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

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3.9 Birds and Bats

BIRDS AND BATS SYNOPSIS

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

- Acoustics: Navy training and testing activities have the potential to expose birds and bats to a variety of acoustic stressors. The exposure to underwater sounds by birds depends on the species and foraging method. Pursuit divers may remain underwater for minutes, increasing the chance of underwater sound exposure. The exposure to in-air sounds by birds and bats depends on the activity (in flight or on the water surface) and the proximity to the sound source. Because birds are less susceptible to both temporary and permanent threshold shift than mammals, unless very close to an intense sound source, responses by birds to acoustic stressors would likely be limited to short-term behavioral responses. Some birds may be temporarily displaced and there may be temporary increases in stress levels. Although individual birds may be impacted, population level impacts are not expected. Unlike other mammals, bats are not susceptible to temporary and permanent threshold shifts. Bats may be temporarily displaced during foraging, but would return shortly after the training or testing is complete. Although individual bats may be impacted, population level impacts are not expected.
- Explosives: Navy training and testing activities have the potential to expose birds and bats to explosions in the water, near the water surface, and in air. Sounds generated by most small underwater explosions are unlikely to disturb birds and bats above the water surface. However, if a detonation is sufficiently large or is near the water surface, birds and bats above the pressure released at the air-water interface could be injured or killed. Detonations in air could injure birds and bats while either in flight or at the water surface; however, detonations in air during anti-air warfare training and testing would typically occur at much higher altitudes where seabirds, migrating birds, and bats are less likely to be present. Detonations may attract birds to possible fish kills, which could cause bird mortalities or injuries if there are multiple detonations in a single event. An explosive detonation would likely cause a startle reaction, as the exposure would be brief and any reactions are expected to be short-term. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.
- Energy: The impact of energy stressors on birds and bats is expected to be negligible based on (1) the limited geographic area in which they are used, (2) the rare chance that an individual bird or bat would be exposed to these devices in use, and (3) the tendency of birds and bats to temporarily avoid areas of activity when and where the devices are in use. The impacts of energy stressors would be limited to individual cases where a bird or bat might become temporarily disoriented and change flight direction, or be injured. Although a small number of individuals may be impacted, the impact at the population level would be negligible.

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BIRDS AND BATS SYNOPSIS

- Physical Disturbance and Strikes: There is the potential for individual birds to be injured or killed by physical disturbance and strikes during training and testing. However, there would not be long-term species or population level impacts due to the vast area over which training and testing activities occur and the small size of birds and their ability to flee disturbance. Impacts to bats would be similar to, but less than, those described for birds since bat occurrence in the Study Area is relatively scant compared to birds and because bats are most active from dusk through dawn.
- Entanglement: Entanglement stressors have the potential to impact birds. However, the likelihood is low because the relatively small quantities of materials that could cause entanglement would be dispersed over very wide areas, often in locations or depth zones outside the range or foraging abilities of most birds. A small number of individuals may be impacted, but no effects at the population level would be expected. The possibility that an individual of an ESA-listed bird species would become entangled is remote due to their rarity and limited overlap with Navy activities. Since bats considered in this analysis do not occur in the water column and rarely occur at the water surface in the Study Area, few, if any, impacts to bats are anticipated from entanglement stressors.
- Ingestion: It is possible that persistent expended materials could be accidentally ingested by birds while they were foraging for natural prey items, though the probability of this event is low as (1) foraging depths of diving birds is generally restricted to the surface of the water or shallow depths, (2) the material is unlikely to be mistaken for prey, and (3) most of the material remains at or near the sea surface for a short length of time. No population-level effect to any bird species would be anticipated. Since bats considered in this analysis do not occur in the water column and rarely feed at the water surface in the Study Area, few, if any, impacts to bats are anticipated from ingestion stressors.
- Secondary: There would be relatively localized, temporary impacts from water quality (turbidity) which may alter foraging conditions, but no impacts on prey availability. Since bats considered in this analysis do not occur in the water column and rarely occur at the water surface in the Study Area, few, if any, impacts to bats are anticipated from secondary stressors.

3.9.1 Introduction

This chapter provides the analysis of potential impacts on birds and bats found in the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area). This section provides an introduction to the species that occur in the Study Area.

The affected environment provides the context for evaluating the effects of the Navy training and testing activities to birds and bats. Because birds occur throughout the Study Area along shorelines, on the surface of the water, in water column and shallow bottom habitats, and are airborne over these habitats, Navy activities within these habitats could potentially impact many individuals and species, including members of diverse taxonomic groups, Endangered Species Act (ESA)-listed species, species protected under the Migratory Bird Treaty Act, and U.S. Fish and Wildlife Service (USFWS) Birds of Conservation Concern. Since bats also occur throughout the Study Area along shorelines, on or near the surface of the water, and are airborne over these habitats, Navy activities could affect bats in a similar manner. Any such impact, however, would be smaller than that to birds since bats are much less abundant in the Study Area compared to birds.

The following sections include Section 3.9.2 (Affected Environment), which provides a description of baseline conditions and brief introduction to the species and major taxonomic groups that occur in the Study Area; Section 3.9.3 (Environmental Consequences); and Section 3.9.4 (Summary of Potential Impacts on Birds and Bats). Throughout this chapter, particular consideration is given to ESA-listed species, species protected under the Migratory Bird Treaty Act, and the USFWS Birds of Conservation Concern.

3.9.2 Affected Environment

Three subsections are included in this section. General background information is given in Section 3.9.2.1 (General Background), which provides brief summaries of group size, habitat use, dive behavior, hearing and vocalization, and threats that affect or have the potential to affect natural communities of birds or bats within the Study Area. Protected species listed under the ESA are described in Section 3.9.2.2 (Endangered Species Act-Listed Species). Section 3.9.2.3 (Species Not Listed Under the Endangered Species Act) describes birds and bats not listed under the ESA, including major taxonomic groups and migratory birds protected under the Migratory Bird Treaty Act.

3.9.2.1 General Background

There are at least 160 species of birds that regularly occur in the Study Area (Sibley, 2014). Most of these are waterbirds – birds that live in marine, estuarine, and freshwater habitats. Waterbirds include seabirds, wading birds, shorebirds, and waterfowl, as described in more detail below. The remainder of species that may be regularly encountered in the Study Area are landbirds that are coastal resident species that live on land but forage in the adjacent coastal and inshore waters. Many more species (primarily songbirds) are neotropical migrants that occur briefly during transit between breeding areas in eastern North America and wintering areas in Central and South America and the Caribbean. Trans-Gulf migrants [birds that fly 600 miles across the Gulf of Mexico between the Yucatan Peninsula and the U.S. Gulf Coast (Texas to Florida)], passing through the Study Area, include at least 73 species of landbirds (Shackelford et al., 2005).

Seabirds – birds that forage primarily on the open ocean – are of particular interest as the group of birds with the broadest distribution and exposure to Navy activities in the Study Area. Seabirds are a diverse group that are adapted to living in marine environments (Enticott & Tipling, 1997) and use coastal (nearshore) waters, offshore waters (continental shelf), or open ocean areas (Harrison, 1983). There are many biological, physical, and behavioral adaptations that are different for seabirds than for terrestrial birds. Seabirds typically live longer, breed later in life, and produce fewer young than other bird species (Onley & Scofield, 2007). The feeding habits of seabirds are related to their individual physical characteristics, such as body mass, bill shape, and wing area (Hertel & Ballance, 1999). Some seabirds look for food (forage) on the sea surface, whereas others dive to variable depths to obtain prey (Burger, 2001). Many seabirds spend most of their lives at sea and come to land only to breed, nest, and occasionally rest (Schreiber & Chovan, 1986). Most species nest in groups (colonies) on the ground of coastal areas or oceanic islands, where breeding colonies number from a few individuals to thousands.

However, some species of seabirds and many other waterbird species are distributed nesters, and some are cavity nesters. Typical bird behavior to be encountered within the Study Area would include breeding, foraging, roosting, and migration. Beaches and wetlands within or bordering the Study Area may also be used as molting grounds by some species.

Additional information on the biology, life history, and conservation of bird species, including species-specific descriptions, is available from the websites of these sources:

- USFWS Migratory Bird Program and Endangered Species Program
- Birdlife International
- International Union for Conservation of Nature and Natural Resources Red List of Threatened Species
- National Audubon Society
- The Waterbird Society
- Department of Defense's (DoD) Partners in Flight
- Birds of North America

Bats include resident and migratory, hibernating and non-hibernating species (National Park Service, 2017a). Although all bats are terrestrial, many bat species occur in coastal (nearshore) waters, offshore waters (continental shelf), or open ocean areas while migrating or foraging and will use islands, ships, and other offshore structures as opportunistic or deliberate stopover sites for resting or roosting (Constantine, 2003; Cryan & Brown, 2007; Pelletier et al., 2013; Thompson et al., 2015; U.S. Department of Energy, 2016). While bats are typically nocturnal, there are anecdotal accounts of migratory tree bats (*Lasiurus* and *Lasionycteris* spp.) traveling during autumn migration in diurnal flocks (Hatch et al., 2013). In North America, bats almost exclusively use echolocation to navigate and feed on insects (Kunz, 2017).

Additional information on the biology, life history, and conservation of bat species is available from the websites of these sources:

- International Union for Conservation of Nature Red List of Threatened Species
- Bat Conservation International
- North American Bat Monitoring Program
- North American Bat Conservation Alliance
- North American Society for Bat Research

The following sections contain additional information on group size, habitat use, dive behavior, hearing and vocalization, and general threats for birds and bats in the Study Area.

3.9.2.1.1 Group Size

A variety of bird group sizes and diversity of species may be encountered throughout the Study Area, ranging from the solitary migration of an individual bird to thousands of birds in single-species and mixed-species flocks. Depending on season, location, and time of day, the number of birds observed (group size) will vary and will likely fluctuate from year to year. During spring and fall periods, diurnal and nocturnal migrants would likely occur in large groups as they migrate over open water. Many waterbirds migrate in very small groups or pairs, and then can be found in large groups at stopover areas and wintering grounds (Elphick, 2007).

Avian radar studies at sea show nocturnal migrants as well as seabirds moving across open oceans in large numbers (Desholm et al., 2006; Gauthreaux & Belser, 2003). During the nesting and breeding season, pelagic seabirds could be encountered in large groups following the currents and upwellings in pursuit of prey (Sibley, 2014). In the nearshore environments, terns, gulls, shorebirds, and plovers may occur in large groups while in their breeding and feeding areas.

Many bird species forage in large groups on shoaling fish or on concentrations of molluscs attached to the seafloor. Water temperatures, currents, upwellings, wind direction, and ocean floor topography can all influence when, where, and how many seabirds forage, and patterns of distribution and abundance vary from year to year (Elphick, 2007; Fauchald et al., 2002).

Depending on season, location, and time of day, the number of bats observed (group size) in the Study Area will vary and will likely fluctuate from year to year, ranging from solitary migration or foraging of an individual bat to single-species flocks (Constantine, 2003; Pelletier et al., 2013; U.S. Department of Energy, 2016). Bats flying over the ocean and other parts of the Study Area would most likely occur as single or a small number of individuals. No communal roosts or other large concentrations of bats are known within the Study Area.

3.9.2.1.2 Habitat Use

The Study Area includes portions of three major bird migration routes or flyways (Elphick, 2007) (Shackelford et al., 2005): the Atlantic, Mississippi, and Central flyways. The Atlantic Flyway includes an oceanic route which passes directly over the Atlantic Ocean from Labrador and Nova Scotia to the Lesser Antilles and mainland South America; and a coastal route that follows the coast between New England and Florida and continues across the Caribbean to South America. Over water routes used by many species to cross the Gulf of Mexico between mainland Mexico and the Gulf coast from Florida to Texas encompass the Mississippi Flyway and part of the Central Flyway. These routes overlap all of the large marine ecosystems detailed in Section 3.0.2.1 (Biogeographic Classifications). Many migratory song- and shorebirds fly close to the coastline of the Atlantic Flyway, although large numbers of seabirds and a few species of shore- and songbirds follow the oceanic flyway further offshore (throughout this section, offshore refers to areas beyond the immediate nearshore coastal areas both within and outside of the continental shelf). The largest numbers of neotropical migrants fly across the Gulf of Mexico at the southern end of the Mississippi Flyway (Elphick, 2007; Shackelford et al., 2005).

Birds forage in a variety of habitats such as coastal wetlands, estuaries, kelp beds, lagoons, and in the intertidal zone, as well as nearshore (immediately adjacent to the coastline) in shallower waters, and on the open ocean where they catch prey near or at the ocean surface. When and where birds occur is highly dependent on environmental factors and life stage and varies with prey location and time of year. Due to the uneven distribution of prey within the marine environment, some seabirds must fly long distances to obtain food. Other species like neotropical migrants must fly across open water twice a year to reach their wintering or breeding grounds in the search for food (Elphick, 2007; Shackelford et al., 2005).

Within the Study Area, species diversity of foraging seabirds is higher in the southern and lower in the northern portions of the Study Area (Karpouzi et al., 2007). Though the northern temperate regions have low species diversity, seabird densities and the amount of prey consumed are greater, due to overall higher productivity of northern waters (Karpouzi et al., 2007). Species particularly abundant in the northwest Atlantic include breeding auks in west Greenland; breeding Leach's storm-petrels (*Oceanodroma leucorhoa*) and northern gannets (*Morus bassanus*) in Newfoundland; and nonbreeding shearwaters and sea ducks in Eastern Newfoundland, Labrador, Gulf of St Lawrence, Scotian Shelf, and Gulf of Maine to Cape Hatteras (Barrett et al., 2006). Most seabirds forage in offshore waters over the continental shelves of North America (Karpouzi et al., 2007).

Bats are wide-ranging, occurring on many islands and every continent except for Antarctica. The vast majority of bat species occur in tropical regions; of the more than 1,100 species known world-wide, 44 species occur in the United States and Canada (Kunz, 2017). While all bats are terrestrial, numerous studies have shown that many species will forage within or migrate over marine environments, sometimes at considerable distances from shore. Hatch et al. (2013), for example, reported that offshore bats observed were located between 16.9 and 41.9 kilometers (km) from shore (with an average distance of 30 km) and that historic observations ranged from 2.9 to 1,950 km offshore (with an average distance of 103.6 km). Several North American bats have been found on Bermuda, located approximately 670 miles (mi.) (1,078 km) from the coast of the U.S. (Constantine, 2003; Pelletier et al., 2013). Thompson et al. (2015) reported a large flock of little brown bats (*Myotis lucifugus*) roosting on a ship and buoys approximately 68 mi. (110 km) off the coast of Maine during optimal summertime conditions, with warm air and no wind. While resident bats occur in marine environments, migratory bats – particularly long-distance migratory bats – are the most likely species to be observed in the Study Area (Bureau of Ocean Energy Management, 2013; Pelletier et al., 2013; U.S. Department of Energy, 2016). One study found that the eastern red bat (*Lasiurus borealis*) (73% of all occurrences) and hoary bat (*Lasiurus cinereus*) (22% of all occurrences) were the most likely species to be detected at buoy monitoring sites (U.S. Department of Energy, 2016), perhaps because they prefer open areas (Tetra Tech Inc, 2016d). Occurrence in a given area over the open ocean, however, is infrequent and seasonal, occurring most frequently during summer, particularly when the air is warm, the humidity is high, the wind speed is low, and when near forested land (Ahlén et al., 2009; Bureau of Ocean Energy Management, 2013; Johnson et al., 2011; U.S. Department of Energy, 2016).

Several studies have shown that bats typically fly close to the water's surface (e.g., lower than 10 meters [m] above sea level) when flying over water (Pelletier et al., 2013). However, many of these studies have had a limited ability to detect bats migrating at higher altitudes. Aerial surveys for bats, using high-definition video cameras mounted on a small aircraft at 610 m, off the Mid-Atlantic coast, revealed that, "of the six bats observed during aerial surveys for which flight height was estimable, all six were at altitudes over 100 m above sea level and five of the six were over 200 m" above sea level (Hatch et al. (2013).

3.9.2.1.3 Dive Behavior

Many of the seabird species found in the Study Area will dive, skim, or grasp prey at the water's surface or within the upper portion (1 to 2 m) of the water column (Cook et al., 2011; Jiménez et al., 2012). However, numerous seabirds, including various species of diving ducks, cormorants, and alcids (the family that includes murres, auks, auklets, and puffins) feed on the bottom at depths greater than 100 feet (ft.) (Cook et al., 2011; Ehrlich et al., 1988). Some seabirds are aerial plunge-divers in which they dive from above the surface and make generally shallow dives into the water column after prey (e.g., terns, gannets). Others are considered surface divers where they plunge directly from the surface underwater after prey (e.g., puffins, loons). Most diving species tend to catch the majority of their prey near the surface of the water column or on the bottom in shallow water (e.g., clams, mussels, and other invertebrates) (Cook et al., 2011). Dive durations are correlated with depth and range from a few seconds in shallow divers to several minutes in alcids (Ponganis, 2015). Petrels forage both night and day; they capture prey by resting on the water surface and dipping their bill and by aerial pursuit of flying fish (International Union for Conservation of Nature and Natural Resources, 2010b). More specific diving information in regard to species and taxonomic groups is provided in Sections 3.9.2.2.1 (Bermuda Petrel [*Pterodroma cahow*]) through 3.9.2.3.1.11 (Neotropical Migrant Songbirds, Thrushes, Allies, Cuckoos, Swifts, and Owls [Orders Passeriformes, Cuculiformes, and Apodiformes]).

While no bat species will dive into water, one bat species (the Mexican bulldog bat, or fishing bat [*Noctilio leporinus*]) primarily eats fish caught with its relatively large feet and long, sharp claws near the water's surface. Though this species does occur in Mexico, Puerto Rico, and the the U.S. Virgin Islands, it would be an infrequent visitor to the Study Area. (Jones et al., 1973; Placer, 1998). In a study of bat occurrence over water in the seas around Scandinavia, Ahlén et al. (2009) reported that both migrant and resident bats foraged over the sea in areas with an abundance of insects in the air and crustaceans in the surface waters. While it is expected that bats forage in a similar manner in the Study Area, it is also expected that such occurrence is infrequent and seasonal for the reasons described in Section 3.9.2.1 (General Background), above.

3.9.2.1.4 Hearing and Vocalization

Birds

Although hearing range and sensitivity has been measured for many land birds, little is known of seabird hearing. The majority of the published literature on bird hearing focuses on terrestrial birds and their ability to hear in air. A review of 32 terrestrial and marine species indicates that birds generally have greatest hearing sensitivity between 1 and 4 kilohertz (kHz) (Beason, 2004; Dooling, 2002). Very few can hear below 20 hertz (Hz), most have an upper frequency hearing limit of 10 kHz, and none exhibit hearing at frequencies higher than 15 kHz (Dooling, 2002; Dooling & Popper, 2000). Hearing capabilities have been studied for only a few seabirds (Beason, 2004; Beuter et al., 1986; Crowell et al., 2015; Johansen et al., 2016; Thiessen, 1958; Wever et al., 1969); these studies show that seabird hearing ranges and sensitivity in air are consistent with what is known about bird hearing in general.

Auditory abilities have been measured in ten diving bird species in-air using electrophysiological techniques (Crowell et al., 2015). All species tested had the best hearing sensitivity from 1 to 3 kHz. The red-throated loon (*Gavia stellata*) and northern gannet (*Morus bassanus*) (both non-duck species) had the highest thresholds of the diving birds while the lesser scaup (Aythya affinis) and ruddy duck (Oxyura jamaicensis) (both duck species) had the lowest thresholds (Crowell et al., 2015). Auditory sensitivity varied amongst the species tested, spanning over 30 dB in the frequency range of best hearing. While electrophysiological techniques provide insight into hearing abilities, auditory sensitivity is more accurately obtained using behavioral techniques. Crowell (2016) used behavioral methods to obtain an in-air audiogram of the lesser scaup. Best hearing frequency range in air was similar to other birds, with best sensitivity of 14 dB re 20 μPa at 2.86 kHz. Maxwell et al. (2017) obtained the behavioral in-air audiogram of a great cormorant (*Phalacrocorax carbo*) and the most sensitive hearing was 18 dB re 20 μPa at 2 kHz.

Crowell et al. (2015) also compared the vocalizations of the same ten diving bird species to the region of highest sensitivity of in-air hearing. Of the birds studied, vocalizations of only eight species were obtained due to the relatively silent nature of two of the species. The peak frequency of the vocalizations of seven of the eight species fell within the range of highest sensitivity of in-air hearing. Crowell et al. (2015) suggested that the colonial nesters tested had relatively reduced hearing sensitivity because they relied on individually distinctive vocalizations over short ranges. Additionally, Crowell et al.

(2015) observed that the species with more sensitive hearing were those associated with freshwater habitats, which are quieter compared to marine habitats with wind and wave noise.

Although important to seabirds in air, it is unknown if seabirds use hearing or vocalizations underwater for foraging, communication, predator avoidance or navigation (Crowell, 2016; Dooling & Therrien, 2012). Some scientists suggest that birds must rely on vision rather than hearing while underwater (Hetherington, 2008), while others suggest birds must rely on an alternative sense in order to coordinate cooperative foraging and foraging in low light conditions (e.g., night, depth) (Dooling & Therrien, 2012).

There is little known about the hearing abilities of birds underwater (Dooling & Therrien, 2012). In air, the size of the bird is usually correlated with the sensitivity to sound (Johansen et al., 2016); for example, songbirds tend to be more sensitive to higher frequencies and larger non-songbirds tend to be more sensitive to lower frequencies (Dooling & Popper, 2000). Two studies have tested the ability of a single diving bird, a great cormorant (*Phalacrocorax carbo sinensis*), to respond to underwater sounds (Hansen et al., 2017; Johansen et al., 2016). These studies suggests that the cormorant's hearing in air is less sensitive than birds of similar size; and the hearing capabilities in water are better than what would be expected for a purely in-air adapted ear (Johansen et al., 2016). The frequency range of best hearing underwater was observed to be narrower than the frequency range of best hearing in air, with greatest sensitivity underwater observed around 2 kHz (about 71 dB re 1 µPa based on behavioral responses) (Hansen et al., 2017). Although results were not sufficient to be used to generate an audiogram, Therrien (2014) also examined underwater hearing sensitivity of long-tailed ducks (*Clangula hyemalis*) by examining behavioral responses. The research showed that auditory thresholds at frequencies within the expected range of best sensitivity (1, 2, and 2.86 kHz) are expected to be between 77 and 127 dB re 1 µPa.

Diving birds may not hear as well underwater, compared to other (non-avian) species, based on adaptations to protect their ears from pressure changes (Dooling & Therrien, 2012). Because reproduction and communication with conspecifics occurs in air, adaptations for diving may have evolved to protect in-air hearing ability and may contribute to reduced sensitivity underwater (Hetherington, 2008). There are many anatomical adaptations in diving birds that may reduce sensitivity both in air and underwater. Anatomical ear adaptations are not well investigated, but include cavernous tissue in the meatus and middle ear that may fill with blood during dives to compensate for increased pressure on the tympanum, active muscular control of the meatus to prevent water entering the ear, and interlocking feathers to create a waterproof outer covering (Crowell et al., 2015; Rijke, 1970; Sade et al., 2008). The northern gannet, a plunge diver, has unique adaptations to hitting the water at high speeds, including additional air spaces in the head and neck to cushion the impact and a thicker tympanic membrane than similar sized birds (Crowell et al., 2015). All these adaptions could explain the measured higher thresholds of diving birds.

Bats

The hearing range of insect-eating bats in North America is 10 – 100 kHz. The most sensitive frequency band is 20 – 50 kHz, where bats can detect sounds at approximately 20 dB re 20 µPa (Bohn et al., 2006; Koay et al., 1997)Bats are generally unable to hear frequencies below 500 Hz. While hearing is the primary sense used by echolocating bats to forage and avoid obstacles, they use a combination of auditory and visual landmark recognition (Denzinger & Schnitzler, 2013; Gonzalez-Terrazas et al., 2016; Jensen et al., 2005; Schnitzler et al., 2003), magneto-reception (Holland et al., 2006; Holland et al., 2008; Wang et al., 2007), and spatial memory for long-distance navigation (Barchi et al., 2013; Ulanovsky & Moss, 2008, 2011; William & Williams, 1970; Williams et al., 1966).

The variety of vocalizations produced by bats can be separated into two general categories: ultrasonic echolocation sounds and communication sounds. Echolocation is used while foraging, in which bats listen for received echoes from insect targets. Sound detection levels are somewhat dependent on ambient noise, and bats increase the loudness of their calls when they encounter noise (Hage et al., 2013; Hotchkin & Parks, 2013; Luo & Wiegrebe, 2016). Echolocating bats have also been shown to passively listen for prey-generated sounds in the 2 – 14 kHz range when foraging (Kalko & Schnitzler, 1998; Razak et al., 1999). Call frequency and duration varies with habitat, food source, and social situation. Ultrasonic echolocation sound types vary by species (Denzinger & Schnitzler, 2013; Siemers & Schnitzler, 2004), and the duration of each call can range from 0.5 – 20 ms (Ulanovsky & Moss, 2008). Outgoing echolocation beams produced by bats are directional and are analogous to a searchlight in that it illuminates or 'ensonifies' objects when it is aimed at them (Moss et al., 2011). Insect targets can be identified from a maximum range of approximately 25 m using echoes in the 25 – 30 kHz frequency spectra (Stilz & Schnitzler, 2012). The big brown bat (*E. fuscus*) is the most-studied North American bat species and is a good representative insect-eating species that produces different types of echolocation calls depending on whether it is hunting in a dense forest or an open space (Moss et al., 2011). This species produces broadband ultrasonic echolocation sounds in the 22 – 105 kHz range.

