended materials would not be used in areas that overlap with the American crocodile known range or critical habitat designated for this species, the American crocodile is not analyzed for potential impacts from military expended materials.

The primary concern is the potential for a sea turtle, American alligator, or diamondback terrapin to be struck with a military expended material at or near the water's surface, which could result in injury or death. For sea turtles, although disturbance or strike from an item as it falls through the water column is possible, it is not likely because the objects generally sink through the water slowly and can be avoided by most sea turtles. Materials will slow in their velocity as they approach the bottom of the water and will likely be avoided by any juvenile or adult sea turtles (e.g., Kemp's ridley, green, loggerhead, or hawksbill turtles) that happen to be in the vicinity foraging in benthic habitats. Therefore, the discussion of military expended materials strikes focuses on the potential of a strike at the surface of the water. Other reptiles (such as American alligators and terrapins) could be on the water's surface. However, these reptiles may respond to other types of stressors (e.g., vessel noise or visual disturbance) and flee the vicinity of the inshore activity, thereby reducing the potential for physical disturbance and strike. Where inshore training and testing activities are adjacent to any terrapin rookery locations, terrapins (nesting females and hatchlings) may be at higher risk of physical disturbance and strike because more individual terrapins would be expected to occur in inshore waters in close proximity to these locations.

American alligators are likely sensitive to approaching vessels, often demonstrating avoidance behaviors to both motorized and non-motorized recreational boating in lakes (Lewis et al., 2014), and are likely at higher risk for strike in narrow shallow channels that would restrict the movements of a fleeing alligator. It is unlikely that military expended materials would strike American alligators in these waters because materials would not be expended in small creeks and similar habitats. American alligators would be at higher risk for strike in more relatively open waters like rivers and estuaries where materials may be expended.

Diamondback terrapins likely detect approaching vessels, but do not typically exhibit avoidance behaviors (Lester et al., 2012; Lester, 2013); therefore, terrapins are likely at increased strike risk by military expended materials when transiting an open water area or foraging at the surface.

While no strike from military expended materials has ever been reported or recorded on a reptile, the possibility of a strike still exists. Therefore, the potential for sea turtles to be struck by military expended materials was evaluated using statistical probability modeling to estimate potential direct strike exposures to a sea turtle. American alligators and diamondback terrapins were not included in the model because these species occur in relatively more shallow water habitats and would likely respond to other stressors from inshore training and testing activities. To estimate potential direct strike exposures of sea turtles, a scenario was calculated using the sea turtle species with the highest average monthly density in areas with the highest amounts of military expended material expenditures, specifically Virginia Capes and Jacksonville Range Complexes (see Appendix F, Military Expended Materials and Direct Strike Impact Analyses). Input values include munitions data (frequency, footprint and type), size of the training or testing area, sea turtle density data, and size of the animal. To estimate the potential of military expended materials to strike a sea turtle, the impact area of all military expended materials was totaled over one year in the area with the highest combined amounts of military expended materials for the Proposed Action. Loggerhead turtles are used as a proxy for modeling impacts because this species has the highest seasonal density within these two areas; therefore, loggerhead turtles provide the most conservative estimate of potential strikes. For estimates of expended materials in all areas, see Section 3.0.3.3.4.2 (Military Expended Materials). The analysis of the potential for a sea turtle strike is influenced by the following assumptions:

- The model is two-dimensional, assumes that all sea turtles would be at or near the surface 100 percent of the time, and does not consider any time a sea turtle would be submerged.

- The model also does not take into account the fact that most of the projectiles fired during training and testing activities are fired at targets, and that most projectiles hit those targets, so only a very small portion of those would hit the water with their maximum velocity and force.

- The model assumes the animal is stationary and does not account for any movement of the sea turtle or any potential avoidance of the training or testing activity.

The potential of fragments from high-explosive munitions or expended material other than munitions to strike a sea turtle is likely lower than for the worst-case scenario calculated above because those events happen with much lower frequency. Fragments may include metallic fragments from the exploded target, as well as from the exploded munitions.

There is a possibility that an individual turtle at or near the surface may be struck if they are in the target area at the point of physical impact at the time of non-explosive munitions delivery. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. Direct munitions strikes from non-explosive bombs, missiles, and rockets are potential stressors to some species. Some individuals at or near the surface may be struck directly if they are at the point of impact at the time of non-explosive practice munitions delivery. However, most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and aerial targets hit the water as fragments, which quickly dissipates their kinetic energy within a short distance of the surface.

Adult sea turtles are generally at the surface for short periods and spend most of their time submerged; however, hatchlings and juveniles of all sea turtle species spend more time at the surface while in ocean currents, and all sea turtle life stages bask on the surface. Leatherback sea turtles of all age classes are more likely to be foraging at or near the surface in the open ocean than other species, but the likelihood of being struck by a projectile remains very low because of the wide spatial distribution of leatherbacks relative to the point location of an activity. Furthermore, projectiles are aimed at targets, which will absorb the impact of the projectile. Other factors that further reduce the likelihood of a sea turtle being struck by an expended munition include the recovery of all non-explosive torpedoes as well as target-related materials that are intact after the activity. The Navy will implement mitigation (e.g., not conducting gunnery activities against a surface target when a specified distance from sea turtles) to avoid potential impacts from military expended materials on sea turtles throughout the Study Area (see Section 5.3, Procedural Mitigation to be Implemented).

3.8.3.4.3.1 Impacts from Military Expended Materials under Alternative 1

Impacts from Military Expended Materials under Alternative 1 for Training Activities

Training activities in offshore waters under Alternative 1 that involve military expended materials under the Proposed Action would occur in the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, Gulf of Mexico Range Complexes, and other AFTT areas. In addition, training activities that involve military expended materials would be conducted within inshore waters within and around Boston, Massachusetts; Earle, New Jersey; Delaware Bay, Delaware; Narragansett, Rhode Island; Hampton Roads, Virginia; James River and tributaries, Virginia; the Lower Chesapeake Bay, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Cooper River, South Carolina; Savannah, Georgia; Kings Bay, Georgia; Mayport, Florida; Port Canaveral, Florida; Tampa, Florida; Beaumont, Texas; and Corpus Christi, Texas (see Table 3.0-30 and Table 3.0-33). Navy training activities have the potential to expose all age classes of any species of sea turtle within these offshore and inshore areas to military expended materials.

Sea turtles are expected to be highly dispersed in offshore waters. Repeated exposures to sea turtles are not anticipated as these offshore areas do not have resident animals year round. Navy training activities involving military expended materials in the inshore waters occur in several locations along the Atlantic coast, but fewer types of military materials would be expended compared to the activities in the offshore areas (see Section 3.0.3.3.4.2, Military Expended Materials). For training activities occurring in inshore waters, loggerhead, green, Kemp's ridley, and hawksbill turtles that have recruited to benthic foraging grounds could be present. Leatherbacks that forage at the surface in coastal and sometimes estuarine waters would also be present. Hatchlings of all sea turtle species would be present very briefly as they leave the nest, enter the water, and move to offshore areas to develop. Hatchlings would only be present a few months of the year between summer and fall from southern Virginia and further south.

As stated previously, factors that further reduce the likelihood of a sea turtle being struck by an expended munition include the recovery of all non-explosive torpedoes as well as target-related materials that are intact after the activity. The Navy will implement mitigation (e.g., not conducting gunnery activities against a surface target when a specified distance from sea turtles) to avoid potential impacts from military expended materials on sea turtles throughout the Study Area. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated Sargassum mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented).

American alligators and diamondback terrapins would also be exposed to training activities using military expended materials in inshore locations. Under Alternative 1, American alligators may be potentially exposed to military expended materials in inshore locations in North Carolina, South Carolina, Georgia, Florida, and Texas, while diamondback terrapins may be exposed in all inshore training locations. The likelihood of a physical disturbance and strike of an American alligator and diamondback terrapin is low because of the relatively lower numbers of military expended materials that would be expended in inshore waters compared to offshore locations, and the anticipated lower density of alligators and terrapins in inshore training locations. However, because of the potential for larger concentrations of female adult terrapins at coastal rookery locations at the beginning of nesting season and the larger concentration of hatchlings in waters at the end of nesting season, terrapins are at higher risk of physical disturbance and strike of military expended materials.

The model results presented in Appendix F (Military Expended Materials and Direct Strike Impact Analyses) estimate loggerhead sea turtle exposures (as discussed above, as a conservative proxy for all sea turtles) during training activities in the Virginia Capes and Jacksonville Range Complexes. The loggerhead turtle was used as a proxy for all sea turtle species because this species has the highest offshore density estimates, which would provide the most conservative output results. Based on a worst-case scenario, the results indicate with a reasonable level of certainty that sea turtles would not be struck by non-explosive practice munitions and expended materials other than munitions. In the Virginia Capes Range Complex, the model estimates approximately 0.08 direct strike exposures per year. In the Jacksonville Range Complex, the model estimates 0.03 direct strike exposures per year. As stated previously, for the purposes of modeling, only Virginia Capes and Jacksonville Range Complexes were used because these two training areas would have the highest estimated numbers and concentrations of military expended materials for each alternative and would thus provide a reasonable comparison for all other areas with fewer expended materials.

Green, Kemp's ridley, and loggerhead sea turtles may occur in these areas used for modeling (Virginia Capes and Jacksonville Range Complexes). Hawksbill turtles may also occur in the Jacksonville Range Complex and farther south off the U.S. Atlantic and Gulf coasts, but less frequently than the other species of sea turtles. Leatherback turtles are more likely to be farther offshore, in the open ocean, although in the summer they are known to forage in nearshore environments in inshore waters of Virginia and North Carolina. Military expended materials deposition would be less concentrated in the Gulf of Mexico because of fewer activities that would expend materials. All of these sea turtle species may occur within the Gulf of Mexico, but Kemp's ridley and green sea turtles are more abundant.

Under Alternative 1, training activities could introduce exposure risk to military expended materials, but activities are not expected to result in substantial changes in an individual reptile's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species.

Proposed training activities under Alternative 1 that use military expended materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use military expended materials would occur year round within the five critical habitat types for the loggerhead sea turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Military expended materials use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to some of the military expended materials being recovered or sinking through the water column. Military expended materials would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, activities that use military expended materials during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Military Expended Materials under Alternative 1 for Testing Activities

Testing activities in offshore waters that involve military expended materials under the Proposed Action would primarily occur in the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West and Gulf of Mexico Range Complexes within the Study Area. Other areas include the Naval Undersea Warfare Center, Newport Testing Range; the South Florida Ocean Measurement Facility Testing Range; and Naval Surface Warfare Center, Panama City Testing Range (see Table 3.0-26, Table 3.0-28, Table 3.0-31, and Table 3.0-34). It should be noted that military expended materials would not be expended in inshore waters; therefore, American crocodiles, American alligators, and diamondback terrapins are not analyzed for potential impacts from Alternative 1 testing activities.

Sea turtles are expected to be highly dispersed in offshore waters. Repeated exposures to sea turtles are not anticipated as these offshore areas do not have resident animals year round. The results presented in Appendix F (Military Expended Materials and Direct Strike Impact Analyses) indicate a reasonable level of certainty that no sea turtles would be struck by military expended materials. Based on a worst-case scenario, the results indicate with a reasonable level of certainty that sea turtles would not be struck by non-explosive practice munitions and expended materials other than munitions. In the Virginia Capes Range Complex, the model estimates approximately 0.03 direct strike exposures per year. In the Jacksonville Range Complex, the model estimates 0.06 direct strike exposures per year. As mentioned previously, the loggerhead turtle was used as a proxy for all sea turtle species because this species has the highest offshore density estimates, which would provide the most conservative modeling output results. In addition, Virginia Capes Range Complex and Jacksonville Range Complex were the only areas modeled because these two areas would have the highest concentration of military expended materials from testing activities, again providing the most conservative modeling output results.

Under Alternative 1, testing activities will introduce exposure risk to military expended materials, which could result in changes to a sea turtle's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. No impacts to individual sea turtles are expected; therefore, no population-level effects would result from testing activities under Alternative 1.

As with training activities, factors that further reduce the likelihood of a sea turtle being struck by an expended munition include the recovery of all non-explosive torpedoes as well as target-related materials that are intact after the activity. The Navy will implement mitigation (e.g., not conducting gunnery activities against a surface target when a specified distance from sea turtles) to avoid potential impacts from military expended materials on sea turtles throughout the Study Area. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated Sargassum mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented).

Under Alternative 1 testing activities, release of military expended materials would not occur in critical habitat designations for the American Crocodile (Florida Bay), green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), or leatherback sea turtle (St. Croix Island). Navy testing activities that use military expended materials would occur year round within the five critical habitat types for the loggerhead sea turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Military expended materials use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to some of the military expended materials being recovered or sinking through the water column. Military expended materials would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, activities that use military expended materials during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.4.3.2 Impacts from Military Expended Materials under Alternative 2

Impacts from Military Expended Materials under Alternative 2 for Training Activities

Although there is a slight increase in the numbers of military expended materials released during training activities under Alternative 2 relative to Alternative 1, probability analyses conducted for training activities under Alternative 2 yielded nearly identical exposures compared to Alternative 1. Based on a worst-case scenario, the results indicate with a reasonable level of certainty that sea turtles would not be struck by non-explosive practice munitions and expended materials other than munitions. In the Virginia Capes Range Complex, the model estimates approximately 0.066 exposures per year. In the Jacksonville Range Complex, the model estimates 0.040 strikes per year. These results provide a high level of certainty that no sea turtles would be struck by military expended materials under Alternative 2 training activities. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated Sargassum mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented). In addition, the results indicate that fractional increases in expendable targets and expended materials other than munitions proposed under Alternative 2 does not substantially increase the potential for direct strike to sea turtles. Therefore, the associated impacts on sea turtles are expected to be identical to Alternative 1 as presented in Section 3.8.3.4.3.1 (Impacts from Military Expended Materials under Alternative 1) for training activities.

As with Alternative 1, American alligators and diamondback terrapins would also be exposed to training activities using military expended materials in inshore locations. Under Alternative 2, American alligators may be potentially exposed to military expended materials in inshore locations in North Carolina, South Carolina, Georgia, Florida, and Texas, while diamondback terrapins may be exposed in all inshore training locations. The likelihood of a physical disturbance and strike of an American alligator and diamondback terrapin is low because of the relatively lower numbers of military expended materials that would be expended in inshore waters compared to offshore locations, and the anticipated lower density of alligators and terrapins in inshore training locations. However, because of the potential for larger concentrations of female adult terrapins at coastal rookery locations at the beginning of nesting season and the larger concentration of hatchlings in waters at the end of nesting season, terrapins are at higher risk of physical disturbance and strike of military expended materials.

Proposed training activities under Alternative 2 that use military expended materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use military expended materials would occur year round within the five critical habitat types for the loggerhead sea turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Military expended materials use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to some of the military expended materials being recovered or sinking through the water column. Military expended materials would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, activities that use military expended materials during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from Military Expended Materials under Alternative 2 for Testing Activities

Although there is a slight increase in the numbers of military expended materials released during testing activities under Alternative 2 relative to Alternative 1, probability analyses conducted for testing activities under Alternative 2 yielded nearly identical exposures compared to Alternative 1. Based on a worst-case scenario, the results indicate with a reasonable level of certainty that sea turtles would not be struck by non-explosive practice munitions and expended materials other than munitions. In the Virginia Capes Range Complex, the model estimates approximately 0.025 exposures per year. In the Jacksonville Range Complex, the model estimates 0.068 strikes per year. These results provide a high level of certainty that no sea turtles would be struck by military expended materials under Alternative 2 training activities. In addition, the results indicate that fractional increases in expendable targets and expended materials other than munitions proposed under Alternative 2 does not substantially increase the potential for direct strike to sea turtles. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated Sargassum mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented). Therefore, the associated impacts on sea turtles are expected to be identical to Alternative 1 as presented in Section 3.8.3.4.3.1 (Impacts from Military Expended Materials under Alternative 1) for testing activities.

As with Alternative 1, testing activities under Alternative 2 that would use military expended materials would not occur in inshore waters; therefore, American crocodiles, American alligators, and diamondback terrapins are not analyzed for potential impacts from Alternative 2 testing activities.

Proposed testing activities under Alternative 2 that use military expended materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that use military expended materials would occur year round within the five critical habitat types for the loggerhead sea turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Military expended materials use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to some of the military expended materials being recovered or sinking through the water column. Military expended materials would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, activities that use military expended materials during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.4.3.3 Impacts from Military Expended Materials under the No Action Alternative

<u>Impacts from Military Expended Materials under the No Action Alternative for Training and Testing Activities</u>

Under the No Action Alternative, the Navy would not conduct the proposed training or 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.

3.8.3.4.4 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices refer to Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many exercises would occur under each alternative, see Section 3.0.3.3.4.3 (Seafloor Devices). These include items placed on, dropped on or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed instruments, and bottom-crawling unmanned underwater vehicles. The likelihood of any reptile species encountering seafloor devices is considered low because these items are either stationary or move very slowly along the bottom.

Benthic-foraging sea turtles (e.g., Kemp's ridley, green, loggerhead, or hawksbill turtles), American alligators, and diamondback terrapins would most likely encounter a seafloor device, but would likely avoid it. In the unlikely event that a reptile is in the vicinity of a seafloor device, the slow movement and stationary characteristics of these devices would not be expected to physically disturb or alter natural behaviors of sea turtles, alligators, or terrapins. As discussed in Section 3.8.3.4.3 (Impacts from Military Expended Materials), objects fall through the water slowly until they rest on the seafloor and could be avoided by most reptiles. Therefore, these items do not pose a significant strike risk to sea turtles, terrapins, or alligators. The only seafloor device used during training and testing activities that has the potential to strike a reptile at or near the surface is an aircraft deployed mine shape, which is used during aerial mine laying activities. These devices are identical to non-explosive practice bombs, therefore the analysis of the potential impacts from those devices are covered in Section 3.8.3.4.3 (Impacts from Military Expended Materials) and are not further analyzed in this section.

All of the inshore training locations shown in Table 3.0-36 may potentially be inhabited by diamondback terrapins, while inshore training locations in North Carolina, South Carolina, Georgia, Florida, and Texas may be inhabited by the American alligator. Seafloor devices would not be used in American crocodile habitats or within critical habitat designated for this species; therefore, American crocodiles are not discussed further in the analysis for potential impacts of the use of seafloor devices.

3.8.3.4.4.1 Impacts from Seafloor Devices under Alternative 1

Impacts from Seafloor Devices under Alternative 1 for Training Activities

Offshore training activities that use seafloor devices under Alternative 1 would primarily occur in the Virginia Capes Range Complex. Other locations include Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes; and the Naval Surface Warfare Center, Panama City Testing Range (see Table 3.0-35). In addition training activities that use seafloor devices would be conducted within inshore waters including and surrounding Boston, Massachusetts; Earle, New Jersey; Delaware Bay, Delaware; Hampton Roads, Virginia, the Lower Chesapeake Bay, Virginia; James River and tributaries, Virginia; York River, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Savannah, Georgia; Kings Bay, Georgia; Mayport, Florida; Port Canaveral, Florida; Truman Harbor, Florida; Demolition Key, Florida; Tampa Florida; Beaumont, Texas; and Corpus Christi, Texas (see Table 3.0-36).

For training activities occurring in the offshore waters, loggerhead, green, and hawksbill turtles may be impacted, especially if seafloor devices are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth). Adult loggerhead turtles may be found foraging in waters as deep as 200 m (Hochscheid, 2014). Juvenile sea turtles (e.g., green turtles) may rest and forage in waters as deep as approximately 30 m (Hochscheid, 2014), and hawksbill turtles have a recorded maximum dive depth of about 80 m. Leatherback turtles are more likely to co-occur with these offshore activities given their preference for open-ocean habitats and its feeding behavior (feed throughout the water column); therefore, this species may be exposed to a seafloor device as it is being deployed to the bottom. For example, leatherbacks may dive to depths greater than 1,000 m in search of prey (e.g., jellyfish) (Hochscheid, 2014). Animals are expected to be highly dispersed in offshore waters. Repeated exposures to animals are not anticipated as these offshore areas do not have resident sea turtles year round.

Navy training activities involving seafloor devices in the inshore waters occur in several locations along the Atlantic coast, but fewer estimated annual activities involving seafloor devices would be conducted compared to the activities in the offshore areas. The most training events involving seafloor devices would be conducted in the Lower Chesapeake Bay. Other locations include the James River and

Tributaries, Virginia; and Narragansett, Rhode Island. For training activities occurring in inshore waters, juvenile, sub-adult, and adult loggerhead, green, Kemp's ridley, and to a lesser extent hawksbill sea turtles that have recruited to benthic foraging grounds would most likely be impacted. Sub-adult and adult leatherbacks that forage at the surface in coastal and sometimes estuarine waters would also be present. Based on the analysis in Section 3.8.3.4.3 (Impacts from Military Expended Materials), there is a reasonable level of certainty that no sea turtles would be struck by seafloor devices. The likelihood of a sea turtle encountering seafloor devices in benthic foraging habitats is considered low because these items are either stationary or move very slowly along the bottom. Seafloor devices are not likely to interfere with sea turtles resident to coastal or inshore waters, or engaging in migratory, reproductive, and feeding behaviors within the range complexes of the AFTT Study Area. Further, seafloor devices would mostly impact sea turtle species that are foraging in benthic habitats (e.g., Kemp's ridley, loggerhead, hawksbill, and green sea turtles) or throughout the water column in deep waters (e.g., leatherback sea turtle). Additionally, some sea turtle species in coastal habitats can occur near the bottom resting. Sea turtles encountering seafloor devices would likely avoid them because of the devices' slow movement and visibility. Given the slow movement of seafloor devices, the effort expended by sea turtles to avoid them would be minimal, and any behavioral impacts would be temporary.

American alligators may encounter seafloor devices in inshore training locations in Morehead City, North Carolina; Wilmington, North Carolina; Savannah, Georgia; Kings Bay, Georgia; Mayport, Florida; Port Canaveral, Florida; Truman Harbor, Florida; Demolition Key, Florida; Tampa Florida; Beaumont, Texas; and Corpus Christi, Texas. American alligators can spend extended periods of time under water (as much as 40 percent of the time during nighttime foraging activities, Nifong [2014]). During this submerged time, the potential for alligators to be struck by seafloor devices is low, as alligators would likely avoid seafloor devices due to their slow movement and visibility and because they do not resemble prey items. Given the slow movement of seafloor devices, the effort expended by alligators to avoid them would be minimal, and any behavioral impacts would be temporary.

Diamondback terrapins may encounter seafloor devices in all inshore training locations. Terrapins would likely be in estuarine benthic habitats foraging for prey items, such as shellfish (Hart & Lee, 2006; Pfau & Roosenburg, 2010). For the same reasons as for sea turtles and for alligators, terrapins would likely avoid and not be struck by seafloor devices, because these devices are slow moving and likely visible to diamondback terrapins in estuarine benthic habitats. Given the slow movement of seafloor devices, the effort expended by diamondback terrapins to avoid them would be minimal, and any behavioral impacts would be temporary.

Proposed training activities under Alternative 1 that use seafloor devices would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use seafloor devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Seafloor devices use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the localized area potentially impacted by seafloor devices and the fact that most seafloor devices are recovered. Seafloor devices would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, training activities that use seafloor devices under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Seafloor Devices under Alternative 1 for Testing Activities

Testing activities that involve the use of seafloor devices under Alternative 1 would occur in the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes; Naval Undersea Warfare Center, Newport Testing Range; South Florida Ocean Measurement Facility Testing Range; Naval Surface Warfare Center, and Panama City Testing Range (see Table 3.0-35). In addition, testing activities that use seafloor devices would be conducted within the inshore waters surrounding Little Creek, Virginia and Norfolk, Virginia. For testing activities under Alternative 1, seafloor devices may be deployed in habitats used by sea turtles and diamondback terrapins. Inshore locations proposed for use under Alternative 1 testing activities do not include habitat areas for the American crocodile, critical habitat for the American crocodile, or American alligator habitats; therefore, crocodilian species are not analyzed for impacts under Alternative 1 testing activities.

For testing activities occurring in the offshore waters, the species and age classes that may be impacted are juvenile and adult loggerhead, green, and hawksbill sea turtles, especially if seafloor devices are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth). The loggerhead turtle is the most abundant species in the Virginia Capes Range Complex, and adults may be found foraging in waters as deep as 200 m (Hochscheid, 2014). Juvenile sea turtles (e.g., green turtles) may rest and forage in waters as deep as approximately 30 m (Hochscheid, 2014), and hawksbill turtles have a recorded maximum dive depth of about 80 m. Juvenile and adult leatherback turtles are more likely to co-occur with these offshore activities given their preference for open-ocean habitats and their feeding behavior (e.g., feed throughout the water column); therefore, this species may be exposed to a seafloor device as it is being deployed to the bottom. For example, leatherbacks may dive to depths greater than 1,000 m in search of prey (e.g., jellyfish) (Hochscheid, 2014). Animals are expected to be highly dispersed in offshore waters. Repeated exposures to animals are not anticipated as these offshore areas do not have resident sea turtles year round.

Navy testing activities involving seafloor devices in the inshore waters occur at two locations along the Atlantic coast; Little Creek, Virginia; and Norfolk, Virginia. Only one activity involving seafloor devices is estimated to occur per year at each location (see Section 3.0.3.3.4.3, Seafloor Devices). For testing activities occurring in inshore waters, juvenile, sub-adult, and adult loggerhead, green, and Kemp's ridley turtles that have recruited to benthic foraging grounds would most likely be impacted. Sub-adult and adult leatherbacks that forage at the surface in coastal and sometimes estuarine waters would also be present. Based on the analysis in Section 3.8.3.4.3 (Impacts from Military Expended Materials), there is a reasonable level of certainty that no sea turtles would be struck by seafloor devices. The likelihood of a sea turtle encountering seafloor devices in benthic foraging habitats is considered low because these items are either stationary or move very slowly along the bottom. Seafloor devices are not likely to interfere with sea turtles resident to coastal or inshore waters, or engaging in migratory, reproductive, and feeding behaviors within the range complexes of the AFTT Study Area. Further, seafloor devices would impact sea turtle species that are foraging in benthic habitats (e.g., Kemp's ridley, loggerhead, hawksbill, and green sea turtles) or throughout the water column in deep waters (e.g., leatherback sea turtle). Additionally, some sea turtle species in coastal habitats can occur near the bottom when resting.

Sea turtles encountering seafloor devices would likely avoid them because of their slow movement and visibility. Given the slow movement of seafloor devices, the effort expended by sea turtles to avoid them would be minimal, and behavioral impacts would be temporary.

Diamondback terrapins may encounter seafloor devices in the testing locations of Little Creek and Norfolk, Virginia. Terrapins would likely be in estuarine benthic habitats foraging for prey items, such as shellfish (Pfau & Roosenburg, 2010). For the same reasons as for sea turtles, terrapins would likely not be struck by and would avoid seafloor devices, which are slow moving and likely visible to diamondback terrapins in estuarine benthic habitats. Given the slow movement of seafloor devices, the effort expended by diamondback terrapins to avoid them would be minimal, and any behavioral impacts would be temporary.

Proposed testing activities under Alternative 1 that use military expended materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that use seafloor devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Seafloor devices use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the localized area potentially impacted by seafloor devices and the fact that most seafloor devices are recovered. Seafloor devices would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, testing activities that use seafloor devices under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.4.4.2 Impacts from Seafloor Devices under Alternative 2

Impacts from Seafloor Devices under Alternative 2 for Training Activities

As stated in Section 3.0.3.3.4.3 (Seafloor Devices), the locations and annual number of training activities that involve seafloor devices are the same under Alternatives 1 and 2. Based on the analysis in Section 3.8.3.4.4.1 (Impacts from Seafloor Devices under Alternative 1) for training activities, there is a reasonable level of certainty that no reptiles would be struck by seafloor devices.

Proposed training activities under Alternative 2 that use military expended materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use seafloor devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Seafloor devices use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the localized area potentially impacted by seafloor devices and the fact that most seafloor devices are recovered. Seafloor devices would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, training activities that use seafloor devices under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from Seafloor Devices under Alternative 2 for Testing Activities

As stated in Section 3.0.3.3.4.3 (Seafloor Devices) the location of testing activities that use seafloor devices are the same under Alternatives 1 and 2; however, the number of testing activities proposed under Alternative 2 would increase by approximately 2 percent annually and by approximately 7 percent over five years. Based on the analysis in Section 3.8.3.4.3.2 (Impacts from Military Expended Materials under Alternative 2) for testing activities, there is a reasonable level of certainty that no reptiles would be struck by seafloor devices.

Proposed training activities under Alternative 2 that use military expended materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that use seafloor devices would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Seafloor devices use has no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the localized area potentially impacted by seafloor devices and the fact that most seafloor devices are recovered. Seafloor devices would not be expended in the water to the point where migratory corridors would be obstructed and would not degrade nearshore reproductive habitat, winter areas, breeding areas, or *Sargassum* habitat.

Pursuant to the ESA, testing activities that use seafloor devices under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.4.4.3 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 or 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.

3.8.3.4.5 Pile Driving

Pile driving occurs during training activities and would have no effect on reptiles because they are mobile and would be able to avoid the physical disturbance and strike stressors associated with pile driving activities. Pile driving would occur at two locations: Little Creek, Virginia; and Camp Lejeune, North Carolina. Pile driving would not occur during testing activities. This activity is analyzed under acoustic stressors (see Section 3.8.3.1.4, Impacts from Pile Driving) for potential impacts on reptiles (sea turtles, alligators, and diamondback terrapins).

Proposed training activities that involve pile driving would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), loggerhead sea turtle (breeding areas, nearshore reproductive habitat, winter areas, migration corridors, or *Sargassum* habitat), or American crocodile (Florida Bay).

Pursuant to the ESA, training activities that involve pile driving under Alternative 1 and Alternative 2 would have no effect on the ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and have no effect on the ESA-listed American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and there would be no effect on American crocodile critical habitat.

3.8.3.5 Entanglement Stressors

This section analyzes the potential entanglement impacts of the various types of expended materials used by the Navy during training and testing activities within the Study Area. This analysis includes the potential impacts from three types of military expended materials: (1) wires and cables (2) decelerators/parachutes and (3) biodegradable polymers. Because expended materials that present entanglement risk to sea turtles are not expended in crocodilian or terrapin habitats, and because it is reasonable to assume that military expended materials would not drift into crocodilian or terrapin habitats, entanglement stressors are not analyzed for potential impacts on the American crocodile, American alligator, or the diamondback terrapin.

These materials could be encountered by sea turtles and if encountered, may have the potential to entangle sea turtles in the AFTT Study Area at the surface, in the water column, or along the seafloor. The number and location of materials or activities that involve the use of items that may pose an entanglement risk are provided in Section 3.0.3.3.5 (Entanglement Stressors). General discussion of impacts can also be found in Section 3.0.3.6.4 (Conceptual Framework for Assessing Effects from Entanglement).

Risk factors for entanglement of sea turtles include animal size (and life stage), sensory capabilities, and foraging methods. Most entanglements discussed in the literature are attributable to sea turtle entrapments with fishing gear or other non-military materials that float or are suspended at the surface. Entanglement events are difficult to detect from land or from a boat as they may occur at considerable distances from shore and typically take place underwater. Juvenile turtles and hatchlings are inherently less likely to be detected than larger adult sea turtles. The likelihood of witnessing an entanglement event is therefore typically low. However, the properties and size of these military expended materials, as described in Section 3.0.3.3.5 (Entanglement Stressors) and Section 3.0.3.6.4 (Conceptual Framework for Assessing Effects from Entanglement), makes entanglement a possibility.

3.8.3.5.1 Impacts from Wires and Cables

For a discussion of the types of activities that use wires and cables see Appendix B (Activity Stressor Matrices). For a discussion on where they are used and how many wires and cables would be expended under each alternative, see Section 3.0.3.3.5.1 (Wires and Cables). A sea turtle that becomes entangled in nets, lines, ropes, or other foreign objects under water may suffer temporary hindrance to movement before it frees itself or may remain entangled. The turtle may suffer minor injuries but recover fully, or it may die as a result of the entanglement. The entanglement risk to sea turtles of these items are discussed below.

Some fiber optic cables used during Navy training and testing associated with remotely operated mine neutralization activities would be expended, although a portion may be recovered. The length of the expended tactical fiber would vary (up to about 3,000 m) depending on the activity. Tactical fiber has an 8-micrometer (0.008 mm) silica core and acylate coating, and looks and feels like thin monofilament fishing line. Other characteristics of tactical fiber are a 242-micrometer (0.24 mm) diameter, 12-lb. tensile strength, and 3.4-mm bend radius (Corning Incorporated, 2005; Raytheon Company, 2015). Tactical fiber is relatively brittle; it readily breaks if knotted, kinked, or abraded against a sharp object. Deployed tactical fiber breaks if it is looped beyond its bend radius (3.4 mm) or exceeds its tensile strength (12 lb.). If the fiber becomes looped around an underwater object or sea turtle, it does not tighten unless it is under tension. Such an event would be unlikely based on its method of deployment and its resistance to looping after it is expended. The tactical fibers are often designed with controlled buoyancy to minimize the fiber's effect on vehicle movement. The tactical fiber would be suspended within the water column during the activity, and then be expended and sink to the seafloor (effective sink rate of 1.45 cm/second [Raytheon, 2015]) where it would be susceptible to abrasion and burial by sedimentation. Additionally, encounter rates with fiber optic cables by sea turtles are limited by the small number of cables that are expended.

If the isobath is greater than the maximum benthic foraging ability (dive depth) of a sea turtle, then these cables would not present an entanglement risk. For example, as discussed previously, leatherbacks may dive to depths greater than 1,000 m in search of prey (e.g., jellyfish), while other species (e.g., loggerheads) may forage in benthic habitats as deep as approximately 200 m, and juvenile sea turtles (e.g., green sea turtles) resting and foraging in waters as deep as approximately 30 m (Hochscheid, 2014). In addition, although hatchlings would not likely be able to escape entrapment if entangled, but the chance of entanglement for a hatchling is very unlikely since these cables will be within the water column during the activity. Therefore, fiber optic cables present an entanglement risk to sea turtles, but it is unlikely that an entanglement event would occur and any entanglement would be temporary (a few seconds) before the sea turtle could resume normal activities. As noted in Section 3.8.2.1.5 (General Threats), entanglement by fishing gear is a serious global threat to sea turtles. The various types of marine debris attributed to sea turtle entanglement (e.g., commercial fishing gear, towed gear, stationary gear, or gillnets) have substantially higher (up to 500–2,000 lb.) breaking strengths at their “weak links.” If fiber optic cables and fragments of cables sink to the seafloor in an area where the bottom is calm, they would remain there undisturbed. In an area with bottom currents or active tidal influence, the fiber optic strands may move along the seafloor, away from the location in which they were expended and potentially into sea turtle benthic foraging habitats. Over time, these strands may become covered by sediment in most areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for reintroduction as an entanglement risk.

Similar to tactical fibers discussed above, guidance wires may pose an entanglement threat to sea turtles either in the water column or after the wire has settled to the seafloor. The Navy previously analyzed the potential for entanglement of sea turtles by guidance wires and concluded that the potential for entanglement is low (U.S. Department of the Navy, 1996). These conclusions have also been carried forward in NMFS analyses of Navy training and testing activities (National Marine Fisheries Service, 2013b). The likelihood of a sea turtle encountering and becoming entangled in a guidance wire depends on several factors. With the exception of a chance encounter with the guidance wire while it is sinking to the seafloor (at an estimated rate of 0.7 ft. per second), it is most likely that a sea turtle would only encounter a guidance wire once it had settled on the seafloor. Since the guidance wire will only be within the water column during the activity and while it sinks, the likelihood of a sea turtle encountering and becoming entangled within the water column is extremely low. The tensile breaking strength of the wire is a maximum of 40.4 lb. and can be broken by hand (Swope & McDonald, 2013) in contrast with the rope or lines associated with commercial fishing activities. However, it has a somewhat higher breaking strength than the monofilament used in the body of most commercial gillnets (typically 31 lb. or less). In addition, any undispensed wire would be contained in the dispensers upon impact of the sonobuoy or missile with the target. In addition, based on degradation times, the guidance wires would break down within one to two years and therefore no longer pose an entanglement risk. As with fiber optic cables, guidance wire fragments may move with bottom currents or active tidal influence, and present an enduring entanglement risk if the wires were moved into benthic foraging habitats. Subsequent colonization by encrusting organisms, burying by sediment, and chemical breakdown of the copper filament would further reduce the potential for reintroduction as an entanglement risk. The length of the guidance wires varies, as described in Section 3.0.3.3.5.1 (Wires and Cables), but greater lengths increase the likelihood that a sea turtle could become entangled. The behavior and feeding strategy of a species can determine whether it may encounter items on the seafloor, where guidance wires will most likely be available. There is potential for those species (e.g., green, hawksbill, Kemp's ridley, and loggerhead) that feed on the seafloor to encounter guidance wires and potentially become entangled; however, the relatively few guidance wires being expended within the AFTT Study Area limits the potential for encounters.

Sonobuoys consist of a surface antenna and float unit and a subsurface hydrophone assembly unit. The two units are attached through a thin-gauge, dual-conductor, hard draw copper strand wire, which is then wrapped by a hollow rubber tubing or bungee in a spiral configuration. The tensile breaking strength of the sonobuoy wire and rubber tubing is no more than 40 lb. The length of the sonobuoy wire is housed in a plastic canister dispenser, which remains attached upon deployment. The length of cable that extends out is no more than 1500 ft. and is dependent on the water depth and type of sonobuoy. Attached to the sonobuoy wire is a kite-drogue and damper disk stabilizing system made of non-woven nylon fabric. The nylon fabric is very thin and can be broken by hand. The sonobuoy wire runs through the stabilizing system and leads to the hydrophone components. The hydrophone components may be covered by thin plastic netting depending on type of sonobuoy. Each sonobuoy has a saltwater activated polyurethane float that inflates when the sonobuoy is submerged and keeps the sonobuoy components floating vertically in the water column below it. Sonobuoys remain suspended in the water column for no more than 30 hours, after which they sink to the seafloor. Several factors reduce the likelihood of sea turtle entanglement from sonobuoy components. The materials that present an entanglement risk in sonobuoys are weak, and if wrapped around an adult or juvenile sea turtle, would likely break soon after entanglement or break while bending into potentially entangling loops, although hatchlings would not likely be able to escape entrapment if entangled. These materials, however, are only temporarily buoyant and would begin sinking after use in an activity. The entanglement risk from these components would only occur when a sea turtle and these components were in close proximity, which is only in the water column. These materials would be expended in waters too deep for benthic foraging, so bottom foraging sea turtles would not interact with these materials once they sink. Some sonobuoy components, once they sink to the bottom, may be transported by bottom currents or active tidal influence, and present an enduring entanglement risk. In the benthic environment, subsequent colonization by encrusting organisms, burying by sediment, and chemical breakdown of the various materials would further reduce the potential for reintroduction as an entanglement risk.

3.8.3.5.1.1 Impacts from Wires and Cables under Alternative 1

Impacts from Wires and Cables under Alternative 1 for Training Activities

Training activities under Alternative 1 would expend wires and cables within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes as well as other AFTT areas (see Table 3.0-39). Wires would be expended in greatest concentration within the Jacksonville Range Complex which is approximately 50,090 square nautical miles (NM^2) resulting in one wire per 2 NM^2 throughout the entire Jacksonville Range Complex. Cables would be expended in the greatest concentration within the Virginia Capes Range Complex, which is approximately 27,672 square NM^2. As a result, there would one cable per 36 NM^2 throughout the entire Virginia Capes Range Complex per year if they were expended evenly throughout the area. It should be noted that wires and cables would be expended in offshore deep water portions, and would not be an entanglement risk for sea turtles in inshore waters.

Any species of sea turtle that occurs in the Study Area could at some time encounter expended cables or wires. Based on the numbers and geographic locations of their use, wires and cables most likely pose a risk of entanglement for hatchlings and pre-recruitment juveniles of all sea turtle species, and leatherback turtles of all age classes. Wires and cables may pose a slight risk to juvenile, sub-adult, and adult loggerhead, green, and hawksbill sea turtles that have recruited to benthic foraging grounds. However, wires and cables from sonobuoys would be expended in waters too deep for benthic foraging, so bottom-foraging sea turtles (e.g., loggerhead and green turtles) would not interact with these materials once they sink. The sink rates of cables and wires would rule out the possibility of these drifting great distances into nearshore and coastal areas where juvenile, sub-adult, and adult green, hawksbill, Kemp's ridley, and loggerhead sea turtles are more likely to occur and feed on the bottom. However, if wires and cables are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth), then juvenile, sub-adult, and adult loggerhead, green, and hawksbill sea turtles could be at risk of entanglement. For example, loggerheads may forage in benthic habitats as deep as approximately 200 m (Hochscheid, 2014). Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles. Training activities that use wires and cables may cause short-term or long-term disturbance to an individual turtle because if a sea turtle were to become entangled in a cable or wire, it could free itself, or the entanglement could lead to injury or death. Potential impacts of exposure to cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, cables and wires are generally expected to cause an insignificant impact to sea turtles because of (1) the physical characteristics of the cables and wires; (2) the behavior of the species, as sea turtles are unlikely to become entangled in an object that is resting on the seafloor; and (3) the low concentrations of expended wires and cables in the AFTT Study Area. Given the low concentration of expended wires and cables, and the patchy distribution of sea turtles and the wires and cables expended in the offshore waters throughout the Study Area, the likelihood of encountering a wire or cable and becoming entangled is low.

Potential impacts of exposure to wires and cables are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species.

Proposed training activities under Alternative 1 that expend wires and cables would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that expend wires and cables would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas, but would occur in the following loggerhead turtle designated critical habitat year round: nearshore reproductive habitat, winter areas, migratory corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Wires and cables have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of wires and cables that are expended, the sparse distribution of the wires and cables expended in the deeper offshore waters throughout the Study Area, the fact that the wires and cables sink upon release, and the physical properties and degradation time of the wires and cables.

Pursuant to the ESA, the use of wires and cables during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Wires and Cables under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.5.1 (Wires and Cables), under Alternative 1 testing activities, fiber optic cables, guidance wires, and sonobuoy components that would pose an entanglement risk to sea turtles would be similar to those described training activities, even though testing activities occur at a higher frequency and in more locations compared to training activities. Testing activities involving wires and cables occur at Virginia Capes Range Complex, Jacksonville Range Complex, Key West Range Complex, Northeast Range Complexes, Navy Cherry Point Range Complex, Gulf of Mexico Range Complex, Naval Undersea Warfare Center Newport Testing Range, Naval Surface Warfare Center Panama City Testing Range, and South Florida Ocean Measurement Facility (see Table 3.0-40). Wires would be expended with the greatest concentration in the Northeast Range Complexes, which account for 27,798 NM^2 in size. If expended evenly throughout the area, there would be one wire per approximately 1 NM^2. Fiber optic cables would be expended with greatest concentration in the Naval Surface Warfare Center, Panama City Testing Range, which is 7,966 NM^2 in size, resulting in approximately one cable per 24 NM^2 if expended evenly throughout the area.

Any species of sea turtle that occurs in the Study Area could at some time encounter expended cables or wires. Based on the numbers and geographic locations of their use, wires and cables most likely pose a risk of entanglement for hatchlings and pre-recruitment juveniles of all sea turtle species, and leatherback turtles of all age classes. Wires and cables may pose a slight risk to juvenile, sub-adult, and adult loggerhead, green, and hawksbill sea turtles that have recruited to benthic foraging grounds. However, wires and cables from sonobuoys would be expended in waters too deep for benthic foraging, so bottom-foraging sea turtles (e.g., loggerhead and green turtles) would not interact with these materials once they sink. The sink rates of cables and wires would rule out the possibility of these drifting great distances into nearshore and coastal areas where juvenile, sub-adult, and adult green, hawksbill, Kemp's ridley, and loggerhead sea turtles are more likely to occur and feed on the bottom. However, if wires and cables are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth), then juvenile, sub-adult, and adult loggerhead, green, and hawksbill sea turtles could be at risk of entanglement. For example, loggerheads may forage in benthic habitats as deep as approximately 200 meters (Hochscheid, 2014). Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles. Testing activities that use wires and cables may cause short-term or long-term disturbance to an individual turtle because if a sea turtle were to become entangled in a cable or wire, it could free itself, or the entanglement could lead to injury or death. Potential impacts of exposure to cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, cables and wires are generally expected to cause an insignificant impact to sea turtles because of (1) the physical characteristics of the cables and wires; (2) the behavior of the species, as sea turtles are unlikely to become entangled in an object that is resting on the seafloor; and (3) the low concentrations of expended wires and cables in the AFTT Study Area. Given the low concentration of expended wires and cables, and the patchy distribution of sea turtles and the wires and cables expended in the offshore waters throughout the Study Area, the likelihood of encountering a wire or cable and becoming entangled is low.

Proposed testing activities under Alternative 1 that expend wires and cables would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend wires and cables would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Wires and cables have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of wires and cables that are expended, the sparse distribution of the wires and cables expended in the deeper offshore waters throughout the Study Area, the fact that the wires and cables sink upon release, and the physical properties and degradation time of the wires and cables.

Pursuant to the ESA, the use of wires and cables during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with the NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.5.1.2 Impacts from Wires and Cables under Alternative 2

Impacts from Wires and Cables under Alternative 2 for Training Activities

The locations of training activities that expend wires and cables are the same under Alternatives 1 and 2. Table 3.0-39 shows the number and location of wires and cables expended during proposed training activities. The numbers of wires and cables would be the same for Alternative 2 as for Alternative 1 except for increased numbers of sonobuoy wires in the Gulf of Mexico Range Complex, as well as increases in the number of bathythermograph wires in Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes. Overall, the number of wires (there would be no increases in the number of fiber optic cables) expended during training activities would increase by 2 percent annually and by 3 percent over five years. It should be noted that wires and cables would be expended in offshore deep water portions, and would not be an entanglement risk for sea turtles in inshore waters. Because activities under Alternative 2 occur at a similar rate and frequency relative to Alternative 1, entanglement stress experienced by sea turtles from guidance wires, fiber optic cables, and sonobuoy wires under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. Therefore, impacts associated with training activities under Alternative 2 are the same as Alternative 1.

As with Alternative 1, the use of wires and cables in training activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a cable or wire, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Proposed training activities under Alternative 2 that expend wires and cables would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that expend wires and cables would not occur within the southeast portion of loggerhead critical habitat that is designated as breeding areas, but would occur in the following loggerhead turtle designated critical habitat year round: nearshore reproductive habitat, winter areas, migratory corridors, and *Sargassum* habitat. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Wires and cables have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of wires and cables that are expended, the sparse distribution of the wires and cables expended in the deeper offshore waters throughout the Study Area, the fact that the wires and cables sink upon release, and the physical properties and degradation time of the wires and cables.

Pursuant to the ESA, the use of wires and cables during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from Wires and Cables under Alternative 2 for Testing Activities

The locations of testing activities that expend wires and cables are nearly the same under Alternatives 1 and 2. Table 3.0-40 shows the number and location of wires and cables expended during proposed testing activities. The numbers of wires and cables would mostly be the same for Alternative 2 as for Alternative 1 except for increased numbers sonobuoy wires expended in the Northeast, Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes. There would also be a slight increase in the number of fiber optic cables in Virginia Capes Range Complex and NSWC Panama City Testing Range under Alternative 2. Overall, the number of wires and cables expended during testing activities would increase by 0.6 percent annually and by 3 percent over five years. The differences in species overlap and potential impacts from cables and wires on sea turtles during testing activities would not be discernible from those described for testing activities in Section 3.8.3.5.1.1 (Impacts from Wires and Cables under Alternative 1). As with Alternative 1, the use of wires and cables in testing activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a cable or wire, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Proposed testing activities under Alternative 2 that expend wires and cables would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend wires and cables would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Wires and cables have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of wires and cables that are expended, the sparse distribution of the wires and cables expended in the deeper offshore waters throughout the Study Area, the fact that the wires and cables sink upon release, and the physical properties and degradation time of the wires and cables.

Pursuant to the ESA, the use of wires and cables during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.5.1.3 Impacts from Wires and Cables under the No Action Alternative

Impacts from Wires and Cables under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training or testing activities in the AFTT Study Area. Various entanglement stressors (e.g., wires and cables) 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.

3.8.3.5.2 Impacts from Decelerators/Parachutes

Section 3.0.3.3.5.2 (Decelerators/Parachutes) describes the types of decelerators/parachutes used during training and testing activities, while Section 3.0.3.3.4.2 (Military Expended Materials) provides the number and location of decelerators/parachutes expended during training and testing activities. Training and testing activities that introduce decelerators/parachutes into the water column can occur anywhere in the AFTT Study Area and may pose an entanglement risk to sea turtles. Potential impacts from decelerators/parachutes as ingestion stressors to sea turtles are discussed in Section 3.8.3.6.2.1 (Impacts from Military Expended Materials Other Than Munitions under Alternative 1).

Some aerial targets use large and extra-large decelerators/parachutes (see Section 3.0.3.3.5.2, Decelerators/Parachutes). Large decelerators/parachutes are up to 50 ft. in diameter and extra-large decelerators/parachutes are up to 80 ft. in diameter. The majority of these larger-sized decelerators/parachutes that would be expended are the large parachutes, with a small amount of extra-large decelerators/parachutes being expended. The large and extra-large decelerators/parachutes have long attachment cords (up to 70 ft. and 82 ft. in length, respectively), and upon water impact may remain at the surface for up to 5 minutes before eventually sinking to the seafloor. As previously stated, the rate of sinking depends upon sea conditions and the shape of the decelerator/parachute, and the duration of the descent would depend on the water depth. The decelerators/parachutes that are associated with shore-launched aerial targets have the potential to be recovered, if safety allows for it; however, this analysis assumes the decelerators/parachutes are not recovered.

While in the water column, a sea turtle is less likely to become entangled because the decelerator/parachute would have to land directly on the turtle, or the turtle would have to swim into the decelerator/parachute or its cords before it sank. This is the case for the small and medium decelerators/parachutes; however, the likelihood for entanglement is higher for the large and extra-large decelerators/parachutes due to their size and the length of the attachment cords. Prior to reaching the seafloor, the decelerator/parachute could be carried along in a current, or snagged on a hard structure near the bottom. Conversely, the decelerator/parachute and associated cords could settle to the bottom, where they would be buried by sediment in most soft bottom areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for reintroduction as an entanglement risk. Decelerators/parachutes or decelerator/parachute cords may be a risk for sea turtles to become entangled, particularly while at the surface. A sea turtle would have to surface to breathe or grab prey from under the decelerator/parachute and swim into the decelerator/parachute or its cords in order to become entangled.

If bottom currents are present, the canopy may billow and pose an entanglement threat to sea turtles that feed in benthic habitats (i.e., green, Kemp's ridley, hawksbill, and loggerhead sea turtles). Bottom-feeding sea turtles tend to forage in nearshore and coastal areas rather than offshore, where some of these decelerators/parachutes are used. The small and medium decelerators/parachutes would be expended in offshore waters too deep for benthic foraging, so bottom-foraging sea turtles would not interact with these materials once they sink; therefore, sea turtles are not likely to encounter small and medium decelerators/parachutes once they reach the seafloor. However, some of the large and extra-large decelerators/parachutes have the potential to be expended near shore, therefore posing more of an entanglement risk to bottom-feeding sea turtles. Hatchlings and pre-recruitment juveniles would not likely be able to escape entrapment if they became entangled in a decelerator/parachute at or near the water surface. The potential for a sea turtle to encounter an expended small or medium decelerator/parachute at the surface or in the water column is extremely low, and is even less probable at the seafloor, given the general improbability of a sea turtle being near the deployed decelerator/parachute, the sparse distribution of the small and medium decelerators/parachutes expended throughout the Study Area, as well as the patchy distribution and general behavior of sea turtles; therefore, potential impacts are anticipated to be insignificant. The potential for a sea turtle to encounter an expended large or extra-large parachute at the surface, in the water column, or on the seafloor is a possibility due to their size and the length of the attachment cords as well as the potentially concentrated distribution of these decelerators/parachutes within the nearshore waters of the Study Area where there is a higher concentration of some sea turtle species; therefore, potential impacts may be significant. Depending on how quickly the decelerator/parachute may degrade, the risk may increase with time if the decelerator/parachute remains intact or if underwater currents delay settling of the decelerator/parachute on the seafloor (where they would likely be covered by sediment and encrusted). Factors that may influence degradation times include exposure to ultraviolet radiation and the extent of physical damage of the decelerator/parachute on the water's surface, as well as water temperature and sinking depth. It should be noted that no known instances of sea turtle entanglement with a decelerator/parachute assembly have been reported.

3.8.3.5.2.1 Impacts from Decelerators/Parachutes under Alternative 1

Impacts from Decelerators/Parachutes under Alternative 1 for Training Activities

Training activities under the Proposed Action would expend decelerators/parachutes within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes, along with other areas outside the Range Complexes within the AFTT Study Area. The area with the greatest concentration of small and medium expended decelerators/parachutes would be within the Jacksonville Range Complex, where one decelerator/parachute would be expended per 2 NM^2, if evenly distributed throughout the area. It should be noted that the small and medium decelerators/parachutes would be expended in offshore deep water portions and would not be an entanglement risk for sea turtles in inshore waters. The area with the greatest concentration of large and extra-large expended decelerators/parachutes would be within the Virginia Capes Range Complex. These types of decelerators/parachutes would have the potential to be expended from shore seaward.

Any species of sea turtle that occurs in the Study Area could at some time encounter an expended decelerator/parachute. Based on the numbers and geographic locations of their use, decelerators/ parachutes and decelerator/parachute cords pose a risk of entanglement for all age classes of any sea turtle species. The sink rates of a small and medium decelerator/parachute assembly would rule out the possibility of these drifting great distances into nearshore and coastal areas where juvenile, sub-adult, and adult green, hawksbill, Kemp's ridley, and loggerhead sea turtles are more likely to occur and feed on the bottom. Although these species may feed along the seafloor, they surface periodically to breathe while feeding and moving between nearshore habitats. Kemp's ridley sea turtles can spend extended periods foraging at depth, even in open ocean areas (Sasso & Witzell, 2006; Seney, 2016; Servis et al., 2015). Leatherback turtles of all age classes are more likely to feed at or near the surface in open ocean areas, but sub-adult and adult leatherbacks may also forage at the surface and throughout the water column in coastal and sometimes estuarine waters. Hatchlings and pre-recruitment juveniles of all sea turtle species may co-occur with these activities, since these age classes occur in open-ocean habitats at or near the water surface and are usually affiliated with concentrated *Sargassum* mats. However, activities expending small and medium decelerators/parachutes will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles, further reducing the low likelihood of encountering an expended small or medium decelerator/parachute and entanglement risk (see Section 5.3, Procedural Mitigation to be Implemented).

Over the continental shelf and within nearshore waters, juveniles, sub-adults, and adults of all sea turtle species that have recruited to coastal foraging grounds are at risk of entanglement from the expended large and extra-large decelerators/parachutes because of greater densities of sea turtles and the potential location of these expended decelerators/parachutes (nearshore seaward). Hatchlings of all sea turtle species would also be present very briefly as they leave the nest, enter the water, and move to offshore areas to develop. Hatchlings would only be present a few months of the year between summer and fall from southern Virginia and further south. Green, Kemp's ridley, and loggerhead sea turtles are the only species that nest as far north as Virginia. Leatherback turtles may nest as far north as North Carolina. Only rare nesting activity occurs in parts of Florida for the hawksbill turtle (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013a). Therefore, sea turtle species that occur over the continental shelf and within nearshore waters would have a greater potential for impacts.

For training activities under Alternative 1, exposure to decelerators/parachutes used in training activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a decelerator/parachute, it could free itself, or the entanglement could lead to injury or death. Based on the general discussion presented above and in Section 3.0.3.3.5.2 (Decelerators/Parachutes), small and medium decelerators/parachutes and the associated cords are generally expected to cause an insignificant impact to sea turtles. However, large and extra-large decelerators/parachutes and the associated cords have the potential to cause a significant impact to sea turtles. Potential impacts of exposure to decelerator/parachute may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number, location and size of the decelerators/parachutes and the associated cords there is the potential for disturbance to sea turtles if the decelerator/parachute were to land directly on an animal or an animal were to swim into it before it sinks. It is possible that a benthic feeding sea turtle could become entangled when foraging in areas where decelerators/parachutes have settled on the seafloor. For example, if bottom currents are present, the canopy may temporarily billow and pose a greater entanglement threat.

Potential impacts of exposure to decelerators/parachutes may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the number and location of expended large and extra-large decelerators/parachutes, and the density of sea turtles in the area, the possibility of entanglement cannot be discounted; however, potential impacts of exposure to decelerators/parachutes are not expected to result in population-level impacts for all sea turtle species.

Given the high amount of high-speed vessel movement hours, the inshore water locations of where these activities would occur, and species' distribution throughout the Study Area, co-occurrence with individuals of loggerhead, green, Kemp's ridley, and leatherback turtles are likely, especially in the Virginia Capes Range Complex.

Proposed training activities under Alternative 1 that use decelerators/parachutes would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that expend decelerators/parachutes would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Decelerators/parachutes have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of decelerators/parachutes that are expended, the sparse distribution of the decelerators/parachutes expended in the deeper offshore waters throughout the Study Area, the fact that assemblies are designed to sink rapidly through the water column.

Pursuant to the ESA, the use of decelerators/parachutes during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Decelerators/Parachutes under Alternative 1 for Testing Activities

Testing activities under Alternative 1 testing activities would expend decelerators/parachutes primarily within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes. Other locations include the Naval Undersea Warfare Center Newport Testing Range; South Florida Ocean Measurement Facility Testing Range; and the Naval Surface Warfare Center, Panama City Testing Range. Small and medium decelerators/parachutes would be expended with greatest concentration in the Virginia Capes Range Complex; approximately one decelerator/parachute would be expended per 3 NM^2, if evenly distributed throughout the area. It should be noted that small and medium decelerators/parachutes would be expended in offshore deep water portions and would not be an entanglement risk for sea turtles in inshore waters. The area with the greatest concentration of large expended decelerators/parachutes would be within the Virginia Capes Range Complex. This type of decelerator/parachute has the potential to be expended from shore seaward. Fewer decelerators/parachutes of this size will be expended during testing activities compared to training activities. Extra-large decelerators/parachutes would not be expended during testing activities.

Any species of sea turtle that occurs in the Study Area could at some time encounter an expended decelerator/parachute. Based on the numbers and geographic locations of their use, decelerators/parachutes and decelerator/parachute lines pose a risk of entanglement for all age classes of any sea turtle species. The sink rates of a small and medium decelerator/parachute assembly would rule out the possibility of these drifting great distances into nearshore and coastal areas where juvenile, sub-adult, and adult green, hawksbill, Kemp's ridley, and loggerhead sea turtles are more likely to occur and feed on the bottom. Although these species may feed along the seafloor, they surface periodically to breathe while feeding and moving between nearshore habitats. Kemp's ridley sea turtles can spend extended periods foraging at depth, even in open ocean areas (Sasso & Witzell, 2006; Seney, 2016; Servis et al., 2015). Leatherback turtles of all age classes are more likely to feed at or near the surface in open ocean areas, but sub-adult and adult leatherbacks may also forage at the surface and throughout the water column in coastal and sometimes estuarine waters. Hatchlings and pre-recruitment juveniles of all sea turtle species may also co-occur with these activities, since these age classes occur in open-ocean habitats at or near the water surface and are usually affiliated with concentrated *Sargassum* mats. However, activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles, further reducing the low likelihood of encountering an expended small or medium decelerator/parachute and entanglement risk.