Communication sounds produced by bats are typically lower in frequency than echolocation calls, although some bats use ultrasonic vocalizations for communication (Smotherman et al., 2016). Echolocation sounds may also contain socially relevant information (Kazial & Masters, 2004; Masters et al., 1995). Vocal communication in bats is restricted to short ranges because high-frequency sounds dampen very quickly in air. However, research suggests that hoary bats (*Lasiurus cinereus*) and silver-haired bats (*Lasionycteris noctivagans*) are not likely to socially communicate on migration routes (Baerwald & Barclay, 2016).

3.9.2.1.5 General Threats

Approximately half of the 346 species of seabirds that depend on ocean habitats are declining (Crowell et al., 2015). Seabirds are some of the most threatened marine animals in the world, with 29 percent of species at risk of extinction (Spatz et al., 2014). Threats to bird populations in the Study Area include human-caused stressors (including incidental mortality) from interactions with commercial and recreational fishing gear, predation and competition by introduced species, disturbance and degradation of nesting areas by humans and domesticated animals, noise pollution from construction and other human activities, nocturnal collisions with power lines and artificial lights, collisions with aircraft, and pollution, such as that from oil spills and plastic debris (Anderson et al., 2007; Burkett et al., 2003; California Department of Fish and Game, 2010; Carter & Kuletz, 1995; Carter et al., 2005; Clavero et al., 2009; International Union for Conservation of Nature and Natural Resources, 2010b; North American Bird Conservation Initiative & U.S. Committee, 2010; Onley & Scofield, 2007; Piatt & Naslund, 1995; U.S. Fish and Wildlife Service, 2005, 2008b; Waugh et al., 2012; Weimerskirch, 2004). Disease, volcanic eruptions, storms, and harmful algal blooms are also threats to birds (Anderson et al., 2007; Jessup et al., 2009; North American Bird Conservation Initiative U.S. Committee, 2009; U.S. Fish and Wildlife Service, 2005).

Beach-nesting birds are vulnerable to disturbance from people, pets, and off road vehicles that may inadvertently destroy or disturb nests (North American Bird Conservation Initiative U.S. Committee, 2009). Feral species (primarily cats [*Felis catus*] and rats [*Rattus* spp.], occasionally pigs [*Sus scrofa*], and cattle [*Bos taurus*]) may destroy nesting colonies. Seabirds are especially vulnerable to feral species on islands where nests and populations have been devastated through predation or habitat destruction.

Invasive plants can also eliminate nesting habitat on beaches (Clavero et al., 2009; North American Bird Conservation Initiative U.S. Committee, 2009).

Lighting on boats and on offshore oil and gas platforms has also contributed to bird fatalities in open ocean environments when birds are attracted to these lights, usually in inclement weather conditions (Merkel & Johansen, 2011). Recent studies have looked at different lighting systems and how they may impact migrating songbirds (Poot et al., 2008). Land-based lighting has been linked to episodes of "fallout" (grounding) involving seabirds, especially petrels, and ship-based lighting could have similar effects (Rodríguez et al., 2017).

Large-scale wind energy development in offshore areas has the potential to affect bird populations through 1) displacement from favored foraging habitats, especially to species that forage in deeper, offshore waters; and 2) mortality to species that tend to fly within the rotor swept zones of large wind turbines (approximately 20 m and 200 m from the surface) (Williams et al., 2015).

Natural causes of seabird and shorebird population declines include disease, storms, and harmful algal blooms, although human activities are also associated with harmful algal blooms (Jessup et al., 2009; North American Bird Conservation Initiative U.S. Committee, 2009; Onley & Scofield, 2007). In addition, seabird distribution, abundance, breeding, and other behaviors are influenced by cyclical environmental events, such as the El Niño Southern Oscillation and Pacific Decadal Oscillation in the Pacific Ocean (Congdon et al., 2007; Vandenbosch, 2000).

The primary threats to bats include disease (discussed in Section 3.9.2.1.5.3, Disease and Parasites), climate change (discussed in Section 3.9.2.1.5.5, Climate Change), commercial industries, especially wind energy development (discussed in Section 3.9.2.1.5.2, Commercial Industries), and habitat loss and fragmentation.

3.9.2.1.5.1 Water Quality

Spills of oil and other petroleum products pose a risk to seabirds and shorebirds through direct contamination and destruction of nesting, roosting, and foraging habitats (U.S. Environmental Protection Agency, 1999). Estimates of bird mortality caused by the BP *Deepwater Horizon* oil spill in the Gulf of Mexico during 2010 are that approximately 200,000 birds were killed in the offshore area and approximately 700,000 killed along the coastline during the 103-day duration of the spill (Haney et al., 2014a, 2014b). Additional mortality occurred subsequently but has not been estimated.

3.9.2.1.5.2 Commercial Industries

A recent review of reported bycatch estimates suggests that at least 400,000 birds die in gillnets each year (Zydelis et al., 2013). Commercial fisheries are considered the most serious threat to the world's seabirds, while invasive species are the most pervasive – affecting the largest number of species; other threats include pollution, hunting, trapping, energy production, and mining (BirdLife International, 2012).

Large-scale offshore wind development may occur in highly productive areas of the Atlantic Seaboard and impact bird populations 1) by displacing some species from their preferred foraging habitats and migration routes; 2) increasing the mortality of species that fly within the rotor-swept zones of large turbines individuals (Williams et al., 2015).

Wind turbines may attract bats directly (e.g., there is evidence that bats perceive smooth wind turbine surfaces to be water) (McAlexander, 2013) or indirectly (e.g., by attracting insects) (Pelletier et al., 2013), where they may be injured or killed by collision with a wind turbine's blade or by barotrauma (a sudden drop in pressure that a bat encounters when flying near the rotating blade). Bats are also known to roost on wind turbines, including offshore wind turbines (Ahlén et al., 2009).

3.9.2.1.5.3 Disease and Parasites

Avian diseases can cause chronic population declines, dramatic die-offs or reductions in the reproductive success and survival of individual birds. They can even cause extinctions. Certain avian diseases appear to be spreading to populations previously unaffected, including to species already threatened by other factors. Examples include avian botulism, cholera, *Erysipelothrix rhusiopathiae*, West Nile virus and Mycoplasmal conjunctivitis. A brief description of each follows.

Avian botulism is a bacterial disease that is arguably the most important disease of migratory birds world-wide, affecting millions of birds. Avian cholera and (*Erysipelothrix rhusiopathidae*) are two bacterial diseases that caused considerable declines of Indian yellow-nosed albatross (*Thalassarche carteri*) on Amsterdam Island (French Southern Territories). These two diseases may have spread to nearby colonies of sooty albatross (*Phoebetria fusca*) and Amsterdam albatross (*Diomedea amsterdamensis*) with a world population of approximately 130 birds. Avian cholera has also devastated the population of Cape cormorant (*Phalacrocorax capensis*) in Western Cape Province, South Africa, killing approximately 13,000 individuals between May and October 2002. The West Nile Virus, a largely mosquito-borne viral disease (causing both bird and human mortalities), has established itself over much of eastern United States since 1999, spreading to Latin America and the Caribbean. American crow (*Corvus brachyrhynchos*) and other corvid species have shown very high levels of mortality from this disease but remains relatively stable across its range. Mycoplasmal conjunctivitis, as the disease is commonly called, is caused by a unique strain of (*Mycoplasmal gallisepticum*), a parasitic bacterium previously known to infect only poultry. This infectious disease has recently caused a significant decline in the introduced population of house finch (*Carpodacus mexicanus*) in eastern North America, and has started to spread to the native population of this species in western North America (BirdLife International, 2008c).

White-nose syndrome, caused by a white fungus, (*Pseudogymnoascus destructans*) was first discovered in North America in a cave in New York in 2006. Since then, the disease has spread to seven bat species in 32 states and 5 Canadian provinces. The disease has killed at least 5.7 million bats, caused precipitous declines in populations of cave-hibernating bat species in the northeast region, and led to the federal listing of the northern long-eared bat as threatened under the ESA. From its original detection in New York, the disease has spread widely throughout the New England states and the interior of the eastern United States (U.S. Geological Survey, 2018). On average, 96 percent of new white-nose syndrome counties in any single year were within 150 miles of a county that was fungus or white-nose syndrome-positive during the prior year. The fungus is generally present for a year or two before symptoms of white-nose syndrome appear and mortality of bats begins to occur (U.S. Fish and Wildlife Service, 2016a). It is thought that half of America's bats are at risk to the disease (Bat Conservation International, 2017). The most common bats affected by white-nose syndrome are little brown bats, followed by the federally threatened northern long-eared bats and the federally endangered Indiana bat (*Myotis sodalis*). Some small-footed bats (*Myotis leibii*), tri-colored bats (*Perimyotis subflavus*) and big brown bats have also been affected (Yates, 2015).

Surveys at several sites in the Gulf of Maine from 2009-2014 detected a decline in the amount of *Myotis* species relative to that of other species, primarily in 2012 and 2013. At one site, overall activity levels declined from 294 passes per night (with activity during 97% of nights) in 2012 to 6.4 passes per night (with activity during 37% of nights) in 2014 (U.S. Department of Energy, 2016).

The little brown bat has had one of the highest mortality rates from white-nose syndrome and is estimated to have had a population decrease of 91 percent in the east. Big brown bats are less affected by white-nose syndrome and red bats, hoary bats, and silver-haired bats are migrators rather than hibernators, which allow them to avoid hibernacula that harbor this fungus (Hayman et al., 2016; Tetra Tech Inc, 2016a).

3.9.2.1.5.4 Invasive Species

Significant threats to seabirds occur on islands, which is where seabirds breed, including predation and habitat disturbance from invasive alien species such as rats, cats and pigs. Ground-nesting seabirds are particularly vulnerable to these threats, and invasive predators on islands have been the primary cause of global seabird declines, extirpations, and local extinctions (Spatz et al., 2014). However, in many cases, effective island conservation can mitigate these threats.

3.9.2.1.5.5 Climate Change

In the long term, global climate change could be the greatest threat to seabirds (North American Bird Conservation Initiative & U.S. Committee, 2010). Climate change impacts include changes in air and sea temperatures, precipitation, the frequency and intensity of storms, pH level of sea water, and sea level. These changes could impact the timing of migration and overall marine productivity, which could in turn have an impact on the food resources, distribution, and reproductive success of seabirds at critical times in their life cycles (Aebischer et al., 1990; Congdon et al., 2007; Davoren et al., 2012).

Open ocean seabird species are particularly vulnerable to climate change due to their low reproductive rates, their use of islands for nesting, and their reliance on a highly variable marine system (North American Bird Conservation Initiative & U.S. Committee, 2010). Coastal birds are vulnerable to climate change due to rising sea levels, which are expected to impact foraging and nesting habitat quality and quantity by flooding or fragmenting habitats such as barrier islands, beaches, and mudflats (North American Bird Conservation Initiative & U.S. Committee, 2010).

Climate change could impact bats at all stages in their annual cycle. U.S. Fish and Wildlife Service (2016a), for example, writes:

> “The unique life history traits of bats and their susceptibility to local temperature, humidity, and precipitation patterns make them an early warning system for effects of climate change in regional ecosystems. Climate influences food availability, timing of hibernation, frequency and duration of torpor, rate of energy expenditure, reproduction, and rates of juvenile bat development. Climate change may lead to warmer winters, which could lead to a shorter hibernation period, increased winter activity, and reduced reliance on the relatively stable temperatures of underground hibernation sites. An earlier spring would presumably result in a shorter hibernation period and the earlier appearance of foraging bats. An earlier emergence from hibernation may have no detrimental effect on populations if sufficient food is available; however, predicting future insect population dynamics and distributions is complex. Alterations in precipitation, stream flow, and soil moisture could alter insect populations and, therefore, food availability for bats.”

Additionally, altered seasonal ambient temperatures and precipitation patterns could also shift the range of some species and alter water and roost availability (U.S. Fish and Wildlife Service, 2016a), and extreme weather events have led to large die-offs (Mistry & Moreno-Valdez, 2008). Bat populations are particularly susceptible to such large die-offs due to their low reproductive rates (Bogan, 2016). Climate change will also change prey detection ability of echolocating bats, with some species gaining a greater ability to detect prey and others having a reduced ability to detect prey species (Luo et al., 2013).

3.9.2.1.5.6 Marine Debris

Marine debris is any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes (National Oceanic and Atmospheric Administration, 2016). Marine debris is a growing environmental concern. With the rapid increase in global plastics production and the resulting large volume of litter that enters the marine environment, determining the consequences of this debris on marine fauna, including seabirds and ocean health has now become a critical environmental priority, particularly for threatened and endangered species (Wilcox et al., 2016).

Plastic debris is abundant and pervasive in the world oceans and, because of its durability, is continuing to increase. The ingestion of plastics by seabirds such as albatrosses and shearwaters occurs with high frequency and is of particular concern because of impacts on body condition and the transmission of toxic chemicals, both of which affect mortality and reproduction. The rates of plastic ingestion by seabirds are closely related to the concentrations of plastics in different areas of the ocean due to waste discharges and ocean currents, and are increasing (Kain et al., 2016; Wilcox et al., 2015).

The impacts from entanglement of marine species in marine debris are clearly profound, and in many cases entanglements appear to be increasing despite efforts over four decades to reduce the threat. Many coastal states have undertaken certain efforts to reduce entanglement rates through marine debris clean-up measures and installed fishing line recycle centers at boat landings in part due to entanglement of seabirds and other marine species.

Fishing related gear, balloons and plastic bags were estimated to pose the greatest entanglement risk to marine fauna. In contrast, experts identified a broader suite of items of concern for ingestion, with plastic bags and plastic utensils ranked as the greatest threats. Entanglement and ingestion affected a similar range of taxa, although entanglement was rated as slightly worse because it is more likely to be lethal. Contamination was scored the lowest in terms of impact, affecting a smaller portion of the taxa and being rated as having solely non-lethal impacts (Wilcox et al., 2016).

There are likely other species from other regions of the U.S. that suffer injury or death from being entangled in marine debris, but are not widely recognized or reported. Most of the literature describes entanglement of marine species from Alaska, California, Puget Sound, and Florida. However, the Mid-Atlantic and Gulf of Mexico regions of the U.S. are lacking in reports of marine debris entanglement. Similarly, reports of marine debris entanglement on seabirds are limited to a few papers (National Oceanic and Atmospheric Administration, 2016). This review reported entanglement in marine debris in the U.S. of 44 species of seabirds. The majority of cases revolve around entanglement in abandoned, lost or otherwise discarded fishing gear and to a lesser degree other plastic debris.

More general information about marine debris along the southeast Atlantic coast concluded 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.

3.9.2.2 Endangered Species Act-Listed Species

There are four species of birds and two species of bats listed as endangered or threatened under the ESA that occur in the Study Area (U.S. Fish and Wildlife Service, 2015a). One ESA-listed species, the piping plover (*Charadrius melodus*), has critical habitat that is described in greater detail in Section 3.9.2.2.2.1 (Status and Management). The status, presence, and occurrence of ESA-listed bird and bat species in the Study Area are discussed further below.

Table 3.9-1: Endangered Species Act-List Bird and Bat Species in the Study Area

Species Name and Regulatory Status			*Presence in the Study Area*[1]		
Common Name	***Scientific Name***	***ESA Status***	***Open Ocean Area***	***Large Marine Ecosystem***	***Inshore Waters***
Bermuda Petrel	*Pterodroma cahow*	Endangered	North Atlantic Gyre (nesting), Gulf Stream	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf	None
Roseate Tern[2]	*Sterna dougallii dougallii*	Endangered Threatened	North Atlantic Gyre, Gulf Stream	Scotian Shelf (nesting), Northeast U.S. Continental Shelf (nesting), Southeast U.S. Continental Shelf, Gulf of Mexico (nesting), Caribbean Sea (nesting)	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Cape Fear River (Wilmington, NC); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)
Piping Plover	*Charadrius melodus*	Threatened	None	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Cape Fear River (Wilmington, NC); St. Mary's River Inlet (St. Mary's, GA); St. Johns River and Fort George River Inlets (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)
Red Knot	*Calidris canutus rufa*	Threatened	North Atlantic Gyre, Gulf Stream	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Cape Fear River (Wilmington, NC); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)

Table 3.9-1: Endangered Species Act-List Bird and Bat Species in the Study Area (continued)

Species Name and Regulatory Status			***Presence in the Study Area[1]***		
Common Name	***Scientific Name***	***ESA Status***	***Open Ocean Area***	***Large Marine Ecosystem***	***Inshore Waters***
Indiana bat	*Myotis sodalis*	Endangered	None	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA)
Northern long-eared bat	*Myotis septentrionalis*	Threatened	None	Scotian Shelf (roosting), Northeast U.S. Continental Shelf (roosting), Southeast U.S. Continental Shelf	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Cape Fear River (Wilmington, NC)

[1]Presence in the Study Area indicates open ocean areas (North Atlantic Gyre, Gulf Stream, and Labrador Current) and coastal waters of large marine ecosystems (West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea) in which the species are found. Open ocean areas and coastal waters where breeding occurs are indicated as (nesting).

[2]The roseate tern is listed as endangered under the ESA along the Atlantic coast south to North Carolina, Canada (Newfoundland, Nova Scotia, Quebec), and Bermuda. It is listed as threatened under the ESA in the Western Hemisphere and adjacent oceans, including Florida, Puerto Rico, and the Virgin Islands.

Source**:** (U.S. Fish and Wildlife Service, 2015a), for ESA Status.

Note**:** The abbreviations in the table are defined as follows—DE: Delaware; FL: Florida; GA: Georgia; NC: North Carolina; NJ: New Jersey; TX: Texas; VA: Virginia; ESA: Endangered Species Act, Gulf of Mexico: Gulf of Mexico.

The federally endangered Florida bonneted bat (*Eumops floridanus*) occurs in southern Florida and is thought to be the rarest bat in the world (Florida Fish and Wildlife Conservation Commission, 2017b). However, it is not expected to occur in the Study Area as it primarily forages over freshwater ponds, streams, and wetlands (U.S. Fish and Wildlife Service, 2013a). The nearest occurrence of the federally endangered gray bat (*Myotis grisescens*) to the Study Area is one county in Florida’s panhandle that is adjacent to Alabama and Georgia and is also not expected to occur in the Study Area (Florida Fish and Wildlife Conservation Commission, 2017c). The Mexican Long-nosed bat (*Leptonycteris nivalis*) and the lesser long-nosed bat (*Leptonycteris curasoae*) migrate through Central Mexico (from the Pacific Coast to Gulf of Mexico) to the southwest U.S. (International Union for Conservation of Nature, 2017; National Park Service, 2017b). Therefore, some individuals may migrate over the western-most portions of the Gulf of Mexico but the chances they would interact with Navy training activities is discountable. As such, these four species will not be discussed further.

3.9.2.2.1 Bermuda Petrel (*Pterodroma cahow*)

3.9.2.2.1.1 Status and Management

The USFWS listed the Bermuda petrel as endangered under the ESA in 1970. There is no designated critical habitat for this seabird species. This extremely rare seabird nests only on Bermuda in the Atlantic Ocean (White, 2004). The Bermuda petrel was thought to be extinct for about three decades until its existence was confirmed in the mid-1900s. In 1951, 18 pairs of the Bermuda petrel (commonly referred to as “cahow”) were rediscovered breeding on a group of four rocky islets in Castle Harbor, Bermuda. An intensive recovery and management program followed, which included removing predators, such as rats (Murphy & Mowbray, 1951), and adapting nest burrow entrances with baffles and artificial burrows to prevent nest site competition with the white-tailed tropicbird (*Phaethon lepturus*) (Murphy & Mowbray, 1951). Efforts to establish a new breeding colony in the higher areas of Nonsuch Island Nature Reserve have been slow but promising (Dobson & Madeiros, 2009). The total population is estimated as approximately 250-275 individuals with 71 breeding pairs in 2005, 96 breeding pairs in 2009 (Dobson & Madeiros, 2009), and 101 breeding pairs in 2012 (U.S. Fish and Wildlife Service, 2013c).

3.9.2.2.1.2 Habitat and Geographic Range

The Bermuda petrel is a pelagic species and spends most of its life at sea, except during the breeding season from January to June where it comes ashore to breed. Breeding occurs outside the Study Area, exclusively in Bermuda on five small islets off Nonsuch Island in the North Atlantic Gyre (National Audubon Society, 2005). Available islet nesting habitat is limited to 2.4 acres (ac) (0.97 hectares [ha]), which is occupied by a varying number of breeding pairs each year (BirdLife International, 2008a). During the breeding season, the Bermuda petrel arrives and leaves the island only at night to avoid predation (Wurster & Wingate, 1968). During the breeding season, the Bermuda petrel nests in colonies, but is otherwise solitary (Onley & Scofield, 2007). Due to its solitary behavior the Bermuda petrel is unlikely to approach ships (Enticott & Tipling, 1997; Onley & Scofield, 2007). More specific nest density or colony size information was not found.

Open Ocean Areas. In the nonbreeding season (June–December) (Brooke, 2004), the species migrates from the breeding grounds in Bermuda to foraging routes over much of the Atlantic Ocean, including waters of the North Atlantic Gyre and the Gulf Stream (includes off-shelf portions of the Virginia Capes and Navy Cherry Point Range Complexes) (Lee & Mackin, 2008; National Audubon Society, 2005; Onley & Scofield, 2007). However, dispersal and at-sea distribution are generally poorly known (Brooke, 2004; Onley & Scofield, 2007). One additional migration route was recorded into the northeast Atlantic, off the coast of southwestern Ireland (Dobson & Madeiros, 2009).

Southeast U.S. Continental Shelf Large Marine Ecosystem. First reported off North Carolina's Outer Banks in April 1983 (Lee, 1987), today the species regularly occurs off the North Carolina coast (National Audubon Society, 2005; White, 2004).

Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems. Recent data recorded during the nonbreeding season documented western routes to the Gulf Stream and northern movements to the Bay of Fundy, into the Gulf of St. Lawrence, and over the Grand Banks. An additional route was recorded off the coast of southwestern Ireland (Madeiros, 2009).

3.9.2.2.1.3 Population Trends

The Bermuda petrel is an extremely rare seabird that is slowly but steadily increasing: 18 pairs were recorded in the year 1951; 70 pairs raising 40 young were recorded in 2003; 71 pairs raising 35 young were recorded in 2005 (International Union for Conservation of Nature and Natural Resources, 2010a). The reproductive output between 2000 to 2001 and 2007 to 2008 ranged from 29 to 40 fledglings per year (Madeiros et al., 2012). Conservation efforts continue and the species is recovering in number, with the population estimated at 250-275, with 101 breeding pairs as of 2012 (U.S. Fish and Wildlife Service, 2013c). The number of chicks successfully fledged per nesting season has also increased, reaching 52 in 2010 (Dobson, 2010) and 57 in 2012 (U.S. Fish and Wildlife Service, 2013c).

3.9.2.2.1.4 Predator and Prey Interactions

Bermuda petrels feed mostly on squid, but their diet also consists of shrimp and small fish (National Audubon Society, 2005). Specific information on the feeding behavior of Bermuda petrels is lacking, but petrels of the genus *Pterodroma* often land on the ocean surface where they scavenge or grab prey;

they also feed on the wing (while flying), where they are able to catch flying fish (Onley & Scofield, 2007).

Maximum dive depths for several species of *Pterodroma* petrels in New Zealand were determined from depth gauges that were attached to individual birds and recovered after varying lengths of time during which the birds were foraging at sea (Taylor, 2008). Mean maximum dive depths ranged from 1.1 to 4.7 m, with a maximum depth recorded of 23 meters. Maximum dive depths were similarly determined for the Providence petrel (*Pterodroma solandri*), an Australian species, and found to average 2.9 m (Bester et al., 2011). It is reasonable to conclude that in addition to feeding at the surface, petrels of the genus *Pterodroma,* (probably including the Bermuda petrel) frequently engage in surface plunging or pursuit diving to reach prey several meters below the surface. No data are available on submergence times, but to reach these depths presumably requires a petrel to be underwater for roughly 5-10 seconds.

3.9.2.2.1.5 Species-Specific Threats

Current threats to this species include habitat loss; competition for nest sites with the white-tailed tropicbird (Dobson & Madeiros, 2009); egg failure from contaminants (Brooke, 2004; Wurster & Wingate, 1968); light pollution from a nearby Bermuda airport; sea level rise; and increasing frequency and magnitude of tropical storms and hurricanes, which destroy nests through erosion, wave damage, and flooding (BirdLife International, 2008a, 2008b; Dobson & Madeiros, 2009; Madeiros et al., 2012; U.S. Fish and Wildlife Service, 2013c).

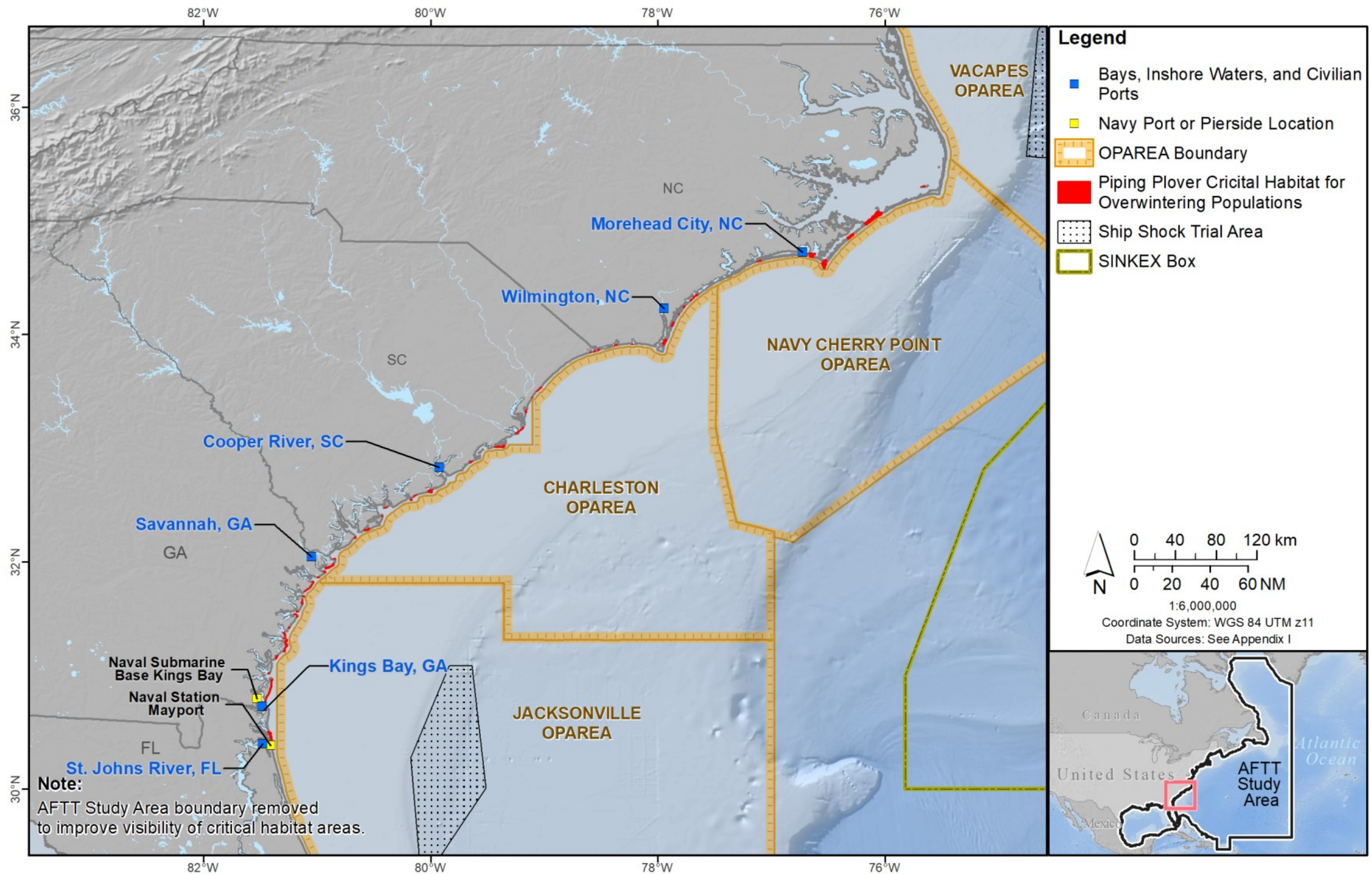
3.9.2.2.2 Piping Plover (*Charadrius melodus*)

The piping plover is divided into two subspecies of plovers. The piping plovers that breed on the Atlantic coast of the United States and Canada belong to the Atlantic subspecies *C. melodus* (U.S. Fish and Wildlife Service, 2009b) and occur within the Study Area.

3.9.2.2.2.1 Status and Management

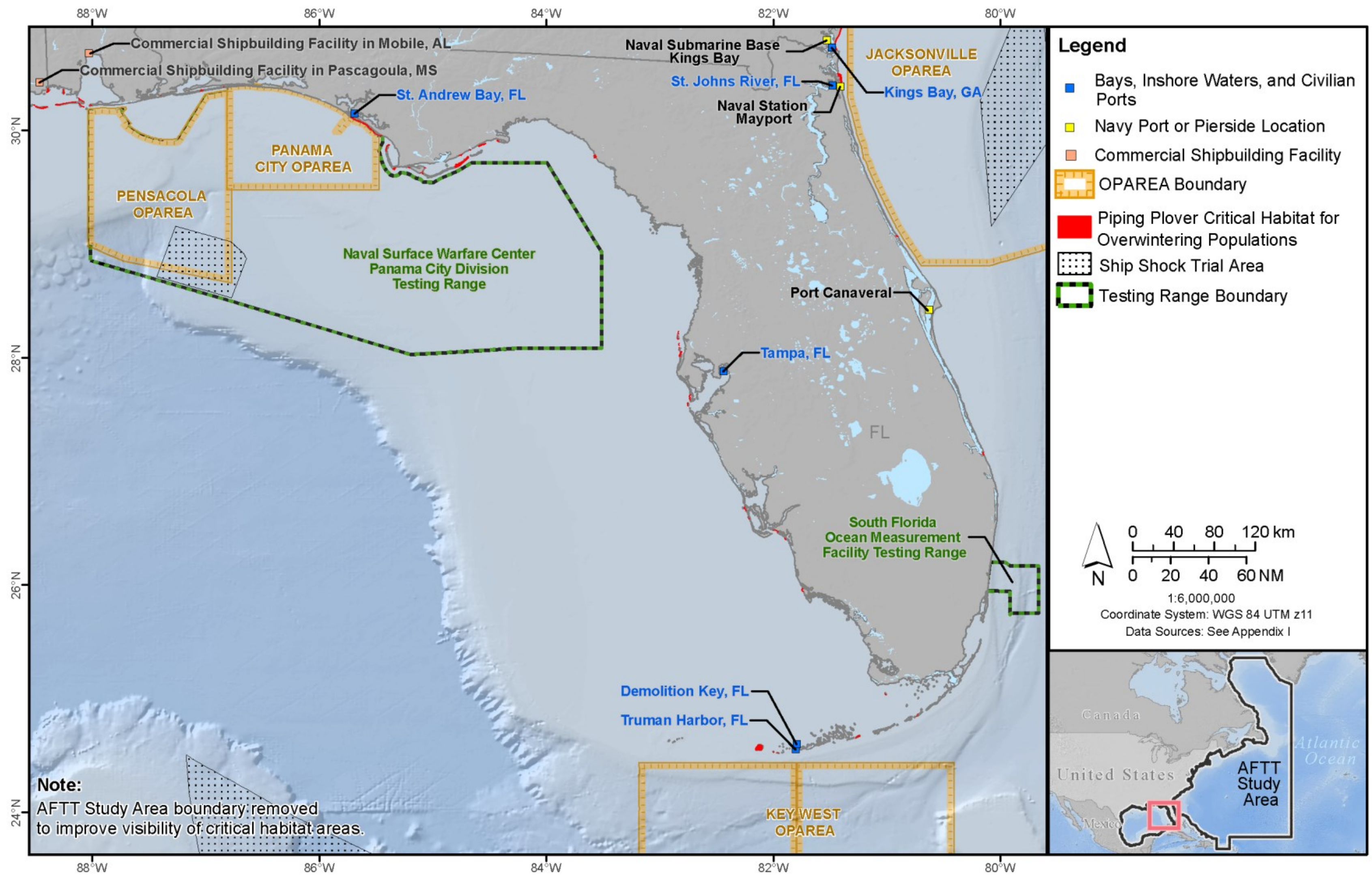
The USFWS listed the Atlantic coast piping plover population as threatened under the ESA in 1985 and has instituted a recovery plan for this shorebird species (U.S. Fish and Wildlife Service, 1996). In 2001 and 2002, critical habitat was designated for the Great Lakes breeding population and Northern Great Plains breeding population, and for all three breeding populations while on their wintering grounds. Critical habitat for wintering plovers has been designated in coastal areas near or within the Study Area as shown in Figure 3.9-1, Figure 3.9-2, and Figure 3.9-3.

The USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for wintering populations. This critical habitat includes 1,798.3 mi. (2,891.7 km) of mapped shoreline and 165,211 ac (66,881 ha) of mapped area along the gulf and Atlantic coasts and along interior bays, inlets, and lagoons (*Federal Register* 66[132]: 36038-36086, July 10, 2001). In 2008 and 2009, the USFWS updated designated critical habitat for wintering piping plover populations in North Carolina and Texas, adding 2,043 ac (827 ha) in North Carolina and 139,029 ac (56,263 ha) along the Gulf Coast of Texas (*Federal Register* 73[204]: 62816-62841, October 21, 2008; and *Federal Register* 74 [95]: 23476-23600, May 19, 2009, respectively). Any critical habitat located above the mean high tide line is outside the Study Area, as described in Section 3.0.2 (Ecological Characterization of the Study Area).



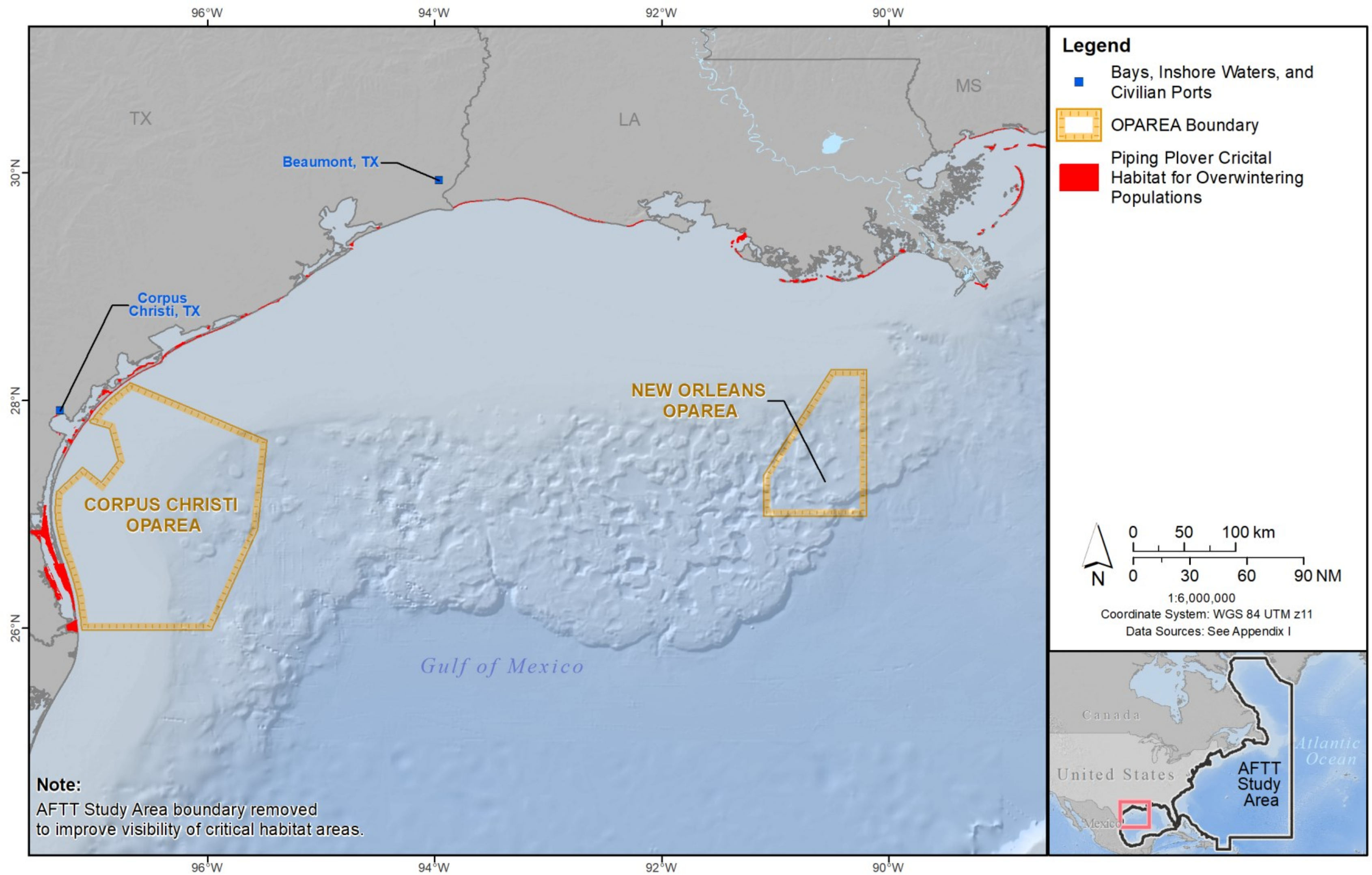
Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: operating area; SINKEX: ship sinking exercise; VACAPES: Virginia Capes.

Figure 3.9-1: Critical Habitat Areas for Piping Plover in and Adjacent to the Atlantic Coastal Portions of the Study Area



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: operating area; SINKEX: ship sinking exercise.

Figure 3.9-2: Critical Habitat Areas for Piping Plover in and Adjacent to the Eastern Gulf of Mexico Coastal Portions of the Study Area



Notes: AFTT: Atlantic Fleet Training and Testing; OPAREA: operating area; SINKEX: ship sinking exercise.

Figure 3.9-3: Critical Habitat Areas for Piping Plover in and Adjacent to the Western Gulf of Mexico Coastal Portions of the Study Area

The 2004 National Defense Authorization Act allows military installations to be excluded from critical habitat designation for endangered species under the ESA provided that the installation's Integrated Natural Resource Management Plan affords (1) a benefit to the species; (2) certainty that the management plan will be implemented; and (3) certainty that the conservation effort will be effective. On Navy installations where piping plovers breed or overwinter, the Navy is exempt from critical habitat designations.

3.9.2.2.2.2 Habitat and Geographic Range

In the Study Area, the Atlantic breeding population of piping plovers nest and breed on coastal beaches from southern Maine to North Carolina and are primarily an inhabitant of sandy shorelines in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems (Haig & Elliott-Smith, 2004; O'Brien et al., 2006). Piping plovers nest above the mean high tide line (outside the Study Area) on coastal beaches, sand flats at the ends of sandpits and barrier islands, gently sloping foredunes (dunes parallel to the shoreline), blowout areas behind primary dunes, and washover areas cut into or between dunes (U.S. Fish and Wildlife Service, 1996). Individuals migrate through and winter in coastal areas of the United States from North Carolina to Texas and portions of Yucatan in Mexico and the Caribbean (U.S. Fish and Wildlife Service, 2009b). Different breeding populations tend to occur in different coastal wintering areas, although there is some overlap (Gratto-Trevor et al., 2012). In winter, the species is only found in coastal areas in habitats that include mudflats and dredge spoil areas and, most commonly, sandflats (Gratto-Trevor et al., 2012; O'Brien et al., 2006). Plovers appear to prefer sandflats adjacent to inlets or passes, sandy mudflats along spits (beaches formed by currents), and overwash areas as foraging habitats. Piping plover migration routes overlap with breeding and wintering habitats.

Southeast U.S. Continental Shelf Large Marine Ecosystem. Recovery results from birds banded during the breeding season indicate that most Atlantic coast breeders winter along the southern Atlantic coast from North Carolina to Florida, although some birds have been reported to winter in Texas (Gratto-Trevor et al., 2012) Evidence suggests that most of the Great Lakes population winters south along the Atlantic coast. Both spring and fall migration routes are believed to follow the Atlantic coast (Gratto-Trevor et al., 2012).

Gulf of Mexico Large Marine Ecosystem. Evidence suggests that most of the threatened Northern Plains population winters on the Gulf Coast (Gratto-Trevor et al., 2012).

Caribbean Sea Large Marine Ecosystem. Islands in the Caribbean, the Bahamas and West Indies, serve as important wintering habitat (U.S. Geological Survey, 2007).

3.9.2.2.2.3 Population Trends

A 1991 international census documented 5,482 piping plovers and a decade later in 2001 the population estimate was 5,945 piping plovers (Haig & Elliott-Smith, 2004). The current population has been estimated to be approximately 8,100 individuals (BirdLife International, 2016). Coastal Atlantic United States populations have trended upward since listing, though some areas' breeding populations are remaining at depressed levels and showing little or no increase in size. Since its 1985 listing, the Atlantic coast population estimate has increased from 790 pairs to an estimated 1,849 pairs in 2008, and the United States portion of the population has almost tripled, from approximately 550 pairs to an estimated 1,596 pairs (U.S. Fish and Wildlife Service, 2009c). Between 1989 and 2008, the largest population increase occurred in New England (245 percent), followed by New York–New Jersey (74 percent). Overall population growth was tempered by rapid declines in the Southern and Eastern Canada recovery units; the eastern Canada population decreased 21 percent (2002–2005), and the population in the southern half of the Southern recovery unit declined 68 percent (1995–2001) (U.S. Fish and Wildlife Service, 2009c). Also, the Maine population declined 64 percent, from 66 pairs in the year 2002 to 24 pairs in 2008, mostly due to loss of habitat from spring storms and dune stabilization projects. More recently, numbers have declined, with 3,973 piping plovers observed during the winter census of the 2011 International Piping Plover Census, with Texas having by far the largest number of any state (2,145), and more than 1,000 piping plovers discovered wintering in the Bahamas (Elliott-Smith et al., 2015). The 2011 breeding census resulted in an estimated breeding population of at least 5,723 birds, 75 percent of which were in the United States, with a breeding population of 1,476 pairs in the Atlantic coastal states (Elliott-Smith et al., 2015). Though the abundance of the Atlantic coast plovers has reduced near-term extinction threats, geographic variation in population growth and sensitivity to survival and productivity are cause for continuing conservation concern (U.S. Fish and Wildlife Service, 2009c).

3.9.2.2.2.4 Predator and Prey Interactions

Feeding habitats of breeding piping plovers include intertidal portions of ocean beaches, washover areas, mudflats, sandflats, wrack lines (line of deposited seaweed on the beach), shorelines of coastal ponds, lagoons, and salt marshes (Gratto-Trevor et al., 2012; U.S. Fish and Wildlife Service, 1996). They hunt visually using a start-and-stop running method, gleaning and probing the substrate for a variety of small invertebrates (marine worms, crustaceans, molluscs, insects, and the eggs and larvae of many marine invertebrates) (Maslo et al., 2012; U.S. Fish and Wildlife Service, 1996). Foraging occurs throughout the day and at night.

Piping plovers are preyed upon by various species. These predators, such as crows, gulls, raptors, raccoons, foxes, skunks, and domestic and feral cats, are often associated with developed beaches and have been identified as a substantial source of mortality for piping plover eggs and chicks (U.S. Fish and Wildlife Service, 2009b; Winter & Wallace, 2006).

3.9.2.2.2.5 Species-Specific Threats

The localized declines of the Atlantic coast piping plover population is attributed to habitat loss and degradation and increased predator populations in coastal environments (U.S. Fish and Wildlife Service, 1996). Excessive disturbance may cause the parents to flee the nest, exposing eggs or chicks to the hot sun or predators. High disturbance levels around nest sites can also result in the abandonment of nests and, ultimately, decreased breeding success (Cohen & Gratto-Trevor, 2011). Causing parents or juveniles to flush while foraging may stress juveniles enough to negatively influence critical growth and development. Few areas used by wintering piping plovers are free of human disturbance, and nearly 50 percent have leashed and unleashed dog presence (U.S. Fish and Wildlife Service, 2009b).

Along the Atlantic coast, commercial, residential, and recreational development have decreased the amount of coastal habitat available for piping plovers. Trends show continued loss and degradation of habitat in migration and wintering areas due to sand placement projects, inlet stabilization, sand mining, erosion prevention structures (groins, seawalls, and revetments, exotic and invasive vegetation, and wrack removal) (U.S. Fish and Wildlife Service, 2009b). Unusual events, such as hurricanes, can impact hundreds of young-of-the-year and adults. Storms can also, over time, positively impact local piping plover populations by leveling dunes and creating suitable nesting habitat (U.S. Fish and Wildlife Service, 1996). Beach development and stabilization activities, dredging, recreational activities, and pollution are factors that impact the plover population on wintering grounds (U.S. Fish and Wildlife Service, 1996). There are also unknown sources of mortality experienced during migration or on the wintering grounds

(Calvert et al., 2006; Root et al., 1992). Recent data suggest that lighting on vessels and on offshore oil and gas platforms may cause mortality and could help explain some of these unknown mortality events (Merkel & Johansen, 2011). New potential threats include wind turbine development projects which introduce the possibility of collision, disturbance, and displacement of plovers (Burger et al., 2011). Another threat is climate change resulting in sea level rise that would directly impact Atlantic coast piping plovers breeding and wintering habitat (U.S. Fish and Wildlife Service, 2009b).

3.9.2.2.3 Roseate Tern (*Sterna dougallii*)

Five subspecies of the roseate tern have been described, though some taxonomic designations are uncertain: *S. d. dougallii* in the North Atlantic, Europe, and the Caribbean; *S. d. korustes* in India, Sri Lanka, and Burma; *S. d. gracilis* in Australia and Indonesia; and *S. d.arideensis* on the Seychelles Islands (Cornell Lab of Ornithology, 2014). All subspecies are similar in appearance to *S. d. dougallii*, with slight differences in wing length and bill color. The North Atlantic and Caribbean population of *S. d. dougallii* is the subspecies that occurs within the Study Area (U.S. Fish and Wildlife Service, 2010a).

3.9.2.2.3.1 Status and Management

In the year 1987, the USFWS listed the roseate tern as endangered under the ESA along the Atlantic coast of the United States (Maine to North Carolina); in Canadian provinces of Newfoundland, Nova Scotia, and Quebec, as well as in Bermuda (U.S. Fish and Wildlife Service, 2010c). The species is listed as threatened under the ESA in the Western Hemisphere, including Florida, Puerto Rico, and the Virgin Islands (U.S. Fish and Wildlife Service, 2010c). No critical habitat has been designated for this species in the United States. In the year 2006, Canada designated critical habitat for the species (U.S. Fish and Wildlife Service, 2010a). Recovery and management plans have been implemented to protect breeding colonies, foraging areas, and wintering grounds (Cornell Lab of Ornithology, 2014). The plans intend to increase breeding population size, distribution, and productivity by maintaining, expanding, and enhancing nesting habitat (U.S. Fish and Wildlife Service, 1998). Recovery and management methods include posting nesting areas with signs and fencing, discouraging and controlling competing gull species, managing vegetation to enhance nesting habitat, and attempting to attract individuals to historically occupied sites (U.S. Fish and Wildlife Service, 1998).

3.9.2.2.3.2 Habitat and Geographic Range

Roseate terns arrive at their breeding grounds in late April and early May (early to mid-May in the Caribbean population) and spend approximately 2 weeks feeding before they occupy nesting grounds (U.S. Fish and Wildlife Service, 1998). Northeastern roseate terns migrate in late August and early September, traveling in groups through the eastern Caribbean and along the north coast of South America to wintering grounds along the northern and eastern South American coast (Cornell Lab of Ornithology, 2014; Kirkham & Nettleship, 1987; National Audubon Society, 2017; U.S. Fish and Wildlife Service, 1998, 2010a). The migratory pathway of Caribbean birds is not known, but the route is almost certain to be 2,000 to 4,000 km (1,243 to 2,485 mi.) shorter than the route taken by the northeastern population (U.S. Fish and Wildlife Service, 2010a).

Roseate terns are colonial breeders. The North Atlantic populations are known to nest on a limited number of small islands off New York and Massachusetts, while the Caribbean population similarly nests in Puerto Rico, the Dry Tortugas, and the Florida Keys, as well as other non-U.S. affiliated Caribbean islands (Cornell Lab of Ornithology, 2014). They nest on islands near or under cover, such as vegetation, rocks, driftwood, and even human-made objects. They have also been documented nesting on sand dunes found at the end of barrier beaches (U.S. Fish and Wildlife Service, 1998). North American roseate terns use moderately to heavily vegetated sites for nesting (Burger & Gochfeld, 1988). Unlike the northeastern population, Caribbean roseate tern nests are exposed. Nests are near vegetation or rocks, on open sandy beaches, narrow rock ledges close to the water line, or among coral rubble (U.S. Fish and Wildlife Service, 1993).

Open Ocean. Within the Study Area, North American roseate terns occur within open ocean areas (Gulf Stream and North Atlantic Gyre) more often during migration and staging for migration than during winter or the breeding season. Between May and September, small numbers of common and roseate terns are widely distributed at sea, southeast of Cape Cod and throughout the Gulf of Maine, east to the southeast edge of Georges Bank. Flocks of terns, including roseate terns, have been observed resting on the sea. Such occurrences at sea are typically associated with the occurrence of predatory fish (e.g., tuna) that drive prey species to the surface (U.S. Fish and Wildlife Service, 2010a).