Over the continental shelf and within nearshore waters, juveniles, sub-adults, and adults of all sea turtle species that have recruited to coastal foraging grounds, are at risk of entanglement from the expended large decelerators/parachutes because of greater densities of sea turtles and the potential location of these expended decelerators/parachutes (nearshore seaward). Hatchlings of all sea turtle species would also be present very briefly as they leave the nest, enter the water, and move to offshore areas to develop. Hatchlings would only be present a few months of the year between summer and fall from southern Virginia and further south. Green, Kemp's ridley, and loggerhead turtles are the only species that nest as far north as Virginia. Leatherback turtles may nest as far north as North Carolina. Only rare nesting activity occurs in parts of Florida for the hawksbill turtle (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013a). Therefore, sea turtle species that occur over the continental shelf and within nearshore waters would have a greater potential for impacts.

Exposure to decelerators/parachutes used in testing activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a decelerator/parachute, it could free itself, or the entanglement could lead to injury or death. Based on the general discussion presented above, small and medium decelerators/parachutes and the associated cords are generally expected to cause an insignificant impact to sea turtles. Large decelerators/parachutes and the associated cords have the potential to cause a significant impact to sea turtles; however, decelerators/parachutes are not as frequently expended during testing activities, and therefore the likelihood of an impact is low. Potential impacts of exposure to decelerator/parachute may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the location and size of the decelerators/parachutes and the associated cords there is the potential for disturbance to sea turtles if the decelerator/parachute were to land directly on an animal, or an animal were to swim into it before it sinks, although the likelihood of this type of disturbance is low. It is possible that a benthic feeding sea turtle could become entangled when foraging in areas where decelerators/parachutes have settled on the seafloor. For example, if bottom currents are present, the canopy may temporarily billow and pose a greater entanglement threat. However, the potential for a sea turtle to encounter an expended decelerator/parachute at the surface or in the water column is low, and it is even less probable at the seafloor, given the general improbability of a sea turtle being near the deployed decelerator/parachute and the distribution of sea turtles and of the decelerators/parachutes expended throughout the Study Area.

Based on the number of decelerators/parachutes expended under testing activities for the Proposed Action, the small footprint of impact, and the low likelihood of a decelerator/parachute assembly landing directly on a sea turtle or a sea turtle swimming directly into it, insignificant impacts on sea turtles are anticipated. While entanglement is a serious stressor for sea turtles from a wide range of debris in the ocean, decelerators/parachutes used during military testing activities are an unlikely source.

Potential impacts of exposure to decelerators/parachutes are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species from testing activities under Alternative 1.

Proposed testing activities under Alternative 1 that use decelerators/parachutes would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend decelerators/parachutes would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Decelerators/parachutes have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of decelerators/parachutes that are expended, the sparse distribution of the decelerators/parachutes expended in the deeper offshore waters throughout the Study Area, and the fact that assemblies are designed to sink rapidly through the water column upon release and either break down or be encrusted with benthic organisms if settled on the seafloor.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.5.2.2 Impacts from Decelerators/Parachutes under Alternative 2

Impacts from Decelerators/Parachutes under Alternative 2 for Training Activities

Under Alternative 2, the number of decelerators/parachutes that would be expended during training activities would be similar to Alternative 1 within Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, and Key West Range Complexes, and entanglement stress experienced by sea turtles from decelerators/parachutes under Alternative 2 is not expected to be meaningfully different than what is described under Alternative 1. Therefore, the impact conclusion for decelerators/parachutes under Alternative 2 training activities is the same as for Alternative 1. Within the Gulf of Mexico Range Complex, the number of parachutes would increase compared to Alternative 1; thereby exposing more sea turtles in open ocean habitats within the Gulf of Mexico.

Proposed training activities under Alternative 2 that use decelerators/parachutes would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend decelerators/parachutes would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Decelerators/parachutes have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of decelerators/parachutes that are expended, the sparse distribution of the decelerators/parachutes expended in the deeper offshore waters throughout the Study Area, and the fact that assemblies are designed to sink rapidly through the water column upon release and either break down or be encrusted with benthic organisms if settled on the seafloor.

Pursuant to the ESA, the use of decelerators/parachutes during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from Decelerators/Parachutes under Alternative 2 for Testing Activities

The locations of testing activities that expend decelerators/parachutes are the same under Alternatives 1 and 2. However, the total number of decelerators/parachutes expended during testing activities would increase by approximately 2 percent annually and by 8 percent over five years. This level of increase is not expected to appreciably increase the risk of entanglement to sea turtles that occur in these areas. Potential impacts from testing activities that expend decelerators/parachutes presented in Section 3.8.3.5.2.1 (Impacts from Decelerators/Parachutes under Alternative 1) for testing activities would be applicable to testing activities under Alternative 2. Therefore, the Navy anticipates that no sea turtles would become entangled in decelerators/parachutes.

Proposed testing activities under Alternative 2 that use decelerators/parachutes would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend decelerators/parachutes would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Decelerators/parachutes have no pathway to impact the physical and biological features identified for these habitats (National Marine

Fisheries Service, 2014b) due to the low concentration of decelerators/parachutes that are expended, the sparse distribution of the decelerators/parachutes expended in the deeper offshore waters throughout the Study Area, and the fact that assemblies are designed to sink rapidly through the water column upon release and either break down or be encrusted with benthic organisms if settled on the seafloor.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.5.2.3 Impacts from Decelerators/parachutes under the No Action Alternative

Impacts from Decelerators/parachutes under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training or testing activities in the AFTT Study Area. Various entanglement stressors (e.g., decelerators/parachutes) 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.

3.8.3.5.3 Impacts from Biodegradable Polymer

For a discussion of the types of activities that use biodegradable polymers see Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many activities would occur under each alternative, see Section 3.0.3.3.5.3 (Biodegradable Polymer). Navy activities that involve vessel entanglement systems include the development of the biodegradable polymer and would be associated with testing activities in the AFTT Study Area. As indicated by its name, vessel entanglement systems that make use of biodegradable polymers are designed to entangle the propellers of in-water vessels, which would significantly slow and potentially stop the advance of the vessel. A biodegradable polymer is a high molecular weight polymer that degrades to smaller compounds as a result of microorganisms and enzymes. The rate of biodegradation could vary from hours to years and the type of small molecules formed during degradation can range from complex to simple products, depending on whether the polymers are natural or synthetic (Karlsson & Albertsson, 1998). Based on the constituents of the biodegradable polymer the Navy proposes to use, it is anticipated that the material will breakdown into small pieces within a few days to weeks. This will breakdown further and dissolve into the water column within weeks to a few months. The final products which are all environmentally benign will be dispersed quickly to undetectable concentrations. Unlike other entanglement stressors, biodegradable polymers only retain their strength for a relatively short period of time, therefore the potential for entanglement by a sea turtle would be limited. Furthermore, the longer the biodegradable polymer remains in the water, the weaker it becomes making it more brittle and likely to break. A sea turtle would have to encounter the biodegradable polymer immediately after it was expended for it to be a potential entanglement risk. If an animal were to encounter the polymer a few hours after it was expended, it is very likely that it would break easily and would no longer be an entanglement stressor. Hatchlings, however, would not likely be able to escape entrapment if they became entangled in a biodegradable polymer if entanglement occurred. Biodegradable polymers would only be a risk to hatchlings while the biodegradable polymer retained its tensile strength. As stated above for larger life stages, this is likely in the timeframe of a few hours after expending, but for hatchlings, a lower tensile strength would be required; therefore, the risk to hatchlings would extend over weeks. Due to the wide dispersion and low numbers of biodegradable polymers as well as the patchy distribution of sea turtles, there is a low likelihood of sea turtles, especially hatchlings, interacting with biodegradable polymers while they are an entanglement risk.

3.8.3.5.3.1 Impacts from Biodegradable Polymer under Alternative 1

Impacts from Biodegradable Polymer under Alternative 1 for Training Activities

Biodegradable polymers would not be used during Navy training activities under Alternative 1.

Impacts from Biodegradable Polymer under Alternative 1 for Testing Activities

Testing activities under the Proposed Action that use biodegradable polymers would be conducted within the Virginia Capes, Jacksonville, Key West, and Gulf of Mexico Range Complexes, as well as the Naval Undersea Warfare Division, Newport Testing Range. The number of testing activities involving biodegradable polymers conducted in these areas is relatively low, as discussed in Section 3.0.3.3.5.3 (Biodegradable Polymer) and shown in Table 3.0-42.

Based on the geographic locations of their use and the fact that they may be expended within the coastal zone (3 or 9 NM from shore depending on the state), biodegradable polymers could have the potential to impact all age classes of all sea turtle species. Hatchlings and pre-recruitment juveniles of all sea turtle species, occasionally adult loggerhead turtles, and leatherback turtles of all age classes would most likely be impacted if biodegradable polymers were expended in offshore waters of the Virginia Capes, Jacksonville, Key West, and Gulf of Mexico Range Complexes, as well as the Naval Undersea Warfare Division, Newport Testing Range. Sea turtles are expected to be highly dispersed in offshore waters, and co-occurrence with testing activities is unlikely.

For testing activities that may occur within the coastal zone, juvenile, sub-adult, and adult loggerhead, green, Kemp's ridley and hawksbill sea turtles that have recruited to benthic foraging grounds in coastal waters would most likely be impacted. Sub-adult and adult leatherbacks that forage at the surface and throughout the water column in coastal waters may also be impacted. Hatchlings of all sea turtle species would also be present very briefly as they leave the nest, enter the water, and move to offshore areas to develop. Hatchlings would only be present a few months of the year from southern Virginia and further south. Green, Kemp's ridley, and loggerhead sea turtles are the only species that nest as far north as Virginia. Leatherback sea turtles may nest as far north as North Carolina. Only rare nesting activity occurs in parts of Florida for the hawksbill sea turtle (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013a).

No more than 30 testing events using biodegradable polymers are planned per year in the Virginia Capes, Jacksonville, Key West, and Gulf of Mexico Range Complexes, as well as the Naval Undersea Warfare Division, Newport Testing Range. Given the very low number of events and species' distribution, co-occurrence with individuals of any species is very unlikely, especially in northern areas.

Based on the general discussion presented above and in Section 3.8.3.5.3 (Impacts from Biodegradable Polymer), biodegradable polymers are generally expected to cause a discountable impact to all sea turtle species. Provided the low level of activity, the concentration of these items being expended throughout these areas is likewise considered low, which would result in a very low potential for all sea turtles to encounter biodegradable polymers. In addition, there is only a short duration that a sea turtle would be exposed to an entanglement risk due to the physical properties of the biodegradable polymer, further making the likelihood of entanglement extremely low. The Navy does not anticipate that any sea turtles would become entangled with biodegradable polymers.

Potential impacts of exposure to biodegradable polymers are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species.

Proposed testing activities under Alternative 1 that use biodegradable polymers would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend biodegradable polymers would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Biodegradable polymers have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of biodegradable polymers that are expended, the sparse distribution of the biodegradable polymers expended throughout the Study Area, and the fact that biodegradable polymers are expected to degrade rapidly in water with the final products dispersed quickly to undetectable concentrations.

Pursuant to the ESA, the use of biodegradable polymers during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.5.3.2 Impacts from Biodegradable Polymer under Alternative 2

Impacts from Biodegradable Polymer under Alternative 2 for Training Activities

Biodegradable polymers would not be used during Navy training activities under Alternative 2.

Impacts from Biodegradable Polymer under Alternative 2 for Testing Activities

The location and number of testing activities that expend biodegradable polymers under Alternative 2 would be identical to what is proposed under Alternative 1. The analysis presented in Section 3.8.3.5.3.1 (Impacts from Biodegradable Polymer under Alternative 1) for testing activities would also apply to Alternative 2.

Proposed testing activities under Alternative 2 that use biodegradable polymers would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend biodegradable polymers would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Biodegradable polymers have no pathway to impact the physical and biological features identified for these habitats (National Marine Fisheries Service, 2014b) due to the low concentration of biodegradable polymers that are expended, the sparse distribution of the biodegradable polymers expended throughout the Study Area, and the fact that biodegradable polymers are expected to degrade rapidly in water with the final products dispersed quickly to undetectable concentrations.

Pursuant to the ESA, the use of biodegradable polymers during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.5.3.3 Impacts from Biodegradable Polymer under the No Action Alternative

Impacts from Biodegradable Polymer under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed testing activities in the AFTT Study Area. Biodegradable polymer use is not a part of ongoing Navy activities in the Study Area and this entanglement stressor would not be introduced into the marine environment under the No Action Alternative. Therefore, no change in baseline conditions of the existing environment would occur.

3.8.3.6 Ingestion Stressors

This section analyzes the potential impacts of the various types of ingestion stressors used during training and testing activities within the Study Area. This analysis includes the potential impacts from the following types of military expended materials: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), decelerators/parachutes, and biodegradable polymers. For a discussion on the types of activities that use these materials refer to Appendix B (Activity Stressor Matrices) and for a discussion on the various types of ingestion stressors, see Section 3.0.3.3.6 (Ingestion stressors); for the amounts and locations of each ingestion stressor used under each alternative, see Section 3.0.3.3.4.2 (Military Expended Materials). General discussion of impacts can also be found in Section 3.0.3.6.5 (Conceptual Framework for Assessing Effects from Ingestion). These activities would occur in offshore and inshore training and testing locations that overlap with all species of sea turtles, American alligators, and diamondback terrapins. Because military expended materials would not be used in areas that overlap with the American crocodile known range or critical habitat designated for this species, the American crocodile is not analyzed for potential ingestion risks from expending materials during training or testing activities.

The potential impacts from ingesting these materials is dependent upon the probability of the animal encountering these items in their environment, which is primarily contingent on where the items are expended and how a sea turtle feeds. Sea turtles commonly mistake debris for prey, and ingestion can cause injury or mortality. The United Nations Environment Program estimates that approximately 6.4 million tons of anthropogenic debris enters the marine environment every year (United Nations Environmental Program, 2005). Plastic is the primary type of debris found in marine and coastal environments, and plastics are the most common type of marine debris ingested by sea turtles (Schuyler et al., 2014). Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherback turtles to have ingested various types of plastic (Mrosovsky et al., 2009), and Narazaki et al. (2013) noted an observation of a loggerhead exhibiting hunting behavior on approach to a plastic bag, possibly mistaking the bag for a jelly fish. Even small amounts of plastic ingestion can cause an obstruction in a sea turtle's digestive track and mortality (Bjorndal et al., 1994; Bjorndal, 1997), and hatchlings are at risk for ingesting small plastic fragments. Ingested plastics can also release toxins, such as bisphenol-A (commonly known as "BPA") and phthalates, or absorb heavy metals from the ocean and release those into tissues (Fukuoka et al., 2016; Teuten et al., 2007). The risk is prolific throughout sea turtle habitats; ingestion of expended materials by sea turtles could occur in all large marine ecosystems and open ocean areas and can occur at the surface, in the water column, or at the seafloor, depending on the size and buoyancy of the expended object and the feeding behavior of the turtle. Life stage and feeding preference affects the likelihood of ingestion. Turtles living in oceanic or coastal environments and feeding in the open ocean or on the seafloor may encounter different types and densities of debris, and may therefore have different probabilities of ingesting debris. For example, floating material could be eaten by turtles such as leatherbacks (all age classes), and by juveniles and hatchlings of all species that feed at or near the water surface. It is well documented that these species and age classes are prone to ingesting non-prey items (Hardesty & Wilcox, 2017; Mitchelmore et al., 2017; Schuyler et al., 2014; Schuyler et al., 2016). Materials that sink to the seafloor pose a risk to bottom-feeding sea turtles such as loggerheads, Kemp's ridleys, hawksbills, and greens. In 2014, Schuyler et al. (2014) reviewed 37 studies of debris ingestion by sea turtles, showing that young oceanic sea turtles are more likely to ingest debris (particularly plastic), and that green and loggerhead turtles were significantly more likely to ingest debris than other sea turtle species.

The consequences of ingestion could range from temporary and inconsequential to long-term physical stress or even death. Ingestion of these items may not be directly lethal; however, ingestion of plastic and other fragments can restrict food intake and have sublethal impacts caused by reduced nutrient intake (McCauley & Bjorndal, 1999). Poor nutrient intake can lead to decreased growth rates, depleted energy, reduced reproduction, and decreased survivorship. These long-term sublethal effects may lead to population-level impacts, but the extent of these impacts is difficult to assess because the affected individuals remain at sea and the trends may only arise after several generations have passed. Schuyler et al. (2014) determined that most sea turtles at some point will ingest some amount of debris. However, military expended materials have not been documented to be ingested by sea turtles, although whether this is because of a lack of occurrence or an inability to distinguish military expended materials from other ingested items is unknown. Because bottom-feeding occurs in nearshore areas, materials that sink to the seafloor in the open ocean are less likely to be ingested due to their location. While these depths may be within the diving capabilities of most sea turtle species, especially leatherback turtles, bottom foraging species (i.e., greens, hawksbills, Kemp's ridleys, and loggerheads) are more likely to forage in the shallower waters less than 100 m in depth. This overlaps with only a small portion of the depth range at which munitions are expended. However, loggerhead turtles may forage in benthic habitats as deep as 200 m (Hochscheid, 2014).

Rosenblatt et al. (2015) examined stomach content results collected from 960 American alligators, showing alligators have a diverse array of prey items (e.g., crustaceans, mollusks, fishes, amphibians, reptiles, mammals, birds, aquatic and terrestrial insects, and seeds), with individual alligators demonstrating diet specialization. Alligator populations inhabiting lakes exhibited lower specialization than coastal populations, likely driven by variation in habitat type and available prey types available to individual alligators in estuaries and other coastal habitats. Ingestion risk of non-prey items does not appears to be a concern while alligators are engaging in normal hunting behaviors (Nifong & Silliman, 2017).

Diamondback terrapins would be exposed to ingestion risks within inshore training and testing locations. appear to be dietary generalists and opportunistic in foraging habits with a wide array of prey and forage items, which may increase the risk of ingestion for non-prey items. As visual predators, however, diamondback terrapins appear to use visual cues while foraging, showing selectivity in the prey that they eat (Outerbridge et al., 2017). Tulipani and Lipcius (2014) found that different age classes and sex of Chesapeake Bay diamondback terrapins influenced diet, with larger females consuming larger snails, crabs, and small amphibians and other reptiles, while smaller males and females consumed plant material (e.g., grass, seeds), insects, and small crustaceans. In a study of fecal samples from 42 different diamondback terrapins in Bermuda (the only native population of diamondback terrapins outside of the

United States), Outerbridge et al. (2017) found that only one sample contained non-prey items (a cigarette filter), with the remaining 41 samples containing natural prey and forage items. The trash item came from an adult female fecal sample, while samples from adult males, juveniles, and neonates (hatchlings) did not contain any trash items. This one study seems to indicate that consumption of marine debris is not a major threat for terrapins; however, large individual terrapins, particularly the larger females, are most at risk of ingesting non-prey items.

3.8.3.6.1 Impacts from Military Expended Material – Munitions

Many different types of explosive and non-explosive practice munitions are expended at sea during training and testing activities. Types of non-explosive practice munitions generally include projectiles, missiles, and bombs. Of these, only small- or medium-caliber projectiles would be small enough for a reptile to ingest in offshore and inshore waters. Small- and medium-caliber projectiles include all sizes up to and including 2.25 in. (57 mm) in diameter. These are solid metal munitions; therefore, even if a reptile did try to bite a larger munition, the munition would not break apart and be ingestible. These solid metal materials would quickly move through the water column and settle to the seafloor. Ingestion of non-explosive practice munitions is not expected to occur in the water column because the munitions sink quickly.

A sea turtle would have to be undetected by Navy Lookouts (i.e., observers) prior to the commencement of training and testing activities (Section 5.3, Procedural Mitigation to be Implemented), be immediately adjacent to falling munitions, mistake sinking munitions for prey items, and react quickly enough to ingest the sinking material. This chain of events is highly unlikely given the Navy's mitigation measures, density of animals in the study area, rapid sinking of munitions in the water column, and general movement speed of the animals involved. Instead, they are most likely to be encountered by species that forage on the bottom (i.e., loggerhead, green, Kemp's ridley, and hawksbill sea turtles). Types of high-explosive munitions that can result in fragments include demolition charges, projectiles, missiles, and bombs. Fragments would result from fractures in the munitions casing and would vary in size depending on the size of the net explosive weight and munitions type; however, typical sizes of fragments are unknown. These solid metal materials would quickly move through the water column and settle to the seafloor; therefore, ingestion is not expected by most species. Fragments are primarily encountered by species that forage on the bottom. Other munitions and munitions fragments such large-caliber projectiles or intact training and testing bombs are too large for loggerhead, green, Kemp's ridley, and hawksbill sea turtles to consume and are made of metal so they cannot be broken up by sea turtles.

In inshore waters, however, training and testing activities would expend small caliber munitions shells into waters, and if they overlapped with benthic foraging of sea turtles, American alligators, diamondback terrapins present a higher risk of ingestion.

Sublethal effects due to ingestion of munitions used in training and testing activities may cause short-term or long-term disturbance to an individual reptiles because: (1) if a reptile were to incidentally ingest and swallow a metal fragment, it could potentially disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the reptile ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the reptile's ability to feed or take in nutrients. Potential impacts of exposure to munitions may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment.

In open ocean environments, munitions used in training activities are generally not expected to cause disturbance to sea turtles because: (1) sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because of the depth at which these would be expended; and (2) in some cases, a turtle would likely pass the projectile through their digestive tract and expel the item without impacting the individual. For example, Schuyler et al. (2014) noted that less than 10 percent of sea turtles (out of a sample size of 454 turtles) that ingested a wide range of debris suffered mortality, and 4 percent of turtles necropsied were killed by plastics ingestion (out of a sample size of 1,106 necropsied turtles). Because juvenile and adult green, loggerhead, Kemp's ridley, and hawksbill sea turtles feed along the seafloor, they are more likely to encounter munitions of ingestible size that settle on the bottom than leatherbacks that primarily feed at the surface and in the water column. Additionally, activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented); therefore, the likelihood of hatchlings and pre-recruitment juveniles encountering munitions is even further unlikely. Furthermore, these four species typically use nearshore feeding areas, while leatherbacks are more likely to feed in the open ocean. Given the very low probability of a leatherback encountering and ingesting materials on the seafloor or water column or any other species encountering munitions in the water column, this analysis will focus on green, loggerhead, Kemp's ridley, and hawksbill turtles and ingestible materials expended nearshore, within range complexes and testing ranges.

A discussion of the types, numbers, and locations of activities using these devices under each alternative is presented in Sections 3.0.3.3.6.1 (Non-Explosive Practice Munitions) and 3.0.3.3.6.2 (Fragments from High-Explosive Munitions).

3.8.3.6.1.1 Impacts from Military Expended Materials – Munitions under Alternative 1

<u>Impacts from Military Expended Materials – Munitions under Alternative 1 for Training Activities</u>

As provided in Tables 3.0-24, 3.0-25 and 3.0-27, offshore training activities involving non-explosive practice munitions and high-explosive munitions fragments would occur within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes, as well as other AFTT areas outside of the range complexes. The Virginia Capes and Jacksonville Range Complexes have the highest estimated annual numbers of munitions for training activities (see Section 3.0.3.3.6.2, Fragments from High-Explosive Munitions). In addition, training activities that expend non-explosive practice munitions would occur within inshore waters including and surrounding Narragansett, Rhode Island; James River and Tributaries, Virginia; the Lower Chesapeake Bay, Virginia; Cooper River, South Carolina; and Port Canaveral, Florida (see Table 3.0-33).

For training activities occurring in the offshore waters, the species and age classes that may be impacted are juvenile, sub-adult, and adult loggerhead, Kemp's ridley, green, and hawksbill sea turtles, especially if munitions are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth); there is a low probability that leatherback sea turtles could be impacted. For example, hawksbill turtles and adult loggerheads may be found foraging in waters as deep as 80 m and 200 m, respectively (Hochscheid, 2014). Juvenile sea turtles (e.g., green turtles) may rest and forage in waters as deep as approximately 30 m (Hochscheid, 2014). Sea turtles are expected to be highly dispersed in offshore waters. Repeated exposures to sea turtles are not anticipated as these offshore areas do not have resident animals year round.

In open ocean environments, munitions used in training activities are generally not expected to cause disturbance or long-term effects to individual sea turtles or their populations because (1) sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because the depth at which these would be expended precludes foraging; and (2) in the unexpected circumstance of a sea turtle foraging at depths greater than 200m, a turtle would likely pass the projectile through its digestive tract and expel the item without significantly impacting the individual permanently. For example, Schuyler et al. (2014) noted that less than 10 percent of sea turtles (out of a sample size of 454 turtles) that ingested a wide range of debris suffered mortality, and 4 percent of turtles necropsied were killed by plastics ingestion (out of a sample size of 1,106 necropsied turtles). In offshore waters, the amount of non-explosive practice munitions and high-explosive munitions fragments that an individual sea turtle would encounter is generally low based on the patchy distribution of both the munitions and sea turtles.

Navy training activities involving non-explosive practice munitions in the inshore waters occur in several locations along the Atlantic coast, but substantially less munitions would be expended annually compared to the activities in the offshore areas (see Section 3.0.3.3.6.2, Fragments from High-Explosive Munitions). The highest concentration of munitions would be expended in the James River and Tributaries. Other locations include the Lower Chesapeake Bay, Virginia; Port Canaveral, Florida; and Narragansett Bay, Rhode Island. In inshore waters, training activities would concentrate small-caliber shell casings in areas that may potentially be overly benthic foraging areas (e.g., Lower Chesapeake Bay and Port Canaveral). Juvenile, sub-adult, and adult green, loggerhead, Kemp's ridley, and hawksbill sea turtles that have recruited to benthic foraging grounds are more likely to encounter munitions of ingestible size that settle on the bottom since these species and age classes feed along the seafloor. There is a low probability that sub-adult and adult leatherbacks that forage in coastal waters could be impacted.

Based on the discussion presented above, the likelihood that a sea turtle would encounter and subsequently ingest a military expended item associated with Navy training activities in inshore waters and offshore waters is considered low, and munitions are generally expected to cause an insignificant impact to sea turtles. Adverse impacts from ingestion of military expended materials would be limited to the unlikely event that a sea turtle would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. In addition, a sea turtle would not likely ingest every projectile it encountered. A sea turtle may attempt to ingest a projectile or fragment and then reject it when it realizes it is not a food item. Therefore, potential impacts of non-explosive practice munitions and fragments ingestion would be limited to the unlikely event in which a sea turtle might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The Navy considers the likelihood of this occurring to be very low.

Potential impacts of exposure to non-explosive practice munitions and high-explosive munitions fragments are not expected to result in substantial changes in an individual sea turtle's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species.

Munitions in inshore waters would be expended in areas potentially occupied by American alligators at Cooper River, South Carolina; and Port Canaveral, Florida. As stated above in Section 3.8.3.6 (Ingestion Stressors), American alligators are generalist predators, but they may specialize in specific prey items depending on habitat, age class of the alligator, and behaviors specific to individual alligators. In inshore waters, training activities would concentrate small-caliber shell casings in areas that may potentially be used for benthic foraging by alligators; however, this hunting behavior is generally rare for alligators. There is a very low probability that American alligators foraging in estuarine habitats would encounter expended munitions. If an alligator did encounter expended munitions, it is unlikely that an American alligator would mistake munitions fragments or casings for prey items. Potential impacts of exposure to non-explosive practice munitions and high-explosive munitions fragments are not expected to result in substantial changes in an individual alligator's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the American alligator.

Munitions in inshore waters would be expended in areas potentially occupied by diamondback terrapins in waters surrounding Narragansett, Rhode Island; James River and Tributaries, Virginia; the Lower Chesapeake Bay, Virginia; Cooper River, South Carolina; and Port Canaveral, Florida. In inshore waters, training activities would concentrate small-caliber shell casings in estuarine areas that may potentially be used by terrapins while foraging for benthic prey items (e.g., crustaceans, molluscs). There is a very low probability that diamondback terrapins foraging in estuarine habitats would encounter expended munitions. Diamondback terrapins are believed to use visual cues for foraging for benthic prey; therefore, it is unlikely that a diamondback terrapin would mistake munitions fragments or casings for prey items. Potential impacts of exposure to non-explosive practice munitions and high-explosive munitions fragments are not expected to result in substantial changes in an individual terrapin's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the diamondback terrapin.

Proposed training activities under Alternative 1 that expend munitions would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that expend munitions would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Munitions that pose ingestion risk have no way of impacting the habitat types that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, activities that release military expended materials-munitions during training activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Military Expended Materials – Munitions under Alternative 1 for Testing Activities

As provided in Tables 3.0-26 and 3.0-28, testing activities involving non-explosive practice munitions and high-explosive munitions fragments would be expended within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes, as well as the Naval Undersea Warfare Center Newport Testing Range, the South Florida Ocean Measurement Facility, and the Naval Surface Warfare Center Panama City Testing Range. No testing activities would release munitions or fragments in inshore waters; therefore, only sea turtles in offshore areas are analyzed for potential impacts from non-explosive practice munitions and high-explosive munitions fragments under Alterative 1 testing activities.

For testing activities, the species and age classes that may be impacted are juvenile, sub-adult, and adult loggerhead, Kemp's ridley, green, and hawksbill sea turtles, especially if non-explosive practice munitions and high-explosive munitions fragments are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth); there is a low probability that leatherback turtles could be impacted. For example, hawksbill turtles and adult loggerheads may be found foraging in waters as deep as 80 m and 200 m, respectively (Hochscheid, 2014). Juvenile sea turtles (e.g., green turtles) may rest and forage in waters as deep as approximately 30 m (Hochscheid, 2014). Sea turtles are expected to be highly dispersed in offshore waters. Repeated exposures to sea turtles are not anticipated as these offshore areas do not have resident animals year round.