Northeast U.S. Continental Shelf Large Marine Ecosystem. Most breeding North American roseate terns occur in this large marine ecosystem from late April/early May to late August/early September (Table 3.9-1). Approximately 80 percent of the northeast population breeds at two large colonies on Great Gull Island, New York; and Bird Island, Massachusetts; with the remaining percentage breeding at 15–20 smaller colonies in Canada and the United States (Connecticut, Massachusetts, Maine, and New York) (Cornell Lab of Ornithology, 2014). Sand flats and beaches of southeastern Massachusetts, particularly along outer Cape Cod and nearshore islands provide important roosting and loafing habitats during fall staging. The Nantucket Shoal between the Massachusetts mainland and the islands of Martha's Vineyard and Nantucket is a particularly important foraging area for the entire northeastern population (U.S. Fish and Wildlife Service, 2010a).

Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea Large Marine Ecosystems. Wintering North American roseate terns occur along the southeast Atlantic and gulf coasts (U.S. Fish and Wildlife Service, 2010c). The Caribbean population of roseate tern breeds from the Florida Keys through the West Indies to islands off Central America and northern South America (U.S. Fish and Wildlife Service, 1993). Within the Study Area, the Gulf of Mexico and Caribbean Sea Large Marine Ecosystems contain the population in the Florida Keys and Dry Tortugas, and Puerto Rico.

3.9.2.2.3.3 Population Trends

The estimated global population of roseate terns is approximately 70,000 to 82,000 (BirdLife International, 2010). They are a widespread species that breed on every continent except Antarctica, with populations in the Indian Ocean, Caribbean, Australasian, European, African, and North American regions (Gochfeld, 1983). Approximately 3,200 pairs are estimated in the northeast U.S. population, with an additional 75 pairs in Canada and 250 pairs in Florida (Cornell Lab of Ornithology, 2014). Within the Caribbean population, approximately 1,000 pairs occur in Puerto Rico, with an estimated 500 to 2,300 pairs in the U.S. Virgin Islands (Cornell Lab of Ornithology, 2014). The roseate tern experienced drastic declines in the late nineteenth century due to commercial hunting of feathers for the millinery (hat-making) industry (U.S. Fish and Wildlife Service, 1998), as well as humans seeking eggs for food (Kirkham & Nettleship, 1987). Populations again showed decline in the 1940s and 1970s as the geographic range and the number of breeding colonies decreased (U.S. Fish and Wildlife Service, 1998).

Groups of roseate terns can be small due to their limited population size and limited nesting habitat in North America. In the northeast, breeding colonies of roseate terns range from 2 to more than 1,000 pairs, depending on breeding colony location (U.S. Fish and Wildlife Service, 1998). After chicks fledge from their breeding colonies, terns tend to congregate in large numbers at post-breeding staging areas to build up energy reserves for their seasonal fall migration to South America (U.S. Fish and Wildlife Service, 2010a). Northeastern roseate terns are always mixed with gulls and other species of terns, while populations in the Caribbean and the Seychelles Islands are known to form single-species colonies (Cornell Lab of Ornithology, 2014). Duffy (1986) found that roseate terns foraging in smaller flocks experienced higher survival rates, while in larger groups they were often out-competed by common terns.

3.9.2.2.3.4 Predator and Prey Interactions

The roseate tern is a coastal species that forages for small schooling fishes over shallow waters around bays, channels, sandbars, shoals, and reefs (Cornell Lab of Ornithology, 2014; Nisbet & Spendelow, 1999). They are also known to forage out over deeper waters than other tern species (Olsen & Larsson, 1995). Local commutes of up to 16 mi. (25 km) from nesting grounds to dependable foraging sites have been documented (Nisbet & Spendelow, 1999). Roseate terns generally concentrate in areas where prey is available close to the surface, driven there either by water movements or larger predatory fish.

Roseate terns are specialized aerial plunge-divers that often completely submerge themselves when seizing fish (U.S. Fish and Wildlife Service, 2010c). Roseate terns tend to plunge from heights above the water's surface ranging from 3 to 20 ft., although plunges from greater than 39 ft. have been observed (Cornell Lab of Ornithology, 2014). Roseate terns do not plunge deep into the water column, usually less than 3 feet. Given the shallow depth of dives, submergence times of roughly 1-2 seconds can be anticipated. Roseate terns will often fly into the wind and hover (a behavior known as "kiting") with rapid wingbeats and then, with accelerated flapping, aerial plunge into the water (Kaufman, 1990; U.S. Fish and Wildlife Service, 1998). Prey species are herring, mackerel, anchovies, and sand eels (Cornell Lab of Ornithology, 2014).

Roseate tern eggs and young are preyed upon by hermit and land crabs, ants, snakes, other birds (e.g., hawks, owls, gulls, and some shorebirds), and mammals such as rats and feral cats (U.S. Fish and Wildlife Service, 1993).

3.9.2.2.3.5 Species-Specific Threats

Roseate tern population declines have been attributed to commercial hunting and egg collection, habitat loss and disturbance, organochlorine contamination, predation, and competition from gulls (U.S. Fish and Wildlife Service, 1998). These threats, combined with the small number of breeding sites used by the species, warranted the listing of the species (Nisbet & Spendelow, 1999). Roseate terns are sensitive to disturbance on their nesting grounds, and many suitable nesting sites have been lost or abandoned due to the expansion of recreational, residential, and commercial use (Gochfeld, 1983). Beach erosion and the expansion of gull populations have also displaced roseate terns from suitable nesting habitat (Cornell Lab of Ornithology, 2014). Roseate terns are vulnerable to predation and flooding because they nest on the ground, often in low-lying areas (Gochfeld, 1983). Storms and prolonged periods of cold, wet weather also impact nest success (U.S. Fish and Wildlife Service, 1993). Climate change and sea level rise may exacerbate erosion of nesting grounds and could result in more severe or more frequent storms, which could disturb these habitats and result in reduced survival of adults, eggs, chicks, and fledglings (U.S. Fish and Wildlife Service, 2010a). Starvation is likely a greater cause of death during the winter in areas such as the southern Caribbean where nutrients are relatively poor (Gochfeld, 1983). Although little is known about roseate tern ecology during migration and wintering periods, one major cause of death is believed to be humans hunting this species on its wintering grounds (outside the United States) (Cornell Lab of Ornithology, 2014). Emerging potential threats include wind turbine development projects which introduce the possibility of collision, disturbance, and displacement of this species during the breeding and migratory seasons (Burger et al., 2011).

3.9.2.2.4 Red Knot (*Calidris canatus rufa*)

Red knots are found on the Atlantic coast of the United States and Canada. They belong to the subspecies *C. canutus rufa* (Cornell Lab of Ornithology, 2013). This subspecies of red knot, referred to as the rufa red knot, is listed as threatened under the ESA.

3.9.2.2.4.1 Status and Management

Four petitions to emergency list the red knot have been submitted since 2004, and in December of 2014, the USFWS listed the red knot as threatened under the ESA (*Federal Register* 79[238]: 73706-73748, December 11, 2014). Currently there is no designated critical habitat for the red knot, nor are there any developed conservation plans available from the USFWS. The five-year goal highlighted in the species action plan is to stabilize and improve the conservation status of the species through increasing habitat protection, reducing disturbance, and protecting key resources at migration and wintering sites (Cornell Lab of Ornithology, 2013). The Western Hemisphere Shorebird Reserve Network has established an international network of wetlands in an effort to protect important sites used by shorebirds, including the red knot (Tsipoura & Burger, 1999). Additionally, efforts to develop protection for Delaware Bay, an important migration staging area for red knots, are underway by the Western Hemisphere Shorebird Reserve Network (Cornell Lab of Ornithology, 2013).

3.9.2.2.4.2 Habitat and Geographic Range

The species breeds on the central Canadian arctic tundra but migrates down and winters along the Atlantic and gulf coasts from southern New England to Florida, and as far south as South America (Cornell Lab of Ornithology, 2013). Red knots will briefly use important stopover areas such as the Delaware Bay to forage before returning to their breeding grounds each year. An interior red knot population winters in Texas and Louisiana and migrates through the west and midwest to central Canada.

Open Ocean Areas. Red knots migrate some of the longest distances known for birds, with many individuals annually flying more than 9,300 mi. (15,000 km) (Cornell Lab of Ornithology, 2013), during which they may cross over each of the open ocean areas in the Study Area. However, outside of migration they are typically found in nearshore habitats along coastlines. Fall migration peaks in August with birds flying south along the Atlantic coast to major wintering grounds on the coasts of Argentina and southern Chile (Cornell Lab of Ornithology, 2013).

Northeast U.S. Continental Shelf Large Marine Ecosystem. During migration stopovers, the red knot uses marine habitats and generally prefers coastal, sandy habitats near tidal bays, inlets, and estuaries for foraging (Cornell Lab of Ornithology, 2013). Red knots migrate in large flocks and stop over at the same coastal sites along the Atlantic coast during spring migration to feed on eggs of horseshoe crabs (*Limulus polyphemus*). In particular, Delaware Bay is one of the largest known spring (mid-May to early June) stopover sites for this species (*Federal Register* 71[176]: 53756-53835, September 12, 2006) (Clark et al., 1993). Up to 80 percent of the entire estimated red knot population has been observed at once in the Delaware Bay during spring migration, leading to the area being designated as the first hemispheric site in the Western Hemisphere Shorebird Reserve Network (Clark et al., 1993; Niles et al., 2008; Tsipoura & Burger, 1999).

Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems. During fall and spring migration and winter months, red knots occur in nearshore coastal habitats, along the Atlantic and gulf coasts from southern New England to Florida and into the Gulf of Mexico (Cornell Lab of Ornithology, 2013). The Virginia Atlantic barrier islands are a second major stopover location, with red knot peak counts between 5,500 and 9,100 birds since 1995 (Niles et al., 2008). They primarily occur in intertidal surf-zone habitats, particularly near coastal inlets, estuaries, and bays.

3.9.2.2.4.3 Population Trends

The red knot population was previously estimated at 100,000 to 150,000 individuals in the 1980s (Niles et al., 2008). However, annual aerial and ground surveys of Delaware Bay show fluctuation but generally a downward trend. Population surveys during the stopover period in the spring of 1998 at Delaware Bay estimated 50,000 red knots. In 2004, the same survey was repeated and the estimated population was substantially lower at 18,000 (Niles et al., 2008). Surveys of red knots at both migration stopover sites and wintering grounds continually show substantial population declines in recent decades (*Federal Register* 71[176]: 53756-53835, September 12, 2006). For example, surveys during the mid-1980s of wintering red knot populations in South America (Argentina and Chile) provided an estimate of 67,500 individuals (Niles et al., 2008); but according to the USFWS, since 2005, numbers have been under 20,000 birds, and dipped below 10,000 in 2011. Studies from 1994 to 2002 also show decreased annual adult survival rates related to these population declines (Niles et al., 2008).

3.9.2.2.4.4 Predator and Prey Interactions

Red knots forage by surface pecking and probing for intertidal invertebrates and various species of mussels and other molluscs (Cornell Lab of Ornithology, 2013). During spring migration, a major food source for red knots are horseshoe crab eggs; millions of which can be found in the Delaware Bay during the second half of May (Botton et al., 1994). Red knot migration coincides with the horseshoe crabs laying their eggs, allowing birds to restore their fat reserves to continue their northward migration to their breeding grounds in the arctic (Cornell Lab of Ornithology, 2013; Tsipoura & Burger, 1999).

Outside of the breeding grounds, red knot predators include peregrine falcon (*Falco peregrinus*), merlin (*Falco columbarius*), northern harrier (*Circus cyaneus*), short-eared owl (*Asio flammeus*), great black-backed gull (*Larus marinus*), and accipiters (*Accipiter* spp.) (Niles et al., 2008). Predators on breeding grounds include arctic fox (*Alopex lagopus*), long-tailed jaeger (*Stercorarius longicaudus*), and parasitic jaeger (*Stercorarius parasiticus*) (Piersma et al., 1993).

3.9.2.2.4.5 Species-Specific Threats

The red knot is threatened under the ESA mainly by habitat loss and degradation of foraging resources such as reduction of horseshoe crab populations (U.S. Fish and Wildlife Service, 2010b). Horseshoe crabs are harvested for their blood for biomedical research and their eggs for bait in the conch and eel fishing industries; consequently, the reduction in the amount of horseshoe crab eggs available for red knots, especially in Delaware Bay, is believed to be the cause of lower weight gain in red knots during migratory stopovers and contributing to lower adult survival (Niles et al., 2008). Beach erosion, shoreline protection and stabilization projects, human disturbance, limited food resources, oil spills, red tides, hunting, and severe weather all threaten the stability of the population (Niles et al., 2008; U.S. Fish and Wildlife Service, 2010b). Because large percentages of the entire population gather at single sites during migration (i.e., Delaware Bay) and winter, the species is especially vulnerable to loss of key resources at these sites (Clark et al., 1993; Cornell Lab of Ornithology, 2013; Niles et al., 2008).

3.9.2.2.5 Indiana Bat (*Myotis sodalis*)

3.9.2.2.5.1 Status and Management

The Indiana bat was originally listed as in danger of extinction under the Endangered Species Preservation Act of 1966 and is currently listed as endangered under the ESA. In 2009, its recovery priority was changed from 8 (meaning that the species has a moderate degree of threat and high recovery potential) to 5 (meaning that the species has a high degree of threat and a low recovery potential) due to the emergence and poor understanding of white-nose syndrome (U.S. Fish and Wildlife Service, 2009a). Critical habitat was designated for the species in 1976 (*Federal Register* 41[187]: 41914-41916, September 24, 1976). Eleven caves and two mines in six states (Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia) were listed as critical habitat. Significant information gaps remain regarding the species' ecology that hinder sound decision-making on how best to manage and protect the species (U.S. Fish and Wildlife Service, 2007).

3.9.2.2.5.2 Habitat and Geographic Range

Indiana bats hibernate, typically beginning in mid-October (in northern areas) or by the end of November (in southern areas) and ending by early May (for females) or mid-May (for males), with female peak emergence in mid-April and male peak emergence early May. It is thought that spring migration, which may occur either immediately upon emergence or a few days after emergence, may cause higher mortality due to low fat reserves and food supplies. Large numbers of Indiana bats complete their migration in mid-May, and fall migration begins during the first two weeks of August (U.S. Fish and Wildlife Service, 2007).

Extent hibernacula are patchily distributed northeast-southwest from Vermont to Tennessee, and east-west from Tennessee to Arkansas. Between 1995 and 2005, 281 hibernacula were active for at least one year. Of these, only one county (in Connecticut) containing one Priority 4 (i.e., lowest priority) hibernacula was located along the eastern coast of the U.S., and only one county (in New Jersey) containing two Priority 3 (i.e., second-lowest priority) hibernacula are adjacent to a county located along the eastern coast of the U.S. (U.S. Fish and Wildlife Service, 2007).

Extent maternity colonies are generally more clustered, located along the borders of Iowa, Missouri, and Illinois as well as throughout Indiana and southern Michigan, with scattered colonies in the northeastern U.S. None of the 269 extent maternity colonies are located in a county along the coast, and only 6 colonies (all in New Jersey) are located adjacent to a county along the coast (U.S. Fish and Wildlife Service, 2007).

Based on the description provided above, the Indiana bat is expected to occur in portions of the Study Area (refer to Table 3.9-1) infrequently, during summer months.

3.9.2.2.5.3 Population Trends

Estimates of prehistoric Indiana bat populations, based on paleontological evidence, range from 1.7 million to 9-13 million. One analysis of bone deposits at Bat Cave, Kentucky, in Mammoth Cave National Park, revealed an estimated 300,000 Indiana bats had died during a single flood event; it is uncertain whether this catastrophic population loss occurred during prehistoric times or during a large flood in 1937 that devastated much of the Ohio River valley (U.S. Fish and Wildlife Service, 2007).

When the Indiana bat was originally listed, its rangewide population was estimated at approximately 880,000. In 1983, when the first recovery plan was completed and approved, the rangewide population was estimated at about 550,000. Despite the acquisition and protection of over 35 caves and mines by government agencies or private conservation organizations, the rangewide Indiana bat population was estimated at 353,000 bats in 1997 (U.S. Fish and Wildlife Service, 2009a). These earlier estimates are considered low, however, due to discoveries of new hibernaculums. For example, one hibernaculum was discovered in Missouri in 2012 that contained a minimum of 123,000 bats when partially surveyed in January 2013 and over 167,000 bats when more completely surveyed in January 2015. Based on earlier accounts of very large numbers of unidentified bats using this hibernaculum for decades, the U.S. Fish and Wildlife Service decided to add the same number of bats as was found in 2015 (i.e., 167,000) to each previous biennium total for Missouri through 1981. Based on the best available data for the species, the U.S. Fish and Wildlife Service currently estimates that approximately 635,000 bats occurred rangewide in 2007 and that the population fell to approximately 524,000 in 2015 (U.S. Fish and Wildlife Service, 2015b).

3.9.2.2.5.4 Predator and Prey Interactions

Indiana bats feed on flying insects, with only a very small amount of spiders (presumably ballooning individuals) included in the diet. Four orders of insects contribute most to the diet: Coleoptera, Diptera, Lepidoptera, and Trichoptera. Terrestrial-based prey (moths and beetles) were more common in southern studies, whereas aquatic-based insects (flies and caddisflies) dominated in the north. It is presumed that this difference indicates southern bats foraged more in upland habitats, and northern bats hunted more in wetlands or above streams and ponds. Indiana bats are also known to consume other flying insects such as Hymenopterans (winged ants) and Asiatic oak weevils (*Cyrtepistomus castaneus*) when opportunistically available (U.S. Fish and Wildlife Service, 2007).

3.9.2.2.5.5 Species-Specific Threats

Threats to the Indiana bat vary during its annual cycle. Within the last 10 years, white-nose syndrome emerged as a significant threat as it as it causes precipitous declines in populations of cave-hibernating bat species (see Section 3.9.2.1.5.3, Disease and Parasites). Other threats at the hibernacula include modifications to caves, mines, and surrounding areas that change airflow and alter the microclimate within the hibernacula. Human disturbance and vandalism pose significant threats during hibernation through direct mortality and by inducing arousal and consequent depletion of fat reserves. Natural catastrophes can also have a significant effect during winter because of the concentration of individuals in a relatively few sites. During summer months, possible threats relate to the loss and degradation of forested habitat. Migration pathways and swarming sites may also be affected by habitat loss and degradation (U.S. Fish and Wildlife Service, 2007).

3.9.2.2.6 Northern Long-eared Bat (*Myotis septentrionalis*)

3.9.2.2.6.1 Status and Management

The northern long-eared bat was listed as threatened under the ESA on 4 May 2015. It occurs in 37 states, the District of Columbia, and 13 Canadian provinces (U.S. Fish and Wildlife Service, 2016a). The USFWS has determined that designating wintering habitat as critical habitat for the species would likely increase the threat of vandalism, disturbance, or the spread of white-nose syndrome. Furthermore, the USFWS has determined there are no areas within the summer habitat that meet the definition of critical habitat (U.S. Fish and Wildlife Service, 2016b). In January 2016, the USFWS established a white-nose syndrome zone under Rule 4(d) of the ESA. Incidental take of the northern long-eared bat is only allowed outside of the white-nose syndrome zone. The boundary of this zone is updated monthly as new data are collected and is available online at the U.S. Fish and Wildlife Service's Midwest Region website. As of May 2017, the white-nose syndrome zone included a vast majority of the northern long-eared bat's range and virtually the entire extent of its range along the east coast (Section 3.9.2.2.1.2, Habitat and Geographic Range) (U.S. Fish and Wildlife Service, 2017b).

3.9.2.2.6.2 Habitat and Geographic Range

Hibernation generally occurs from October through April, depending on the local climate. Suitable habitat for hibernation includes caves and cave-like structures (e.g., abandoned or active mines, railroad tunnels). The spring migration period typically runs from mid-March to mid-May. Suitable summer habitat for the northern long-eared bat consists of a wide variety of forested and wooded habitats as well as linear features such as fence rows, riparian forests, and other wooded corridors with variable amounts of canopy closure. Mature forests are an important habitat type for foraging northern long-eared bats (U.S. Fish and Wildlife Service, 2016a).

Unlike the true long-distance migratory bats (*Lasiurus* spp. and *Lasionycteris* spp.), the northern long-eared bat does not undertake long-distance migrations between summer and winter ranges but will make shorter distance movements between summer roosts and winter hibernacula (Yates, 2015). Within the United States, its range extends along the eastern coast from Canada to northeastern North Carolina, with additional small patches along the coast of southern North Carolina and southern South Carolina (U.S. Fish and Wildlife Service, 2017a, 2017b). Within the Study Area, northern long-eared bats are most likely to occur off the coast of the Northeastern United States and Canada (U.S. Department of Energy, 2016).

In a literature review, Pelletier et al. (2013) report that northern long-eared bats were found along the coastline or offshore on islands at:

- Kejimkujik National Park, Brier Island, and Bon Portage Island in Nova Scotia, Canada. Nova Scotia is a peninsula that is separated from the mainland to the south by 30 to 50 mi. of water. Brier Island and Bon Portage Island are separated from Nova Scotia by approximately 8 mi. and about 2 mi., respectively. Observed during summer months.
- Bay of Fundy National Park, New Brunswick, Canada, in summer to early fall.
- Martha's Vineyard, Massachusetts, approximately 4 mi. from mainland, during mist-netting surveys from April through October.
- Mount Desert Island, Maine (2 mi. off the coast), between May and September.

In addition, U.S. Department of Energy (2016) reports that ongoing mist-netting surveys at coastal sites in the northeast have also indicated relatively high numbers of northern long-eared bats post the introduction of white-nose syndrome compared to other, non-coastal areas in the northeast.

Northern long-eared bats have been detected during surveys at a variety of Navy installations along the eastern coast. These installations include:

- Naval Computer and Telecommunications Area Master Station Atlantic Detachment Cutler, located on the coast in Cutler, Maine, near the border with Canada. Data suggests there were likely some long-distance migratory tree-roosting bats spending the summer residency period at the installation and that other long-distance migratory bats moved through the Installation during the fall (Tetra Tech Inc, 2014). However, no northern long-eared bats were detected at the Installation in surveys by Yates (2015).

- Naval Weapons Station Earle in Colts Neck, New Jersey, where northern long-eared bats were present and roosting at the installation. The survey report authors note that the "presence of a sustained population of northern long-eared bats on Naval Weapons Station Earle is a testament to the amount of preferred habitat, contiguous forest, that the installation is able to provide compared to the surrounding areas."
- Naval Weapons Station Yorktown and Naval Supply Center Cheatham Annex in Williamsburg, Virginia (Tetra Tech Inc, 2017b). One bat was detected during the 2016 surveys, and a juvenile was detected during 2014 surveys. The authors report that the presence of the juvenile "suggests that there may be successful Northern long-eared bat maternity colonies in the area."
- Two installations along the coast in Virginia Beach, Virginia:
    - Joint Expeditionary Base Fort Story (Tetra Tech Inc, 2016a).
    - Naval Air Station Oceana Dam Neck Annex (Tetra Tech Inc, 2016b).

In addition to the above, although no northern long-eared bats were detected at Naval Air Station Oceana in Virginia Beach, Virginia, they were detected near the installation in 2014 and 2015, and there is suitable habitat available on the installation (Tetra Tech Inc, 2016c).

3.9.2.2.6.3 Population Trends

The U.S. Fish and Wildlife Service (2016c) estimated the rangewide northern long-eared bat population at over 6.5 million adults. The Midwest supports 43% of the total population, followed by the Southern range (38%), the Eastern range (17%), and the Western range (2%). Arkansas and Minnesota are the two states with the largest populations, with approximately 863,850 (13%) and 829,890 (13%) adults, respectively. In areas affected by white-nose syndrome, however, the population is likely overestimated as (1) there is a clear downward trend in these areas, (2) most data are at least a year old, and (3) three years of occupancy data were used.

3.9.2.2.6.4 Predator and Prey Interactions

The northern long-eared bat has a diverse diet including moths, flies, leafhoppers, caddisflies, and beetles, and its diet differs geographically and seasonally. It forages using both hawking (catching prey in flight) and gleaning (picking motionless insects from vegetation and water surfaces) behaviors (U.S. Fish and Wildlife Service, 2016a, 2017a). Lepidopterans (moths) and coleopterans (beetles) are the most common insects found in northern long-eared bat diets, although arachnids are also a common prey item. Most foraging occurs above the understory, 1 to 3 m above the ground, but under the canopy on forested hillsides and ridges, rather than along riparian areas.

3.9.2.2.6.5 Species-Specific Threats

The northern long-eared bat is one of the species of bats most impacted by white-nose syndrome (see Section 3.9.2.1.5.3, Disease and Parasites), which has caused declines of 90 to 100% where the disease has been found and is the primary factor supporting the endangered species status determination. Declines in the numbers of northern long-eared bats are expected to continue as white-nose syndrome extends across the species' range (U.S. Fish and Wildlife Service, 2016a).

3.9.2.3 Species Not Listed Under the Endangered Species Act

At least 160 species of birds, and at least 24 species of bats, are found within the Study Area that are not listed under the ESA. The major groups of birds are described in Section 3.9.2.3.1 (Major Groups), and

Section 3.9.2.3.3 (Migratory Birds) describes species that are protected and of conservation concern under the Migratory Bird Treaty Act. Section 3.9.2.3.2 (Bats) describes the bats that are known or are expected to occur in the Study Area.

3.9.2.3.1 Major Bird Groups

There are 11 major taxonomic groups of birds represented in the Study Area Table 3.9-2. These birds may be found in the air, at the water's surface, or in the water column of the Study Area. The vertical distribution descriptions in Table 3.9-2 provide a representative description of the taxonomic group; however, due to variations in species behavior, these descriptions may not apply to all species within each group. Distribution in the water column is indicative of a species known to dive under the surface of the water (for example, during foraging). More detailed species descriptions, including diving behavior, are provided in Sections 3.9.2.3.1.1 (Geese, Swans, Dabbling, and Diving Ducks [Order Anseriformes]) through 3.9.2.3.1.11 (Neotropical Migrant Songbirds, Thrushes, Allies, Cuckoos, Swifts, and Owls [Orders Passeriformes, Cuculiformes, and Apodiformes]).

All 11 major taxonomic groups of birds in the Study Area occur in open ocean areas (Labrador Current, North Atlantic Gyre, Gulf Stream) or coastal waters of large marine ecosystems (West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea), as shown in Table 3.9-2 Refer to Figure 3.0-1 for a map of open ocean areas and large marine ecosystems in the Study Area.

Table 3.9-2: Major Taxonomic Groups of Birds in the Study Area

Major Bird Groups		***Vertical Distribution in the Study Area***		
Common Name (Taxonomic Group)	***Description***	***Open Ocean Areas***	***Large Marine Ecosystem***	***Inshore Waters***
Geese, swans, dabbling and diving ducks (Order Anseriformes)	Diverse group of birds that inhabit shallow waters, coastal areas, and deeper waters. Feed at the surface by dabbling or by diving in deeper water. Often occur in large flocks.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Loons (Order Gaviiformes)	Duck-like, fish-eating birds that capture prey by diving and underwater pursuit.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Grebes (Order Podicipediformes)	Small diving birds, duck-like. May occur in small groups.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column

Table 3.9-2: Major Taxonomic Groups of Birds in the Study Area (continued)

Major Bird Groups		*Vertical Distribution in the Study Area*		
Common Name (Taxonomic Group)	***Description***	***Open Ocean Areas***	***Large Marine Ecosystem***	***Inshore Waters***
Albatrosses, fulmars, petrels, shearwaters, and storm-petrels (Order Procellariiformes)	Group of largely pelagic seabirds. Fly nearly continuously when at sea. Soar low over the water surface to find prey. Some species dive below the surface.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Boobies, gannets, cormorants, anhingas, and frigatebirds (Order Suliformes)	Diverse group of large, fish-eating seabirds with four toes joined by webbing. Often occur in large flocks near high concentrations of bait fish.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Tropicbirds (Order Phaethontiformes)	Oceanic birds, found far offshore, over warm water and are often seen resting on the water. Flight is high and steady and they plunge into water to catch fish.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Pelicans, herons, egrets, Ibis, and spoonbills (Order Pelecaniformes)	Large wading birds with dagger-like, down-curved, or spoon-shaped bills used to capture prey in water or mud.	None	Airborne, surface, water column	Airborne, surface, water column
Flamingos (Order Phoenicopteriformes)	Large, wading birds with unique angled bill to filter invertebrates from water or mud.	None	Airborne, surface	Airborne, surface
Osprey, bald eagles, peregrine falcons (Orders Accipitriformes, and Falconiformes)	Large raptors that inhabit habitats with open water, including coastal areas. Feed on fish, waterfowl, or other mammals. Migrate and forage over open water.	None	Airborne, surface	Airborne, surface
Osprey, bald eagles, peregrine falcons (Orders Accipitriformes, and Falconiformes)	Large raptors that inhabit habitats with open water, including coastal areas. Feed on fish, waterfowl, or other mammals. Migrate and forage over open water.	None	Airborne, surface	Airborne, surface
Shorebirds, phalaropes, gulls, noddies, terns, skua, jaegers, and alcids (Order Charadriiformes)	Diverse group of small to medium-sized shorebirds, seabirds and allies inhabiting coastal, nearshore, and open ocean waters	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column

Table 3.9-2: Major Taxonomic Groups of Birds in the Study Area (continued)

Major Bird Groups		*Vertical Distribution in the Study Area*		
Common Name (Taxonomic Group)	***Description***	***Open Ocean Areas***	***Large Marine Ecosystem***	***Inshore Waters***
Neotropical Migrant Songbirds, Warblers, Thrushes, Cuckoos, Owls, Swifts, and Allies (Orders Passeriformes Cuculiformes, Strigiformes, and Apodiformes)	Largest and most diverse group of birds in North America, primarily occur in coastal, and inland areas, but occur in large numbers over the open ocean (particularly over the Gulf of Mexico) during annual spring and fall migration periods.	Airborne	Airborne	Airborne

Sources: American Ornithologists' Union (2017), Sibley (2014) for major bird taxonomic groups.

3.9.2.3.1.1 Geese, Swans, Dabbling and Diving Ducks (Order Anseriformes)

There are 50 species of swans, geese, and dabbling, diving, and seaducks in the family Anatidae in North America. No birds from this group are considered Birds of Conservation Concern (U.S. Fish and Wildlife Service, 2008b). Birds from this group range from dabbling ducks found in coastal bays, estuaries, and lagoons to more open water ducks found in deeper water environments. Twenty-three of these species are diving ducks that inhabit nearshore or offshore waters of the Study Area (Sibley, 2014). Eiders, scoters, long-tailed duck (*Clangula hyemalis*), and harlequin duck (*Histrionicus histrionicus*) are seaducks that winter in nearshore ocean waters. All these species can be found in deeper water where they dive to forage (Sibley, 2014), some also forage on the ocean bottom in shallow water. Most diving duck species dive down to depths up to 33 ft. (10 m) but long-tailed ducks have been reported to dive down to depths up to 218 ft. (66 m) with a dive time of around 35 seconds (Sibley, 2014). Some inshore shark species, as well as alligators and crocodiles, prey on ducks on the surface of the water (Ehrlich et al., 1988).

Seaducks and some diving ducks (e.g., scaups) breed inland but winter in large numbers in the Atlantic coastal waters of the Study Area and dive to the bottom, feeding primarily on benthic invertebrates. The harlequin duck is small and agile and prefers very turbulent water such as freshwater streams during the breeding season. Their winter habitat includes coastal intertidal areas, but they roost at night on open water farther offshore (greater than 0.6 mi. [1 kilometer]) (Robertson & Goudie, 1999). The long-tailed duck winters in small groups in shallow ocean habitat.

Representative species that can be found in coastal bays, estuaries, and lagoons include geese (e.g., Canada goose [*Branta tellate*], brant [*Branta bernicla*]); swans (e.g., trumpeter swan [*Cygnus buccinators*], tundra swan [*Cygnus columbianus*]); dabbling ducks (e.g., mallard [*Anas platyrhynchos*], gadwall [*Anas strepera*], mottled duck [*Anas fulvigula*], American black duck [*Anas rubripes*], American wigeon [*Anas tellate*], northern shoveler [*Anas clypeata*], blue-winged teal [*Anas discors*], and green-winged teal [*Anas crecca*]); diving ducks (e.g., redhead [*Aythyatellate*], bufflehead [*Bucephala albeola*], common goldeneye [*Bucephala clangula*], and red-breasted merganser [*Mergus serrator*]); eiders (e.g., common eider [*Somateria mollissima*], king eider [*Somateria spectabilis*]); and scoters (e.g., surf scoter [*Melanitta perspicillata*], black scoter [*Melanitta tellate*]) (American Ornithologists' Union, 1998).

3.9.2.3.1.2 Loons (Order Gaviiformes)

There are five species of loons in the family Gaviidae in North America (American Ornithologists' Union, 1998), three of which occur in the Study Area. The common loon (*G. immer*) and the red-throated loon (*G. stellata*) are Birds of Conservation Concern (U.S. Fish and Wildlife Service, 2008b). Loons are medium to large fish-eating birds that capture prey by diving underwater (Sibley, 2014). Loons can dive down to 250 ft. (76 m) with an average dive time of 40 seconds (Sibley, 2014). Loons move ashore only to breed, and all loon species nest on banks of inland ponds or lakes, requiring specific habitat features such as undeveloped shoreline and nest sites that have steep drop offs so they can approach their nest from underwater (Cornell Lab of Ornithology, 2009). For example, common loons spend their time in both freshwater and saltwater environments but prefer to nest on islands where the shoreline is not developed. Most loons need about 100 ft. (30.5 m) of room to take off, so size is another habitat feature that is important for nesting areas. During migration, loons fly high above land or water in loose groups or singly. They winter in coastal, nearshore, or open water marine habitats (Sibley, 2014). For example, the Pacific loon (*G. pacifica*) prefers deep water and is found on the open ocean and in bays. The red-throated loon, a representative species within the Study Area, has a circumpolar distribution, breeds in high latitudes on remote ponds, and winters along the Atlantic and Pacific coasts (American Ornithologists' Union, 1998).

3.9.2.3.1.3 Grebes (Order Podicipediformes)

There are seven species of grebes in the family Podicipedidae in North America (American Ornithologists' Union, 1998). Two of these species, the pied-billed grebe (*Podilymbus podiceps*) and horned grebe (*Podiceps auritus*) are Birds of Conservation Concern (U.S. Fish and Wildlife Service, 2008b). Grebes can be found in a variety of aquatic habitats ranging from seasonally flooded scrubland and roadside ditches to deep lakes and coastal bays. Most grebe species winter in open waters while preferring marshy, vegetated habitats during the summer months (Sibley, 2014). Grebes forage by diving for small aquatic animals such as insects, fish, and crustaceans in the water column. For example, horned grebes can dive for up to 3 minutes and travel 500 ft. underwater, where they are sometimes preyed upon by sharks and orcas (Ehrlich et al., 1988). Grebes tend to escape predators by diving or sinking, leaving only the head exposed, rather than taking flight. All grebe species build floating nests in marshes and winter on the ocean and nearshore coastal areas (Sibley, 2014).

3.9.2.3.1.4 Albatrosses, Fulmars, Petrels, Shearwaters, and Storm-Petrels (Order Procellariiformes)

Procellariiformes is a large order of open ocean seabirds that are divided into four families: Diomedeidae (albatrosses), Procellariidae (petrels and shearwaters), Hydrobatidae (storm-petrels), and Pelecanoididae (diving petrels) (Enticott & Tipling, 1997; Onley & Scofield, 2007). This order includes species that are generally long-lived, breed once a year, and lay only one egg; thus, they have a low reproductive output. One of these species is listed as endangered under the ESA (Section 3.9.2.2.1, Bermuda Petrel [*Pterodroma cahow*]) (U.S. Fish and Wildlife Service, 2010d) and four are Birds of Conservation Concern as shown in (U.S. Fish and Wildlife Service, 2008b).

Many seabirds spend most of their lives at sea and come to land only to breed, nest, and occasionally roost (Schreiber & Chovan, 1986). Colonial breeding is believed to have evolved in response to the limited availability of relatively predator-free nesting habitats and distance to foraging sites from breeding grounds (Siegel-Causey & Kharitonov, 1990). Benefits of colonial breeding include increased detection of predators and decreased chance of predation of young while parent birds are foraging away from the nest (Gill, 1995).

Seabirds can be found in high numbers resting on the water surface in flocks where prey is concentrated (Enticott & Tipling, 1997). Some species are found around fishing boats, where they often feed on bycatch and may become injured from longline gear (Enticott & Tipling, 1997; Onley & Scofield, 2007). Also, because of their pelagic nature, this group is preyed on by some pelagic shark species (Ehrlich et al., 1988). Oceanic fronts (gradients in current speed, temperature, salinity, density, and enhanced circulation) attract seabirds due to increased foraging opportunities. For example, the at-sea distribution of some seabirds is associated with oceanic fronts, which support increased numbers of prey and provide favorable foraging conditions (Bost et al., 2009).

There are 20 species of Procellariiformes in North America, with 13 species representing two families-the storm-petrels and petrels and shearwaters (American Ornithologists' Union, 1998)-occurring within the Study Area. Most of the petrel species in the Study Area are not considered part of the diving petrels and forage along the surface of the ocean. Petrels are colonial nesters and tend to nest on remote islands uninhabited by people.

Storm-petrels pick prey off the surface while foraging. Most breed in natural holes/cryptic burrows and visit their colonies only at night (Enticott & Tipling, 1997; Onley & Scofield, 2007). Fulmarine petrels, such as the northern fulmar (*Fulmarus glacialis*) and the black-capped petrel (*Pterodroma hasitata*), feed by landing on the sea and grabbing prey near the surface. Most fulmarine petrels nest in burrows or on cliff ledges and visit nests by day (Enticott & Tipling, 1997; Onley & Scofield, 2007). Gadfly petrels are generally species of the *Pterodroma* genus and are long-winged, fast flying, and highly pelagic. They feed on the wing and land on the sea (Onley & Scofield, 2007). Some gadfly petrels nest in burrows or crevices and visit colonies at night (Enticott & Tipling, 1997; Onley & Scofield, 2007).

Shearwaters are small- to medium-sized and dive to varying depths for prey (Onley & Scofield, 2007). For example, Cory's shearwater (*Calonectris diomedea*) rarely dives to 16 ft. (5 m) below the surface, while sooty (*Puffinus griseus*) and short-tailed shearwaters (*Puffinus tenuirostris*) can reach depths of 230 ft. (70 m), swimming underwater with half-open wings (Enticott & Tipling, 1997; Onley & Scofield, 2007). Greater shearwaters in the South Atlantic Ocean have been reported to dive down to 62 ft. (19 m) and as long as 40 s in a single dive. However, the majority of their dives were less than 6.6 ft. (2 m) (Ronconi et al., 2010).

3.9.2.3.1.5 Boobies, Gannets, Cormorants, and Frigatebirds (Order Suliformes)

The Suliformes order is a diverse group of large seabirds including anhingas, gannets, boobies, cormorants, and frigatebirds. This order is composed of 16 species in 4 families—12 species representing 2 families that occur within the Study Area. Four of these species are considered Birds of Conservation Concern (U.S. Fish and Wildlife Service, 2008b). Species of concern within the Study Area include the brown booby (*Sula leucogaster*), masked booby (*Sula dactylatra*), great cormorant (*Phalacrocorax carbo*), and magnificent frigatebird (*Fregata magnificens*) (American Ornithologists' Union, 1998).

Suliformes are less pelagic than the Procellariiformes, although some of these species such as frigatebirds are pelagic. Most species are colonial, feed on fish, and use a variety of breeding habitats including trees and bushes (but not burrows). Breeding strategies vary among species, with some being long-lived and having low breeding success, while others have higher annual breeding success, but higher annual adult death (Enticott & Tipling, 1997; Onley & Scofield, 2007).

Cormorants are voracious predators on inshore fishes and have been implicated as a major threat to the recovery efforts of Atlantic salmon in the Gulf of Maine where they feed on juvenile salmon (smolts) leaving the estuaries (Fay et al., 2006; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2005). Their offshore foraging range is limited by their need for undisturbed, dry nocturnal roosting sites (Shields et al., 2002).

Boobies and gannets are large seabirds that plunge from the air to capture their prey. Filling similar niches, boobies inhabit warmer areas and gannets colder regions. Boobies and gannets often nest on islands in colonies, with gannets nesting on cliffs (BirdLife International, 2012) and boobies generally on the ground if predators allow (Pratt et al., 1987). They forage offshore in large flocks at night, often feeding on squid.

Like tropicbirds and pelicans, members of this group all have webbed feet and eight toes, and all have a throat sac, called a gular sac (Brown & Harshman, 2008). This sac is highly developed and visible in pelicans and frigatebirds but is also readily apparent in boobies and cormorants. Pelicans use the sac to trap fish, frigatebirds use it as a mating display and to feed on fish, squid, and similar marine life (Dearborn et al., 2001), and cormorants and boobies utilize the sac for heat regulation. These birds nest in colonies, but individual birds are monogamous (Brown & Harshman, 2008).

3.9.2.3.1.6 Tropicbirds (Order Phaethontiformes)

Tropicbirds are medium-sized seabirds, predominately white with black patterning on the back, wings, and face. They have thick, pointed bills that are red or orange in color that are slightly decurved. Their most notable feature is the extremely long and narrow central tail feathers, which can be 11 to 22 inches (in.) long. Their wingspans average around 3 feet. Superficially, tropicbirds resemble terns. Tropicbirds are highly pelagic foragers in tropical and subtropical oceans, coming to land mainly to breed (Sibley, 2014). Tropicbirds are plunge-divers that feed on fish and could occur as rare visitors offshore in the Study Area in the Gulf of Mexico, Caribbean Sea, and Southeast U.S. Continental Shelf Large Marine Ecosystems, and in the Gulf Stream and North Atlantic Gyre Open Ocean Areas (Sibley, 2014). No birds from this group are considered Birds of Conservation Concern (U.S. Fish and Wildlife Service, 2008b).

3.9.2.3.1.7 Pelicans, Herons, Egrets, Ibis, and Spoonbills (Order Pelecaniformes)

Pelecaniformes is a large group composed of long-legged, large billed species that includes pelicans, herons, egrets, ibis, and spoonbills. However, with the exception of two species of pelicans (described below), they are inhabitants of freshwater marshes and are unlikely to occur in the Study Area. Five of these species (roseate spoonbill, reddish egret, snowy egret, American bittern, and least bittern) are Birds of Conservation Concern as shown in Table 3.9-4 (U.S. Fish and Wildlife Service, 2008b).

The brown pelican (*Pelecanus occidentalis*) primarily occurs in shallow (less than 150 ft. [46 m]) warm coastal marine and estuarine environments, as well as offshore where they forage primarily on fish by head first plunge-diving. Most plunge-diving is limited to 3.5 to 6.5 ft. (1 to 2 m) within the water column. Foraging occurs within 12 mi. (20 km) of nesting islands during the breeding season, and up to 47 mi. (75 km) offshore during the nonbreeding season (Shields et al., 2002). American white pelicans (*Pelecanus erythrorhynchos*) are found in shallow coastal bays, inlets, and estuaries that support forage fish (Knopf & Evans, 2004). Flocks forage cooperatively, swimming and encircling fish as a coordinated group or driving them into shallows, where they are caught with synchronized bill dipping (Enticott & Tipling, 1997; Onley & Scofield, 2007).

3.9.2.3.1.8 Flamingos (Order Phoenicopteriformes)

Flamingos are gregarious (social) wading birds in the genus *Phoenicopterus*, and the only genus in the family Phoenicopteridae. The American flamingo (*P. ruber)* species is found in the Study Area. The distribution range of the flamingo is extremely large and includes many Caribbean and South American countries. However, their occurrence in the United States is limited to the southern tip of Florida (Everglades National Park) (Sibley, 2014; Stevens & Pickett, 1994).

These wading birds forage in intertidal areas by rhythmically swinging their bills from side to side and filtering small organisms out of the mud (Sibley, 2014). Though most of their life cycle is spent along coastal areas, migration over offshore areas does occur (Elphick, 2007). They forage in shallow water, swinging their bill from side to side and filtering small organisms out of the mud (Sibley, 2014).

3.9.2.3.1.9 Osprey, Bald Eagles, Kites and Falcons (Orders Accipitriformes and Falconiformes)

Accipitriformes is a large group consisting of 60 species in three families (American Ornithologists' Union, 1998). This order generally has broad wings well-suited for soaring. Falconiformes include 9 North American species that, with the exception of the caracara (*Caracara cheriway*), are fast flying predators with pointed wings and a streamline body shape (Sibley, 2014). Members of both orders hunt by day and feed on a variety of prey, including fish, small mammals, reptiles, and carrion. Species that are likely to occur within the Study Area include the osprey (*Pandion haliaetus),* bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), and swallow-tailed kite (*Elanoides forficatus*). The bald eagle, peregrine falcon, and swallow-tailed kite are Birds of Conservation Concern.

Ospreys live near slow-moving waters of coastal, nearshore, and freshwater environments in many parts of the Study Area. They are plunge feeders but also have the ability to capture prey with their feet while keeping their head above water. Fish make up a large portion of their diet, and therefore, their vision is well adapted to detecting underwater objects from 33–131 ft. (10–40 m) above water (Poole et al., 2002). Ospreys migrate from northern latitudes to southern latitudes twice a year and cross bodies of open ocean to reach their destinations (Lott, 2006).

Bald eagles nest, forage, and winter along the Atlantic coast especially in the Chesapeake Bay region. Bald eagles also occur throughout Florida, although no bald eagle sightings have been recorded at Port Canaveral in 27 years (Federal Emergency Management Agency, 2012; Florida Fish and Wildlife Conservation Commission, 2017a). Bald eagles have steadily increased since the ban on DDT from 60 pairs in the 1970s to 646 in 2001. The Chesapeake Bay is very important to bald eagles because it is a convergence point for all three geographically distinct populations (northeast, southeast, and Chesapeake Bay) and has played an important part in their recovery (Watts et al., 2007). Bald eagles are opportunistic feeders that generally prefer fish over other food types (Buehler, 2000). Adults are known to scavenge prey items, pirate food from other species, and capture prey such as ducks from the water's surface.

Swallow-tailed kites breed in the southeastern United States but winter in South America, making long-distance migrations each year between wintering and breeding grounds. Studies in Florida show swallow-tailed kites feed on various animals in the following proportions: frogs (53 percent), birds (30 percent), and reptiles (11 percent) and the remaining prey were insects (Meyer et al., 2004).

Most peregrine falcons occur throughout the nearshore and coastal portions of the Study Area, particularly near barrier islands and mudflats during the winter months. Some peregrine falcons migrate along the coast, cross bodies of water such as the Gulf of Mexico, and occur offshore of the Atlantic coast to reach their wintering/breeding territories on a yearly basis (Lott, 2006). They can reach altitudes up to 12,000 ft. (Cornell Lab of Ornithology, 2011). Peregrine falcons feed mostly on other birds, including shorebirds, ducks, grebes, gulls, and petrels. They occasionally feed on fish while in coastal habitats (Cornell Lab of Ornithology, 2011).

3.9.2.3.1.10 Shorebirds, Phalaropes, Gulls, Noddies, Terns, Skimmers, Skuas, Jaegers, and Alcids (Order Charadriiformes)

Shorebirds are small, generally long-legged coastal birds, many of which forage below the high tide in the surf zone by picking and probing for small aquatic prey (Sibley, 2014). Shorebirds undergo some of the longest distance migrations known for birds, for example, the red knot annually migrates more than 9,300 mi. (U.S. Fish and Wildlife Service, 2005). Though most of their life cycle is spent in coastal areas, shorebird migration over open ocean does occur (Elphick, 2007). Although taxonomically grouped among some shorebirds, two species of phalaropes in the family Scolopacidae that occur within the Study Area are functionally seabirds, spending the nonbreeding months out on the open ocean. For example, the red-necked phalarope (*Phalaropus lobatus*) spends up to 9 months at sea, gathering in small flocks at upwellings and convergence zones, foraging on zooplankton and other small aquatic animals that rise to the surface (Rubega et al., 2000). The red phalarope ranges farthest from shore, spending 11 months at sea feeding on small invertebrates (Cornell Lab of Ornithology, 2002).

The Charadriiformes include shorebirds, phalaropes, gulls, noddies, terns, skimmers, skuas, jaegers, and alcids (Cornell Lab of Ornithology, 2009). There are 81 species from this diverse group that occur within the Study Area ranging from small shorebirds to large pelagic seabirds. Two endangered species under the ESA belong to this group, the roseate tern and piping plover (U.S. Fish and Wildlife Service, 2010a). Nineteen species from this group are Birds of Conservation Concern (U.S. Fish and Wildlife Service, 2008b). Some species in this order are highly pelagic (e.g., jaegers, skuas, alcids), whereas others are more coastal or nearshore species (e.g., shorebirds, gulls).

Skuas and jaegers are oceanic birds that come to land only to nest. On the nesting grounds they prey on lemmings, small birds, and other animals; in other seasons they pirate much of their food from other seabirds by chasing them and forcing them to relinquish captured prey (Sibley, 2014). Representative species from this group include: semipalmated plover (*Charadrius semipalmatus*), great skua (*Stercorarius skua*), long-tailed jaeger (*Stercorarius longicaudus*), sooty tern (*Onychoprion fuscatus*), brown noddy (*Anous stolidus*), dovekie (*Alle alle*), common murre (*Uria aalge*), razorbill (*Alca torda*), long-billed murrelet (*Brachyramphus perdix*), Atlantic puffin (*Fratercula arctica*), and red phalarope (*Phalaropus fulicarius*).