In open ocean environments, munitions used in testing activities are generally not expected to cause disturbance or long-term effects to individual sea turtles or their populations because (1) sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because the depth at which these would be expended precludes foraging; and (2) in the unexpected circumstance of a sea turtle foraging at depths greater than 200m, a turtle would likely pass the projectile through its digestive tract and expel the item without significantly impacting the individual permanently. For example, Schuyler et al. (2014) noted that less than 10 percent of sea turtles (out of a sample size of 454 turtles) that ingested a wide range of debris suffered mortality, and 4 percent of turtles necropsied were killed by plastics ingestion (out of a sample size of 1,106 necropsied turtles). In open ocean and nearshore waters, the amount of non-explosive practice munitions and high-explosive munitions fragments that an individual sea turtle would encounter is generally low based on the patchy distribution of both the munitions and sea turtles.

Based on the discussion presented above, the likelihood that a sea turtle would encounter and subsequently ingest a military expended item associated with Navy testing activities is considered low. Adverse impacts from ingestion of military expended materials would be limited to the unlikely event that a sea turtle would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. In addition, a sea turtle would not likely ingest every projectile it encountered. A sea turtle may attempt to ingest a projectile or fragment and then reject it when it realizes it is not a food item. Therefore, potential impacts of non-explosive practice munitions and fragments ingestion would be limited to the unlikely event in which a sea turtle might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. As with the analysis for training activities, the Navy considers the potential for ingestion of munitions and fragments to be very low.

Potential impacts of exposure to non-explosive practice munitions and high-explosive munitions fragments are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species.

Proposed testing activities under Alternative 1 that expend munitions would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend munitions would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Munitions that pose ingestion risk have no way of impacting the habitat types that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, activities that release military expended materials-munitions during testing activities under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.6.1.2 Impacts from Military Expended Materials – Munitions under Alternative 2

Impacts from Military Expended Materials – Munitions under Alternative 2 for Training Activities

The locations of training activities that expend non-explosive practice munitions and high-explosive munition fragments are the same under Alternatives 1 and 2. In addition, the number of non-explosive practice munitions expended annually and over five years would be identical under Alternatives 1 and 2. While the annual number of high-explosive munition fragments would not change under Alternative 2, there would be a very slight increase (approximately 0.001 percent) over five years. This fractional increase does not substantially increase the risk of ingestion impacts on sea turtles. Therefore, the analysis presented in Section 3.8.3.6.1.1 (Impacts from Military Expended Materials - Munitions under Alternative 1) for training activities would also apply to training activities proposed for Alternative 2.

Proposed training activities under Alternative 2 that expend munitions would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities that expend munitions would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Munitions that pose ingestion risk have no way of impacting the habitat types that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, activities that release military expended materials-munitions during training activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from Military Expended Materials – Munitions under Alternative 2 for Testing Activities

The locations of testing activities that expend non-explosive practice munitions and high-explosive munition fragments would be identical under Alternatives 1 and 2. The numbers of non-explosive practice munitions (of ingestible size) during testing activities would be the same annually, but would increase by 2 percent over five years. In addition, the numbers of high-explosives resulting in fragments expended during testing activities would increase by 0.014 percent annually and by approximately 5 percent over five years. This increased use of munition-related military expended materials would be fractional and would not appreciably increase the potential for adverse ingestion impacts on sea turtles. Therefore, the analysis presented in Section 3.8.3.6.1.1 (Impacts from Military Expended Materials - Munitions under Alternative 1) for testing activities would also apply to testing activities proposed for Alternative 2.

Proposed testing activities under Alternative 2 that expend munitions would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita

Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities that expend munitions would occur year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Munitions that pose ingestion risk have no way of impacting the habitat types that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, activities that release military expended materials-munitions during testing activities under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and will have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.8.3.6.1.3 Impacts from Military Expended Materials-Munitions under the No Action Alternative

<u>Impacts from Military Expended Materials-Munitions under the No Action Alternative for Training and Testing Activities</u>

Under the No Action Alternative, the Navy would not conduct the proposed training or testing activities in the AFTT Study Area. Various ingestion stressors (e.g., military expended materials-munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.6.2 Impacts from Military Expended Materials Other Than Munitions

Several different types of materials other than munitions are expended during training and testing activities in the AFTT Study Area. The following military expended materials other than munitions have the potential to be ingested by reptiles:

- target-related materials
- chaff (including fibers and end caps)
- flares (including end caps and compression pads/pistons)
- decelerators/parachutes (cloth, nylon, and metal weights)
- biodegradable polymer

Target-Related Materials

At-sea targets are usually remotely operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. If they are severely damaged or displaced, targets may sink before they can be retrieved. Expendable targets include air-launched decoys, marine markers (smoke floats), cardboard boxes, and 10-ft. diameter red balloons tethered by a sea anchor. Most target fragments would sink quickly in the sea. Floating material, such as Styrofoam, may be lost from target boats and remain at the surface for some time; however, during target recovery, personnel would collect as much floating debris and Styrofoam as possible. Sea turtles would be exposed to potential ingestion risk of target-related materials where these items are expended in offshore and inshore waters. American alligators may be exposed to target-related materials (specifically, marine markers) in waters near Port Canaveral, Florida, while diamondback terrapins may be exposed to target-related materials at Narragansett, Rhode Island; James River and tributaries, Virginia; York River, Virginia; and Lower Chesapeake Bay, Virginia (see Table 3.0-33).

Chaff

Chaff would only be expended over offshore areas; therefore, only sea turtles are analyzed for potential impacts of ingesting chaff. Chaff is an electronic countermeasure designed to reflect radar waves and obscure aircraft, vessels, and other equipment from radar tracking sources. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide (U.S. Air Force, 1997). It is released or dispensed in cartridges or projectiles that contain millions of chaff fibers. When deployed, a diffuse cloud of fibers undetectable to the human eye is formed. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours and can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten et al., 2002; U.S. Air Force, 1997). Doppler radar has tracked chaff plumes containing approximately 900 grams (g) of chaff drifting 200 mi. from the point of release, with the plume covering greater than 400 cubic miles (1,667 cubic kilometers) (Arfsten et al., 2002).

The chaff concentrations that sea turtles could be exposed to following release of multiple cartridges (e.g., following a single day of training) are difficult to accurately estimate because it depends on several unknown factors. First, specific release points are not recorded and tend to be random, and chaff dispersion in air depends on prevailing atmospheric conditions. After falling from the air, chaff fibers would be expected to float on the sea surface for some period, depending on wave and wind action. The fibers would be dispersed further by sea currents as they float and slowly sink toward the bottom. Chaff concentrations in benthic habitats following release of a single cartridge would be lower than the values noted in this section, based on dispersion by currents and the enormous dilution capacity of the receiving waters.

Several literature reviews and controlled experiments have indicated that chaff poses little risk, except at concentrations substantially higher than those that could reasonably occur from military training (Arfsten et al., 2002; U.S. Air Force, 1997). Nonetheless, some sea turtle species within the Study Area could be exposed to chaff through direct body contact and ingestion. Chemical alteration of water and sediment from decomposing chaff fibers is not expected to result in exposure. Based on the dispersion characteristics of chaff, it is likely that sea turtles would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar to fine human hair (U.S. Air Force, 1997). Because of the flexibility and softness of chaff, external contact would not be expected to impact most wildlife (U.S. Air Force, 1997) and the fibers would quickly wash off shortly after contact. Given the properties of chaff, skin irritation is not expected to be a problem (U.S. Air Force, 1997). Arfsten et al. (2002) reviewed the potential effects of chaff inhalation on humans, livestock, and animals and concluded that the fibers are too large to be inhaled into the lung. The fibers are predicted to be deposited in the nose, mouth, or trachea and are either swallowed or expelled; however, these reviews did not specifically consider sea turtles.

Although chaff fibers are too small for sea turtles to confuse with prey and forage, there is some potential for chaff to be incidentally ingested along with other prey items, particularly if the chaff attaches to other floating marine debris. If ingested, chaff is not expected to impact sea turtles due to the low concentration that would be ingested and the small size of the fibers. While no similar studies to those discussed in Section 3.0.3.3.6.3 (Military Expended Materials Other Than Munitions) on the impacts of chaff have been conducted on sea turtles, they are also not likely to be impacted by incidental ingestion of chaff fibers. For instance, some sea turtles ingest spicules (small spines within the structure of a sponge) in the course of eating the sponges, without harm to their digestive system. Since chaff fibers are of similar composition and size as these spicules (U.S. Department of the Navy, 1999), ingestion of chaff should be inconsequential for sea turtles.

Chaff cartridge plastic end caps and pistons would also be released into the marine environment, where they would persist for long periods and could be ingested by sea turtles while initially floating on the surface and sinking through the water column. Chaff end caps and pistons would eventually sink in saltwater to the seafloor (Spargo, 2007), which reduces the likelihood of ingestion by sea turtles at the surface or in the water column. However, bottom-feeding sea turtles, such as green, hawksbill, Kemp's ridley, and loggerhead turtles, would be at increased risk if these items were deposited in potential benthic feeding areas and before these items would be encrusted or buried.

Flares

Flares and components of flares (e.g., o-rings, compression pads, plastic pistons) would be introduced in offshore areas and one inshore location (James River and tributaries, Virginia). Therefore, these items are analyzed for potential ingestion risk for sea turtles and diamondback terrapins. Flares are designed to burn completely. The only material that would enter the water would be a small, round, plastic compression pad or piston (0.45 to 4.1 g depending on flare type). The flare pads and pistons float in sea water.

An extensive literature review and controlled experiments conducted by the United States Air Force demonstrated that self-protection flare use poses little risk to the environment or animals (U.S. Air Force, 1997). For sea turtles and diamondback terrapins, these types of flares are large enough to not be considered an ingestion hazard. Nonetheless, sea turtles within the vicinity of flares could be exposed to light generated by the flares. Compression pads/pistons, o-rings and endcaps from flares would have the same impact on sea turtles and terrapins in inshore waters as discussed under chaff cartridges. It is unlikely that sea turtles or terrapins would be exposed to any chemicals that produce either flames or smoke since these components are consumed in their entirety during the burning process. Animals are unlikely to approach or get close enough to the flame to be exposed to any chemical components.

Decelerators/Parachutes

Decelerators/parachutes would only be expended in offshore waters; therefore, these items are only analyzed as potential ingestion risks for sea turtles.

As noted previously in Section 3.0.3.3.5.2 (Decelerators/Parachutes), decelerators/parachutes are classified into four different categories based on size: small, medium, large, and extra-large. The majority of expended decelerators/parachutes are in the small category. Decelerators/parachutes in the three remaining size categories (medium – up to 19 ft. in diameter, large – between 30 and 50 ft. in diameter, and extra-large – up to 80 ft.in diameter) are likely too big to be mistaken for prey items and ingested by a sea turtle.

The majority of decelerators/parachutes are weighted and by design must sink below the surface within five minutes of contact with the water. Once on the seafloor, decelerators/parachutes become flattened (Environmental Sciences Group, 2005). Ingestion of a small decelerator/parachute by a sea turtle at the surface or within the water column would be unlikely, since the decelerator/parachute would not be available for very long before it sinks. Once on the seafloor, if bottom currents are present, the canopy may temporarily billow and be available for potential ingestion by sea turtles with bottom-feeding habits.

Ingestion of a decelerator/parachute by a sea turtle at the surface or within the water column would be unlikely, since the decelerator/parachute would not be available for very long before it sinks. Once on the seafloor, if bottom currents are present, the canopy may temporarily billow and be available for potential ingestion by a sea turtle feeding on or near the seafloor. Conversely, the decelerator/parachute could be buried by sediment in most soft bottom areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for an ingestion risk. Some decelerators/parachutes may be too large to be a potential prey item for certain age classes (e.g., hatchlings and pre-recruitment juveniles), although degradation of the decelerator/parachute may create smaller items that are potentially ingestible. The majority of these items (from sonobuoys), however, would be expended in deep offshore waters. Bottom-feeding sea turtles (e.g., green, hawksbill, Kemp's ridley, and loggerhead turtles) tend to forage in nearshore and coastal areas rather than offshore, where the majority of these decelerators/parachutes are used. Since these materials would most likely be expended in offshore waters too deep for benthic foraging, it would be unlikely for bottom foraging sea turtles to interact with these materials once they sink; therefore, unlikely that sea turtles would encounter decelerators/parachutes once they reach the seafloor.

Biodegradable Polymer

Biodegradable polymers would only be expended in offshore waters; therefore, these items are only analyzed as potential ingestion risks for sea turtles. As stated in Section 3.0.3.3.5.3 (Biodegradable Polymer) based on the constituents of the biodegradable polymer, it is anticipated that the material will breakdown into small pieces within a few days to weeks. The small pieces will breakdown further and dissolve into the water column within weeks to a few months and could potentially be incidentally ingested by sea turtles. Because the final products of the breakdown are all environmentally benign, the Navy does not expect the use biodegradable polymer to be an ingestion stressor for sea turtles; therefore, is not analyzed further.

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

Impacts from Military Expended Materials Other Than Munitions under Alternative 1 for Training Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors) and Section 3.0.3.3.4.2 (Military Expended Materials), military expended materials other than munitions would be expended during offshore training activities within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes as well as other areas outside the range complexes. In addition, training activities that expend other materials would occur within inshore waters including and surrounding Narragansett, Rhode Island; James River and tributaries, Virginia; York River, Virginia; Lower Chesapeake Bay, Virginia; and Port Canaveral, Florida.

Target-related material, chaff, flares, and decelerators/parachutes (and their subcomponents) have the potential to be ingested by a sea turtle, American alligator, or diamondback terrapin, although that is considered unlikely since most of these materials would quickly drop through the water column, settle on the seafloor, or in the case of biodegradable polymers, rapidly decay and not present an ingestion hazard. Some Styrofoam, plastic endcaps, chaff, and other small items may float for some time before sinking.

While the smaller items discussed here may pose a hazard to reptiles, as discussed for non-explosive practice munitions ingestion, the impacts of ingesting these forms of expended materials on reptiles would be minor because of the following factors:

- the limited geographic area where materials other than munitions are expended during a given event
- the limited period of time these military expended materials would remain in the water column
- the unlikely chance that a sea turtle might encounter and swallow these items on the seafloor, particularly given that many of these items would be expended over deep, offshore waters
- the limited types of military expended materials that would be expended in inshore waters where benthic feeding may occur in higher concentrations that overlap with activities
- the ability of reptiles to reject and not swallow non-food items incidentally ingested.

For sea turtles, the impacts of ingesting military expended materials other than munitions would be limited to cases where an individual sea turtle might eat an indigestible item too large to be passed through the gut. The sea turtle would not be preferentially attracted to these military expended materials, with the possible exception of decelerators/parachutes that may appear similar to the prey of some sea turtle species and life stages that feed on jellyfish and similar organisms. Post-hatchling loggerhead turtles have been found to feed on jellyfish and zooplankton (Browlow et al., 2016; Burkholder et al., 2004; Carr & Meylan, 1980; Richardson & McGillivary, 1991), and post-hatchling green turtles have been found to feed on comb jellies and gelatinous eggs (Salmon et al., 2004; Salmon et al., 2016). Late juvenile hawksbill turtles and Kemp's ridley turtles may also prey on jellyfish (Bjorndal, 1997; Frick et al., 1999; Marquez, 1994; Seney, 2016). Leatherback turtles predominately prey upon jellyfish (Wallace et al., 2015).

For the most part, these military expended materials would most likely only be incidentally ingested by individuals feeding on the bottom in the precise location where these items were deposited. Military expended materials other than munitions that would remain floating on the surface are too small to pose a risk of intestinal blockage to any sea turtle that happened to encounter it. Because leatherbacks of all age classes, and hatchlings and juveniles of green, hawksbill, Kemp's ridley, and loggerhead sea turtles are more likely to feed at or near the surface in the open ocean, they are more likely to encounter materials at the surface than other age classes of sea turtles that primarily feed along the seafloor. For example, the non-munitions material that floats in the water, such as flare pads and pistons, as well as some target-related materials that may not be recovered (e.g., Styrofoam) may pose an ingestion risk for these age classes and species given their feeding behavior and prey choice. Though green, hawksbill, Kemp's ridley, and loggerhead sea turtles are bottom-feeding species that generally recruit to and feed in nearshore waters once they reach the juvenile stage, they may occur in the open ocean during migrations.

For training activities occurring in the offshore waters, the species and age classes that have the potential to be impacted are hatchlings and pre-recruitment juveniles of all sea turtle species, and leatherback turtles of all age classes. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats and be exposed to these activities; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented). Non-munitions materials, with the exception of decelerators/parachutes since they are expended in deeper offshore waters, may pose a slight risk to juvenile, sub-adult, and adult loggerhead, green, and hawksbill turtles that have recruited to benthic foraging grounds, especially if non-munitions materials are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth), then these age classes and species could be at risk of potentially ingesting non-munitions materials. For example, hawksbills and loggerheads may forage in benthic habitats as deep as approximately 80 m and 200 m, respectively (Hochscheid, 2014). Juvenile sea turtles (e.g., green turtles) may rest and forage in waters as deep as approximately 30 m (Hochscheid, 2014). Sea turtles are expected to be highly dispersed in offshore waters. Repeated exposures to sea turtles are not anticipated as these offshore areas do not have resident animals year round. In offshore waters, the amount of military expended materials other than munitions that an individual sea turtle would encounter is generally low based on the patchy distribution of both the non-munitions and sea turtles.

Navy training activities involving military expended materials other than munitions in the inshore waters occur in several locations along the Atlantic coast, but fewer types of military materials (e.g., flares and target related materials) would be expended compared to the activities in the offshore areas (see Table 3.0-33). As stated above, target-related materials are recovered to the maximum extent practical, thereby decreasing the potential for ingestion by sea turtles. The highest concentration of non-munitions materials would be expended in the James River and tributaries in Virginia. Other locations include Boston, Massachusetts; Lower Chesapeake Bay, Virginia; Moorehead City, North Carolina; and Port Canaveral, Florida. For training activities occurring in inshore waters, juvenile, sub-adult, and adult loggerhead, green, Kemp’s ridley, and hawksbill sea turtles that have recruited to benthic foraging grounds may be impacted. Sub-adult and adult leatherbacks that forage at the surface in coastal and sometimes estuarine waters may also be impacted. Most of the non-munitions materials expended in inshore waters consist of flares (see Table 3.0-33). Since the only material that would enter the water after the flare has burned would be small pads and pistons that float, this decreases the potential for ingestion by juvenile, sub-adult, and adult green, hawksbill, Kemp’s ridley, and loggerhead turtles that feed on the bottom.

Based on the discussion presented above and in Section 3.8.3.6.2 (Impacts from Military Expended Materials Other Than Munitions), the likelihood that a sea turtle would encounter and subsequently ingest a non-munitions item associated with Navy training activities is considered low, and non-munitions are generally expected to cause an insignificant impact to sea turtles. Sublethal impacts due to ingestion of military expended materials other than munitions used in training activities may cause short-term or long-term disturbance to an individual turtle because (1) if a sea turtle were to incidentally ingest and swallow a decelerator/parachute, target fragment, chaff or flare component, it could potentially disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle’s ability to feed or take in nutrients. Potential impacts of exposure to these items may result in changes to an individual’s behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, decelerators/parachutes, target fragments, chaff, and flare components used in training activities are generally not expected to cause disturbance to sea turtles because (1) leatherbacks are more likely to forage further offshore than within range complexes, and other sea turtles (e.g., juvenile, sub-adult, and adult green, hawksbill, Kemp’s ridley, and loggerhead turtles) primarily forage on the bottom in nearshore areas; (2) in some cases, a turtle would likely pass the item through its digestive tract and expel the item without impacting the individual permanently; and (3) chaff, if ingested, would occur in very low concentration and is similar to spicules, which sea turtles (species and life stages such as adult loggerheads that consume sponges and other organisms containing spicules) ingest without harm. For example, Schuyler et al. (2014) noted that less than 10 percent of sea turtles (out of a sample size of 454 turtles) that ingested a wide range of debris suffered mortality, and 4 percent of turtles necropsied were killed by plastics ingestion (out of a sample size of 1,106 necropsied turtles).

Potential impacts of exposure to non-munitions materials are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species.

American alligators would be exposed to potential ingestion risks of other materials expended at Port Canaveral, Florida. As stated above in Section 3.8.3.6 (Ingestion Stressors), American alligators are generalist predators, but may specialize in specific prey items depending on habitat, age class of the alligator, and behaviors specific to individual alligators. In inshore waters at Port Canaveral, Florida, marine markers would be the only other type of military expended material released. Marine markers would likely float on the water's surface or wash ashore in alligator habitats; however, potential ingestion of marine markers should be considered very low because these items do not resemble prey. In addition, there is a very low probability that American alligators foraging in estuarine habitats would encounter expended marine markers. Potential impacts of exposure to marine markers are not expected to result in substantial changes in an individual alligator's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the American alligator.

Other materials expended in inshore waters would be released in areas potentially occupied by diamondback terrapins in waters surrounding Narragansett, Rhode Island; James River and tributaries, Virginia; York River, Virginia; Lower Chesapeake Bay, Virginia; and Port Canaveral, Florida. In inshore waters, training activities would concentrate other materials in estuarine areas that may potentially be used by terrapins while foraging for benthic prey items (e.g., crustaceans, molluscs) once expended materials sink, or when floating on the surface or suspended in the water column. There is a very low probability that diamondback terrapins foraging in estuarine habitats would encounter expended materials. Diamondback terrapins are believed to use visual cues for foraging for prey items; therefore, it is unlikely that a diamondback terrapin would mistake other materials for prey items. Potential impacts of exposure to other materials are not expected to result in substantial changes in an individual terrapin's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the diamondback terrapin.

Proposed training activities under Alternative 1 that expend potentially ingestible non-munitions materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training activities would expend potentially ingestible non-munitions materials year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Ingestion stressors introduced by military expended materials other than munitions have no way of impacting the physical and biological features that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, training activities that expend potentially ingestible non-munitions materials under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Military Expended Materials Other Than Munitions under Alternative 1 for Testing Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors) and Section 3.0.3.3.4.2 (Military Expended Materials), military expended materials other than munitions would be expended during testing activities within the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Gulf of Mexico, and Key West Range Complexes, as well as the Naval Undersea Warfare Center, Division Newport Testing Range; South Florida Ocean Measurement Facility Testing Range; and Naval Surface Warfare Center, Panama City Division Testing Range. The Virginia Capes and Jacksonville Range Complexes have the highest estimated numbers of non-munitions materials per year for testing activities. Testing activities using military expended materials other than munitions would not occur in inshore waters. Therefore, only sea turtles in offshore areas are analyzed for potential impacts from ingestion of other materials under Alternative 1 testing activities.

Target-related material, chaff, flares, and decelerators/parachutes (and their subcomponents) have the potential to be ingested by a sea turtle, although that is considered unlikely since most of these materials would quickly drop through the water column, settle on the seafloor, or in the case of biodegradable polymers, rapidly decay and not present an ingestion hazard. Some Styrofoam, plastic endcaps, chaff, and other small items may float for some time before sinking.

While the smaller items discussed here may pose a hazard to sea turtles, as discussed for non-explosive practice munitions ingestion, the impacts of ingesting these forms of expended materials on sea turtles would be minor because of the following factors:

- the limited geographic area where materials other than munitions are expended during a given event
- the limited period of time these military expended materials would remain in the water column
- the unlikely chance that a sea turtle might encounter and swallow these items on the seafloor, particularly given that many of these items would be expended over deep, offshore waters

The impacts of ingesting military expended materials other than munitions would be limited to cases where an individual sea turtle might eat an indigestible item too large to be passed through the gut. The sea turtle would not be preferentially attracted to these military expended materials, with the possible exception of decelerators/parachutes that may appear similar to the prey of some sea turtle species and life stages that feed on jellyfish and similar organisms. Post-hatchling loggerhead turtles have been found to feed on jellyfish and zooplankton (Browlow et al., 2016; Burkholder et al., 2004; Carr & Meylan, 1980; Richardson & McGillivary, 1991), and post-hatchling green turtles have been found to feed on comb jellies and gelatinous eggs (Salmon et al., 2004; Salmon et al., 2016). Late juvenile hawksbill turtles and Kemp's ridley turtles may also prey on jellyfish (Bjorndal, 1997; Frick et al., 1999; Marquez, 1994; Seney, 2016). Leatherback turtles predominately prey upon jellyfish (Wallace et al., 2015).

For the most part, these military expended materials would most likely only be incidentally ingested by individuals feeding on the bottom in the precise location where these items were deposited. Military expended materials other than munitions that would remain floating on the surface are too small to pose a risk of intestinal blockage to any sea turtle that happened to encounter it. Because leatherbacks of all age classes, and hatchlings and juveniles of green, hawksbill, Kemp's ridley, and loggerhead turtles are more likely to feed at or near the surface in the open ocean, they are more likely to encounter materials at the surface than other age classes of sea turtles that primarily feed along the seafloor. For example, the non-munitions material that floats in the water such as flare pads and pistons as well as some target-related materials that may not be recovered (e.g., Styrofoam) may pose an ingestion risk for these age classes and species given their feeding behavior and prey choice. Though green, hawksbill, Kemp's ridley, and loggerhead sea turtles are bottom-feeding species that generally recruit to and feed in nearshore waters once they reach the juvenile stage, they may occur in the open ocean during migrations.

For testing activities occurring in the offshore waters, the species and age classes that have the potential to be impacted are hatchlings and pre-recruitment juveniles of all sea turtle species, and leatherback turtles of all age classes. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats and be exposed to these activities; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated *Sargassum* mats. Activities will not be initiated near concentrated *Sargassum* mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented). Non-munitions materials, with the exception of decelerators/parachutes since they are expended in deeper offshore waters, may pose a slight risk to juvenile, sub-adult, and adult loggerhead, green, and hawksbill turtles that have recruited to benthic foraging grounds, especially if non-munitions materials are expended in waters where the isobaths are not greater than the benthic foraging ability (dive depth), then these age classes and species could be at risk of potentially ingesting non-munitions materials. For example, hawksbills and loggerheads may forage in benthic habitats as deep as approximately 80 m and 200 m, respectively (Hochscheid, 2014). Juvenile sea turtles (e.g., green turtles) may rest and forage in waters as deep as approximately 30 m (Hochscheid, 2014). Sea turtles are expected to be highly dispersed in offshore waters. Repeated exposures to sea turtles are not anticipated as these offshore areas do not have resident animals year round. In offshore waters, the amount of military expended materials other than munitions that an individual sea turtle would encounter is generally low based on the patchy distribution of both the non-munitions and sea turtles.

Based on the discussion presented above and in Section 3.8.3.6.2 (Impacts from Military Expended Materials Other Than Munitions), the likelihood that a sea turtle would encounter and subsequently ingest a non-munitions item associated with Navy training activities is considered low, and non-munitions are generally expected to cause an insignificant impact to sea turtles. Sublethal impacts due to ingestion of military expended materials other than munitions used in training activities may cause short-term or long-term disturbance to an individual turtle because (1) if a sea turtle were to incidentally ingest and swallow a decelerator/parachute, target fragment, chaff or flare component, it could potentially disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. Potential impacts of exposure to these items may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, decelerators/parachutes, target fragments, chaff, and flare components used in training activities are generally not expected to cause disturbance to sea turtles because (1) leatherbacks are more likely to forage further offshore than within range complexes, and other sea turtles (e.g., juvenile, sub-adult, and adult green, hawksbill, Kemp's ridley, and loggerhead turtles) primarily forage on the bottom in nearshore areas; (2) in some cases, a turtle would likely pass the item through its digestive tract and expel the item without impacting the individual permanently; and (3) chaff, if ingested, would occur in very low concentration and is similar to spicules, which sea turtles (species and life stages such as adult loggerheads that consume sponges and other organisms containing spicules) ingest without harm. For example, Schuyler et al. (2014) noted that less than 10 percent of sea turtles (out of a sample size of 454 turtles) that ingested a wide range of debris suffered mortality, and 4 percent of turtles necropsied were killed by plastics ingestion (out of a sample size of 1,106 necropsied turtles).

Potential impacts of exposure to non-munitions materials are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species.

Proposed testing activities under Alternative 1 that expend potentially ingestible non-munitions materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities would expend potentially ingestible non-munitions materials year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Ingestion stressors introduced by military expended materials other than munitions have no way of impacting the physical and biological features that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, testing activities that expend potentially ingestible non-munitions materials under Alternative 1 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

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

Impacts from Military Expended Materials Other Than Munitions under Alternative 2 for Training Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors), and Section 3.0.3.3.4.2 (Military Expended Materials), the locations of training activities that expend military expended materials other than munitions would be identical under Alternatives 1 and 2. However, the total number of military expended materials other than munitions released throughout these locations would increase by 0.2 percent annually and by 0.2 percent over five years. The fractional increase in amount of military expended materials other than munitions would not substantially increase the potential for sea turtles to ingest these items. Therefore, the analysis presented in Section 3.8.3.6.2.1 (Impacts from Military Expended Materials Other Than Munitions under Alternative 1) for training activities would also apply to training activities proposed under Alternative 2 for sea turtles, American alligators, and diamondback terrapins.