Noddies are tropical tern-like seabirds found foraging over warm, open ocean waters where they feed by swooping or dipping along the surface. Brown noddies breed in colonies on islands, islets, and rocky outcrops in warm seas. They only lay one egg a year and build their nests in trees, shrubs, cliffs, and manmade structures (Sibley, 2014).

Terns are generally more marine or pelagic than gulls, though some tern species do occur more commonly within coastal areas (e.g., least terns). Terns roost and nest in large groups on shorelines, and feed on small fish by plunge-diving head first from the air into the water, often beginning from a hovering position. They feed closer to shore when raising young during the nesting season, but venture farther offshore for longer periods after young have fledged (Sibley, 2014). In the North Atlantic, Gulf

Stream eddies attract foraging seabirds such as the sooty tern and bridled tern (*Onychoprion anaethetus*) (Bost et al., 2009).

Alcids or auks (family *Alcidae*), are small oceanic species that inhabit cold Northern Hemisphere seas, rarely wandering south into the tropics (Pratt et al., 1987). They come to land only to breed (Enticott & Tipling, 1997) and nest colonially in crevices or burrows. Alcids do not undergo long-distance foraging trips but form feeding aggregations in areas where food is concentrated, though they do not form tight flocks (Enticott & Tipling, 1997). All alcids use their wings to dive underwater where they feed on fishes and invertebrates. Auks are pursuit divers and are entirely wing-propelled rather than foot-propelled, as are loons and grebes, for example. Atlantic puffins can dive between 135 to 224 ft. (41 and 68 m) for periods of up to 1 minute (Burger & Simpson, 1986).

The Charadriiformes influence the distribution and abundance of invertebrates, and indirectly algae, in rocky intertidal communities of New England (Ellis et al., 2007). Gulls are one particular group that can be found over land, along the coast, in nearshore, and offshore environments. The great black-backed gull (*Larus marinus*) and the herring gull (*Larus argentatus*) are dominant predators along the rocky shores throughout the North Atlantic. They forage while walking, swimming, or flying, sometimes dipping into the water and sometimes plunge-diving (National Audubon Society, 2015). They often feed on crabs, sea urchins, and mussels in the rocky intertidal habitat; once a prey item is caught, the gull will fly up and drop it on rocks below to break it open.

3.9.2.3.1.11 Neotropical Migrant Songbirds, Thrushes, Cuckoos, Swifts, Owls, and Allies (Orders Passeriformes, Cuculiformes, Apodiformes and Strigiformes)

There are 185 bird species in the orders Passeriformes, Cuculiformes, Apodiformes, and Strigiformes that are considered nocturnal migrants and neotropical migrants with a potential to occur in the Study Area. Twenty-one of these species are Birds of Conservation Concern as shown in Table 3.9-4 (U.S. Fish and Wildlife Service, 2008b). Most of these species are nocturnal migrants and take advantage of favorable weather conditions to migrate (Kerlinger, 2009). Oceans are typically an obstacle for this group of birds because most songbirds cannot swim, or even rest on the water's surface. Migrants tend to avoid large water crossings and follow land to the extent possible. Migration has a substantial risk to birds, ranging from mass mortality events due to inclement weather events (Newton, 2007) and other mortality events associated with lighting of vessels (Merkel & Johansen, 2011) and oil and gas platforms (Poot et al., 2008). In the Gulf of Mexico, long-distance migrants are commonly found stopping over and resting on oil and gas platforms as well as on small boats and vessels. Most neotropical migrants, especially warblers and thrushes from the family *Parulidae* and family *Turdidae*, cross water at some point twice a year to reach their wintering and breeding grounds. For example, the Bicknell's thrush *(Cartharus bicknelli*) breeds in mountainous forests of New England and migrates across open oceans in the fall to reach their wintering grounds in the Caribbean.

Aerial insect feeders such as swifts and predatory birds such as owls may feed opportunistically during migration across the ocean (Elphick, 2007), but the vast majority of bird species in this diverse group do not feed within the Study Area.

3.9.2.3.2 Bats

At least 24 species of bats are known or expected to occur in the Study Area (Table 3.9-3), either during migration or foraging. Additional bat species are known to occur in areas near, or adjacent to, the Study Area. For example, the Mexican Long-tongued bat (*Choeronycteris mexicana*) migrates through Central Mexico but avoids the Gulf of Mexico coastline, with the exception of a small area in northeastern most

Mexico on the border of southernmost Texas (National Park Service, 2017b). Manning et al. (2008) list 33 bats that occur in Texas, Jones et al. (1973) list 44 bat species from Mexico's Yucatan Peninsula, and Placer (1998) states that at least 21 bat species are known to occur in Jamaica. Many of these bat species are included in Table 3.9-3; those that are not included are expected either to not occur in the Study Area or to occur very infrequently, while foraging on insects or crustaceans seasonally, during relatively brief periods of the summer when the air is warm, the humidity is high, the wind speed is low, and when near forested land (Ahlén et al., 2009; Bureau of Ocean Energy Management, 2013; Johnson et al., 2011; U.S. Department of Energy, 2016). Given these highly restrictive circumstances and the dispersed nature of Navy training activities, the chance that any bat species not listed in Table 3.9-3 would interact with Navy training activities is discountable.

As shown in Table 3.9-3, the range of some of the bat species within the Study Area is highly limited (e.g., to Puerto Rico), whereas the range of other bat species includes the vast portions of the Study Area. Most of these bat species are insectivorous, but some are frugivores (i.e., are fruit-eating), and one (the Mexican bulldog bat, discussed in Section 3.9.2.1.3, Dive Behavior) eats fish. In addition, some insectivorous bats are suspected to also eat crustaceans (Ahlén et al., 2009; Hatch et al., 2013).

Table 3.9-3: Bats Known or Expected to Occur in the Study Area

Bat Species		***Presence in the Study Area***		
Common Name	***Scientific Name***	***Open Ocean Areas[2]***	***Large Marine Ecosystem[2]***	***Inshore Waters***
Jamaican fruit bat[1]	*Artibeus jamaicensis*	North Atlantic Gyre	Caribbean Sea, Gulf of Mexico	
Antillean fruit-eating bat[1]	*Brachyphylla cavernarum*	North Atlantic Gyre	Caribbean Sea	
Big brown bat	*Eptesicus fuscus*	Gulf Stream, North Atlantic Gyre	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX);
Brown flower bat	*Erophylla bombifrons*	None	Caribbean Sea	

Table 3.9-3: Bats Known or Expected to Occur in the Study Area (continued)

Bat Species		*Presence in the Study Area*		
Common Name	***Scientific Name***	***Open Ocean Areas[2]***	***Large Marine Ecosystem[2]***	***Inshore Waters***
Silver-haired bat[1]	*Lasionycteris noctivagans*	Gulf Stream, North Atlantic Gyre	Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC)
Eastern red bat[1]	*Lasiurus borealis*	Gulf Stream, North Atlantic Gyre	Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX); Puerto Rico; U.S. Virgin Islands
Hoary bat[1]	*Lasiurus cinereus*	Labrador Current, Gulf Stream, North Atlantic Gyre	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX); Puerto Rico; U.S. Virgin Islands

Table 3.9-3: Bats Known or Expected to Occur in the Study Area (continued)

Bat Species		*Presence in the Study Area*		
Common Name	***Scientific Name***	***Open Ocean Areas***[2]	***Large Marine Ecosystem***[2]	***Inshore Waters***
Northern yellow bat	*Lasiurus intermedius*	None	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)
Minor red bat[1]	*Lasiurus minor*	None	Caribbean Sea	Puerto Rico
Seminole bat[1]	*Lasiurus seminolus*	Gulf Stream, North Atlantic Gyre	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX)
Pallas's mastiff bat or Pallas's free-tailed bat	*Molossus molossus*	North Atlantic Gyre	Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	
Leach's single leaf bat[1]	*Monophyllus redmani*	None	Caribbean Sea	
Antillean ghostfaced bat[1]	*Mormoops blainvillei*	None	Caribbean Sea	
Ghostfaced bat	*Mormoops megalophylla*	None	Caribbean Sea, Gulf of Mexico	Corpus Christi Bay (Corpus Christi, TX)
Southeastern myotis bat	*Myotis austroriparius*	None	Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL)
Eastern small-footed bat	*Myotis leibii*	None	Northeast U.S. Continental Shelf	Sandy Hook Bay (Earle, NJ)

Table 3.9-3: Bats Known or Expected to Occur in the Study Area (continued)

Bat Species		*Presence in the Study Area*		
Common Name	***Scientific Name***	***Open Ocean Areas²***	***Large Marine Ecosystem²***	***Inshore Waters***
Little brown bat	*Myotis lucifugus*	Gulf Stream	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL)
Evening bat	*Nycticeius humeralis*	None	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)
Mexican free-tailed bat	*Tadarida brasiliensis*	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX), Puerto Rico; U.S. Virgin Islands
Mexican bulldog bat or greater bulldog bat	*Noctilio leporinus*	None	Caribbean Sea, Gulf of Mexico	
Rafinesque's big-eared bat	*Plecotus rafinesquii*	None	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico	Beaufort Inlet Channel (Morehead City, NC); Onslow Beach (Camp Lejeune, NC); Cape Fear River (Wilmington, NC); Seminole Beach (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX)
Parnell's moustached bat	*Pteronotus parnellii*	None	Caribbean Sea	

Table 3.9-3: Bats Known or Expected to Occur in the Study Area (continued)

Bat Species		*Presence in the Study Area*		
Common Name	*Scientific Name*	*Open Ocean Areas*[2]	*Large Marine Ecosystem*[2]	*Inshore Waters*
Sooty moustached bats	*Pteronotus quadridens*	None	Caribbean Sea	
Red fruit bat	*Stenoderma rufum*	None	Caribbean Sea	

[1]Has also been reported on Bermuda during the migration season (Pelletier et al., 2013).
Bold font indicates the species migrates long distances.
Sources: (Constantine, 2003; International Union for Conservation of Nature, 2017; Placer, 1998; Tetra Tech Inc, 2016e).

In temperate North America, most species that roost in trees, such as hoary bats, migrate south for winter when insects become scarce. In the fall, hundreds of hoary bats from across the United States gather along the coasts and in northern Mexico. Mexican free-tailed bats that roost in Carlsbad Caverns during the summer also migrate to Mexico over winter (National Park Service, 2017a).

The Navy has performed bat surveys (both mist-netting and passive acoustic surveys) at several installations along the eastern coast of the United States. Results of these surveys are described below. Since echolocation calls for eastern red bats and Seminole bats are indistinguishable from each other, survey results combine these two species. In addition, it typically is not possible to identify specific species from passive acoustic survey recordings of *Myotis* species, and occasionally it is not possible to make a determination more specific than “high frequency call.”

- Cutler, Maine:
  - All seven bat species expected to occur in Maine that are not federally listed are known to occur at Naval Support Activity Cutler: little brown bat, eastern small-footed bat, tri-colored bat, silver-haired bat, big brown bat, eastern red bat, and hoary bat (Tetra Tech Inc, 2014).
  - Little brown bats were the most frequently detected species and occurred across the installation at all acoustic sites during the 2013 survey. Eastern red bat was the second most common species recorded at the Installation, and occurred across all sites. Silver-haired bats and the eastern red bat are known to be active from late April through mid-October, big brown bats from late March through early October, and hoary bats from early May through early October.
  - The installation provides the local bat community with habitat from the late spring to late fall. The data also suggests that bats are utilizing habitat and traveling closer to the coast within forested and edge habitats.
  - The occurrence of migratory bat species during the summer season indicates that long-distance migratory tree-roosting bats spent the summer residency period at the installation. Data also suggests that long-distance migrants move through the installation during the fall.

- Colts Neck, New Jersey
  - Baseline bat survey at NWS Earle acoustically documented activity of eight different bat species, including big brown bat, eastern red bat, hoary bat, silver-haired bat, little

brown bat, eastern small-footed bat, northern long-eared bat, and tri-colored bat. Mist-net surveys further confirmed the presence of big brown bats, eastern red bat, and northern long-eared bat (Tetra Tech Inc, 2016d).

- Norfolk and Portsmouth, Virginia:
  - At Naval Station Norfolk and Naval Supply Center Craney Island Fuel Terminal at Norfolk and Portsmouth, Virginia, mist-netting surveys captured eastern red bats (*Lasiurus borealis*). Approximately 75% of acoustic detections were identified as eastern red bats/Seminole bats; the remainder were mostly designated as "high frequency" bats. Manual review of all tri-colored bat passes were determined to not contain enough detail to accurately identify to species (Tetra Tech Inc, 2017a).
- Virginia Beach, Virginia:
  - Surveys at Naval Air Station Oceana in Virginia Beach, Virginia detected nine bat species not listed under the ESA: Rafinesque's big-eared bat, big brown bat, eastern red/seminole bat, hoary bat, silver-haired bat, southeastern bat, little brown bat, evening bat, and tri-colored bat (Tetra Tech Inc, 2016c). Big brown bats were the most commonly recorded, accounting for 50 percent of the total calls, followed by silver-haired bats (24 percent), eastern red bats/Seminole bats (11 percent), hoary bats (4 percent), and *Myotis* sp. bats (4 percent). Species with 2 percent or less of the total calls were little brown bats, southeastern bats, Rafinesque's big-eared bats, evening bats, tri-colored bats, and high frequency bats.
  - Surveys at JEB Fort Story on the coast acoustically documented activity of at least ten different species of bats including Rafinesque's big-eared bat, big brown bat, eastern red/Seminole bat, hoary bat, silver-haired bat, southeastern myotis, little brown bat, northern long-eared bat, evening bat, and tri-colored bat. Eastern red bats, however, are very common and Seminole bats only occur occasionally in Virginia. The overall activity rate at JEB Fort Story was the highest detected at the four Navy bases surveyed in Virginia (Tetra Tech Inc, 2016a).

3.9.2.3.3 Migratory Birds

A variety of bird species would be encountered in the Study Area including those listed under the Migratory Bird Treaty Act (U.S. Fish and Wildlife Service, 2010d). The Migratory Bird Treaty Act established federal responsibilities for protecting nearly all migratory species of birds, eggs, and nests. Migratory bird means any bird, whatever its origin and whether or not raised in captivity, which belongs to a species listed in Section 10.13 of the Migratory Bird Treaty Act, or which is a mutation or a hybrid of any such species, including any part, nest, or egg of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof. Bird migration is defined as the periodic seasonal movement of birds from one geographic region to another, typically coinciding with available food supplies or breeding seasons. Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 Code of Federal Regulations [CFR] Part 21), the USFWS has promulgated a rule that authorizes the incidental take of migratory birds provided they do not result in a significant impact to a population of a migratory seabird species. Of the 1,026 species protected under the Migratory Bird Treaty Act (U.S. Fish and Wildlife Service, 2013b), over 100 species occur in the Study Area. These species are not analyzed individually, but rather are grouped based on taxonomic or behavioral similarities based on the stressor that is being analyzed. Conclusions of potential impacts on species protected under the Migratory Bird Treaty Act are presented at the conclusion of each stressor subsection as well as in Section 3.9.4 (Summary of Potential Impacts on Birds).

Birds of Conservation Concern are species, subspecies, and populations of migratory birds that the USFWS determined to be the highest priority for conservation actions (U.S. Fish and Wildlife Service, 2008b). The purpose of the Birds of Conservation Concern list is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservation actions needed to conserve these species. Of the species that occur within the Study Area, 62 are considered Birds of Conservation Concern (Table 3.9-4). With the exception of the black-capped petrel, a species that is under review and could be proposed for listing under the ESA in the near future (see below), and the bald eagle, these species are not analyzed individually, but rather are grouped by taxonomic or behavioral similarities based on the stressor being analyzed.

Table 3.9-4: Birds of Conservation Concern that Occur within the Study Area

Order/Family	***Common Name***	***Scientific Name***
Order Gaviiformes		
Family Gaviidae		
	Common loon	*Gavia immer*
	Red-throated loon	*Gavia stellata*
Order Podicipediformes		
Family Podicipedidae		
	Horned grebe	*Podiceps auritus*
	Pied billed grebe	*Podilymbus podiceps*
Order Procellariiformes		
Family Procellariidae		
	Audubon's shearwater	*Puffinus lherminieri*
	Black-capped petrel	*Pterodroma hasitata*
	Greater shearwater	*Puffinus gravis*
Family Hydrobatidae		
	Band-rumped storm petrel	*Oceanodroma castro*
Order Sulifromes		
Family Sulidae		
	Brown booby	*Sula leucogaster*
	Masked booby	*Sula dactylatra*
Family Phalacrocoracidae		
	Great cormorant	*Phalacrocorax carbo*
Family Frigatidae		
	Magnificent frigatebird	*Fregata magnificens*
Order Pelecaniformes		
Family Threskiornithidae		
	Roseate spoonbill	*Platalea ajaja*
Family Ardeidae		

Table 3.9-4: Birds of Conservation Concern that Occur within the Study Area (continued)

Order/Family	*Common Name*	*Scientific Name*
	Reddish egret	*Egretta rufescens*
	Snowy egret	*Egretta thula*
	American bittern	*Botarus lentiginous*
	Least bittern	*Ixobrychus exilis*
Order Falconiformes		
Family Falconidae		
Family Haematopodidae		
	American oystercatcher	*Haematopus palliatus*
Family Scolopacidae		
Subfamily Scolopacinae	Bar-tailed godwit	*Limosa lapponica*
	Dunlin	*Calidris alpina*
	Hudsonian godwit	*Limosa haemastica*
	Lesser yellowlegs	*Tringa flavipes*
	Marbled godwit	*Limosa fedoa*
	Purple sandpiper	*Calidris maritima*
	Red knot	*Calidris canutus*
	Semipalmated sandpiper	*Calidris pusilla*
	Short-billed dowitcher	*Limnodromus griseus*
	Solitary sandpiper	*Tringa solitaria*
	Whimbrel	*Numenius phaeopus*
Family Laridae		
Subfamily Rynchopinae	Black skimmer	*Rynchops niger*
Subfamily Sterninae	Arctic tern	*Sterna paradisaea*
	Gull-billed tern	*Gelochelidon nilotica*
	Least tern	*Sternula antillarum*
	Sandwich tern	*Thalasseus sandvicensis*
Order Passeriformes		
Family Emberizidae		
	Saltmarsh sparrow	*Ammodramus caudacutus*
	Seaside sparrow	*Ammodramus maritimus*
Family Tyrannidae		
	Olive-sided flycatcher	*Contopus cooperi*
Family Turdidae		
	Bicknell's thrush	*Catharus bicknelli*
	Wood thrush	*Hylocichla mustelina*
Family Parulidae		
	Bay-breasted warbler	*Dendroica castanea*
	Blue-winged warbler	*Vermivora pinus*
	Canada warbler	*Wilsonia canadensis*
	Cerulean warbler	*Dendroica cerulea*
	Golden-winged warbler	*Vermivora chrysoptera*
	Kentucky warbler	*Oporornis formosus*
	Prairie warbler	*Dendroica discolor*
	Prothonotary warbler	*Protonotaria citrea*
	Swainson's warbler	*Limnothlypis swainsonii*
	Worm-eating warbler	*Helmitheros vermivorum*

Table 3.9-4: Birds of Conservation Concern that Occur within the Study Area (continued)

Order/Family	*Common Name*	*Scientific Name*
Family Cardinalidae		
	Dickcissel	*Spiza americana*
	Painted bunting	*Passerina ciris*
Order Cuculiformes		
Family Cuculidae		
	Mangrove cuckoo	*Coccyzus minor*
	Yellow-billed cuckoo	*Coccyzus americanus*
Order Strigiformes		
Family Strigiformes		
	Short-eared owl	*Asio flammeus*
Order Apodiformes		
Family Apodidae		
	Black swift	*Cypseloides niger*

3.9.3 ENVIRONMENTAL CONSEQUENCES

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially impact birds or bats known to occur within the Study Area. Tables 2.3-1 through 2.3-5 present the baseline and proposed typical training and testing activity locations for each alternative (including number of events). General characteristics of all Navy stressors were introduced in Section 3.0.3.3 (Identifying Stressors for Analysis), and 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 birds and bats are:

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

Each of these components is analyzed for potential impacts on birds and bats within the stressor categories contained in this section. The specific analysis of the training and testing activities considers these components within the context of geographic location and overlap of marine bird resources and bat occurrence. In addition to the analysis here, the details of all training and testing activities, stressors, components that cause the stressor, and geographic overlap within the Study Area are summarized in Section 3.0.3.3 (Identifying Stressors for Analysis) and detailed in Appendix B (Activity Stressor Matrices).

3.9.3.1 Acoustic Stressors

This section evaluates the potential for acoustic stressors to impact birds and bats during training and testing activities in the Study Area. Assessing whether sounds may disturb or injure an animal involves understanding the characteristics of the acoustic sources, the animals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those animals. Impacts could depend on other factors besides the received level of sound, such as the animal's physical condition, prior experience with the sound, and proximity to the source of the sound.

The below analysis of effects to birds and bats 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 to birds and bats in Section 3.9.3.1.1 (Background). This is followed by an analysis of impacts to birds and bats due to specific Navy acoustic stressors (sonar and other transducers; air guns; pile driving; vessel noise; aircraft noise; and weapons noise). Additional explanation of the acoustic terms and sound energy concepts used in this section is found in Appendix D (Acoustic and Explosive Concepts).

3.9.3.1.1 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 to birds and bats potentially resulting from sound-producing Navy training and testing activities. Impacts to birds and bats depend on the sound source and context of exposure. Possible impacts include auditory or non-auditory trauma, hearing loss resulting in temporary or permanent hearing threshold shift, auditory masking, physiological stress, or changes in behavior, including changing habitat use and activity patterns, increasing stress response, decreasing immune response, reducing reproductive success, increasing predation risk, and degrading communication, (Larkin et al., 1996). Numerous studies have documented that birds and other wild animals respond to human-made noise (Bowles et al., 1994; Larkin et al., 1996; National Park Service, 1994). The manner in which birds or bats respond to noise could depend on species physiology, life stage, characteristics of the noise source, loudness, onset rate, distance from the noise source, presence/absence of associated visual stimuli, and previous exposure. Noise may cause physiological or behavioral responses that reduce the animals' fitness or ability to grow, survive, and reproduce successfully.

The types of birds and bats exposed to sound-producing activities depend on where training and testing activities occur. Birds in the Study Area can be divided into three groups based on breeding and foraging habitat: (1) those species such as albatrosses, petrels, frigatebirds, tropicbirds, boobies, alcids, and some terns that forage over the ocean and nest on oceanic islands; (2) species such as pelicans, cormorants, gulls, and some terns that nest along the coast and forage in nearshore areas; and (3) those few species such as skuas, jaegers, Franklin's gull, Bonaparte's gulls, ring-billed gulls, black terns, and ducks and loons that nest and forage in inland habitats and come to the coastal areas during nonbreeding seasons. In addition, birds that are typically found inland, such as songbirds, may be present flying in large numbers over open ocean areas (particularly over the Gulf of Mexico) during annual spring and fall migration periods. Bats in the Study Area that have the potential to be exposed to sound-producing activities from training and testing would be those that occur in coastal or offshore waters, or those that migrate over open ocean areas.

Birds and bats could be exposed to sounds from a variety of sources. While above the water surface, birds and bats may be exposed to airborne sources such as pile driving, weapons noise, vessel noise, and aircraft noise. While foraging and diving, birds may be exposed to underwater sources such as sonar, pile driving, air guns, and vessel noise. In addition, bats are typically nocturnal and would likely be exposed only to sources of noise from activities that occur between dusk and dawn. While foraging birds will be present near the water surface, migrating birds may fly at various altitudes. Some species such as sea ducks and loons may be commonly seen flying just above the water's surface, but the same species can also be spotted flying high enough (5800 ft.) that they are barely visible through binoculars (Lincoln et al., 1998). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152 m) and 1,000 ft. (305 m). Radar studies have demonstrated that 95 percent of the migratory movements occur at less than 10,000 ft. (3,050 m), with the bulk of the movements occurring under 3,000 ft. (914 m) (Lincoln et al., 1998). While several studies have shown that bats typically fly lower than 10 m above sea level (Ahlén et al., 2009; Pelletier et al., 2013), others have shown that migrating bats have been observed over 200 m above sea level (Hatch et al., 2013; Sjollema et al., 2014).

Seabirds use a variety of foraging behaviors that could expose them to underwater sound. Most seabirds plunge-dive from the air into the water or perform aerial dipping (the act of taking food from the water surface in flight); others surface-dip (swimming and then dipping to pick up items below the surface) or jump-plunge (swimming, then jumping upward and diving underwater). Birds that feed at the surface by surface or aerial dipping with limited to no underwater exposure include petrels, jaegers, and phalaropes. Birds that plunge-dive are typically submerged for short durations, and any exposure to underwater sound would be very brief. Birds that plunge-dive include albatrosses, some tern species, masked boobies, gannets, shearwaters, and tropicbirds. Some birds, such as cormorants, seaducks, alcids, and loons pursue prey under the surface, swimming deeper and staying underwater longer than other plunge-divers. Some of these birds may stay underwater for up to several minutes and reach depths between 50 ft. (15 m) and 550 ft. (168 m) (Alderfer, 2003; Durant et al., 2003; Jones, 2001; Lin, 2002; Ronconi, 2001). Birds that forage near the surface would be exposed to underwater sound for shorter periods of time than those that forage below the surface. Exposures of birds that forage below the surface may be reduced by destructive interference of reflected sound waves near the water surface (see Appendix D, Acoustic and Explosive Concepts). Sounds generated underwater during training and testing would be more likely to impact birds that pursue prey under the surface, although as previously stated, little is known about seabird hearing ability underwater.