Proposed training activities under Alternative 2 that expend potentially ingestible non-munitions materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or

American crocodile (Florida Bay). Navy training activities would expend potentially ingestible non-munitions materials year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Ingestion stressors introduced by military expended materials other than munitions have no way of impacting the physical and biological features that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, training activities that expend potentially ingestible non-munitions materials under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

Impacts from Military Expended Materials-Other Than Munitions under Alternative 2 for Testing Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors) and Section 3.0.3.3.4.2 (Military Expended Materials), the locations of testing activities that expend military expended materials other than munitions would be identical under Alternatives 1 and 2. However, the number of military expended materials other than munitions throughout these locations would increase by approximately 0.3 percent annually and by 1.2 percent over five years. The fractional increase in the amount of military expended materials other than munitions would not appreciably increase the potential for sea turtles to ingest these items. Therefore, the analysis presented in Section 3.8.3.6.2.1 (Impacts from Military Expended Materials Other Than Munitions under Alternative 1) for testing activities would also apply to testing activities proposed under Alternative 2.

Proposed testing activities under Alternative 2 that expend potentially ingestible non-munitions materials would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy testing activities would expend potentially ingestible non-munitions materials year round within the five critical habitat types for the loggerhead sea turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. Ingestion stressors introduced by military expended materials other than munitions have no way of impacting the physical and biological features that comprise loggerhead turtle critical habitat (National Marine Fisheries Service, 2014b).

Pursuant to the ESA, testing activities that expend potentially ingestible non-munitions materials under Alternative 2 may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat.

3.8.3.6.2.3 Impacts from Military Expended Materials Other Than Munitions under the No Action Alternative

Impacts from Military Expended Materials Other Than Munitions under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training or testing activities in the AFTT Study Area. Various ingestion stressors (e.g., military expended materials other than munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.7 Secondary Stressors

This section analyzes potential impacts on sea turtles, crocodilians, and terrapins exposed to stressors indirectly through impacts on their habitat (sediment or water quality) or prey availability. For the purposes of this analysis, indirect impacts on reptiles via sediment or water quality that do not require trophic transfer (e.g., bioaccumulation) in order to be observed are considered here. Bioaccumulation considered previously in this document in the analysis of fishes (Section 3.6), invertebrates (Section 3.4), and marine habitats (Section 3.5) indicated minimal to no impacts on potential prey species of sea turtles, crocodilians, or terrapins. It is important to note that the terms "indirect" and "secondary" do not imply reduced severity of environmental consequences but instead describe how the impact may occur in an organism. The potential for impacts from all of these secondary stressors are discussed below.

Stressors from Navy training and testing activities that could pose indirect impacts on sea turtles via habitat or prey include: (1) explosives, (2) explosive byproducts and unexploded munitions, (3) metals, and (4) chemicals. Stressors from Navy training and testing activities that could pose indirect impacts on crocodilians or terrapins via habitat or prey include metals from training and testing activities in inshore waters. Analyses of the potential impacts on sediment and water quality are discussed in Section 3.2 (Sediments and Water Quality).

Explosives

As it pertains to sea turtles, underwater explosions could impact other species in the food web, including prey species that sea turtles feed upon and disrupt ecological relationships and conditions that would lead to decreased availability of forage. The impacts of explosions would differ depending on the type of prey species in the area of the blast. As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.6-1 through Table 2.6-4, training and testing activities resulting in underwater explosions will occur in the Study Area.

In addition to the physical effects of an underwater blast (e.g., injury or mortality from the blast pressure wave), prey might have behavioral reactions to underwater sound. For instance, prey species might exhibit a strong startle reaction to detonations that might include swimming to the surface or scattering away from the source. This startle and flight response is the most common secondary defense among animals (Mather, 2004). The abundance of prey species near the detonation point could be diminished for a short period before being repopulated by animals from adjacent waters (Berglind et al., 2009; Craig, 2001). Many sea turtle prey items, such as jellyfish, sponges, and molluscs have limited mobility and ability to react to pressure waves; therefore, mobile prey species for sea turtles would be less affected because of their ability to respond to other stressors preceding an underwater blast (e.g., vessel noise or visual cues). Any of these scenarios would be temporary, only occurring during activities involving explosives, and no lasting effect on prey availability or the pelagic food web would be expected. For example, if prey were removed from an area resulting from a stressor introduced by a training or testing activity, prey species would be expected to recolonize or recruit rapidly in the area because there would be little or no permanent change to the habitat.

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). This mitigation will consequently help avoid or reduce potential impacts from explosives on sea turtle prey species that inhabit shallow-water coral reefs, live hard bottom, artificial reefs, submerged aquatic vegetation, and shipwrecks.

Explosion Byproducts and Unexploded Munitions

High-order explosions consume most of the explosive material, creating typical combustion products. In the case of Royal Demolition Explosive, also known as cyclonite and hexogen, 98 percent of the byproducts are common seawater constituents, and the remainder is rapidly diluted below threshold effect level (Section 3.2, Sediments and Water Quality). Explosion byproducts associated with high-order detonations present no indirect stressors to sea turtles through sediment or water. Furthermore, most explosions occur in depths exceeding that which normally support seagrass beds and coral reefs, areas that are commonly used by green and hawksbill sea turtles, respectively. For example, most detonations would occur in waters greater than 200 ft. in depth, and greater than 3 NM from shore, although mine warfare, demolition, and some testing detonations would occur in shallow water close to shore. These low-order detonations and unexploded munitions present elevated likelihood of secondary impacts on sea turtles.

Deposition of undetonated explosive materials into the marine environment can be reasonably well estimated by the known failure and low-order detonation rates of high-explosives (Section 3.2, Sediments and Water Quality, Table 3.2-7). While it is remotely possible for sea turtles to come into contact with an undetonated explosive, to have contact with unexploded materials in the sediment or water, and or to ingest unexploded materials in sediments, it is very unlikely.

Indirect impacts of explosives and unexploded munitions to sea turtles via sediment contamination is possible only if a sea turtle ingested the sediment. Degradation of explosives proceeds through several pathways, as discussed in Section 3.2.3.1 (Explosives and Explosives Byproducts). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen & Lotufo, 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6 to 12 in. away from degrading munitions, the concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. from the degrading munitions (Section 3.2.3.1, Explosives and Explosives Byproducts). Taken together, it is possible that sea turtles could be exposed to degrading explosives, but it would be within a very small radius of the explosive (1 to 6 ft.). Juvenile, sub-adult, and adult green, hawksbill, Kemp's ridley, and loggerhead sea turtles are the only age classes and species in the Study Area that might routinely ingest sediments while bottom feeding; however, feeding would most likely not occur in deep water areas (greater than 100 m) where unexploded materials are more likely to occur.

A series of studies of a World War II munitions disposal site off Hawaii have demonstrated only minimal concentrations of degradation products were detected in the adjacent sediments and that there was no detectable uptake in sampled organisms living on or in proximity to the site (Briggs et al., 2016; Edwards et al., 2016; Hawaii Undersea Military Munitions Assessment, 2010; Kelley et al., 2016; Koide et al., 2016).A series of research efforts focused on World War II underwater munitions disposal sites in Hawaii (Briggs et al., 2016; Edwards et al., 2016; Hawaii Undersea Military Munitions Assessment, 2010; Kelley et al., 2016; Koide et al., 2016) and an intensively used live fire range in the Mariana Islands Smith and Marx (2016) provide information in regard to the impacts of undetonated materials and unexploded munitions on marine life. Section 3.2.3.1 (Explosives and Explosives Byproducts) and Section 3.2.3.3 (Metals) contains a summary of this literature which investigated water and sediment quality impacts, on a localized scale, from munitions ocean disposal sites and ocean disposed dredge spoils sites. Findings from these studies indicate that there were no adverse impacts on the local ecology from the presence of degrading munitions and there was no bioaccumulation of munitions-related chemicals in local marine species.

The island of Farallon De Medinilla (in the Mariana Islands) has been used as a target area since 1971. Between 1997 and 2012, there were 14 underwater scientific survey investigations around the island providing a long-term look at potential impacts on the marine life from training and testing involving the use of munitions (Smith & Marx, 2016). Munitions use has included high-explosive rounds from gunfire, high-explosives bombs by Navy aircraft and U.S. Air Force B-52s, in addition to the expenditure of inert rounds and non-explosive practice bombs. Marine life assessed during these surveys included algae, corals, benthic invertebrates, sharks, rays, and bony fishes, and sea turtles. The investigators found no evidence over the 16-year period, that the condition of the biological resources had been adversely impacted to a significant degree by the training activities (Smith & Marx, 2016). Furthermore, they found that the health, abundance, and biomass of fishes, corals and other marine resources were comparable to or superior to those in similar habitats at other locations within the Mariana Archipelago.

These findings are consistent with other assessments such as that done for the Potomac River Test Range at Dahlgren, Virginia which was established in 1918 and is the nation's largest fully instrumented, over-the-water gun-firing range. Munitions tested at Naval Surface Warfare Center, Dahlgren have included rounds from small-caliber guns up to the Navy's largest (16-in. guns), bombs, rockets, mortars, grenades, mines, depth charges, and torpedoes (U.S. Department of the Navy, 2013). Results from the assessment indicate that munitions expended at Naval Surface Warfare Center, Dahlgren have not contributed to significant concentrations of metals to the Potomac River water and sediments given those contributions are orders of magnitude less than concentrations already present in the Potomac River from natural and manmade sources (U.S. Department of the Navy, 2013).

The concentration of munitions/explosions, expended material, or devices in any one location in the AFTT Study Area would be a small fraction of that from a World War II dump site, or a target island used for 45 years, or a water range in a river used for almost 100 years. Based on findings from much more intensively used locations, the water quality effects from the use of munitions, expended material, or devices resulting from any of the proposed actions would be negligible by comparison. As a result, explosion by-products and unexploded munitions would have no meaningful effect on water quality and would therefore not constitute a secondary indirect stressor for sea turtles.

Metals

Metals are introduced into seawater and sediments as a result of training and testing activities involving ship hulks, targets, munitions, and other military expended materials (Section 3.2.3.3, Metals) (Environmental Sciences Group, 2005). Some metals bioaccumulate and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals (Section 3.5, Habitats, and Chapter 4, Cumulative Impacts). Evidence from a number of studies (Briggs et al., 2016; Koide et al., 2016) indicate metal contamination is very localized and that bioaccumulation resulting from munitions cannot be demonstrated. Specifically, in sampled marine life living on or around munitions on the seafloor, metal concentrations could not be definitively linked to the munitions since comparison of metals in sediment next to munitions show relatively little difference in comparison to other "clean" marine sediments used as a control/reference (Koide et al., 2015). Research has demonstrated that some smaller marine organisms are attracted to metal munitions as a hard substrate for colonization or as shelter (Smith & Marx, 2016). Although this would likely increase prey availability for some benthic foraging sea turtles that feed on molluscs (e.g., loggerheads), the relatively low density of metals deposited by training and testing activities compared to concentrated dump and range sites would not likely substantively benefit sea turtles. Inshore waters, which would receive small-caliber shells from training activities have the potential to be deposited in substrates in estuaries used by some sea turtles (in particular Kemp's ridley, loggerhead, and green sea turtles), crocodilians, and terrapins; and riverine habitats where crocodilians and terrapins would be expected to occur. As with other studies discussed above, leaching of metals contained in shell casings would be expected to be localized in sediments with little opportunity for bioaccumulation into the food web that would impact crocodilian species or terrapins.

Chemicals

Several Navy training and testing activities introduce chemicals into the marine environment that are potentially harmful in higher concentrations; however, rapid dilution would occur and toxic concentrations are unlikely to be encountered. Chemicals introduced are principally from flares and propellants for missiles and torpedoes. Properly functioning flares, missiles, and torpedoes combust most of their propellants, leaving benign or readily diluted soluble combustion byproducts (e.g., hydrogen cyanide). Operational failures may allow propellants and their degradation products to be released into the marine environment. Flares and missile that operationally fail may release perchlorate, which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals if in sufficient concentration. Such concentrations are not likely to persist in the ocean. Research has demonstrated that perchlorate did not bioconcentrate or bioaccumulate, which was consistent with the expectations for a water soluble compound (Furin et al., 2013). Perchlorate from failed expendable items is therefore unlikely to compromise water quality to that point that it would act as a secondary stressor to sea turtles. It should also be noted that chemicals in the marine environment as a result of Navy training and testing activities would not occur in isolation and are typically associated with military expended materials that release the chemicals while in operation. Because sea turtles' avoidance of an expended flare, missile, or torpedo in the water is almost certain (because of other ques such as visual and noise disturbance), it would further reduce the potential for introduced chemicals to act as a secondary stressor. Avoidance is likely because expending these items would be accompanied by other visual ques or noise disturbances.

3.8.3.7.1 Impacts on Habitat

As presented above in Section 3.8.3.7 (Secondary Stressors), Navy activities that introduce explosive byproducts and unexploded munitions, metals, and chemicals into the marine environment have not demonstrated long-term impacts on sediment and water quality. Explosive byproducts and unexploded munitions from ongoing Navy activities have not resulted in water quality impacts, and the likelihood of sea turtles, crocodilians, or terrapins being in contact with sediments contaminated from degrading explosives is low, given the small radius of impact around the location of the explosive. Furthermore, there is no evidence of bioconcentration or bioaccumulation of chemicals introduced by Navy activities that would alter water quality to an extent that would result in overall habitat degradation for sea turtles, crocodilians, or terrapins.

As stated previously, most detonations would occur in waters greater than 200 ft. in depth, and greater than 3 NM from shore, although mine warfare, demolition, and some testing detonations would occur in shallow water close to shore. In deep waters, explosions would not likely remove habitat for sea turtles because the explosion would not be on or proximate to the sea floor. These habitats include corals, seagrass beds, and other benthic habitats that are used by juvenile and adult sea turtle species, e.g., green and hawksbill turtles. Metals are introduced into the water and sediments from multiple types of military expended materials. Available research indicates metal contamination is very localized and that bioaccumulation resulting from munitions would not occur. Several Navy training and testing activities introduce chemicals into the marine environment that are potentially harmful in concentration; however, through rapid dilution, toxic concentrations are unlikely to be encountered by sea turtles, crocodilians, and terrapins. In near shore waters, explosions would typically occur in the same locations, limiting the removal of habitat to previously disturbed areas. Therefore, habitat loss from training and testing activities that use explosions would not substantially remove habitats available to sea turtles, crocodilians, or terrapins and not impact individuals or populations.

Secondary stressors from Navy training and testing activities in the Study Area are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species, crocodilians, and terrapins.

Proposed training and testing activities that would introduce secondary stressors (potentially impacting habitats) would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training and testing activities would introduce secondary stressors (that may impact habitats) year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. In nearshore waters, explosions would typically occur in the same locations, limiting the removal of habitat to previously disturbed areas. In offshore areas where most explosions would occur, the Navy would not initiate activities near concentrated *Sargassum* mats (see Section 5.3, Procedural Mitigation to be Implemented); therefore, developmental habitat for hatchlings and pre-recruitment juveniles of all sea turtle species would not be affected. Explosion byproducts, metals, and chemicals from training and testing activities, as discussed above, induce very localized or short-term impacts to water quality within the water column. Activities that introduce secondary stressors would occur over wide areas and in sufficiently low frequency as to not impact the physical and biological features that comprise loggerhead critical habitat.

Pursuant to the ESA, Navy training and testing activities would introduce secondary stressors with potential impacts on habitats that may affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard, for training and testing activities described under Alternative 1.

3.8.3.7.2 Impacts on Prey Availability

As presented above in Section 3.8.3.7 (Secondary Stressors), Navy activities that introduce explosives, metals, and chemicals into the marine environment have not demonstrated long-term impacts on prey availability for sea turtles, crocodilians, or terrapins. Bioaccumulation of metals from munitions in prey species has not been demonstrated and no effects to prey availability from metals and chemicals are known to occur. Bioaccumulation of metals from munitions in prey species has not been demonstrated, and no effects to prey availability from metals and chemicals are known to occur. In-water explosions have the potential to injure or kill prey species that reptiles feed on within a small area affected by the blast; however, impacts would not substantially impact prey availability for sea turtles. Training and testing activities in the Study Area would be unlikely to impact coral reefs (a direct or indirect source of prey and forage items for juvenile, sub-adult, and adult hawksbill turtles) because the Navy implements measures within mitigation areas for shallow-water coral reefs. Also, activities are not initiated near concentrated *Sargassum* mats, where hatchlings and pre-recruitment juvenile sea turtle prey is found, due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented). These mitigation measures would continue under both Alternative 1 and Alternative 2. Activities that involve the use of explosives typically occur at depths that exceed areas that support seagrass beds for foraging juvenile, sub-adult, and adult green turtles. For inshore training and testing activities, impacts on prey availability for crocodilians and terrapins, if they occurred, would not likely be measureable because of the types of activities that would occur in inshore training and testing locations, and because of the generalist diet of crocodilians and terrapins.

Secondary stressors from Navy training and testing activities in the Study Area that may influence prey availability are not expected to result in substantial changes in an individual’s behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for all sea turtle species, crocodilians, or terrapins.

Proposed training and testing activities that would introduce secondary stressors (potentially impacting prey availability) would not occur in designated critical habitat for the green sea turtle (Culebra Island), hawksbill sea turtle (Mona Island and Monita Island), leatherback sea turtle (St. Croix Island), or American crocodile (Florida Bay). Navy training and testing activities would introduce secondary stressors (that may influence prey availability) year round within the five critical habitat types for the loggerhead turtle. See Section 3.8.2.2.4.1 (Status and Management) for a description of these habitat types and supporting physical and biological factors. In nearshore waters, explosions would typically occur in the same locations, limiting the removal of habitat to previously disturbed areas. In offshore areas where most explosions would occur, the Navy would not initiate activities near concentrated *Sargassum* mats (see Section 5.3, Procedural Mitigation to be Implemented); therefore, developmental habitat for hatchlings and pre-recruitment juveniles of all sea turtle species would not be affected. Explosion byproducts, metals, and chemicals from training and testing activities, as discussed above, induce very localized or short-term impacts to water quality within the water column. Activities that introduce secondary stressors would occur over wide areas and in sufficiently low frequency as to not impact the physical and biological features that comprise loggerhead critical habitat.

Pursuant to the ESA, Navy training and testing activities would introduce secondary stressors influencing prey availability that may affect ESA-listed green, hawksbill, Kemp’s ridley, leatherback, and loggerhead sea turtles; and would have no effect on the American crocodile. There would be no effect on green, hawksbill, leatherback, or loggerhead sea turtle critical habitat; and no effect on American crocodile critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard, for training and testing activities described under Alternative 1.

3.8.4 Summary of Potential Impacts on Reptiles

3.8.4.1 Combined Impacts of All Stressors under Alternative 1

As described in Section 3.0.3.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the potential for combined impacts of all the stressors from the proposed action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in Sections 3.8.3.1 (Acoustic Stressors) through 3.8.3.6 (Ingestion Stressors) and, for ESA-listed species, summarized in Section 3.8.4.4 (Endangered Species Act Determinations). Stressors associated with Navy training and testing activities do not typically occur in isolation but rather occur in some combination. For example, mine neutralization activities include elements of acoustic, physical disturbance and strike, entanglement, ingestion, and secondary stressors that are all coincident in space and time. An analysis of the combined impacts of all stressors considers the potential consequences of additive stressors and synergistic stressors, as described below. This analysis makes the reasonable assumption that the majority of exposures to stressors are non-lethal, and instead focuses on consequences potentially impacting sea turtle, crocodilian, or terrapin fitness (e.g., physiology, behavior, reproductive potential).

Additive Stressors–There are generally two ways that a sea turtle, crocodilian, or terrapin could be exposed to multiple additive stressors. The first would be if an animal were exposed to multiple sources of stress from a single event or activity within a single testing or training event (e.g., a mine warfare event may include the use of a sound source and a vessel). For crocodilians and terrapins, multiple additive stressors would likely be limited to vessel transits in shallow waters and sound sources, or for American alligators and terrapins, weapons firing noise and vessels; because of the limited number of additive stressors that crocodilians and terrapins would likely experience, only sea turtles are addressed further in this section.

The potential for a combination of these impacts from a single activity would depend on the range to effects of each of the stressors and the response or lack of response to that stressor. Most of the activities proposed under Alternative 1 generally involve the use of moving platforms (e.g., ships, torpedoes, and aircraft) that may produce one or more stressors; therefore, it is likely that if a sea turtle were within the potential impact range of those activities, it may be impacted by multiple stressors simultaneously. Individual stressors that would otherwise have minimal to no impact, may combine to have a measurable response. However, due to the wide dispersion of stressors, speed of the platforms, general dynamic movement of many training and testing activities, and behavioral avoidance exhibited by sea turtles, it is very unlikely that a sea turtle would remain in the potential impact range of multiple sources or sequential exercises. Exposure to multiple stressors is more likely to occur at an instrumented range where training and testing using multiple platforms may be concentrated during a particular event, or in inshore waters where sea turtles reside. In such cases involving a relatively small area on an instrumented range, a behavioral reaction resulting in avoidance of the immediate vicinity of the activity would reduce the likelihood of exposure to additional stressors. Nevertheless, the majority of the proposed activities in offshore areas are unit-level training and small testing activities which are conducted in the open ocean. Unit level exercises occur over a small spatial scale (one to a few square miles) and with few participants (usually one or two vessels) or short duration (the order of a few hours or less). In inshore waters, however, exposure to multiple stressors is likely because of the close proximity of stressors and higher numbers of sea turtles.

Secondly, a sea turtle could be exposed to multiple training and testing activities over the course of its life, however, training and testing activities are generally separated in space and time in such a way that it would be unlikely that any individual sea turtle would be exposed to stressors from multiple activities within a short timeframe. However, sea turtles with a home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to sea turtles that simply transit the area through a migratory corridor. This limited potential for exposure of individuals is not anticipated to impact populations.

Synergistic Stressors–Multiple stressors may also have synergistic effects. For example, sea turtles that react to a sound source (behavioral response) or experience injury from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Sea turtles that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to entanglement and physical strike stressors via malnourishment and disorientation. Similarly, sea turtles that may be weakened by disease (e.g., fibropapillomatosis) or other factors that are not associated with Navy training and testing activities may be more susceptible to stressors analyzed in this EIS/OEIS. These interactions are speculative, and without data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors are difficult to predict in any meaningful way. Research and monitoring efforts have included before, during, and after-event observations and surveys, data collection through conducting long-term studies in areas of Navy activity, occurrence surveys over large geographic areas, biopsy of animals occurring in areas of Navy activity, and tagging studies where animals are exposed to Navy stressors. These efforts are intended to contribute to the overall understanding of what impacts may be occurring overall to animals in these areas.

Crocodilians and terrapins in inshore training and testing locations may experience a smaller array of additive and synergistic stressors relative to sea turtles in offshore locations. However, the stressors that could simultaneously occur or quickly follow each other may contribute to major risk factors for these species. For example, a major risk factor for crocodilians and terrapins is recreational boating, which may present the same risk factors as small boat movements associated with military training and testing activities. How crocodilians and terrapins may be at higher risk from other synergistic stressors is speculative. As with sea turtles, the additive and synergistic stressor impacts on crocodilians and terrapins from the combination of Navy stressors is difficult to predict in any meaningful way.

3.8.4.2 Combined Impacts of All Stressors under Alternative 2

Training and testing activities proposed under Alternative 2 would be an increase over what is proposed for Alternative 1. However, this increase is not expected to substantially increase the potential for impacts over what is analyzed for Alternative 1. The analysis presented in Section 3.8.4.1 (Combined Impacts of All Stressors under Alternative 1) would similarly apply to Alternative 2. The combined impacts of all stressors for training and testing activities under Alternative 2 are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations of sea turtles, crocodilians, or terrapins.

3.8.4.3 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, and there would be no combined impact of multiple stressors on sea turtles, crocodilians, or terrapins. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.5 Endangered Species Act Determinations

Administration of ESA obligations associated with sea turtles are shared between NMFS and USFWS, depending on life stage and specific location of the sea turtle. NMFS has jurisdiction over sea turtles in the marine environment, and USFWS has jurisdiction over sea turtles on land. The Navy has consulted with NMFS on its determination of effect on the potential impacts of the Proposed Action. Because no activities analyzed in this EIS/OEIS occur on land within sea turtle nesting areas, consultation with

USFWS is not required for sea turtles. American crocodiles are managed under the jurisdiction of USFWS; therefore, the Navy has consulted with USFWS for the proposed activities considered in this EIS/OEIS as required by section 7(a)(2) of the ESA.

Pursuant to the ESA, the Navy has concluded training and testing activities may affect the green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, loggerhead sea turtle, leatherback sea turtle, and American crocodile. The Navy has also concluded that training and testing activities may affect designated critical habitat for the loggerhead sea turtle; and have no effect on designated critical habitat for the green sea turtle, hawksbill sea turtle, leatherback sea turtle, and American crocodile. The Navy has consulted with NMFS and USFWS as required by section 7(a)(2) of the ESA in that regard. The Navy's summary of effects determinations for each ESA-listed species is shown in Table 3.8-11. NMFS and USFWS concurred with all Navy determinations on their respective species.

Table 3.8-11: Summary of ESA-Effects Determinations for Reptiles (Alternative 1)

Species	Designation Unit	Effect Determinations by Stressor																	
		Acoustic						Explo-sives	Energy		Physical Disturbance and Strike				Entanglement			Ingestion	
		Sonar and Other Transducers	Air Guns	Pile Driving	Vessel Noise	Aircraft Noise	Weapons Noise	Explosives	In-water Electromagnetic Devices	High-energy Lasers	Vessels	In-water Devices	Military Expended Materials	Seafloor Devices	Wires and Cables	Decelerators/Parachutes	Biodegradable Polymer	Military Expended Materials - Munitions	Military Expended Materials - Other Than Munitions
Training Activities																			
American crocodile	Throughout range	NE	N/A	NE	NLAA	NLAA	NE	NLAA	NE	NE	NE	NE	NE	NE	NE	NE	N/A	NE	NE
	Critical habitat	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	N/A	NE	NE
Green turtle	North Atlantic DPS	NLAA	N/A	NLAA	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA	N/A	NLAA	NLAA
	Critical habitat	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	N/A	NE	NE
Hawksbill turtle	Throughout range	NLAA	N/A	NLAA	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	NLAA	N/A	NLAA	NLAA
	Critical habitat	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	N/A	NE	NE
Kemp's ridley turtle	Throughout range	NLAA	N/A	NLAA	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA	N/A	NLAA	NLAA
Leatherback turtle	Throughout range	NLAA	N/A	NLAA	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA	N/A	NLAA	NLAA
	Critical habitat	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	N/A	NE	NE
Loggerhead turtle	NW Atlantic Ocean DPS	NLAA	N/A	LAA	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA	N/A	NLAA	NLAA
	Critical habitat	NLAA	N/A	NE	NLAA	NE	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE	NE	N/A	NE	NE

Table 3.8-11: Summary of ESA-Effects Determinations for Reptiles (Alternative 1) (continued)

Species	Designation Unit	Effect Determinations by Stressor																	
		Acoustic						Explo-sives	Energy		Physical Disturbance and Strike				Entanglement			Ingestion	
		Sonar and Other Transducers	Air Guns	Pile Driving	Vessel Noise	Aircraft Noise	Weapons Noise	Explosives	In-water Electromagnetic Devices	High-energy Lasers	Vessels	In-water Devices	Military Expended Materials	Seafloor Devices	Wires and Cables	Decelerators/Parachutes	Biodegradable Polymer	Military Expended Materials - Munitions	Military Expended Materials - Other Than Munitions
Testing Activities																			
American crocodile	Throughout range	NE	NE	N/A	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Critical habitat	NE	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Green turtle	North Atlantic DPS	NLAA	NLAA	N/A	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Critical habitat	NE	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Hawksbill turtle	Throughout range	NLAA	NLAA	N/A	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Critical habitat	NE	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Kemp's ridley turtle	Throughout range	LAA	NLAA	N/A	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Leatherback turtle	Throughout range	LAA	NLAA	N/A	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Critical habitat	NE	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Loggerhead turtle	NW Atlantic Ocean DPS	LAA	LAA	N/A	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Critical habitat	NLAA	NE	N/A	NLAA	NE	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Note: NW = Northwest; DPS = Distinct Population Segment; NE = no effect; NLAA = may effect, not likely to adversely affect; LAA = may effect, likely to adversely affect; N/A = not applicable, activity related to the stressor does not occur during specified training or testing events (e.g., there are no testing activities that involve the use of pile driving).

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References

Andrady, A. L. (2011). Microplastics in the marine environment. *Marine Pollution Bulletin, 62*, 1595–1605.

Arendt, M. D., J. A. Schwenter, A. L. Segars, J. I. Byrd, P. P. Maier, J. D. Whitaker, D. W. Owens, G. Blanvillain, J. M. Quattro, and M. A. Roberts. (2012). Catch rates and demographics of loggerhead sea turtles (*Caretta caretta*) captured from the Charleston, South Carolina, shipping channel during the period of mandatory use of turtle excluder devices (TEDs). *Fishery Bulletin, 110*(1), 98–109.

Arfsten, D. P., C. L. Wilson, and B. J. Spargo. (2002). Radio frequency chaff: The effects of its use in training on the environment. *Ecotoxicology and Environmental Safety, 53*, 1–11.

Arroyo-Arce, S., I. Thomson, E. Harrison, S. Wilmott, and G. Baker. (2017). First record of jaguar (*Panthera onca*) predation on a loggerhead sea turtle (*Caretta caretta*) in Tortuguero National Park, Costa Rica. *Herpetology Notes, 10*, 17–18.

Avens, L. (2003). Use of multiple orientation cues by juvenile loggerhead sea turtles *Caretta caretta*. *The Journal of Experimental Biology, 206*(23), 4317–4325.

Balazs, G. H. (1986). Fibropapillomas in Hawaiian green turtles. *Marine Turtle Newsletter, 39*, 1–3.

Balazs, G. H., P. Craig, B. R. Winton, and R. K. Miya. (1994). *Satellite telemetry of green turtles nesting at French Frigate Shoals, Hawaii, and Rose Atoll, American Samoa.* Paper presented at the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, Hilton Head, SC.

Barco, S., and G. G. Lockhart. (2015). *Turtle Tagging and Tracking in Chesapeake Bay and Coastal Waters of Virginia: 2014 Annual Progress Report. Draft Report* (Contract No. N62470-10-D-3011, Task Orders 41 and 50, issued to HDR Inc.). Norfolk, VA Naval Facilities Engineering Command Atlantic.

Barco, S., M. Law, B. Drummond, H. Koopman, C. Trapani, S. Reinheimer, S. Rose, W. M. Swingle, and A. Williard. (2016). Loggerhead turtles killed by vessel and fishery interaction in Virginia, USA, are healthy prior to death. *Marine Ecology Progess Series, 555*, 221–234.

Bartol, S. M., J. A. Musick, and M. L. Lenhardt. (1999). Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). *Copeia, 1999*(3), 836–840.

Bartol, S. M., and D. R. Ketten. (2006). *Turtle and Tuna Hearing* (NOAA Technical Memorandum NMFS-PIFSC-7). Honolulu, HI: Pacific Islands Fisheries Science Center.

Basile, E. R., H. W. Avery, W. F. Bien, and J. M. Keller. (2011). Diamondback terrapins as indicator species of persistent organic pollutants: Using Barnegat Bay, New Jersey as a case study. *Chemosphere, 82*(1), 137–144.

Becking, L. E., T. C. J. M. van Bussel, A. O. Debrot, and M. J. A. Christianen. (2014). First record of a Caribbean green turtle (*Chelonia mydas*) grazing on invasive seagrass (*Halophila stipulacea*). *Caribbean Journal of Science, 48*(2–3), 162–163.

Benson, S. R., K. A. Forney, J. T. Harvey, J. V. Carretta, and P. H. Dutton. (2007). Abundance, distribution, and habitat of leatherback turtles (*Dermochelys coriacea*) off California, 1990–2003. *Fishery Bulletin, 105*(3), 337–347.

Berglind, R., D. Menning, R. Tryman, A. Helte, P. Leffler, and R. M. Karlsson. (2009). *Environmental Effects of Underwater Explosions: A Literature Study*. Kjeller, Norway: Forsvarets Forskningsinstitut.

Bergström, L., L. Kautsky, T. Malm, R. Rosenberg, M. Wahlberg, N. Åstrand Capetillo, and D. Wilhelmsson. (2014). Effects of offshore wind farms on marine wildlife–A generalized impact assessment. *Environmental Research Letters, 9*(3), 12.

Berkson, H. (1967). Physiological adjustments to deep diving in the Pacific green turtle (*Chelonia mydas agassizii*). *Comparative Biochemistry and Physiology, 21*(3), 507–524.

Berry, K. A., M. E. Peixoto, and S. S. Sadove. (2000). *Occurrence, Distribution and Abundance of Green Turtles, Chelonia mydas, in Long Island New York: 1986–1987* (Proceedings of the Eighteenth International Sea Turtle Symposium). Mazatlan, Sinaloa, Mexico: U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Bierman, H. S., J. L. Thornton, H. G. Jones, K. Koka, B. A. Young, C. Brandt, J. Christensen-Dalsgaard, C. E. Carr, and D. J. Tollin. (2014). Biophysics of directional hearing in the American alligator (*Alligator mississippiensis*). *The Journal of Experimental Biology, 217*(Pt 7), 1094–1107.

Bilkovic, D. M., K. Havens, D. Stanhope, and K. Angstadt. (2014). Derelict fishing gear in Chesapeake Bay, Virginia: Spatial patterns and implications for marine fauna. *Marine Pollution Bulletin, 80*(1-2), 114–123.

Bjorndal, K. A., and A. B. Bolten. (1988). Growth rates of immature green turtles, *Chelonia mydas*, on feeding grounds in the southern Bahamas. *Copeia, 1988*(3), 555–564.

Bjorndal, K. A., A. B. Bolten, and C. Lagueux. (1994). Ingestion of Marine Debris by Juvenile Sea Turtles in Coastal Florida Habitats. *Marine Pollution Bulletin, 28*(3), 154–158.

Bjorndal, K. A. (1997). Foraging ecology and nutrition of sea turtles. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 199–231). Boca Raton, FL: CRC Press.

Bjorndal, K. A., A. B. Bolten, and H. R. Martins. (2000). Somatic growth model of juvenile loggerhead sea turtles *Caretta caretta*: Duration of pelagic stage. *Marine Ecology Progress Series, 202*, 265–272.

Bjorndal, K. A., A. B. Bolten, B. Koike, B. A. Schroeder, D. J. Shaver, W. G. Teas, and W. N. Witzell. (2001). Somatic growth function for immature loggerhead sea turtles, *Caretta caretta*, in southeastern U.S. waters. *Fishery Bulletin, 99*, 240–246.

Bjorndal, K. A. (2003). Roles of loggerhead sea turtles in marine ecosystems. In A. B. Bolten & B. E. Witherington (Eds.), *Loggerhead Sea Turtles* (pp. 235–254). Washington, DC: Smithsonian Institution Press.

Bolten, A. B., H. R. Martins, K. A. Bjorndal, M. Cocco, and G. Gerosa. (1992). *Caretta caretta* (loggerhead). Pelagic movement and growth. *Herpetological Review, 23*(4), 116.

Bolten, A. B., K. A. Bjorndal, H. R. Martins, T. Dellinger, M. J. Biscoito, S. E. Encalada, and B. W. Bowen. (1998). Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. *Ecological Applications, 8*(1), 1–7.

Bolten, A. B. (2003a). Variation in sea turtle life history patterns: Neritic vs. oceanic developmental stages. In P. L. Lutz, J. A. Musick, & J. Wyneken (Eds.), *The Biology of Sea Turtles* (Vol. II, pp. 243–258). Boca Raton, FL: CRC Press.

Bolten, A. B. (2003b). Active swimmers-passive drifters: The oceanic juvenile stage of loggerheads in the Atlantic system. In A. B. Bolten & B. E. Witherington (Eds.), *Loggerhead Sea Turtles* (pp. 63–78). Washington, DC: Smithsonian Books.

Bovery, C. M., and J. Wyneken. (2015). Seasonal variation in sea turtle density and abundance in the southeast Florida current and surrounding waters. *PLoS ONE, 10*(12), e0145980.

Bowen, B. W., A. L. Bass, S.-M. Chow, M. Bostrom, K. A. Bjorndal, A. B. Bolten, T. Okuyama, B. M. Bolker, S. Epperly, E. Lacasella, D. Shaver, M. Dodd, S. R. Hopkins-Murphy, J. A. Musick, M. Swingle, K. Rankin-Baransky, W. Teas, W. N. Witzell, and P. H. Dutton. (2004). Natal homing in juvenile loggerhead turtles *(Caretta caretta)*. *Molecular Ecology, 13*, 3797–3808.

Boyer, J. N., J. W. Fourqurean, and R. D. Jones. (1999). Seasonal and long-term trends in the water quality of Florida Bay (1989–1997). *Estuaries, 22*(2), 417–430.

Brandt, L. A., J. S. Beauchamp, B. M. Jeffery, M. S. Cherkiss, and F. J. Mazzotti. (2016). Fluctuating water depths affect American alligator (*Alligator mississippiensis*) body condition in the Everglades, Florida, USA. *Ecological Indicators, 67*, 441–450.

Brautigam, A., and K. L. Eckert. (2006). *Turning the Tide: Exploitation, Trade and Management of Marine Turtles in the Lesser Antilles, Central America, Columbia, and Venezuela*. Cambridge, UK: Traffic International.

Bresette, M., J. Gorham, and B. Peery. (1998). Site fidelity and size frequencies of juvenile green turtles (*Chelonia mydas*) utilizing near shore reefs in St. Lucie County, Florida. *Marine Turtle Newsletter, 82*, 5–7.

Bresette, M., D. Singewald, and E. De Maye. (2006). Recruitment of post-pelagic green turtles (*Chelonia mydas*) to nearshore reefs on Florida's east coast. In M. Frick, A. Panagopoulou, A. F. Rees, & K. Williams (Eds.), *Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation: Book of Abstracts* (pp. 288). Athens, Greece: National Marine Fisheries Service Southeast Fisheries Science Center, International Sea Turtle Society.

Briggs-Gonzalez, V., C. Bonenfant, M. Basille, M. Cherkiss, J. Beauchamp, and F. Mazzotti. (2017). Life histories and conservation of long-lived reptiles, an illustration with the American Crocodile (*Crocodylus acutus*). *Journal of Animal Ecology, 86*, 1102–1113.

Briggs, C., S. M. Shjegstad, J. A. K. Silva, and M. H. Edwards. (2016). Distribution of chemical warfare agent, energetics, and metals in sediments at a deep-water discarded military munitions site. *Deep Sea Research Part II: Topical Studies in Oceanography, 128*, 63–69.

Briscoe, D. K., D. M. Parker, G. H. Balazs, M. Kurita, T. Saito, H. Okamoto, M. Rice, J. J. Polovina, and L. B. Croder. (2016). Active dispersal in loggerhead sea turtles (*Caretta caretta*) during the 'lost years'. *Proceeding of the Royal Society B, 283*, 20160690.

Britton, A. (2009). *Alligator mississippiensis (Daudin, 1801)*. Retrieved from http://crocodilian.com/cnhc/csp_amis.htm.

Brothers, J. R., and K. J. Lohmann. (2015). Evidence for geomagnetic imprinting and magnetic navigation in the natal homing of sea turtles. *Current Biology, 25*(3), 392–396.

Browlow, A., J. Onoufriou, A. Bishop, N. Davidson, and D. Thompson. (2016). Corkscrew Seals: Grey Seal (*Halichoerus grypus*) infanticide and cannibalisng may indicate the cause of spiral lacerations in seals. *PLoS ONE, 11*(6), e0156464.

Bugoni, L., T. S. Neves, N. O. Leite, Jr., D. Carvalho, G. Sales, R. W. Furness, C. E. Stein, F. V. Peppes, B. B. Giffoni, and D. S. Monteiro. (2008). Potential bycatch of seabirds and turtles in hook-and-line fisheries of the Itaipava Fleet, Brazil. *Fisheries Research, 90*, 217–224.

Bureau of Ocean Energy Management. (2011). *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species*. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region.

Burkholder, J., D. Eggleston, H. Glasgow, C. Brownie, R. Reed, G. Janowitz, M. Posey, G. Mella, C. Kinder, R. Corbett, D. Toms, T. Alphin, N. Deamer, and J. Springer. (2004). Comparative impacts of two major hurricane seasons on the Neuse River and western Pamlico Sound ecosystems. *Proceedings of the National Academy of Sciences, 101*(25), 9291–9296.

Burns, T. J., H. Davidson, and M. W. Kennedy. (2016). Large-scale investment in the excavation and "camouflaging" phases by nesting Leatherback Turtles (*Dermochelys coriacea*). *Canadian Journal of Zoology, 94*(6), 443–448.

Burt, M. L., L. A. S. Scott-Hayward, and D. L. Borchers. (2014). *Analysis of Aerial Surveys Conducted in Coastal Waters of Maryland and Virginia, Including Chesapeake Bay, 2011–2013: Loggerhead Turtles. Draft Report.* Norfolk, VA: Naval Facilities Engineering Command Atlantic.

Caillouet, C. W., B. J. Gallaway, and N. F. Putman. (2016). Kemp's Ridley Sea Turtle saga and setback: Novel analyses of cumulative hatchlings released and time-lagged annual nests in Tamaulipas, Mexico. *Chelonian Conservation and Biology, 15*(1), 115–131.

Caillouet, C. W., Jr., R. A. Hart, and J. M. Nance. (2008). Growth overfishing in the brown shrimp fishery of Texas, Louisiana, and adjoining Gulf of Mexico EEZ. *Fisheries Research, 92*, 289–302.

Campbell, C. (2016). Port of Baltimore's first container ship through expanded Panama Canal carries hope for future. *The Baltimore Sun*. Retrieved from http://www.baltimoresun.com/business/bs-bz-panama-canal-expansion-20160715-story.html.

Carr, A., and A. B. Meylan. (1980). Evidence of passive migration of green turtle hatchlings in *Sargassum*. *Copeia, 1980*(2), 366–368.

Carr, A. (1986). Rips, FADS, and little loggerheads: Years of research have told us much about the behavioral ecology of sea turtles, but mysteries remain. *BioScience, 36*(2), 92–100.

Carr, A. (1987). New perspectives on the pelagic stage of sea turtle development. *Conservation Biology, 1*(2), 103–121.

Ceccarelli, D. M. (2009). *Impacts of Plastic Debris on Australian Marine Wildlife*. Canberra, Australia: Department of the Environment, Water, Heritage and the Arts.

Chaloupka, M., T. M. Work, G. H. Balazs, S. K. K. Murakawa, and R. Morris. (2008). Cause-specific temporal and spatial trends in green sea turtle strandings in the Hawaiian Archipelago (1982–2003). *Marine Biology, 154*, 887–898.

Chaloupka, M., G. H. Balazs, and T. M. Work. (2009). Rise and fall over 26 years of a marine epizootic in Hawaiian green sea turtles. *Journal of Wildlife Diseases, 45*(4), 1138–1142.

Chapman, R., and J. A. Seminoff. (2016). *Status of Loggerhead Turtles (Caretta caretta) within Nations of the Inter-American Convention for the Protection and Conservation of Sea Turtles*. Argentina, Belize, Brazil, Chile, Costa Rica, Ecuador, Guatemala, Honduras, Panama, Mexico, Peru, the Netherlands, United States of America, Uruguay and Venezuela: Inter-American Convention for the Protection and Conservation of Sea Turtles.

Cherkiss, M. S., F. J. Mazzotti, L. Hord, and M. Aldecoa. (2014). Remarkable movements of an American crocodile (*Crocodylus acutus*) in Florida. *Southeastern Naturalist, 13*(4), N52–N56.

Christian, E. A., and J. B. Gaspin. (1974). *Swimmer Safe Standards from Underwater Explosions. Navy Science Assistance Program Project No. PHP-11-73*. White Oak, MD: Naval Ordnance Laboratory.

Christiansen, F., N. F. Putman, R. Farman, D. M. Parker, M. R. Rice, J. J. Polovina, G. H. Balazs, and G. C. Hays. (2016). Spatial variation in directional swimming enables juvenile sea turtles to reach and remain in productive waters. *Marine Ecology Progress Series, 557*, 247–259.

Clark, S. L., and J. W. Ward. (1943). The effects of rapid compression waves on animals submerged in water. *Surgery, Gynecology & Obstetrics, 77*, 403–412.

Collazo, J. A., R. Boulon, and T. L. Tallevast. (1992). Abundance and growth patterns of *Chelonia mydas* in Culebra, Puerto Rico. *Journal of Herpetology, 26*(3), 293–300.

Conant, T. A., P. H. Dutton, T. Eguchi, S. P. Epperly, C. C. Fahy, M. H. Godfrey, S. L. MacPherson, E. E. Possardt, B. A. Schroeder, J. A. Seminoff, M. L. Snover, C. M. Upite, and B. E. Witherington. (2009). *Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act* (Report of the loggerhead biological review team to the National Marine Fisheries Service, August 2009). Silver Spring, MD: Loggerhead Biological Review Team.

Cook, C. (2016). *Impacts Of Invasive Phragmites Australis On Diamondback Terrapin Nesting.* (Master's thesis). College of William and Mary, Williamsburg, VA.

Cook, S. L., and T. G. Forrest. (2005). Sounds produced by nesting leatherback sea turtles (*Dermochelys coriacea*). *Herpetological Review, 36*(4), 387–389.

Corn, M. L. (2010). *Deepwater Horizon Oil Spill: Coastal Wetland and Wildlife Impacts and Response*. Collingdale, PA: Diane Publishing Co.

Corning Incorporated. (2005). *Corning SMF-28e Optical Fiber Product Information*. Corning, NY: Corning Incorporated.

Coyne, M. S., M. E. Monaco, and A. M. Landry, Jr. (2000). *Kemp's ridley habitat suitability index model* (Proceedings of the Eighteenth International Sea Turtle Symposium). Mazatlán, Sinaloa, México: U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Craig, J. C., Jr. (2001). *Appendix D, Physical Impacts of Explosions on Marine Mammals and Turtles Final Environmental Impact Statement, Shock Trial of the Winston Churchill (DDG 81)*. Washington, DC: U.S. Department of the Navy, Naval Sea Systems Command.

Cummings, E., R. McAlarney, W. McLellan, and D. A. Pabst. (2016). *Aerial Surveys for Protected Species in the Jacksonville Opearating Area: 2015 Annual Progress Report*. Virginia Beach, VA: U.S. Fleet Forces Command.

Davenport, J. (1988). Do diving leatherbacks pursue glowing jelly? *British Herpetological Society Bulletin, 24*, 20–21.

Day, R. D., R. D. McCauley, Q. P. Fitzgibbon, and J. M. Semmens. (2016). Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster *Jasus edwardsii* larvae (Decapoda: Palinuridae). *Scientific Reports, 6*(22723), 9.

Denkinger, J., M. Parra, J. P. Muñoz, C. Carrasco, J. C. Murillo, E. Espinosa, F. Rubianes, and V. Koch. (2013). Are boat strikes a threat to sea turtles in the Galapagos Marine Reserve? *Ocean & Coastal Management, 80*, 29–35.

DeRuiter, S. L., and K. L. Doukara. (2012). Loggerhead turtles dive in response to airgun sound exposure. *Endangered Species Research, 16*(1), 55–63.

Dew, L. A., R. G. Owen, and M. J. Mulroy. (1993). Changes in size and shape of auditory hair cells in vivo during noise-induced temporary threshold shift. *Hearing Research, 66*(1), 99–107.

Dodd, C. K., Jr. (1988). *Synopsis of the Biological Data on the Loggerhead Sea Turtle, Caretta caretta (Linnaeus 1758)*. Washington, DC: U.S. Fish and Wildlife Service.

Dorcas, M. E., J. D. Willson, R. N. Reed, R. W. Snow, M. R. Rochford, M. A. Miller, W. E. Meshaka, P. T. Andreadis, F. J. Mazzotti, and C. M. Romagosa. (2012). Severe mammal declines coincide with proliferation of invasive Burmese pythons in Everglades National Park. *Proceedings of the National Academy of Sciences, 109*(7), 2418–2422.

Draud, M., M. Bossert, and S. Zimnavoda. (2004). Predation on hatchling and juvenile diamondback terrapins (*Malaclemys terrapin*) by the Norway rat (*Rattus norvegicus*). *Journal of Herpetology, 38*(3), 467–470.

Eckert, S. A., K. L. Eckert, P. Ponganis, and G. L. Kooyman. (1989). Diving and foraging behavior of leatherback sea turtles (*Dermochelys coriacea*). *Canadian Journal of Zoology, 67*, 2834–2840.

Eckert, S. A. (2002). Distribution of juvenile leatherback sea turtle, *Dermochelys coriacea,* sightings. *Marine Ecology Progress Series, 230*, 289–293.

Edmonds, N. J., C. J. Firmin, D. Goldsmith, R. C. Faulkner, and D. T. Wood. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. *Marine Pollution Bulletin, 108*, 5–11.

Edwards, M. H., S. M. Shjegstad, R. Wilkens, J. C. King, G. Carton, D. Bala, B. Bingham, M. C. Bissonnette, C. Briggs, N. S. Bruso, R. Camilli, M. Cremer, R. B. Davis, E. H. DeCarlo, C. DuVal, D. J. Fornari, I. Kaneakua-Pia, C. D. Kelley, S. Koide, C. L. Mah, T. Kerby, G. J. Kurras, M. R. Rognstad, L. Sheild, J. Silva, B. Wellington, and M. V. Woerkom. (2016). The Hawaii undersea military munitions assessment. *Deep Sea Research Part II: Topical Studies in Oceanography, 128*, 4–13.

Eisenberg, J. F., and J. Frazier. (1983). A leatherback turtle (*Dermochelys coriacea*) feeding in the wild. *Journal of Herpetology, 17*(1), 81–82.

Elsey, R. M., N. Kinler, V. Lance, and W. Parke Moore, III. (2006). *Effects of Hurricanes Katrina and Rita on alligators (Alligator mississippiensis) in Louisiana.* Paper presented at the 18th Working Meeting of the International Union, for Conservation of Nature-Species Survival Commission, Crocodile Specialist Group. Montelimar, France.

Elsey, R. M., and A. R. Woodward. (2010). American Alligator, *Alligator mississippiensis*. In S. C. Manolis & C. Stevenson (Eds.), *Crocodiles. Status Survey and Conservation Action Plan* (3rd ed., pp. 1–4). Gland, Switzerland and Cambridge, UK: Crocodile Specialist Group, International Union for Conservation of Nature.

Engeman, R. M., D. Addison, and J. C. Griffin. (2016). Defending against disparate marine turtle nest predators: Nesting success benefits from eradicating invasive feral swine and caging nests from raccoons. *Oryx, 50*(02), 289–295.

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

Epperly, S. P., J. Braun, and A. J. Chester. (1995a). Aerial surveys for sea turtles in North Carolina inshore waters. *Fishery Bulletin, 93*, 254–261.

Epperly, S. P., J. Braun, A. J. Chester, F. A. Cross, J. V. Merriner, and P. A. Tester. (1995b). Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. *Bulletin of Marine Science, 56*(2), 547–568.

Epperly, S. P., J. Braun, and A. Veishlow. (1995c). Sea turtles in North Carolina waters. *Conservation Biology, 9*(2), 384–394.

Eriksson, C., and H. Burton. (2003). Origins and biological accumulation of small plastic particles in fur seals from Macquarie Island. *Ambio, 32*(6), 380–384.

Eversole, C. B., S. E. Henke, D. B. Wester, B. M. Ballard, and R. L. Powell. (2015). Responses of American Alligators (*Alligator mississippiensis*) to Environmental Conditions: Implications for Population and Ecosystem Monitoring. *Herpetologica, 71*(1), 37–45.

Fergusson, I. K., L. J. V. Compagno, and M. A. Marks. (2000). Predation by white sharks *Carcharodon carcharias* (Chondrichthyes: Lamnidae) upon chelonians, with new records from the Mediterranean Sea and a first record of the ocean sunfish *Mola mola* (Osteichthyes: Molidae) as stomach contents. *Environmental Biology of Fishes, 58*, 447–453.

Ferrara, C. R., R. C. Vogt, M. R. Harfush, R. S. Sousa-Lima, E. Albavera, and A. Tavera. (2014). First evidence of leatherback turtle (*Dermochelys coriacea*) embryos and hatchlings emitting sounds. *Chelonian Conservation and Biology, 13*(1), 110–114.

Figgener, C., D. Chacón-Chaverri, M. P. Jensen, and H. Feldhaar. (2016). Paternity re-visited in a recovering population of Caribbean leatherback turtles (*Dermochelys coriacea*). *Journal of Experimental Marine Biology and Ecology, 475*, 114–123.

Finkbeiner, E. M., B. P. Wallace, J. E. Moore, R. L. Lewison, L. B. Crowder, and A. J. Read. (2011). Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. *Biological Conservation, 144*(11), 2719–2727.

Fish, M. R., I. M. Cote, J. A. Horrocks, B. Mulligan, A. R. Watkinson, and A. P. Jones. (2008). Construction setback regulations and sea-level rise: Mitigating sea turtle nesting beach loss. *Ocean & Coastal Management, 51*(4), 330–341.

Fishman, J., K. MacKinnon, and S. Baker. (2009). *Crocodylus acutus*. *University of Michigan Animal Diversity Web.* Retrieved from http://animaldiversity.ummz.umich.edu/site/accounts/information/Crocodylus_acutus.html.

Florida Fish and Wildlife Conservation Commission. (2017). *Index Nesting Beach Survey Totals (1989–2017)*. Retrieved from http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/.

Florida Fish and Wildlife Conservation Commission. (n.d.). *American crocodile, Crocodylus acutus*. Retrieved from http://myfwc.com/crocodile/.

Flower, J. E., T. M. Norton, K. M. Andrews, S. E. Nelson, C. E. Parker, L. M. Romero, and M. A. Mitchell. (2015). Baseline plasma corticosterone, haematological and biochemical results in nesting and rehabilitating loggerhead sea turtles (*Caretta caretta*). *Conservation Physiology, 3*(1), cov003.

Foley, A. M., P. H. Dutton, K. E. Singel, A. E. Redlow, and W. G. Teas. (2003). The first records of olive ridleys in Florida, U.S.A. *Marine Turtle Newsletter, 101*, 23–25.

Fossette, S., S. Ferraroli, H. Tanaka, Y. Ropert-Coudert, N. Arai, K. Sato, Y. Naito, Y. Le Maho, and J. Georges. (2007). Dispersal and dive patterns in gravid leatherback turtles during the nesting season in French Guiana. *Marine Ecology Progress Series, 338*, 233–247.

Foster, T., and J. P. Gilmour. (2016). Seeing red: Coral larvae are attracted to healthy-looking reefs. *Marine Ecology Progress Series, 559*, 65–71.

Frick, M. G., C. A. Quinn, and C. K. Slay. (1999). *Dermochelys coriacea* (leatherback sea turtle), *Lepidochelys kempii* (Kemp's ridley sea turtle), and *Caretta caretta* (loggerhead sea turtle): pelagic feeding. *Herpetological Review, 30*(3), 165.

Frost, M. T., S. Dye, B. Stoker, P. Buckley, and J. Baxter. (2017). *Marine Climate Change Impacts: 10 Years' Experience of Science to Policy Reporting. Summary Report*. London, United Kingdom: Marine Climate Change Impacts Partnership.

Fuentes, M. M. P. B., D. A. Pike, A. Dimatteo, and B. P. Wallace. (2013). Resilience of marine turtle regional management units to climate change. *Global Change Biology, 19*(5), 1399–1406.

Fukuoka, T., M. Yamane, C. Kinoshita, T. Narazaki, G. J. Marshall, K. J. Abernathy, N. Miyazaki, and K. Sato. (2016). The feeding habit of sea turtles influences their reaction to artificial marine debris. *Scientific Reports, 6*, 28015.

Furin, C. G., F. A. von Hippel, B. Hagedorn, and T. M. O'Hara. (2013). Perchlorate trophic transfer increases tissue concentrations above ambient water exposure alone in a predatory fish. *Journal of Toxicology and Environmental Health. Part A, 76*(18), 1072–1084.

Garcia-Parraga, D., J. L. Crespo-Picazo, Y. B. de Quiros, V. Cervera, L. Marti-Bonmati, J. Diaz-Delgado, M. Arbelo, M. J. Moore, P. D. Jepson, and A. Fernandez. (2014). Decompression sickness ('the bends') in sea turtles. *Diseases of Aquatic Organisms, 111*(3), 191–205.

Gardner, B., L. A. Garner, D. T. Cobb, and C. E. Moorman. (2016). Factors affecting occupancy and abundance of American alligators at the northern extent of their range. *Journal of Herpetology, 50*(4), 541–547.

Garrick, L. D., J. W. Lang, and H. A. Herzog. (1978). Social signals of adult American alligators. *Bulletin of the American Museum of Natural History, 160*(3), 163–192.

Gitschlag, G. R. (1996). Migration and diving behavior of Kemp's ridley (Garman) sea turtles along the U.S. southeastern Atlantic coast. *Journal of Experimental Marine Biology and Ecology, 205*, 115–135.

Glandon, H. L., and T. J. Miller. (2016). No effect of high pCO_2 on juvenile blue crab, *Callinectes sapidus*, growth and consumption despite positive responses to concurrent warming. *ICES Journal of Marine Science, 74*(4), 1201–1209.

Gleich, O., and G. A. Manley. (2000). The hearing organ of birds and crocodilia. In R. Dooling, A. N. Popper, & R. R. Fay Springer-Verlag (Eds.), *Comparative Hearing: Birds and Reptiles* (pp. 70–138). New York, NY: Springer Handbook of Auditory Research.

Godley, B. J., D. R. Thompson, S. Waldron, and R. W. Furness. (1998). The trophic status of marine turtles as determined by stable isotope analysis. *Marine Ecology Progress Series, 166*, 277–284.

Goertner, J. F. (1978). *Dynamical Model for Explosion Injury to Fish*. Dalgren, VA: U.S. Department of the Navy, Naval Surface Weapons Center.

Gonzalez, L. A. (2011). State of the Bay: Water and Sediment Quality. In *A Characterization of the Galveston Bay Ecosystem* (Third ed., pp. 1–45). Austin, TX: Texas Commission on Environmental Quality, Galveston Bay Estuary Program.

Grant, G. S., and D. Ferrell. (1993). Leatherback turtle, *Dermochelys coriacea* (Reptilia: *Dermochelidae*): Notes on near-shore feeding behavior and association with cobia. *Brimleyana, 19*, 77–81.

Grant, P. B. C., and T. R. Lewis. (2010). High speed boat traffic: A risk to crocodilian populations. *Herpetological Conservation and Biology, 5*(3), 456–460.

Greaves, F. C., R. H. Draeger, O. A. Brines, J. S. Shaver, and E. L. Corey. (1943). An experimental study of concussion. *United States Naval Medical Bulletin, 41*(1), 339–352.

Green, T. W., D. H. Slone, E. D. Swain, M. S. Cherkiss, M. Lohmann, F. J. Mazzotti, and K. G. Rice. (2014). Evaluating effects of Everglades restoration on American crocodile populations in South Florida using a spatially-explicit, stage-based population model. *Wetlands, 34*(1), 213–224.

Gregory, L. F., and J. R. Schmid. (2001). Stress response and sexing of wild Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Northeastern Gulf of Mexico. *General and Comparative Endocrinology, 124*, 66–74.

Griffin, D. B., S. R. Murphy, M. G. Frick, A. C. Broderick, J. W. Coker, M. S. Coyne, M. G. Dodd, M. H. Godfrey, B. J. Godley, and L. A. Hawkes. (2013). Foraging habitats and migration corridors utilized by a recovering subpopulation of adult female loggerhead sea turtles: Implications for conservation. *Marine Biology, 160*(12), 3071–3086.