3.9.3.1.1.1 Injury

Auditory structures can be susceptible to direct mechanical injury due to high levels of impulsive sound. This could include tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the hair cells within the organ of Corti. Auditory trauma differs from auditory fatigue in that the latter involves the overstimulation of the auditory system, rather than direct mechanical damage, which may result in hearing loss (see Section 3.9.3.1.1.2, Hearing Loss). There are no data on damage to the middle ear structures of birds due to acoustic exposures. Because birds are known to regenerate auditory hair cells, studies have been conducted to purposely expose birds to very high sound exposure levels (SELs) in order to induce hair cell damage in the inner ear. Because damage can co-occur with fatiguing exposures at high SELs, effects to hair cells are discussed below in Section 3.9.3.1.1.2 (Hearing Loss).

Because there is no data on non-auditory injury to birds from intense non-explosive sound sources, it may be useful to consider information for other similar-sized vertebrates. The rapid large pressure change near non-explosive impulsive underwater sound sources, such as some large air guns and pile driving, are thought to be potentially injurious to other small animals (fishes and sea turtles). While long duration exposures (i.e., minutes to hours) to high sound levels of sonars are thought to be injurious to fishes, this has not been experimentally observed [see Popper et al. (2014)]. Potential for injury is generally attributed to compression and expansion of body gas cavities, either due to rapid onset of pressure changes or resonance (enhanced oscillation of a cavity at its natural frequency). Because water is considered incompressible and animal tissue is generally of similar density as water, animals would be more susceptible to injury from a high-amplitude sound source in water than in air since waves would pass directly through the body rather than being reflected. Proximal exposures to high-amplitude non-impulsive sounds underwater could be limited by a bird's surfacing response.

In air, the risk of barotrauma would be associated with high-amplitude impulses, such as from explosives (discussed in Section 3.9.3.2, Explosive Stressors). Unlike in water, most acoustic energy will reflect off the surface of an animal's body in air. Plus, air is compressible whereas water is not, allowing energy to dissipate more rapidly. For these reasons, in-air non-explosive sound sources in this analysis are considered to pose little risk of non-auditory injury.

Limited data exists on instances of barotrauma to bats. The data that does exist has investigated the hypothesis of rapid pressure changes due to rotating wind turbine blades (Baerwald et al., 2008; Rollins et al., 2012). Bats in these situations have been shown to have ruptured tympana. Although it is undetermined if these ruptures were due to pressure changes or to direct strike, the potential exists for auditory injury as a result of high-amplitude sound exposure.

3.9.3.1.1.2 Hearing Loss

Exposure to intense sound may result in hearing loss which persists after cessation of the noise exposure. Hearing loss may be temporary or permanent, depending on factors such as the exposure frequency, received sound pressure level (SPL), temporal pattern, and duration. Hearing loss could impair a bird's or a bat's ability to hear biologically important sounds within the affected frequency range. Biologically important sounds come from social groups, potential mates, offspring, or parents; environmental sounds, prey, and predators.

Because in-air measures of hearing loss and recovery in birds due to an acoustic exposure are limited [e.g., quail, budgerigars, canaries, and zebra finches (Ryals et al., 1999); budgerigar (Hashino et al., 1988); parakeet (Saunders & Dooling, 1974); quail (Niemiec et al., 1994)] and no studies exist of bird hearing loss due to underwater sound exposures, auditory threshold shift in birds is considered to be consistent with general knowledge about noise-induced hearing loss described in the Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (see Section 3.0.3.6.1). The frequencies affected by hearing loss would vary depending on the exposure frequency. The limited data on hearing loss in birds shows that the frequency of exposure is the hearing frequency most likely to be affected (Saunders & Dooling, 1974).

Hearing loss can be due to biochemical (fatiguing) processes or tissue damage. Tissue damage can include damage to the auditory hair cells and their underlying support cells. Hair cell damage has been observed in birds exposed to long-duration sounds that resulted in initial threshold shifts greater than 40 dB (Niemiec et al., 1994; Ryals et al., 1999). Unlike many other animals, birds have the ability to regenerate hair cells in the ear, usually resulting in considerable anatomical, physiological, and behavioral recovery within several weeks (Rubel et al., 2013; Ryals et al., 1999). Still, intense exposures are not always fully recoverable, even over periods up to a year after exposure, and damage and subsequent recovery vary significantly by species (Ryals et al., 1999). Birds may be able to protect themselves against damage from sustained sound exposures by reducing middle ear pressure, an ability that may protect ears while in flight (Ryals et al., 1999) and from injury due to pressure changes during diving (Dooling & Therrien, 2012).

Hearing loss is typically quantified in terms of threshold shift—the amount (in dB) that hearing thresholds at one or more specified frequencies are elevated, compared to their pre-exposure values, at some specific time after the noise exposure. The amount of threshold shift measured usually decreases with increasing recovery time—the amount of time that has elapsed since a noise exposure. If the threshold shift eventually returns to zero (i.e., the hearing threshold returns to the pre-exposure value), the threshold shift is called a temporary threshold shift (TTS). If the threshold shift does not completely recover (the threshold remains elevated compared to the pre-exposure value), the remaining threshold shift is called a permanent threshold shift (PTS). By definition, TTS is a function of the recovery time, therefore comparing the severity of noise exposures based on the amount of induced TTS can only be done if the recovery times are also considered. For example, a 20-dB TTS measured 24-h post-exposure indicates a more hazardous exposure than one producing 20 dB of TTS measured only 2 min after exposure; if the TTS is 20 dB after 24 h, the TTS measured after 2 min would have likely been much higher. Conversely, if 20 dB of TTS was measured after 2 min, the TTS measured after 24 h would likely have been much smaller.

Studies in mammals have revealed that noise exposures resulting in high levels of TTS (greater than 40 dB) may also result in neural injury without any permanent hearing loss (Kujawa & Liberman, 2009; Lin et al., 2011). It is unknown if a similar effect would be observed for birds.

Hearing Loss due to Non-Impulsive Sounds

Birds

Behavioral studies of threshold shift in birds within their frequencies of best hearing (between 2 and 4 kHz) due to long-duration (30 minutes to 72 hours) continuous, non-impulsive, high-level sound exposures in air have shown that susceptibility to hearing loss varies substantially by species, even in species with similar auditory sensitivities, hearing ranges, and body size (Niemiec et al., 1994; Ryals et al., 1999; Saunders & Dooling, 1974). For example, Ryals et al. (1999) conducted the same exposure experiment on quail and budgerigars, which have very similar audiograms. A 12-hour exposure to a 2.86 kHz tone at 112 dB re 20 µPa SPL [cumulative SEL of 158 dB re 20 $\mu Pa^2 s$] resulted in a 70 dB threshold shift measured after 24 hours of recovery in quail, but a substantially lower 40 dB threshold shift measured after just 12 hours of recovery in budgerigars which recovered to within 10 dB of baseline after three days and fully recovered by one month (Ryals et al., 1999). Although not directly comparable, this SPL would be perceived as extremely loud but just under the threshold of pain for humans per the American Speech-Language-Hearing Association. Whereas the 158 dB re 20 μPa^2-s SEL tonal exposure to quail discussed above caused 20 dB of PTS (Ryals et al., 1999), a shorter (4-hour) tonal exposure to quail with similar SEL (157 dB re 20 μPa^2-s) caused 65 dB of threshold shift that fully recovered within two weeks (Niemiec et al., 1994).

Data on threshold shift in birds due to relatively short-duration sound exposures that could be used to estimate the onset of threshold shift is limited. Saunders and Dooling (1974) provide the only threshold shift growth data measured for birds. Saunders and Dooling (1974) exposed young budgerigars to four levels of continuous 1/3-octave band noise (76, 86, 96, and 106 dB re 20 µPa) centered at 2.0 kHz and measured the threshold shift at various time intervals during the 72-hour exposure. The earliest measurement found 7 dB of threshold shift after approximately 20 minutes of exposure to the 96 dB re

20 µPa SPL noise (127 dB re 20 µPa^2-s SEL). Generally, onset of TTS in other species has been considered 6 dB above measured threshold (Finneran, 2015), which accounts for natural variability in auditory thresholds. The Saunders and Dooling (1974) budgerigar data is the only bird data showing low levels of threshold shift. Because of the observed variability of threshold shift susceptibility among bird species and the relatively long duration of sound exposure in Saunders and Dooling (1974), the observed onset level cannot be assumed to represent the SEL that would cause onset of TTS for other bird species or for shorter-duration exposures (i.e., a higher SEL may be required to induce TTS for shorter-duration exposures).

Since the goal of most bird hearing studies has been to induce hair cell damage to study regeneration and recovery, exposure durations were purposely long. Studies with other non-avian species have shown that long-duration exposures tend to produce more threshold shift than short-duration exposures with the same SEL [e.g., see Finneran (2015)]. The SELs that induced TTS and PTS in these studies likely over-estimate the potential for hearing loss due to any short-duration sound of comparable SEL that a bird could encounter outside of a controlled laboratory setting. In addition, these studies were not designed to determine the exposure levels associated with the onset of any threshold shift or to determine the lowest SEL that may result in PTS.

With insufficient data to determine PTS onset for birds due to a non-impulsive exposure, data from other taxa are considered. Studies of terrestrial mammals suggest that 40 dB of threshold shift is a reasonable estimate of where PTS onset may begin [see (Southall et al., 2009)]. Similar amounts of threshold shift has been observed in some bird studies with no subsequent PTS. Of the birds studied, the budgerigars showed intermediate susceptibility to threshold shift; the budgerigars exhibited threshold shifts in the range of 40 dB to 50 dB after 12-hour exposures to 112 dB and 118 dB re 20 µPa SPL tones at 2.86 kHz (158 – 164 dB re 20 µPa^2-s SEL), which recovered to within 10 dB of baseline after three days and fully recovered by one month (Ryals et al., 1999). These experimental SELs are a conservative estimate of the SEL above which PTS may be considered possible for birds.

All of the above studies were conducted in air. There are no studies of hearing loss to diving birds due to underwater exposures.

Bats

Bats exposed to loud noise have not been shown to exhibit TTS (Hom et al., 2016; Simmons et al., 2015; Simmons et al., 2016). Recently, Hom et al. (2016) exposed four big brown bats (*Eptesicus fuscus*) to intense broadband noise (10—100 kHz with SEL 152 dB re 20 µPa^2-s over 1 hour) and found no effect on the bats' vocalizations (which could indicate a change in hearing) or psychophysical thresholds 20 minutes, 24 hours, or 48 hours after exposure (Hom et al., 2016; Simmons et al., 2016). Another study on the Japanese house bat (*Pipistrellus abramus*) measured physiological (auditory brainstem response) thresholds immediately after a noise exposure (10—80 kHz, 90 dB re 20 µPa SPL, 30 minute duration) and also did not find evidence of TTS (Simmons et al., 2015). This may be because bats are adapted to hear in an acoustic environment where they are likely to experience loud sounds (110-140 dB re 20 µPa SPL) continuously for several hours while hunting near other bats that are also echolocating (Jakobsen et al., 2013; Simmons et al., 2001). It is also possible that the stimuli used in these experiments were not loud enough to induce TTS or that measurements of hearing sensitivity took place outside the time window where TTS might be observed.

Hearing Loss due to Impulsive Sounds

The only measure of hearing loss in a bird due to an impulsive noise exposure was conducted by Hashino et al. (1988), in which budgerigars were exposed to the firing of a pistol with a received level of 169 dB re 20 µPa peak SPL (two gunshots per each ear); SELs were not provided. While the gunshot frequency power spectrum had its peak at 2.8 kHz, threshold shift was most extensive below 1 kHz. Threshold shift recovered at frequencies above 1 kHz, while a 24 dB PTS was sustained at frequencies below 1 kHz. Studies of hearing loss in diving birds exposed to impulsive sounds underwater do not exist.

Because there is only one study of hearing loss in birds due to an impulsive exposure and no studies of hearing loss in bats due to an impulsive exposure, the few studies of hearing loss in birds and bats due to exposures to non-impulsive sound are the only other data upon which to assess bird and bat susceptibility to hearing loss from an impulsive sound source. Data from other taxa (U.S. Department of the Navy, 2017) indicate that, for the same SEL, impulsive exposures are more likely to result in hearing loss than non-impulsive exposures. This is due to the high peak pressures and rapid pressure rise times associated with impulsive exposures.

3.9.3.1.1.3 Masking

Masking occurs when one sound, distinguished as the 'noise,' interferes with the detection or recognition of another sound. The quantitative definition of masking is the amount in decibels an auditory detection or discrimination threshold is raised in the presence of a masker (Erbe et al., 2016). As discussed in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors), masking can effectively limit the distance over which an animal can communicate and detect biologically relevant sounds. Masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise.

Birds

Critical ratios are the lowest ratio of signal-to-noise at which a signal can be detected. When expressed in decibels, critical ratios can easily be calculated by subtracting the noise level (in dB re 1 μPa^2 /Hz) from the signal level (in dB re 1 µPa) at detection threshold. A signal must be received above the critical ratio at a given frequency to be detectable by an animal. Critical ratios have been determined for a variety of bird species [e.g., Dooling (1980), Noirot et al. (2011), Dooling and Popper (2000), and Crowell (2016)] and inter-species variability is evident. Some birds exhibit low critical ratios at certain vocal frequencies, perhaps indicating that hearing evolved to detect signals in noisy environments or over long distances (Dooling & Popper, 2000).

The effect of masking is to limit the distance over which a signal can be perceived. An animal may attempt to compensate in several ways, such as by increasing the source level of vocalizations (the Lombard effect), changing the frequency of vocalizations, or changing behavior (e.g., moving to another location, increase visual display). Birds have been shown to shift song frequencies in the presence of a tone at a similar frequency (Goodwin & Podos, 2013), and in continuously noisy urban habitats, populations have been shown to have altered song duration and shift to higher frequencies (Slabbekoorn & den Boer-Visser, 2006). Changes in vocalization may incur energetic costs and hinder communication with conspecifics, which, for example, could result in reduced mating opportunities. These effects are of long-term concern in constant noisy urban environments (Patricelli & Blickley, 2006) where masking conditions are prevalent.

Bats

Bats can experience masking during echolocation and communication from a variety of sources such as other bats and jamming of their echolocation signal by prey species (Bates et al., 2011; Chiu et al., 2008; Conner & Corcoran, 2012; Corcoran et al., 2009; Griffin et al., 1962; Simmons et al., 1988; Ulanovsky et al., 2004). They have many strategies to compensate for masking, such as dynamically changing the duration, spectrum, aim, and pattern of their echolocation (Bates et al., 2011; Moss et al., 2011; Petrites et al., 2009; Simmons et al., 2001; Wheeler et al., 2016).

Like other animals, bats increase the amplitude of their vocalizations in response to an increase in background noise level, which is known as the Lombard effect (Hage et al., 2013). It is estimated that a broadband signal of 65 dB re 20 µPa SPL would begin masking most bats' echolocation from targets beyond 1.5 m away (Arnett et al., 2013). Bats have been shown to shift the frequency of their calls when a stimulus was within 2-3 kHz of their preferred frequency (Bates et al., 2008).

Behavioral and psychophysical experiments show that the flexibility of bat vocalizations allows for perceptual rejection of masking due to clutter in the surroundings (Bates et al., 2011; Hiryu et al., 2010; Warnecke et al., 2015) or other sources of noise (Bates et al., 2008; Miller et al., 2004; Ulanovsky et al., 2004).

Overall, bats seem to avoid areas with high levels of noise – especially when the noise frequency spectrum overlaps with frequencies important for hunting (20-90 kHz). In a controlled laboratory experiment, Schaub et al. (2008) found that, when given a choice, bats spent 10% less time foraging in the compartment with noise (traffic, wind, and broadband white noise) as compared to the silent control chamber. Additionally, hunting in the noisy compartment yielded 10% fewer successful prey interceptions. Bats spent significantly less time, and were significantly less successful as noise conditions increased in bandwidth and overall exposure levels. The greater the noise overlap with frequencies being attended to by the bat, the greater the disturbance to the bats' foraging behavior. However, this experiment was conducted on a small spatial scale, and with the absence of other sensory cues (light). Although laboratory research has shown that noise can decrease hunting success (Siemers & Schaub, 2011), and field and laboratory studies show that foraging bats avoid noise (Berthinussen & Altringham, 2012; Schaub et al., 2008), no studies provide direct evidence from playback experiments in the field that commuting or migrating bats are disturbed by sound.

3.9.3.1.1.4 Physiological Stress

Animals in the marine environment 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, as described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors).

Chronic stress due to disturbance may compromise the general health and reproductive success of birds (Kight et al., 2012), but a physiological stress response is not necessarily indicative of negative consequences to individual birds or to populations (Larkin et al., 1996; National Park Service, 1994). The reported behavioral and physiological responses of birds to noise exposure can fall within the range of normal adaptive responses to external stimuli, such as predation, that birds face on a regular basis. These responses can include activation of the neural and endocrine systems, causing changes such as increased blood pressure, available glucose, and blood levels of corticosteroids (Manci et al., 1988). It is possible that individuals would return to normal almost immediately after short-term or transient exposure, and the individual's metabolism and energy budget would not be affected in the long-term. Studies have also shown that birds can habituate to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). However, the likelihood of habituation is dependent upon a number of factors, including species of bird (Bowles et al., 1991), and frequency of and proximity to exposure. Although Andersen et al. (1990) did not evaluate noise specifically, they found evidence that anthropogenic disturbance is related to changes in home ranges; for example, raptors have been shown to shift their terrestrial home range when concentrated military training activity was introduced to the area. On the other hand, cardinals nesting in areas with high levels of military training activity (including gunfire, artillery, and explosives) were observed to have similar reproductive success and stress hormone levels as cardinals in areas of low activity (Barron et al., 2012).

While physiological responses such as increased heart rate or startle response can be difficult to measure in the field, they often accompany more easily measured reactions like behavioral responses. A startle is a reflex characterized by rapid increase in heart rate, shutdown of nonessential functions, and mobilization of glucose reserves. Habituation keeps animals from expending energy and attention on harmless stimuli, but the physiological component might not habituate completely (Bowles, 1995).

A strong and consistent behavioral or physiological response is not necessarily indicative of negative consequences to individuals or to populations (Bowles, 1995; Larkin et al., 1996; National Park Service, 1994). For example, many of the reported behavioral and physiological responses to noise are within the range of normal adaptive responses to external stimuli, such as predation, that wild animals face on a regular basis. In many cases, individuals would return to homeostasis or a stable equilibrium almost immediately after exposure. The individual’s overall metabolism and energy budgets would not be affected if it had time to recover before being exposed again. If the individual does not recover before being exposed again, physiological responses could be cumulative and lead to reduced fitness. However, it is also possible that an individual would have an avoidance reaction (i.e., move away from the noise source) to repeated exposure or habituate to the noise when repeatedly exposed.

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.

3.9.3.1.1.5 Behavioral Reactions

Numerous studies have documented that birds and other wild animals respond to human-made noise, including aircraft overflights, weapons firing, and explosions (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). The manner in which an animal responds to noise could depend on several factors, including life history characteristics of the species, characteristics of the noise source, sound source intensity, onset rate, distance from the noise source, presence or absence of associated visual stimuli, food and habitat availability, and previous exposure (see Section 3.0.3.6.1, Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). Researchers have documented a range of bird behavioral responses to noise, including no response, head turn, alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations (Brown et al., 1999; Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006; Pytte et al., 2003; Stalmaster & Kaiser, 1997). Bat behavioral studies have shown reactions in response to acoustic interference such as reduced activity, area avoidance, and modifying the duration or frequency of calls (Arnett et al., 2013;

Bates et al., 2008; Baxter et al., 2006). Some behavioral responses may be accompanied by physiological responses, such as increased heart rate or short-term changes in stress hormone levels (Partecke et al., 2006).

Behavioral responses may depend on the characteristics of the noise, and whether the noise is similar to biologically relevant sounds, such as alarm calls by other birds and predator sounds. For example, European starlings (*Sturnus vulgaris*) took significantly longer to habituate to repeated bird distress calls than white noise or pure tones (Johnson et al., 1985). Starlings may have been more likely to continue to respond to the distress because it is a more biologically meaningful sound. Starlings were also more likely to habituate in winter than summer, possibly meaning that food scarcity or seasonal physiological conditions may affect intensity of behavioral response (Johnson et al., 1985).

Behavioral Reactions to Impulsive Sound Sources

Studies regarding behavioral responses by non-nesting birds to impulsive sound sources are limited. Seismic surveys had no noticeable impacts on the movements or diving behavior of long-tailed ducks undergoing wing molt, a period in which flight is limited and food requirements are high (Lacroix et al., 2003). The birds may have tolerated the seismic survey noise to stay in preferred feeding areas.

Responses to aircraft sonic booms are informative of responses to single impulsive sounds. Responses to sonic booms are discussed below in Behavioral Reactions to Aircraft.

Behavioral Reactions to Sonar and other Active Acoustic Sources

There are no studies of bird responses underwater to sonars, but the effect of pingers on fishing nets has been examined. Fewer common murres (*Uria aalge*) were entangled in gillnets when the gillnets were outfitted with 1.5 kHz pingers with a source level of 120 dB re 1 µPa; however, there was no significant reduction in rhinoceros auklet (*Cerorhinca monocerata*) bycatch in the same nets (Melvin et al., 1999; Melvin et al., 2011). It was unknown whether the pingers elicited a behavioral response by the birds, or decreased prey availability.

Behavioral Responses to Aircraft

There are multiple possible of the factors involved in behavioral responses to aircraft overflights, including the noise stimulus as well as the visual stimulus.

Observations of tern colonies responses to balloon overflights suggest that visual stimulus is likely to be an important component of disturbance from overflights (Brown, 1990). Although it was assumed nesting colonial waterbirds may be more likely to flush or exhibit a mob response when disturbed, observations of nesting black skimmers and nesting least, gull-billed, and common terns showed they did not modify nesting behavior in response to military fixed-wing aircraft engaged in low-altitude tactical flights and rotary-wing overflights (Hillman et al., 2015). Maximum behavioral responses by crested tern (*Sterna bergii*) to aircraft noise were observed at sound level exposures greater than 85 dBA re 20 µPa. However, herring gulls (*Larus argentatus*) significantly increased their aggressive interactions within the colony and their flights over the colony during overflights with received SPLs of 101–116 dBA re 20 µPa (Burger, 1981).

Raptors and wading birds have responded minimally to jet (110 dBA re 20 µPa) and propeller plane (92 dBA re 20 µPa) overflights, respectively (Ellis, 1981). Jet flights greater than 1,640 ft. (500 m) distance from raptors were observed to elicit no response (Ellis, 1981). The impacts of low-altitude military training flights on wading bird colonies in Florida were estimated using colony distributions and turnover rates. There were no demonstrated impacts of military activity on wading bird colony establishment or size (Black et al., 1984). Fixed-winged jet aircraft disturbance did not seem to adversely affect waterfowl observed during a study in coastal North Carolina (Conomy et al., 1998); however, harlequin ducks were observed to show increased agonistic behavior and reduced courtship behavior up to one to two hours after low-altitude military jet overflights (Goudie & Jones, 2004).

It is possible that birds could habituate and no longer exhibit behavioral responses to aircraft noise, as has been documented for some impulsive noise sources (Ellis, 1981; Russel et al., 1996) and aircraft noise (Conomy et al., 1998). Ellis (1981) found that raptors would typically exhibit a minor short-term startle response to simulated sonic booms, and no long-term effect to productivity was noted.

Near-total failure of sooty tern nesting in the Dry Tortugas in the Key West Range Complex was reported in 1969 during a period when the birds were regularly exposed to sonic booms (Austin et al., 1970). In previous seasons, the birds were reported to react to the occasional sonic booms by rising immediately in a "panic flight," circling over the island, and then usually settling down on their eggs again. Researchers had no evidence that sonic booms caused physical damage to the sooty tern eggs, but hypothesized that the strong booms occurred often enough to disturb the sooty terns' incubating rhythm and cause nest desertion. The 1969 sooty tern nesting failure also prompted additional research to test the hypothesis that sonic booms could cause bird eggs to crack or otherwise affect bird eggs or embryos. However, the findings of the additional research determined that aircraft overflight and sonic booms were not a cause of the failure, and neither were panic flights, predators, weather, inadequate food supplies, or tick infestation (Bowles et al., 1991; Bowles et al., 1994; Teer & Truett, 1973; Ting et al., 2002). That same year, the colony also contained approximately 2,500 brown noddies, whose young hatched successfully. While it was impossible to conclusively determine the cause of the 1969 sooty tern nesting failure, actions were taken to curb planes breaking the sound barrier within range of the Tortugas, and much of the excess vegetation was cleared (another hypothesized contributing factor to the nesting failure). Similar nesting failures have not been reported since the 1969 failure.