Grigg, G., and C. Gans. (1993). Morphology and physiology of the Crocodylia *Fauna of Australia Vol 2A Amphibia and Reptilia* (pp. 326–336). Canberra, Australia: Australian Government Publishing Service.

Hackney, A. D. (2010). *Conservation biology of the diamondback terrapin in North America: Policy status, nest predation, and managing island populations*. Clemson, SC: Clemson University.

Hardesty, B. D., and C. Wilcox. (2017). A risk framework for tackling marine debris. *Royal Society of Chemistry, 9*, 1429–1436.

Hart, K. M., and D. S. Lee. (2006). The Diamondback Terrapin: The Biology, Ecology, Cultural History, and Conservation Status of an Obligate Estuarine Turtle. In R. Greenberg, J. E. Maldonado, S. Droege, & M. V. McDonald (Eds.), *Terrestrial Vertebrates of Tidal Marshes: Evolution, Ecology, and Conservation*. Camarillo, CA: Cooper Ornithological Society.

Hart, K. M., P. J. Schofield, and D. R. Gregoire. (2012). Experimentally derived salinity tolerance of hatchling Burmese pythons (*Python molurus bivittatus*) from the Everglades, Florida (USA). *Journal of Experimental Marine Biology and Ecology, 413*, 56–59.

Hart, K. M., C. F. White, A. R. Iverson, and N. Whitney. (2016). Trading shallow safety for deep sleep: Juvenile green turtles select deeper resting sites as they grow. *Endangered Species Research, 31*, 61–73.

Hatase, H., K. Sato, M. Yamaguchi, K. Takahashi, and K. Tsukamoto. (2006). Individual variation in feeding habitat use by adult female green sea turtles (*Chelonia mydas*): Are they obligately neritic herbivores? *Oecologia, 149*, 52–64.

Hawaii Undersea Military Munitions Assessment. (2010). *Final Investigation Report HI-05 South of Pearl Harbor, O'ahu, Hawaii*. Honolulu, HI: University of Hawaii at Monoa and Environet Inc.

Hawkes, L. A., A. C. Broderick, M. S. Coyne, M. H. Godfrey, L.-F. Lopez-Jurado, P. Lopez-Suarez, S. E. Merino, N. Varo-Cruz, and B. J. Godley. (2006). Phenotypically linked dichotomy in sea turtle foraging requires multiple conservation approaches. *Current Biology, 16*, 990–995.

Hays, G. C., J. D. R. Houghton, C. Isaacs, R. S. King, C. Lloyd, and P. Lovell. (2004). First records of oceanic dive profiles for leatherback turtles, *Dermochelys coriacea*, indicate behavioural plasticity associated with long-distance migration. *Animal Behaviour, 67*, 733–743.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. (2007). Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research, 3*, 105–113.

Hazel, J., I. R. Lawler, and M. Hamann. (2009). Diving at the shallow end: Green turtle behaviour in near-shore foraging habitat. *Journal of Experimental Marine Biology and Ecology, 371*(1), 84–92.

Henry, A. G., T. V. N. Cole, L. Hall, W. Ledwell, D. Morin, and A. Reid. (2016). *Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast and Atlantic Canadian Provinces, 2010–2014*. Woods Hole, MA: U.S. Department of Commerce.

Henry, W. R., and M. J. Mulroy. (1995). Afferent synaptic changes in auditory hair cells during noise-induced temporary threshold shift. *Hearing Research, 84*(1), 81–90.

Hetherington, T. (2008). Comparative anatomy and function of hearing in aquatic amphibians, reptiles, and birds. In J. G. M. Thewissen & S. Nummela (Eds.), *Sensory Evolution on the Threshold* (pp. 182–209). Berkeley, CA: University of California Press.

Hidalgo-Ruz, V., L. Gutow, R. C. Thompson, and M. Thiel. (2012). Microplastics in the marine environment: A review of methods used for identification and quantification. *Environmental Science and Technology, 46*, 3060–3075.

Higgs, D. M., E. F. Brittan-Powell, D. Soares, M. J. Souza, C. E. Carr, R. J. Dooling, and A. N. Popper. (2002). Amphibious auditory responses of the American alligator (*Alligator mississipiensis*). *Journal of Comparative Physiology A, 188*, 217–223.

Hill, M. (1998). Spongivory on Caribbean reefs releases corals from competition with sponges. *Oecologia, 117*(1–2), 143–150.

Hillis, Z. (1990). *Buck Island Reef National Sea Turtle Research Program.* Paper presented at the Tenth Annual Workshop on Sea Turtle Biology and Conservation. Hilton Head, SC.

Hirth, H. F. (1997). *Synopsis of the Biological Data on the Green Turtle Chelonia mydas (Linnaeus 1758)*. Washington, DC: U.S. Fish and Wildlife Service.

Hochscheid, S., C. R. McMahon, C. J. A. Bradshaw, F. Maffucci, F. Bentivegna, and G. C. Hays. (2007). Allometric scaling of lung volume and its consequences for marine turtle diving performance. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 148*(2), 360–367.

Hochscheid, S. (2014). Why we mind sea turtles' underwater business: A review on the study of diving behavior. *Journal of Experimental Marine Biology and Ecology, 450*, 118–136.

Hodge, L. E. W. (2011). *Monitoring Marine Mammals in Onslow Bay, North Carolina, Using Passive Acoustics.* (Doctoral Dissertation in Philosophy). Duke University, Durham, NC. Retrieved from https://dukespace.lib.duke.edu.

Holloway-Adkins, K. G. (2006). Juvenile green turtles (*Chelonia mydas*) forage on high-energy, shallow reef on the east coast of Florida. In M. Frick, A. Panagopoulou, A. F. Rees, & K. Williams (Eds.), *Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation: Book of Abstracts*. Athens, Greece: National Marine Fisheries Service Southeast Fisheries Science Center, International Sea Turtle Society.

Hoopes, L. A., A. M. Landry Jr., and E. K. Stabenau. (2000). Physiological effects of capturing Kemp's ridley sea turtles, *Lepidochelys kempii*, in entanglement nets. *Canadian Journal of Zoology, 78*(11), 1941–1947.

Hopkins-Murphy, S. R., D. W. Owens, and T. M. Murphy. (2003). Ecology of immature loggerheads on foraging grounds and adults in internesting habitat in the eastern United States. In A. B. Bolten & B. E. Witherington (Eds.), *Loggerhead Sea Turtles* (pp. 79–92). Washington, DC: Smithsonian Institution Press.

Horrocks, J. A. (1987). Leatherbacks in Barbados. *Marine Turtle Newsletter, 41*, 7.

Horrocks, J. A., S. Stapleton, H. Guada, C. Lloyd, E. Harris, M. Fastigi, J. Berkel, K. Stewart, J. Gumbs, and K. L. Eckert. (2016). International movements of adult female leatherback turtles in the Caribbean: results from tag recovery data (2002–2013). *Endangered Species Research, 29*(3), 279–287.

Houghton, J. D. R., M. J. Callow, and G. C. Hays. (2003). Habitat utilization by juvenile hawksbill turtles (*Eretmochelys imbricata*, Linnaeus, 1766) around a shallow water coral reef. *Journal of Natural History, 37*, 1269–1280.

Hubbs, C., and A. Rechnitzer. (1952). Report on experiments designed to determine effects of underwater explosions on fish life. *California Fish and Game, 38*, 333–366.

Humber, F., B. J. Godley, and A. C. Broderick. (2014). So excellent a fishe: A global overview of legal marine turtle fisheries. *Diversity and Distributions, 20*(5), 579–590.

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

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

James, M. C., and T. B. Herman. (2001). Feeding of *Dermochelys coriacea* on medusae in the northwest Atlantic. *Chelonian Conservation and Biology, 4*(1), 202–205.

James, M. C., S. A. Eckert, and R. A. Myers. (2005a). Migratory and reproductive movements of male leatherback turtles (*Dermochelys coriacea)*. *Marine Biology, 147*, 845–853.

James, M. C., R. A. Myers, and C. A. Ottensmeyer. (2005b). Behaviour of leatherback sea turtles, *Dermochelys coriacea*, during the migratory cycle. *Proceedings of the Royal Society B: Biological Sciences, 272*, 1547–1555.

James, M. C., C. A. Ottensmeyer, and R. A. Myers. (2005c). Identification of high-use habitat and threats to leatherback sea turtles in northern waters: New directions for conservations. *Ecology Letters, 8*, 195–201.

James, M. C., S. A. Sherrill-Mix, K. Martin, and R. A. Myers. (2006). Canadian waters provide critical foraging habitat for leatherback sea turtles. *Biological Conservation, 133*(3), 347–357.

Jessop, T. S., A. D. Tucker, C. J. Limpus, and J. M. Whittier. (2003). Interactions between ecology, demography, capture stress, and profiles of corticosterone and glucose in a free-living population of Australian freshwater crocodiles. *General and Comparative Endocrinology, 132*(1), 161–170.

Johnson, M. L. (1989). Juvenile leatherback cared for in captivity. *Marine Turtle Newsletter, 47*, 13–14.

Karlsson, S., and A. C. Albertsson. (1998). Biodegradable polymers and environmental interaction. *Polymer Engineering and Science, 38*(8), 1251–1253.

Keinath, J. A., J. A. Musick, and R. A. Byles. (1987). Aspects of the biology of Virginia's sea turtles: 1979–1986. *Virginia Journal of Science, 38*(2), 81.

Kelley, C., G. Carton, M. Tomlinson, and A. Gleason. (2016). Analysis of towed camera images to determine the effects of disposed mustard-filled bombs on the deep water benthic community off south Oahu. *Deep Sea Research Part II: Topical Studies in Oceanography, 128*, 34–42.

Ketten, D. R., and S. Moein-Bartol. (2006). *Functional Measures of Sea Turtle Hearing*. Woods Hole, MA: Woods Hole Oceanographic Institution.

Klima, E. F., G. R. Gitschlag, and M. L. Renaud. (1988). Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. *Marine Fisheries Review, 50*(3), 33–42.

Koide, S., J. A. K. Silva, V. Dupra, and M. Edwards. (2016). Bioaccumulation of chemical warfare agents, energetic materials, and metals in deep-sea shrimp from discarded military munitions sites off Pearl Harbor. *Deep Sea Research Part II: Topical Studies in Oceanography, 128*, 53–62.

Laloë, J.-O., N. Esteban, J. Berkel, and G. C. Hays. (2016). Sand temperatures for nesting sea turtles in the Caribbean: Implications for hatchling sex ratios in the face of climate change. *Journal of Experimental Marine Biology and Ecology, 474*, 92–99.

Lam, T., Lingxu, S. Takahashi, and E. A. Burgess. (2011). *Market Forces: An Examination of Marine Turtle Trade in China and Japan*. Hong Kong, China: TRAFFIC East Asia.

Lamont, M. M., I. Fujisaki, B. S. Stephens, and C. Hackett. (2015). Home range and habitat use of juvenile green turtles (*Chelonia mydas*) in the northern Gulf of Mexico. *Animal Biotelemetry, 3*(1), 53.

Lance, V. A., R. M. Elsey, G. Butterstein, and P. L. Trosclair III. (2004). Rapid suppression of testosterone secretion after capture in male American alligators (*Alligator mississippiensis*). *General and Comparative Endocrinology, 135*(2), 217–222.

Langhamer, O., H. Holand, and G. Rosenqvist. (2016). Effects of an Offshore Wind Farm on the Common Shore Crab *Carcinus maenas*: Tagging Pilot Experiments in the Lillgrund Offshore Wind Farm (Sweden). *PLoS ONE, 11*(10), 17.

Lavender, A. L., S. M. Bartol, and I. K. Bartol. (2014). Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach. *The Journal of Experimental Biology, 217*(Pt 14), 2580–2589.

Law, K. L., S. E. Moret-Ferguson, D. S. Goodwin, E. R. Zettler, E. Deforce, T. Kukulka, and G. Proskurowski. (2014). Distribution of surface plastic debris in the eastern Pacific Ocean from an 11-year data set. *Environmental Science & Technology, 48*(9), 4732–4738.

Lazell, J. D., Jr. (1980). New England waters: Critical habitat for marine turtles. *Copeia, 1980*(2), 290–295.

Lenhardt, M. L., S. Bellmund, R. A. Byles, S. W. Harkins, and J. A. Musick. (1983). Marine turtle reception of bone-conducted sound. *The Journal of Auditory Research, 23*, 119–125.

Lenhardt, M. L., R. C. Klinger, and J. A. Musick. (1985). Marine turtle middle-ear anatomy. *The Journal of Auditory Research, 25*, 66–72.

Lenhardt, M. L. (1994). *Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta).* Paper presented at the Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. Hilton Head, SC.

Leon, Y. M., and K. A. Bjorndal. (2002). Selective feeding in the hawksbill turtle, an important predator in coral reef ecosystems. *Marine Ecology Progress Series, 245*, 249–258.

Lester, L. A., E. A. Standora, W. F. Bien, and H. W. Avery. (2012). Behavioral Responses of Diamondback Terrapins (*Malaclemys terrapin terrapin*) to Recreational Boat Sounds. In A. N. Popper & A. Hawkins (Eds.), *The Effects of Noise on Aquatic Life*. New York, NY: Springer Science + Business Media.

Lester, L. A. (2013). *Direct and Indirect Effects of Recreational Boats on Diamondback Terrapins (Malaclemys terrapin).* (Unpublished doctoral dissertation). Drexel University, Philadelphia, PA. Retrieved from http://hdl.handle.net/1860/3982.

Lewis, J. D., J. W. Cain, III, and R. Denkhaus. (2014). Home range and habitat selection of an inland alligator (*Alligator mississippiensis*) population at the northwestern edge of the distribution range. *Southeastern Naturalist, 13*(2), 261–279.

Lewison, R. L., L. B. Crowder, B. P. Wallace, J. E. Moore, T. Cox, R. Zydelis, S. McDonald, A. DiMatteo, D. C. Dunn, C. Y. Kot, R. Bjorkland, S. Kelez, C. Soykan, K. R. Stewart, M. Sims, A. Boustany, A. J. Read, P. Halpin, W. J. Nichols, and C. Safina. (2014). Global patterns of marine mammal, seabird, and sea turtle bycatch reveal taxa-specific and cumulative megafauna hotspots. *PNAS, 111*(14), 5271–5276.

Liboff, A. R. (2015). Is the geomagnetic map imprinted in pre-emergent egg? *Electromagnetic Biology and Medicine, 35*(2), 167–169.

Lohmann, K. J., and C. M. F. Lohmann. (1996). Orientation and open-sea navigation in sea turtles. *The Journal of Experimental Biology, 199*, 73–81.

Lohmann, K. J., B. E. Witherington, C. M. F. Lohmann, and M. Salmon. (1997). Orientation, navigation, and natal beach homing in sea turtles. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 107–136). Boca Raton, FL: CRC Press.

Lutcavage, M., and J. A. Musick. (1985). Aspects of the biology of sea turtles in Virginia. *Copeia, 1985*(2), 449–456.

Lutcavage, M. E., P. G. Bushnell, and D. R. Jones. (1992). Oxygen stores and aerobic metabolism in the leatherback sea turtle. *Canadian Journal of Zoology, 70*(2), 348–351.

Lutcavage, M. E., and P. L. Lutz. (1997). Diving Physiology. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 277–296). Boca Raton, FL: CRC Press.

Lutcavage, M. E., P. Plotkin, B. Witherington, and P. L. Lutz. (1997). Human impacts on sea turtle survival. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 387–409). New York, NY: CRC Press.

Maison, K. A., I. K. Kelly, and K. P. Frutchey. (2010). *Green Turtle Nesting Sites and Sea Turtle Legislation throughout Oceania* (National Oceanic and Atmospheric Administration Technical Memorandum NMFS-F/SPO-110). Silver Spring, MD: Scientific Publications Office.

Mansfield, K. L. (2006). *Sources of mortality, movements and behavior of sea turtles in Virginia.* (PhD dissertation). College of William and Mary, Williamsburg, VA.

Marquez, M. R. (1994). *Synopsis of biological data on the Kemp's ridley turtle, Lepidochelys kempii (Garman, 1880)*. Silver Springs, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Márquez, M. R. (1990). *FAO Species Catalogue: Sea Turtles of the World; An Annotated and Illustrated Catalogue of Sea Turtle Species Known to Date*. Rome, Italy: United Nations Environment Programme, Food and Agriculture Organization of the United Nations.

Martin, K. J., S. C. Alessi, J. C. Gaspard, A. D. Tucker, G. B. Bauer, and D. A. Mann. (2012). Underwater hearing in the loggerhead turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms. *The Journal of Experimental Biology, 215*(17), 3001–3009.

Mather, J. (2004). Cephalopod Skin Displays: From Concealment to Communication. In D. Kimbrough Oller and Ulrike Griebel (Ed.), *The Evolution of Communication Systems: A Comparative Approach*. Cambridge, MA: The Vienna Series in Theoretical Biology and the Massachusetts Institute of Technology.

Mathis, A., and F. R. Moore. (1988). Geomagnetism and the homeward orientation of the box turtle, *Terrapene carolina*. *Ethology, 78*(4), 265–274.

Mazzotti, F. J. (1983). *The Ecology of Crocodylus acutus in Florida: A Thesis in Ecology.* (Unpublished doctoral dissertation). Pennsylvania State University, University Park, PA.

Mazzotti, F. J., and W. A. Dunson. (1989). Osmoregulation in crocodilians. *American Zoologist, 29*, 903–920.

Mazzotti, F. J., L. A. Brandt, P. Moler, and M. S. Cherkiss. (2007). American crocodile (*Crocodylus acutus*) in Florida: Recommendations for endangered species recovery and ecosystem restoration. *Journal of Herpetology, 41*(1), 122–132.

Mazzotti, F. J. (2014). *American Crocodile Surveys on the Naval Air Station Key West*. Fort Lauderdale, FL: Department of Wildlife Ecology and Conservation Fort Lauderdale Research and Education Center University of Florida.

Mazzotti, F. J., M. S. Cherkiss, M. Parry, J. Beauchamp, M. Rochford, B. Smith, K. Hart, and L. A. Brandt. (2016). Large reptiles and cold temperatures: Do extreme cold spells set distributional limits for tropical reptiles in Florida? *Ecosphere, 7*(8), 1–9 e01439.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. (2000). Marine seismic surveys: A study of environmental implications. *Australian Petroleum Production Exploration Association Journal, 2000*, 692–708.

McCauley, S., and K. Bjorndal. (1999). Conservation implications of dietary dilution from debris ingestion: Sublethal effects in post-hatchling loggerhead sea turtles. *Conservation Biology, 13*(4), 925–929.

Meylan, A. (1988). Spongivory in hawksbill turtles: A diet of glass. *Science, 239*(4838), 393–395.

Meylan, A. (1995). Sea turtle migration—Evidence from tag returns. In K. A. Bjorndal (Ed.), *Biology and Conservation of Sea Turtles* (Revised ed., pp. 91–100). Washington, DC: Smithsonian Institution Press.

Meylan, A. B., B. E. Witherington, B. Brost, R. Rivero, and P. S. Kubilis. (2006). Sea turtle nesting in Florida, USA: Assessments of abundance and trends for regionally significant populations of *Caretta, Chelonia*, and *Dermochelys*. In M. Frick, A. Panagopoulou, A. F. Rees, & K. Williams (Eds.), *Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation: Book of Abstracts* (pp. 306–307). Athens, Greece: National Marine Fisheries Service Southeast Fisheries Science Center, International Sea Turtle Society.

Michel, J. M., R. Greer, M. Hoffman, P. McGowan, and R. Wood. (2001). *Acute Mortality of Diamondback Terrapins from the Chalk Point Oil Spill*. Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Damage Assessment, Remediation, and Restoration Program.

Mintz, J. D., and R. J. Filadelfo. (2011). *Exposure of Marine Mammals to Broadband Radiated Noise* (Specific Authority N0001-4-05-D-0500). Washington, DC: Center for Naval Analyses.

Mintz, J. D. (2012). *Vessel Traffic in the Hawaii-Southern California and Atlantic Fleet Testing and Training Study Areas*. (CRM D0026186.A2/Final). Alexandria, VA: Center for Naval Analyses.

Mitchelmore, C. L., C. A. Bishop, and T. K. Collier. (2017). Toxicological estimation of mortality of oceanic sea turtles oiled during the Deepwater Horizon oil spill. *Endangered Species Research, 33*, 39–50.

Moein Bartol, S. E., J. A. Musick, J. A. Keinath, D. E. Barnard, M. L. Lenhardt, and R. George. (1995). Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges. In L. Z. Hales (Ed.), *Sea Turtle Research Program: Summary Report* (Vol. Technical Report CERC-95, pp. 90–93). Kings Bay, GA: U.S. Army Engineer Division, South Atlantic, Atlanta, GA and U.S. Naval Submarine Base.

Morreale, S. J., and E. A. Standora. (1998). *Early life stage ecology of sea turtles in northeastern U.S. waters*. Silver Springs, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Mortimer, J. A. (1995). Feeding ecology of sea turtles. In K. A. Bjorndal (Ed.), *Biology and Conservation of Sea Turtles* (Revised ed., pp. 103–109). Washington, DC: Smithsonian Institution Press.

Mortimer, J. A., and M. Donnelly. (2008). *Hawksbill Turtle (Eretmochelys imbricate): Marine Turtle Specialist Group 2008 International Union for Conservation of Nature Red List Status Assessment*. Retrieved from http://www.iucnredlist.org/details/8005/0.

Mrosovsky, N. (1972). Spectrographs of the sounds of leatherback turtles. *Herpetologica, 28*(3), 256–258.

Mrosovsky, N., G. D. Ryan, and M. C. James. (2009). Leatherback turtles: The menace of plastic. *Marine Pollution Bulletin, 58*(2), 287–289.

Murray, C. C., A. Bychkov, T. Therriault, H. Maki, and N. Wallace. (2015). The impact of Japanese tsunami debris on North America. *PICES Press, 23*(1), 28.

Murray, M. (2011, August 21). Previously believed loggerhead was actually a green turtle. *The News Journal*. Retrieved from http://www.delawareonline.com/.

Musick, J. A., and C. J. Limpus. (1997). Habitat utilization and migration of juvenile sea turtles. In P. L. Lutz & J. A. Musick (Eds.), *The Biology of Sea Turtles* (pp. 137–163). Boca Raton, FL: CRC Press.

Nagaoka, S., A. Martins, R. dos Santos, M. Tognella, E. de Oliveira Filho, and J. Seminoff. (2012). Diet of juvenile green turtles (*Chelonia mydas*) associating with artisanal fishing traps in a subtropical estuary in Brazil. *Marine Biology, 159*(3), 573–581.

Nance, J. M., C. W. Caillouet, Jr., and R. A. Hart. (2012). Size-composition of annual landings in the white shrimp, *Litopenaeus setiferus*, fishery of the northern Gulf of Mexico, 1960–2006: Its trends and relationships with other fishery-dependent variables. *Marine Fisheries Review, 72*(2), 1–13.

Narazaki, T., K. Sato, K. J. Abernathy, G. J. Marshall, and N. Miyazaki. (2013). Loggerhead turtles (*Caretta caretta*) use vision to forage on gelatinous prey in mid-water. *PLoS ONE, 8*(6), e66043.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (1991). *Recovery Plan for U.S. Populations of Atlantic Green Turtle (Chelonia mydas)*. Washington, DC: National Marine Fisheries Service.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (1993). *Recovery Plan for the Hawksbill Turtle (Eretmochelys imbricata) in the U.S. Caribbean, Atlantic and Gulf of Mexico* St. Petersburg, FL: National Marine Fisheries Service.

National Marine Fisheries Service, and U. S. Fish and Wildlife Service. (2007). *Hawksbill Sea Turtle (Eretmochelys imbricata) 5-year Review: Summary and Evaluation*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (2007). *Loggerhead Sea Turtle (Caretta caretta) 5-year review: Summary and Evaluation*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (2008). *Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta), Second Revision*. Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service. (2010). Endangered and Threatened Species; Proposed Listing of Nine Distinct Population Segments of Loggerhead Sea Turtles as Endangered or Threatened. *Federal Register, 75*(50), 12598–12656.

National Marine Fisheries Service. (2011). *Sea Turtles and the Gulf of Mexico Oil Spill*. Retrieved from http://www.nmfs.noaa.gov/pr/health/oilspill/turtles.htm.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (2011). *Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii)*. Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

National Marine Fisheries Service. (2013a). *2013 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean*. Woods Hole, MA and Miami, FL: Northeast Fisheries Science Center and Southeast Fisheries Science Center.

National Marine Fisheries Service. (2013b). *Biological Opinion and Conference Opinion on Atlantic Fleet Training and Testing Activities (2013–2018)*. Silver Spring, MD: Office of Protected Resources.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (2013a). *Hawksbill Sea Turtle (Eretmochelys imbricata) 5-Year Review: Summary and Evaluation*. Silver Spring, MD: Office of Protected Resources.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (2013b). *Leatherback Turtle (Dermochelys coriacea) 5-Year Review: Summary and Evaluation*. Silver Spring, MD: National

Marine Fisheries Service Office of Protected Resources and U.S. Fish and Wildlife Service Southeast Region.

National Marine Fisheries Service. (2014a). *Deepwater Horizon Oil Spill 2010: Sea Turtles, Dolphins, and Whales*. Retrieved from https://www.fisheries.noaa.gov/national/marine-life-distress/deepwater-horizon-oil-spill-2010-sea-turtles-dolphins-and-whales.

National Marine Fisheries Service. (2014b). 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. *Federal Register, 79*(132), 39856–39912.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. (2015). *Kemp's Ridley Sea Turtle (Lepidochelys kempii) 5-Year Review: Summary and Evaluation*. Silver Spring, MD: National Marine Fisheries Service Office of Protected Resources and U.S. Fish and Wildlife Service Southwest Region.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. (1992). *Recovery Plan for Leatherback Turtles (Dermochelys coriacea) in the U.S. Caribbean, Atlantic and Gulf of Mexico*. Silver Spring, MD: National Marine Fisheries Service.

National Ocean Service. (2016). *Where Are Reef Building Corals Found*. Retrieved from http://oceanservice.noaa.gov/education/tutorial_corals/coral05_distribution.html.

National Oceanic and Atmospheric Administration. (2015). *2015 Annual Report to a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. Waters of the Western North Atlantic Ocean–AMAPPS II*. Woods Hole, MA and Miami, FL: Northeast Fisheries Science Center and Southeast Fisheries Science Center.

National Park Service. (2012). *Everglades National Park, American Alligator: Species Profile*. Retrieved from http://www.nps.gov/ever/naturescience/alligator.htm.

Nifong, J. C., and B. Silliman. (2017). Abiotic factors influence the dynamics of marine habitat use by a highly mobile "freshwater" top predator. *Hydrobiologia, 802*(1), 155–174.

O'Hara, J., and J. R. Wilcox. (1990). Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. *Copeia, 1990*(2), 564–567.

O'Keeffe, D. J., and G. A. Young. (1984). *Handbook on the Environmental Effects of Underwater Explosions*. Silver Spring, MD: U.S. Navy, Naval Surface Weapons Center (Code R14).

Office of the Surgeon General. (1991). Conventional Warfare Ballistic, Blast, and Burn Injuries. In R. Zajitchuk, Col. (Ed.), *U.S.A. Textbook of Military Medicine*. Washington, DC: Office of the Surgeon General.

Oros, J., A. Torrent, P. Calabuig, and S. Deniz. (2005). Diseases and causes of mortality among sea turtles stranded in the Canary Islands, Spain (1998–2001). *Diseases of Aquatic Organisms, 63*, 13–24.

Ortmann, A. C., J. Anders, N. Shelton, L. Gong, A. G. Moss, and R. H. Condon. (2012). Dispersed oil disrupts microbial pathways in pelagic food webs. *PLoS ONE, 7*(7), e42548.

Outerbridge, M. E., R. M. O'Riordan, T. Quirke, and J. Davenport. (2017). Restricted diet in a vulnerable native turtle, *Malaclemys terrapin* (Schoepff), on the oceanic islands of Bermuda. *Amphibian & Reptile Conservation, 11*(1), 25–35.

Pajuelo, M., K. A. Bjorndal, M. D. Arendt, A. M. Foley, B. A. Schroeder, B. E. Witherington, and A. B. Bolten. (2016). Long-term resource use and foraging specialization in male loggerhead turtles. *Marine Biology, 163*(11), 235.

Parker, L. G. (1995). Encounter with a juvenile hawksbill turtle offshore Sapelo Island, Georgia. *Marine Turtle Newsletter, 71*, 19–22.

Patino-Martinez, J., A. Marco, L. Quinones, and B. Godley. (2008). Globally significant nesting of the leatherback turtle (*Dermochelys coriacea*) on the Caribbean coast of Colombia and Panama. *Biological Conservation, 141*(8), 1982–1988.

Patrício, A. R., C. E. Diez, R. P. Van Dam, and B. J. Godley. (2016). Novel insights into the dynamics of green turtle fibropapillomatosis. *Marine Ecology Progress Series, 547*, 247–255.

Patrício, R., C. E. Diez, and R. P. Van Dam. (2014). Spatial and temporal variability of immature green turtle abundance and somatic growth in Puerto Rico. *Endangered Species Research, 23*(1), 51–62.

Peña, J. (2006). *Plotting Kemp's Ridleys, plotting the future of sea turtle conservation* (SWoT Report). Washington, DC: The State of the World's Sea Turtles.

Pepper, C. B., M. A. Nascarella, and R. J. Kendall. (2003). A review of the effects of aircraft noise on wildlife and humans, current control mechanisms, and the need for further study. *Environmental Management, 32*(4), 418–432.

Pfau, B., and W. M. Roosenburg. (2010). Diamondback terrapins in Maryland: Research and conservation. *Radiata, 19*, 2–34.

Pike, D. A. (2014). Forecasting the viability of sea turtle eggs in a warming world. *Global Change Biology, 20*(1), 7–15.

Pike, D. A., E. A. Roznik, and I. Bell. (2015). Nest inundation from sea-level rise threatens sea turtle population viability. *Royal Society Open Science, 2*(7), 150127.

Piniak, W. E. D., D. A. Mann, C. A. Harms, T. T. Jones, and S. A. Eckert. (2016). Hearing in the juvenile green sea turtle (*Chelonia mydas*): A comparison of underwater and aerial hearing using auditory evoked potentials. *PLoS ONE, 11*(10), e0159711.

Plotkin, P., and A. F. Amos. (1998). *Entanglement and Ingestion of Marine Turtles Stranded Along the South Texas Coast.* Paper presented at the Eighth Annual Workshop on Sea Turtle Conservation and Biology, Fort Fisher, NC.

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. M. Bartol, T. J. Carlson, S. Coombs, W. T. Ellison, R. L. Gentry, M. B. Halvorsen, S. Løkkeborg, P. H. Rogers, B. L. Southall, D. G. Zeddies, and W. N. Tavolga. (2014). *ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. New York, NY and London, United Kingdom: Acoustical Society of America Press and Springer Briefs in Oceanography.

Pritchard, P. C. H., and R. c. Marquez. (1973). *Kemp's ridley turtle or Atlantic ridley (Lepidochelys kempii)* (IUCN Monograph No. 2: Marine Turtle Series). Morges, Switzerland: International Union for Conservation of Nature and Natural Resources.

Putman, N. F., F. A. Abreu-Grobois, I. Iturbe-Darkistade, E. M. Putman, P. M. Richards, and P. Verley. (2015a). Deepwater Horizon oil spill impacts on sea turtles could span the Atlantic. *Biology letters, 11*(12).

Putman, N. F., and K. L. Mansfield. (2015). Direct Evidence of Swimming Demonstrates Active Dispersal in the Sea Turtle "Lost Years". *Current Biology, 25*(9), 1221–1227.

Putman, N. F., P. Verley, C. S. Endres, and K. J. Lohmann. (2015b). Magnetic navigation behavior and the oceanic ecology of young loggerhead sea turtles. *Journal of Experimental Biology, 218*(7), 1044–1050.

Rabon, D. R., Jr., S. A. Johnson, R. Boettcher, M. Dodd, M. Lyons, S. Murphy, S. Ramsey, S. Roff, and K. Stewart. (2003). Confirmed leatherback turtle (*Dermochelys coriacea*) nests from North Carolina, with a summary of leatherback nesting activities north of Florida. *Marine Turtle Newsletter, 101*, 4–8.

Raytheon Company. (2015). *Airborne Mine Neutralization System (AMNS): Alternative Optical Fiber Engineering Study Final Report*. Portsmouth, RI: Integrated Defense Systems.

Reece, J. S., D. Passeri, L. Ehrhart, S. C. Hagen, A. Hays, C. Long, R. F. Noss, M. Bilskie, C. Sanchez, and M. V. Schwoerer. (2013). Sea level rise, land use, and climate change influence the distribution of loggerhead turtle nests at the largest U.S.A. rookery (Melbourne Beach, Florida). *Marine Ecology Progress Series, 493*, 259–274.

Renaud, M. L., and J. A. Carpenter. (1994). Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. *Bulletin of Marine Science, 55*(1), 1–15.

Renaud, M. L., J. A. Carpenter, J. A. Williams, and S. A. Manzellatirpak. (1995). Activities of juvenile green turtles, *Chelonia mydas*, at a jettied pass in south Texas. *Fishery Bulletin, 93*(3), 586–593.

Renaud, M. L., J. A. Carpenter, J. A. Williams, and A. M. Landry, Jr. (1996). Kemp's ridley sea turtle (*Lepidochelys kempii*) tracked by satellite telemetry from Louisiana to nesting beach at Rancho Nuevo, Tamaulipas, Mexico. *Chelonian Conservation and Biology, 2*(1), 108–109.

Reneker, J. L., and S. J. Kamel. (2016). Climate change increases the production of female hatchlings at a northern sea turtle rookery. *Ecology, 97*(12), 3257–3264.

Rester, J., and R. Condrey. (1996). The occurrence of the hawksbill turtle, *Eretmochelys imbricata*, along the Louisiana coast. *Gulf of Mexico Science, 14*(2), 112–114.

Ribic, C. A., S. B. Sheavly, D. J. Rugg, and E. S. Erdmann. (2010). Trends and drivers of marine debris on the Atlantic coast of the United States 1997–2007. *Marine Pollution Bulletin 60*(8), 1231–1242.

Rice, M. R., and G. H. Balazs. (2008). Diving behavior of the Hawaiian green turtle (*Chelonia mydas*) during oceanic migrations. *Journal of Experimental Marine Biology and Ecology, 356*(1–2), 121–127.

Richardson, and McGillvary. (1991). *Proceedings of the Twenty-fourth Annual Symposium on Sea Turtle Biology and Conservation* (NOAA Technical Memorandum). Miami, FL: National Marine Fisheries Service.

Richardson, J. I., and P. McGillivary. (1991). Post-hatchling loggerhead turtles eat insects in *Sargassum* community. *Marine Turtle Newsletter, 55*, 2–5.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. (1995). *Marine Mammals and Noise*. San Diego, CA: Academic Press.

Richmond, D. R., J. T. Yelverton, and E. R. Fletcher. (1973). *Far-Field Underwater-Blast Injuries Produced by Small Charges*. Washington, DC: Lovelace Foundation for Medical Education and Research, Defense Nuclear Agency.

Ridgway, S. H., E. G. Wever, J. G. McCormick, J. Palin, and J. H. Anderson. (1969). Hearing in the giant sea turtle, *Chelonia mydas*. *Proceedings of the National Academy of Sciences U.S.A., 64*(3), 884–890.

Roberts, M. A., C. J. Anderson, B. Stender, A. Segars, J. D. Whittaker, J. M. Grady, and J. M. Quattro. (2005). Estimated contribution of Atlantic coastal loggerhead turtle nesting populations to offshore feeding aggregations. *Conservation Genetics, 6*, 133–139.

Robinson, N. J., S. E. Valentine, P. Santidrián Tomillo, V. S. Saba, J. R. Spotila, and F. V. Paladino. (2013). Multidecadal trends in the nesting phenology of Pacific and Atlantic leatherback turtles are associated with population demography. *Endangered Species Research, 24*, 197–206.

Rochford, M. R., K. L. Krysko, F. J. Mazzotti, M. H. Shirley, M. W. Parry, J. A. Wasilewski, J. S. Beauchamp, C. R. Gillette, E. F. Metzger, III, and M. A. Squires. (2016). Molecular analyses confirming the introduction of Nile crocodiles, *Crocodylus niloticus* Laurenti 1768 (Crocodylidae), in southern Florida, with an assessment of potential for establishment, spread, and impacts. *Herpetological Conservation and Biology, 11*(1), 80–89.

Roosenburg, W. M., W. Cresko, M. Modesitte, and M. B. Robbins. (1997). Diamondback terrapin (*Malaclemys terrapin*) mortality in crab pots. *Conservation Biology, 11*(5), 1166–1172.

Rosen, G., and G. R. Lotufo. (2010). Fate and effects of composition B in multispecies marine exposures. *Environmental Toxicology and Chemistry, 9999*(12), 1–8.

Rosenblatt, A. E., J. C. Nifong, M. R. Heithaus, F. J. Mazzotti, M. S. Cherkiss, B. M. Jeffery, R. M. Elsey, R. A. Decker, B. R. Silliman, and L. J. Guillette. (2015). Factors affecting individual foraging specialization and temporal diet stability across the range of a large "generalist" apex predator. *Oecologia, 178*(1), 5–16.

Rosman, I., G. S. Boland, L. Martin, and C. Chandler. (1987). *Underwater Sightings of Sea Turtles in the Northern Gulf of Mexico*. (OCS Study MMS 87-0107). Bryan, TX: U.S. Department of the Interior, Minerals Management Service.

Russell, D. J., and G. H. Balazs. (2015). Increased use of non-native algae species in the diet of the green turtle (*Chelonia mydas*) in a primary pasture ecosystem in Hawaii. *Aquatic Ecosystem Health & Management, 18*(3), 342–346.

Sakamoto, W., K. Sato, H. Tanaka, and Y. Naito. (1993). Diving patterns and swimming environment of two loggerhead turtles during internesting. *Nippon Suisan Gakkaishi, 59*(7), 1129–1137.

Salmon, M., T. T. Jones, and K. W. Horch. (2004). Ontogeny of diving and feeding behavior in juvenile seaturtles: Leatherback seaturtles (*Dermochelys coriacea* L) and green seaturtles (*Chelonia mydas* L) in the Florida current. *Journal of Herpetology, 38*(1), 36–43.

Salmon, M., M. Reising, and S. Stapleton. (2016). The Evolution of Hatchling Morphology. *Marine Turtle Newsletter*(149), 9.

Sampson, L., and A. Giraldo. (2014). Annual abundance of salps and doliolids (*Tunicata*) around Gorgona Island (Colombian Pacific), and their importance as potential food for green sea turtles. *Revista de Biología Tropical, 62*, 149–159.

Sasso, C. R., and W. N. Witzell. (2006). Diving behaviour of an immature Kemp's ridley turtle (*Lepidochelys kempii*) from Gullivan Bay, Ten Thousand Islands, southwest Florida. *Journal of the Marine Biological Association of the United Kingdom, 86*, 919–925.

Saunders, J. C., R. K. Duncan, D. E. Doan, and Y. L. Werner. (2000). The Middle Ear of Reptiles and Birds. In Dooling R.J., Fay R.R., & Popper A.N. (Eds.), *Comparative Hearing: Birds and Reptiles* (Vol. 13, pp. 13–69). New York, NY: Springer.

Savannah River Ecology Laboratory, and Herpetology Program. (2012). *Species Profile: American Alligator (Alligator mississippiensis)*. Retrieved from http://srelherp.uga.edu/alligators/allmis.htm.

Schofield, G., V. J. Hobson, M. K. S. Lilley, K. A. Katselidis, C. M. Bishop, P. Brown, and G. C. Hays. (2010). Inter-annual variability in the home range of breeding turtles: Implications for current and future conservation management. *Biological Conservation, 143*(3), 722–730.

Schroeder, B. A., and N. B. Thompson. (1987). *Distribution of the Loggerhead Turtle, Caretta caretta, and the Leatherback Turtle, Dermochelys coriacea, in the Cape Canaveral, Florida Area: Results of Aerial Surveys*. (National Oceanic and Atmospheric Administration Technical Report National Marine Fisheries Service 53). Miami, FL: U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Schroeder, B. A., A. M. Foley, and D. A. Bagley. (2003). Nesting patterns, reproductive migrations, and adult foraging areas of loggerhead turtles. In A. B. Bolten & B. E. Witherington (Eds.), *Loggerhead Sea Turtles* (pp. 114–124). Washington, DC: Smithsonian Institution Press.

Schuyler, Q., B. D. Hardesty, C. Wilcox, and K. Townsend. (2014). Global analysis of anthropogenic debris ingestion by sea turtles. *Conservation Biology, 28*(1), 129–139.

Schuyler, Q. A., C. Wilcox, K. A. Townsend, K. R. Wedemeyer-Strombel, G. Balazs, E. Sebille, and B. D. Hardesty. (2016). Risk analysis reveals global hotspots for marine debris ingestion by sea turtles. *Global Change Biology, 22*(2), 567–576.

Schwartz, F. J. (1989). *Zoogeography and Ecology of Fishes Inhabiting North Carolina's Marine Waters to Depths of 600 Meters*. Silver Spring, MD: National Oceanic and Atmospheric Administration.

Seminoff, J. A., A. Resendiz, and W. J. Nichols. (2002). Home range of green turtles, *Chelonia mydas,* at a coastal foraging area in the Gulf of California, Mexico. *Marine Ecology Progress Series, 242*, 253–265.

Seminoff, J. A., and Marine Turtle Specialist Group Green Turtle Task Force. (2004). *Marine Turtle Specialist Group Review: 2004 Global Status Assessment, Green turtle (Chelonia mydas)*. Gland, Switzerland: The World Conservation Union (IUCN) Species Survival Commission, Red List Programme.

Seminoff, J. A., C. D. Allen, G. H. Balazs, P. H. Dutton, T. Eguchi, H. L. Haas, S. A. Hargrove, M. P. Jensen, D. L. Klemm, A. M. Lauritsen, S. L. MacPherson, P. Opay, E. E. Possardt, S. L. Pultz, E. E. Seney, K. S. Van Houtan, and R. S. Waples. (2015). *Status Review of the Green Turtle (Chelonia mydas) Under the U.S. Endangered Species Act*. (NOAA Technical Memorandum NMFS-SWFSC-592). La Jolla, CA: Southwest Fisheries Science Center.

Seney, E. E. (2016). Diet of Kemp's ridley sea turtles incidentally caught on recreational fishing gear in the northwestern Gulf of Mexico. *Chelonian Conservation and Biology, 15*(1), 132–137.

Servis, J. A., G. Lovewell, and A. D. Tucker. (2015). Diet analysis of subadult Kemp's ridley (*Lepidochelys kempii*) turtles from west-central Florida. *Chelonian Conservation and Biology, 14*(2), 173–181.

Shaver, D. (2018). [Personnal communication from Donna Shaver to Taylor Houston containing PAIS sea turtle nesting data].

Shaver, D. J., and C. W. Caillouet, Jr. (1998). More Kemp's Ridley turtles return to South Texas to nest. *Marine Turtle Newsletter, 82*, 1–5.

Shaver, D. J., K. M. Hart, I. Fujisaki, C. Rubio, A. R. Sartain-Iverson, J. Peña, D. G. Gamez, R. J. G. D. Miron, P. M. Burchfield, and H. J. Martinez. (2016). Migratory corridors of adult female Kemp's ridley turtles in the Gulf of Mexico. *Biological Conservation, 194*, 158–167.

Sheridan, C. M., J. R. Spotila, W. F. Bien, and H. W. Avery. (2010). Sex-biased dispersal and natal philopatry in the diamondback terrapin, *Malaclemys terrapin*. *Molecular Ecology, 19*(24), 5497–5510.

Shine, R., X. Bonnet, M. J. Elphick, and E. G. Barrott. (2004). A novel foraging mode in snakes: Browsing by the sea snake *Emydocephalus annulatus* (Serpentes, Hydrophiidae). *Functional Ecology, 18*(1), 16–24.

Shoop, C. R., and R. D. Kenney. (1992). Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. *Herpetological Monographs, 6*, 43–67.

Shute, C. C. D., and A. d. A. Bellairs. (1955). The external ear in Crocodilia. *Journal of Zoology, 124*(4), 741–749.

Smith, A., T. Stehly, and W. Musial. (2015). *2014 U.S. Offshore Wind Market Report: Industry Trends, Technology Advancement, and Cost Reduction*. Baltimore, MD: National Renewable Energy Laboratory.

Smith, C. E., S. T. Sykora–Bodie, B. Bloodworth, S. M. Pack, T. R. Spradlin, and N. R. LeBoeuf. (2016). Assessment of known impacts of unmanned aerial systems (UAS) on marine mammals: Data gaps and recommendations for researchers in the United States. *Journal of Unmanned Vehicle Systems, 4*(1), 31–44.

Smith, S. H., and D. E. Marx, Jr. (2016). De-facto marine protection from a Navy bombing range: Farallon de Medinilla, Mariana Archipelago, 1997 to 2012. *Marine Pollution Bulletin, 102*(1), 187–198.

Snoddy, J. E., M. Landon, G. Blanvillain, and A. Southwood. (2009). Blood biochemistry of sea turtles captured in gillnets in the lower Cape Fear River, North Carolina, USA. *Journal of Wildlife Management, 73*(8), 1394–1401.

Southern California Marine Institute. (2016). *Southern California Offshore Banks, National Marine Sanctuary Proposal*. Los Angeles, CA: Marine Institute and the Vantuna Research Group and Moore Laboratory of Zoology, Occidental College.

Southwood, A. L., R. D. Andrews, M. E. Lutcavage, F. V. Paladino, N. H. West, R. H. George, and D. R. Jones. (1999). Heart rates and diving behavior of leatherback sea turtles in the eastern Pacific Ocean. *The Journal of Experimental Biology, 202*, 1115–1125.

Spargo, B. J. (2007). [Personal Communication with Mark Collins Regarding Chaff End Cap and Piston Bouyancy].

Spotila, J. R., A. E. Dunham, A. J. Leslie, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. (1996). Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct? *Chelonian Conservation and Biology, 2*(2), 209–222.

Stabenau, E. K., T. A. Heming, and J. F. Mitchell. (1991). Respiratory, acid-base and ionic status of Kemp's ridley sea turtles (*Lepidochelys kempii*) subjected to trawling. *Comparative Biochemistry and Physiology Part A: Physiology, 99*(1), 107–111.

Stewart, K., M. Sims, A. Meylan, B. Witherington, B. Brost, and L. B. Crowder. (2011). Leatherback nests increasing significantly in Florida, USA; Trends assessed over 30 years using multilevel modeling. *Ecological Applications, 21*(1), 263–273.

Stewart, K. R., K. J. Martin, C. Johnson, N. Desjardin, S. A. Eckert, and L. B. Crowder. (2014). Increased nesting, good survival and variable site fidelity for leatherback turtles in Florida, USA. *Biological Conservation, 176*, 117–125.

Stewart, K. R., E. L. LaCasella, S. E. Roden, M. P. Jensen, L. W. Stokes, S. P. Epperly, and P. H. Dutton. (2016). Nesting population origins of leatherback turtles caught as bycatch in the US pelagic longline fishery. *Ecosphere, 7*(3), 1–18.

Swingle, W. M., S. G. Barco, E. B. Bates, G. G. Lockhart, K. M. Phillips, K. R. Rodrique, S. A. Rose, and K. M. Williams. (2016). *Virginia Sea Turtle and Marine Mammal Stranding Network 2015 Grant Report*. Virginia Beach, VA: Virginia Aquarium Foundation.

Swisdak, M. M., Jr., and P. E. Montanaro. (1992). *Airblast and Fragmentation Hazards Produced by Underwater Explosions*. Silver Spring, MD: Naval Surface Warfare Center.

Swope, B., and J. McDonald. (2013). *Copper-Based Torpedo Guidance Wire: Applications and Environmental Considerations*. San Diego, CA: Space and Naval Warfare Systems Command Center Pacific.

Teuten, E. L., S. J. Rowland, T. S. Galloway, and R. C. Thompson. (2007). Potential for plastics to transport hydrophobic contaminants. *Environmental Science and Technology, 41*(22), 7759–7764.

Thorbjarnarson, J., F. Mazzotti, E. Sanderson, F. Buitrago, M. Lazcano, K. Minkowski, M. Muniz, P. Ponce, L. Sigler, R. Soberon, A. M. Trelancia, and A. Velasco. (2006). Regional habitat conservation priorities for the American crocodile. *Biological Conservation, 128*(1), 25–36.

Tucker, A. D., B. D. MacDonald, and J. A. Seminoff. (2014). Foraging site fidelity and stable isotope values of loggerhead turtles tracked in the Gulf of Mexico and Northwest Caribbean. *Marine Ecology Progress Series, 502*, 267–279.

Tulipani, D. C., and R. N. Lipcius. (2014). Evidence of eelgrass (*Zostera marina*) seed dispersal by northern diamondback terrapin (*Malaclemys terrapin terrapin*) in lower Chesapeake Bay. *PLoS ONE, 9*(7), e103346.

Turtle Expert Working Group. (2007). *An assessment of the leatherback turtle population in the Atlantic Ocean*. Miami, FL: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service and Southeast Fisheries Science Center.

U.S. Air Force. (1997). *Environmental Effects of Self-Protection Chaff and Flares - Final Report*. Langley Air Force Base, VA: U.S. Air Force, Headquarters Air Combat Command.

U.S. Department of the Navy. (1996). *Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK-46 and MK-50 Torpedoes*. Pearl Harbor, HI: United States Command Pacific Fleet.

U.S. Department of the Navy. (1999). *Environmental Effects of RF Chaff: A Select Panel Report to the Undersecretary of Defense for Environmental Security*. Washington, DC: U.S. Department of the Navy, Naval Research Laboratory.

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

U.S. Department of the Navy. (2013). *Water Range Sustainability Environmental Program Assessment: Potomac River Test Range*. Dahlgren, VA: Naval Surface Warfare Center.

U.S. Department of the Navy. (2017). *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. San Diego, CA: Space and Naval Warfare System Command, Pacific.

U.S. Department of the Navy. (2018). *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (Technical Report prepared by NUWC Division Newport, Space and Naval Warfare Systems Center Pacific, G2 Software Systems, and the National Marine Mammal Foundation). Newport, RI: Naval Undersea Warfare Center.

U.S. Fish and Wildlife Service. (2010). *Species Profile: American crocodile Crocodylus acutus*. Retrieved from https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=C02J.

United Nations Environmental Program. (2005). *Marine Litter: An analytical overview*. Nairobi, Kenya: United Nations Environment Programme's Regional Seas Programme.

University of Georgia. (2017). *Diamondback Terrapin (Malaclemys terrapin)*. Retrieved from https://srelherp.uga.edu/turtles/malter.htm.

Urick, R. J. (1983). *Principles of Underwater Sound* (3rd ed.). Los Altos, CA: Peninsula Publishing.

Valverde, R. A., D. W. Owens, D. S. MacKenzie, and M. S. Amoss. (1999). Basal and stress-induced corticosterone levels in olive ridley sea turtles (*Lepidochelys olivacea*) in relation to their mass nesting behavior. *Journal of Experimental Zoology, 284*(6), 652–662.

Van Houtan, K. S., D. L. Francke, S. Alessi, T. T. Jones, S. L. Martin, L. Kurpita, C. S. King, and R. W. Baird. (2016). The developmental biogeography of hawksbill sea turtles in the North Pacific. *Ecology and Evolution, 6*(8), 2378–2389.

Vergne, A. L., M. B. Pritz, and N. Mathevon. (2009). Acoustic communication in crocodilians: From behaviour to brain. *Biological Reviews, 84*, 391–411.

Verkaik, K., J. Hamel, and A. Mercier. (2016). Carry-over effects of ocean acidification in a cold-water lecithotrophic holothuroid. *Marine Ecology Progress Series, 557*, 189–206.

Viada, S. T., R. M. Hammer, R. Racca, D. Hannay, M. J. Thompson, B. J. Balcom, and N. W. Phillips. (2008). Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. *Environmental Impact Assessment Review, 28*, 267–285.

Vliet, K. A. (1989). Social displays of the American alligator. *American Zoology, 29*, 1019–1031.

Vliet, K. A. (2001). Courtship behaviour of American alligators, *Alligator mississippiensis*. In G. C. Grigg, F. Seebacher, & C. E. Franklin (Eds.), *Crocodilian Biology and Evolution* (pp. 383–408). Baulkham Hills, Australia: Surrey Beatty & Sons.

Votier, S. C., K. Archibald, G. Morgan, and L. Morgan. (2011). The use of plastic debris as nesting material by a colonial seabird and associated entanglement mortality. *Marine Pollution Bulletin, 62*(1), 168–172.

Wallace, B. P., A. D. DiMatteo, B. J. Hurley, E. M. Finkbeiner, A. B. Bolten, M. Y. Chaloupka, B. J. Hutchinson, F. A. Abreu-Grobois, D. Amorocho, K. A. Bjorndal, J. Bourjea, B. W. Bowen, R. B. Duenas, P. Casale, B. C. Choudhury, A. S. Costa, P. H. Dutton, A. Fallabrino, A. Girard, M. Girondot, M. H. Godfrey, M. Hamann, M. Lopez-Mendilaharsu, M. A. Marchovaldi, J. A. Mortimer, J. A. Musick, R. Nel, N. J. Pitcher, J. A. Seminoff, S. Troeng, B. Witherington, and R. B. Mast. (2010a). Regional Management Units for Marine Turtles: A Novel Framework for Prioritizing Conservation and Research across Multiple Scales. *PLoS ONE, 5*(12), e15465.

Wallace, B. P., R. L. Lewison, S. L. McDonald, R. K. McDonald, C. Y. Kot, S. Kelez, R. K. Bjorkland, E. M. Finkbeiner, S. Helmbrecht, and L. B. Crowder. (2010b). Global patterns of marine turtle bycatch. *Conservation Letters, 3*(3), 131–142.

Wallace, B. P., M. Zolkewitz, and M. C. James. (2015). Fine-scale foraging ecology of leatherback turtles. *Frontiers in Ecology and Evolution, 3*, 15.

Walters, T. M., F. J. Mazzotti, and H. C. Fitz. (2016). Habitat selection by the invasive species Burmese python in southern Florida. *Journal of Herpetology, 50*(1), 50–56.

Watson, T. K., K. Hoomanawanui, R. Thurman, B. Thao, and K. Boyne. (2017). *Na Ikena I Kai (Seaward Viewsheds): Inventory of Terrestrial Properties for Assessment of Marine Viewsheds on the Eight MAin HAwaiian Islands*. Camarillo, CA.

Watwood, S. L., J. D. Iafrate, E. A. Reyier, and W. E. Redfoot. (2016). Behavioral Response of Reef Fish and Green Sea Turtles to Mid-Frequency Sonar. In A. N. Popper & A. Hawkins (Eds.), *The Effects of Noise on Aquatic Life II* (pp. 1213–1221). New York, NY: Springer.

Weaver, J. P., D. Rodriguez, M. Venegas-Anaya, J. R. Cedeño-Vázquez, M. R. J. Forstner, and L. D. Densmore. (2008). Genetic characterization of captive Cuban crocodiles (*Crocodylus rhombifer*) and evidence of hybridization with the American crocodile (*Crocodylus acutus*). *Journal of Experimental Zoology Part A: Ecological Genetics and Physiology, 309*(10), 649–660.

Weber, M. (1995). *Kemp's Ridley Sea Turtle, Lepidochelys kempii*. Silver Spring, MD: National Marine Fisheries Service.

Weir, C. R. (2007). Observations of marine turtles in relation to seismic airgun sound off Angola. *Marine Turtle Newsletter, 116*, 17–20.

Weishampel, J. F., D. A. Bagley, and L. M. Ehrhart. (2006). Intra-annual loggerhead and green turtle spatial nesting patterns. *Southeastern Naturalist, 5*(3), 453–462.

Wever, E. G. (1971). Hearing in the Crocodilia. *Proceedings of the National Academy of Sciences U.S.A., 68*, 1498–1500.

Wheatley, P. V., H. Peckham, S. D. Newsome, and P. L. Koch. (2012). Estimating marine resource use by the American crocodile, *Crocodylus acutus*, in southern Florida, U.S.A. *Marine Ecology-Progress Series, 447*, 211–229.

Wiley, M. L., J. B. Gaspin, and J. F. Goertner. (1981). Effects of underwater explosions on fish with a dynamical model to predict fishkill. *Ocean Science and Engineering, 6*(2), 223–284.

Wilkin, S. M., T. K. Rowles, E. Stratton, N. Adimey, C. L. Field, S. Wissman, G. Shigenaka, E. Fougeres, B. Mase, Southeast Region Stranding Network, and M. H. Ziccardi. (2017). Marine mammal response operations during the *Deepwater Horizon* oil spill. *Endangered Species Research, 33*, 107–118.

Williams-Walls, N., J. O'Hara, R. M. Gallagher, D. F. Worth, B. D. Peery, and J. R. Wilcox. (1983). Spatial and temporal trends of sea turtle nesting on Hutchinson Island, Florida, 1971–1979. *Bulletin of Marine Science, 33*(1), 55–66.

Williams, K. A., I. J. Stenhouse, E. E. Connelly, and S. M. Johnson. (2015). *Mid-Atlantic Wildlife Studies: Distribution and Abundance of Wildlife along the Eastern Seaboard 2012–2014* (Science Communications Series BRI 2015-19). Portland, ME: Biodiversity Research Institute.

Willis, K. L., J. Christensen-Dalsgaard, D. R. Ketten, and C. E. Carr. (2013). Middle ear cavity morphology is consistent with an aquatic origin for testudines. *PLoS ONE, 8*(1), e54086.

Witherington, B., and S. Hirama. (2006). Sea turtles of the epi-pelagic *Sargassum* drift community. In M. Frick, A. Panagopoulou, A. F. Rees, & K. Williams (Eds.), *Book of Abstracts. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation* (pp. 209). Athens, Greece: International Sea Turtle Society.

Witt, M. J., L. A. Hawkes, M. H. Godfrey, B. J. Godley, and A. C. Broderick. (2010). Predicting the impacts of climate change on a globally distributed species: The case of the loggerhead turtle. *The Journal of Experimental Biology, 213*(6), 901–911.

Witzell, W. N. (1983). *Synopsis of biological data on the hawksbill turtle, Eretmochelys imbricata (Linnaeus, 1766)*. Rome, Italy: United Nations Environment Programme, Food and Agriculture Organization of the United Nations.

Work, T. M., and G. H. Balazs. (2013). Tumors in sea turtles: The insidious menace of fibropapillomatosis. *The Wildlife Professional*, 44–47.

Wright, A. J., and L. A. Kyhn. (2015). Practical management of cumulative anthropogenic impacts with working marine examples. *Conservation Biology, 29*(2), 333–340.

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

Yelverton, J. T., D. R. Richmond, E. R. Fletcher, and R. K. Jones. (1973). *Safe Distances From Underwater Explosions for Mammals and Birds*. Albuquerque, NM: Lovelace Foundation for Medical Education and Research.

Yelverton, J. T., and D. R. Richmond. (1981). *Underwater Explosion Damage Risk Criteria for Fish, Birds, and Mammals.* Paper presented at the 102nd Meeting of the Acoustical Society of America. Miami Beach, FL.