As described in Section 5.3.2.5 (Aircraft Overflight Noise), the Navy implements mitigation within the Tortugas Military Operations Area, which is a unique block of special use airspace above the Dry Tortugas National Park that has special flight rules designed to minimize military aircraft noise. Mitigation includes not conducting combat maneuver flights below 5,000-ft. or tactical maneuvers resulting in supersonic flights below 20,000 ft. Audible sonic booms within the Dry Tortugas National Park are predicted to be infrequent and at low received levels based on mitigation measures implemented by the Navy to reduce the occurrence of focused sonic booms in the Tortugas Military Operations Area. In addition, initial efforts by Florida Fish and Wildlife Conservation Commission and National Park Service biologists to reestablish a nesting colony of the federally listed roseate tern in the Dry Tortugas have been successful. During this time, Navy use of the Tortugas Military Operations Area and surrounding Special Use Airspace remained constant. Given the increase in nests coincident with air combat maneuver training, the aircraft training following guidelines of the Military Operations Area has likely had minimal impact on nesting roseate terns.

3.9.3.1.1.6 Long Term Consequences

Long-term consequences to birds and bats due to acoustic exposures are considered following the Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (Section 3.0.3.6.1).

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 birds and bats 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. Most research on long-term consequences to birds due to acoustic exposures has focused on breeding colonies or shore habitats, and does not address the brief exposures that may be encountered during migration or foraging at sea. More research is needed to better understand the long-term consequences of human-made noise on birds and bats, although intermittent exposures are assumed to be less likely than prolonged exposures to have lasting consequences.

3.9.3.1.2 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).

Impacts from sonar and other transducers are not applicable to bats because bats are an airborne species and will not be analyzed further in this section. In addition, there is no overlap of sonar and other transducer noise and piping plover critical habitat.

Information regarding the impacts of sonar on birds is unavailable, and little is known about the ability of birds to hear underwater. The limited information (Johansen et al., 2016) and data from other species suggest the range of best hearing may shift to lower frequencies in water (Dooling & Therrien, 2012; Therrien, 2014) (see Section 3.9.2.1.4, Hearing and Vocalization). Because few birds can hear above 10 kHz in air, it is likely that the only sonar sources they may be able to detect are low and mid-frequency sources.

Other than pursuit diving species, the exposure to birds by these sounds is likely to be negligible because they spend only a very short time underwater (plunge-diving or surface-dipping) or forage only at the water surface. Pursuit divers may remain underwater for minutes, increasing the chance of underwater sound exposure.

In addition to diving behavior, the likelihood of a bird being exposed to underwater sound depends on factors such as duty cycle (defined as the percentage of the time during which a sound is generated over a total operational period), whether the source is moving or stationary, and other activities that might be occurring in the area. When used, continuously active sonars transmit more frequently (greater than 80% duty cycle) than traditional sonars, but at a substantially lower source level. However, it should be noted that active sonar is rarely used continuously throughout the listed activities, and many sources are mobile. For moving sources such as hull-mounted sonar, the likelihood of an individual bird being repeatedly exposed to an intense sound source over a short period of time is low because the training activities are transient and sonar use and bird diving are intermittent. The potential for birds to be exposed to intense sound associated with stationary sonar sources would likely be limited for some training and testing activities because other activities occurring in conjunction may cause them to leave the immediate area. For example, birds would likely react to helicopter noise during dipping sonar exercises by flushing from the immediate area, and would, therefore, not be exposed to underwater sonar.

Injury due to acoustic resonance of air space in the lungs from sonar and other transducers is unlikely in birds. Unlike mammals, birds have compact, rigid lungs with strong pulmonary capillaries that do not change much in diameter when exposed to extreme pressure changes (Baerwald et al., 2008), leading to resonant frequencies lower than the frequencies used for Navy sources.

A physiological impact, such as hearing loss, would likely only occur if a seabird were close to an intense sound source. An underwater sound exposure would have to be intense and of a sufficient duration to cause hearing loss. Avoiding the sound by returning to the surface would limit extended or multiple sound exposures underwater. Additionally, some diving birds may avoid interactions with large moving vessels upon which the most powerful sonars are operated (Schwemmer et al., 2011). In general, birds are less susceptible to both temporary and PTS than mammals (Saunders & Dooling, 1974). Diving birds have adaptations to protect the middle ear and tympanum from pressure changes during diving that may affect hearing (Dooling & Therrien, 2012). While some adaptions may exist to aid in underwater hearing, other adaptations to protect in-air hearing may limit aspects of underwater hearing (Hetherington, 2008). Because of these reasons, the likelihood of a diving bird experiencing an underwater exposure to sonar or other transducers that could result in an impact to hearing is considered low.

Because diving birds may rely more on vision for foraging, and there is no evidence that diving birds rely on underwater acoustic communication for foraging (see Section 3.9.2.1.4, Hearing and Vocalization), the masking of important acoustic signals underwater by sonar or other transducers is unlikely.

There have been no studies documenting diving seabirds' reactions to sonar. However, given the information and adaptations discussed above, diving seabirds are not expected to detect high-frequency sources underwater and are only expected to detect mid- and low-frequency sources when in close proximity. A diving bird may not respond to an underwater source, or it may respond by altering its dive behavior, perhaps by reducing or ceasing a foraging bout. It is expected that any behavioral interruption would be temporary, as the source or the bird changes location.

Some birds commonly follow vessels, including certain species of gulls, storm petrels, and albatrosses, as there is increased potential of foraging success as the prop wake brings prey to the surface (Hamilton, 1958; Hyrenbach, 2001, 2006; Melvin et al., 2001). Birds that approach vessels while foraging are the most likely to be exposed to underwater active acoustic sources, but only if the ship is engaged in anti-submarine warfare or mine warfare with active acoustic sources. However, hull-mounted sonar does not project sound aft of ships (behind the ship, opposite the direction of travel), so most birds diving in ship wakes would not be exposed to sonar. In addition, based on what is known about bird hearing capabilities in air, it is expected that diving birds may have limited or no ability to perceive high-frequency sounds, so they would likely not be impacted by high-frequency sources such as those used in mine warfare.

3.9.3.1.2.1 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).

Under Alternative 1, the number of Major Training Exercises and Civilian Port Defense Activities would fluctuate annually. In addition, a portion of Anti-Submarine Warfare Tracking Exercise-Ship unit-level training activities would be conducted using synthetic means (e.g., simulators) or in conjunction with other training exercises. 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.

Sonar and other transducers would not be regularly used in nearshore areas that could be used by foraging shorebirds, except during maintenance and for navigation in areas around ports. Therefore, birds that forage in open ocean areas would have a greater chance of underwater sound exposure than birds that forage in coastal areas.

The possibility of an ESA-listed bird species being exposed to sonar and other active acoustic sources depends on whether it submerges during foraging and whether it forages in areas where these sound sources may be used. Although Bermuda petrels forage in open ocean areas where sonar training occurs, it is unlikely they would be exposed to underwater sound because they typically forage at the surface and, if pursuit diving, only stay underwater for a short period (typically less than 10 seconds). The roseate tern's plunge-dive is shallow and brief in duration. Typical dives submerge less than the full body length of the tern with the duration of submergence seldom exceeding 1 to 2 seconds. Any exterior sound would be masked by the sound of the tern entering and exiting the water so no exposure is expected. Piping plovers and red knots do not submerge while foraging in intertidal areas; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Because impacts to individual birds, 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 bird populations, and sonar and other transducers will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of sonar and other transducers during training events as described under Alternative 1 will have no effect on Indiana bats, northern long-eared bats, roseate terns, piping plovers, red knots, or piping plover critical habitat. The use of sonar and other transducers during training activities as described under Alternative 1 may affect Bermuda petrels. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Sonar and Other Transducers Under Alternative 1 for Testing

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).

The possibility of an ESA-listed bird species being exposed to sonar and other active acoustic sources depends on whether it submerges during foraging and whether it forages in areas where these sound sources may be used. Although Bermuda petrels forage in open ocean areas where sonar testing occurs, it is unlikely they would be exposed to underwater sound because they typically forage at the surface and, if pursuit diving, only stay underwater for a short period (typically less than 10 seconds). The roseate tern's plunge-dive is shallow and brief in duration. Typical dives submerge less than the full body length of the tern with the duration of submergence seldom exceeding 1 to 2 seconds. Any exterior sound would be masked by the sound of the tern entering and exiting the water so no exposure is expected. Piping plovers and red knots do not submerge while foraging in intertidal areas; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Because impacts to individual birds, 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 bird populations, and sonar and other transducers will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 will have no effect on Indiana bats, northern long-eared bats, roseate terns, piping plovers, red knots, or piping plover critical habitat. The use of sonar and other transducers during testing activities as described under Alternative 1 may affect Bermuda petrels. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

3.9.3.1.2.2 Impacts from Sonar and Other Transducers 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 the use of synthetic means (e.g., simulators). This would result in an increase of sonar use compared to Alternative 1. 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.

Sonar and other transducers would not be regularly used in nearshore areas that could be used by foraging shorebirds, except during maintenance and for navigation in areas around ports. Therefore, birds that forage in open ocean areas would have a greater chance of underwater sound exposure than birds that forage in coastal areas.

The possibility of an ESA-listed bird species being exposed to sonar and other active acoustic sources depends on whether it submerges during foraging and whether it forages in areas where these sound sources may be used. Although Bermuda petrels forage in open ocean areas where sonar training occurs, it is unlikely they would be exposed to underwater sound because they typically forage at the surface and, if pursuit diving, only stay underwater for a short period (typically less than 10 seconds). The roseate tern’s plunge-dive is shallow and brief in duration. Typical dives submerge less than the full body length of the tern with the duration of submergence seldom exceeding 1 to 2 seconds. Any exterior sound would be masked by the sound of the tern entering and exiting the water so no exposure is expected. Piping plovers and red knots do not submerge while foraging in intertidal areas; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Because impacts to individual birds, 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 bird populations, and sonar and other transducers will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 will have no effect on Indiana bats, northern long-eared bats, piping plover critical habitat, roseate terns, piping plovers, red knots, or piping plover critical habitat. The use of sonar and other transducers during training activities as described under Alternative 2 may affect Bermuda petrels.

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.

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 possibility of an ESA-listed bird species being exposed to sonar and other active acoustic sources depends on whether it submerges during foraging and whether it forages in areas where these sound sources may be used. Although Bermuda petrels forage in open ocean areas where sonar testing occurs, it is unlikely they would be exposed to underwater sound because they typically forage at the surface and, if pursuit diving, only stay underwater for a short period (typically less than 10 seconds). The roseate tern's plunge-dive is shallow and brief in duration. Typical dives submerge less than the full body length of the tern with the duration of submergence seldom exceeding 1 to 2 seconds. Any exterior sound would be masked by the sound of the tern entering and exiting the water so no exposure is expected. Piping plovers and red knots do not submerge while foraging in intertidal areas; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Because impacts to individual birds, 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 bird populations, and sonar and other transducers will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 will have no effect on Indiana bats, northern long-eared bats, roseate terns, piping plovers, red knots, or piping plover critical habitat. The use of sonar and other transducers during testing activities as described under Alternative 2 may affect Bermuda petrels.

3.9.3.1.2.3 Impacts from Sonar and Other Transducers Under No Action Alternative

Impacts from Sonar and Other Transducers Under No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the 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.

3.9.3.1.3 Impacts from Air Guns

Air guns can introduce brief impulsive, broadband sounds into the marine environment. Section 3.0.3.3.1.2 (Air Guns) provides additional details on the use and acoustic characteristics of the small underwater air guns used during Navy activities.

Impulses from air guns used by the Navy lack the strong shock wave and rapid pressure increases of explosions that can cause primary blast injury or barotraumas. Underwater impulses would be generated using small (approximately 60 cubic in.) air guns, which are essentially stainless steel tubes charged with high-pressure air via a compressor. An impulsive sound is generated when the air is almost instantaneously released into the surrounding water, an effect similar to popping a balloon in air. Generated impulses would have short durations, typically a few hundred milliseconds.

Impacts from air guns are not applicable to bats because bats are an airborne species and will not be analyzed further in this section. In addition, there is no overlap of air gun noise and piping plover critical habitat.

The exposure to these sounds by birds, other than pursuit diving species, would be negligible because they spend only a very short time underwater (plunge-diving or surface-dipping) or forage only at the water surface. Pursuit divers may remain underwater for minutes, increasing the chance of underwater sound exposure. However, the short duration of an air gun pulse and its relatively low source level means that a bird would have to be very close to a small air gun used in Navy activities at the moment of discharge to be exposed. In addition, air guns may be fired at greater depths than birds conduct their foraging dives. Because of these reasons, the likelihood of a diving bird experiencing an underwater exposure to an air gun that could result in an impact to hearing is negligible.

Because diving birds may rely more on vision for foraging, there is no evidence that diving birds rely on underwater acoustic communication for foraging (see Section 3.9.2.1.4, Hearing and Vocalization), and the signal from an air gun is very brief, the masking of important acoustic signals underwater by an air gun is unlikely.

The limited data on behavioral reactions to underwater impulsive noise suggest that birds are unlikely to exhibit any notable behavioral reaction toward a small air gun (see Section 3.9.3.1.1.5, Behavioral Reactions).

3.9.3.1.3.1 Impacts from Air Guns Under Alternative 1

<u>**Impacts form Air Guns Under Alternative 1 for Training Activities**</u>

Training activities under Alternative 1 do not use air guns.

<u>**Impacts from Air Guns Under Alternative 1 for Testing**</u>

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 in.^{3}) would be fired pierside at Newport, Rhode Island and at offshore locations typically in the Northeast, Virginia Capes, and Gulf of Mexico Range Complexes.

The possibility of an ESA-listed seabird species being exposed to sounds from air guns depends on whether it submerges during foraging and whether it forages in areas where this sound source may be used. Although Bermuda petrels forage in open ocean areas where some air gun use occurs, it is unlikely they would be exposed to underwater sound because they typically forage at the surface and, if pursuit diving, only stay underwater for a short period (typically less than 10 seconds). Red knots and piping plovers do not submerge while foraging; therefore, they would not be exposed to underwater sound from air guns. Because roseate terns only briefly submerge while plunge-diving during foraging in coastal shallow waters, their risk of air gun exposure is negligible. As discussed above, impacts to individual birds, 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 bird populations, and air guns will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of air guns during testing activities as described under Alternative 1 will have no effect on Indiana bats, northern long-eared bats, piping plovers, roseate terns, red knots, or piping plover critical habitat. The use of air guns during testing activities as described under Alternative 1 may affect Bermuda petrels. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

3.9.3.1.3.2 Impacts from Air Guns Under Alternative 2

<u>Impacts from Air Guns Under Alternative 2 for Training Activities</u>

Training activities under Alternative 2 do not use air guns.

<u>Impacts from Air Guns Under Alternative 2 for Testing Activities</u>

Air gun testing activities planned under Alternative 2 are identical to those planned under Alternative 1; therefore, the estimated impacts would be identical. Because impacts to individual birds, 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 bird populations, and air guns will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of air guns during testing activities as described under Alternative 2 will have no effect on Indiana bats, northern long-eared bats, piping plovers, roseate terns, red knots, or piping plover critical habitat. The use of air guns during testing activities as described under Alternative 2 may affect Bermuda petrels.

3.9.3.1.3.3 Impacts from Air Guns Under No Action Alternative

<u>Impacts from Air Guns Under No Action Alternative for Training and Testing Activities</u>

Under the No Action Alternative, the Navy would not conduct the 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.

3.9.3.1.4 Impacts from Pile Driving

Impact pile driving and vibratory pile extraction would occur during construction of an Elevated Causeway System, a temporary pier that allows the offloading of ships in areas without a permanent port. Installation of piles would involve the use of an impact hammer mechanism and pile extraction would involve using the vibratory mechanism. These activities would occur over multiple days, although noise generated by the actual pile driving and extraction would only occur over a portion of any given day (generally an hour or less in total). 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.

Noise from the installation and removal of piles has a potential to affect animals in the vicinity of the training event. Impact pile driving creates repetitive impulsive sound. An impact pile driver generally operates in the range of 36–50 blows per minute. Vibratory pile extraction creates a nearly continuous sound made up of a series of short duration rapid impulses at a much lower source level than impact pile driving. The sounds are emitted both in the air and in the water in nearshore areas where some birds forage. It is expected that most birds would exhibit avoidance behavior and leavethe pile driving location. However, if prey species such as fish are killed or injured as a result of pile driving, some birds may continue to forage close to the construction area, or may be attracted to the area, and be exposed to associated noise. Behavioral responses and displacement from the area are expected to be temporary for the duration of the pile driving and extraction activities. Bats may be exposed to the in-air noise from pile driving installation and extraction.

Impulses from the impact hammer are broadband and carry most of their energy in the lower frequencies. The underwater SPLs produced by impact pile driving during Navy activities are below the conservatively estimated injury thresholds recommended for other small animals with similar sized air cavities [sea turtles and fish; see Popper et al. (2014)]. Therefore, the risk of barotrauma to any diving birds is negligible. Impulses from the impact hammer attenuate more quickly in air than in water and birds are likely to avoid the area during impact driving. Therefore, the risk of barotrauma to birds in air or at the water surface is negligible.

Pursuit divers may remain underwater for minutes, increasing the chance of underwater sound exposure. However, the short duration of driving or extracting a single pile would limit the likelihood of exposure, especially since a bird that is disturbed by pile driving while underwater may respond by swimming to the surface. Although it is not known what duration or intensity of underwater sound exposure would put a bird at risk of hearing loss, birds are less susceptible to both temporary and PTS than mammals (Saunders & Dooling, 1974). Diving birds have adaptations to protect the middle ear and tympanum from pressure changes during diving that may affect hearing (Dooling & Therrien, 2012). While some adaptions may exist to aid in underwater hearing, other adaptations to protect in-air hearing may limit aspects of underwater hearing (Hetherington, 2008). Because of these reasons, the likelihood of a diving bird experiencing an underwater exposure to impact pile driving that could affect hearing is considered low. Vibratory pile extraction sound levels are low and are not considered to pose a risk to bird hearing in air or in water.

Because diving birds may rely more on vision for foraging, there is no evidence that diving birds rely on underwater acoustic communication for foraging (see Section 3.9.2.1.4, Hearing and Vocalization), and individual pile driving and extraction occurs only over a few minutes, the masking of important acoustic signals underwater by pile driving is unlikely. The potential for masking of calls in air would also likely be limited because of the short duration of individual pile driving and extraction and the likelihood that birds would avoid the area around pile driving activities.

Responses by birds to noise from pile driving would be short-term behavioral or physiological responses (e.g., alert response, startle response, and temporary increase in heart rate). Startle or alert reactions are not likely to disrupt major behavior patterns such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any birds. Some birds may be attracted to the area to forage forn prey species killed or injured as a result of pile driving and be exposed to noise from pile driving temporarily. Birds may be temporarily displaced and there may be temporary increases in stress levels; however, behavior and use of habitat would return shortly after the training is complete.

3.9.3.1.4.1 Impacts from Pile Driving Under Alternative 1

Impacts form Pile Driving Under Alternative 1 for Training Activities

Characteristics of pile driving 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.

The impact of noise produced by pile driving and extraction would be short-term and localized. Birds in the close vicinity are expected to most likely respond by increasing distance from pile driving and extraction activities, or not respond at all to extraction activities. As discussed above, impacts to individual birds or bats, 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 bird or bat populations and pile driving will not have a significant adverse effect on populations of migratory bird species.

Bermuda petrels are unlikely to be present in coastal areas where pile driving could occur. Piping plovers, roseate terns, and red knots may be present in coastal areas where pile driving could occur, depending on time of year. None of these species are pursuit divers; therefore, there would be no risk from underwater pile driving noise exposure. If present, birds of these species may be exposed to in-air noise from pile driving, but would be expected to avoid the area around active impact pile driving and extraction construction activities. Pile driving activities would not occur at beaches that are designated as piping plover critical habitat. Bats may be exposed to the in-air noise from pile driving installation and extraction; however, most of the energy from pile driving would be carried in the lower frequencies out of the hearing range of bats.

Pursuant to the ESA, the use of pile driving during training activities described under Alternative 1 will have no effect on piping plover critical habitat. The use of pile driving during training activities described under Alternative 1 may affect piping plovers, Bermuda petrels, roseate terns, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Pile Driving Under Alternative 1 for Testing

Testing activities under Alternative 1 do not include pile driving.

3.9.3.1.4.2 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. Because impacts on individual birds and bats, 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 bird or bat populations, and pile driving will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of pile driving during training activities described under Alternative 2 will have no effect on piping plover critical habitat. The use of pile driving during training activities described under Alternative 2 may affect piping plovers, Bermuda petrels, roseate terns, red knots, Indiana bats, and northern long-eared bats.

<u>**Impacts from Pile Driving Under Alternative 2 for Testing Activities**</u>

Testing activities under Alternative 2 do not include pile driving.

3.9.3.1.4.3 Impacts from Pile Driving Under No Action Alternative

<u>**Impacts from Pile Driving Under No Action Alternative for Training and Testing Activities**</u>

Under the No Action Alternative, the Navy would not conduct the 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.

3.9.3.1.5 Impacts from Vessel Noise

The training and testing proposed in the Study Area involve maneuvers by various types of surface ships, boats, submarines, and unmanned vehicles (collectively referred to as vessels) (see Section 3.0.3.3.1.4, Vessel Noise). Birds could be exposed to both in-air and underwater noise from vessels throughout the Study Area and bats may be exposed to in-air noise from vessels throughout the Study Area, but few exposures would occur based on the infrequency of operations and the low density of vessels within the Study Area at any given time. Potential for exposure to vessel noise due to Navy activities would be greatest near Navy ports.

Birds respond to vessels in various ways. Some birds are commonly attracted to and follow vessels including certain species of gulls, storm-petrels, and albatrosses (Hamilton, 1958; Hyrenbach, 2001, 2006), while other species such as frigatebirds, sooty terns, and a variety of diving birds seem to avoid vessels (Borberg et al., 2005; Hyrenbach, 2006; Schwemmer et al., 2011). Vessel noise could elicit short-term behavioral or physiological responses but are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any birds. Harmful bird/vessel interactions are commonly associated with commercial fishing vessels because birds are attracted to concentrated food sources around these vessels (Dietrich & Melvin, 2004; Melvin & Parrish, 2001). The concentrated food sources (catch and bycatch) that attract birds to commercial fishing vessels are not present around Navy vessels.

Although loud sudden noises can startle and flush birds, Navy vessels are not expected to result in major acoustic disturbance of birds in the Study Area. The continuous noise from Navy vessels has the potential to cause masking for birds, both in air and underwater. Due to the transient nature of Navy vessels, this masking is expected to be temporary. Birds near ports may experience increased masking and become habituated to this noise or attempt to compensate for the masking. Noises from Navy vessels are similar to or less than those of the general maritime environment. Birds may respond to the physical presence of a vessel, regardless of the associated noise (See section 3.9.3.4.1, Impacts from Vessels and In-water Devices).

Very little is known about the impact of vessel noise on bats, although studies of vehicle noise suggest that the distance from and number of passing vehicles affect the intensity of the acoustic habitat degradation, which will affect bats' behavior (Schaub et al., 2008). Bats have been known to temporarily roost on vessels along their migration routes as noted in Section 3.9.2.1 (General Background). Anecdotal evidence exists for the ability of bats to cope with considerable background noise in non-foraging situations (Schaub et al., 2008). Navy vessels are not expected to result in major acoustic disturbance of bats in the Study Area.

3.9.3.1.5.1 Impacts from Vessel Noise Under Alternative 1

Impacts form 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). Navy vessel traffic could occur anywhere within the Study Area, but would be concentrated near the Norfolk and Mayport Navy ports and within the Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes. Navy vessel noise would continue to be a minor contributor to overall radiated vessel noise in the exclusive economic zone. A study of Navy vessel traffic found that traffic was heaviest just offshore between the mouth of the Chesapeake Bay and Jacksonville, FL, with very little Navy vessel traffic in the Northeast or Gulf of Mexico Range Complexes (Mintz, 2012). There is no overlap of vessel noise and piping plover critical habitat.

A bird in the open ocean could be exposed to vessel noise as the vessel passes. Birds foraging or migrating through a training area in the open ocean may respond by avoiding areas of temporarily concentrated vessel noise. Exposures to most seabirds would be infrequent, based on the brief duration and dispersed nature of the vessels.

If a bird or bat responds to vessel noise, only short-term behavioral responses such as startle responses, head turning, or avoidance responses would be expected. Repeated exposures would be limited due to the transient nature of vessel use and regular movement of birds and bats. Because impacts to individual birds and bats, 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 bird or bat populations, and vessel noise will not have a significant adverse effect on populations of migratory bird species.

Coastal roseate terns, red knots, and piping plovers could be exposed to intermittent vessel noise along the coast. If present in the open water areas where training activities involving vessel noise occur, roseate terns, red knots, Bermuda petrels, Indiana bats, and northern long-eared bats could be temporarily disturbed while foraging or migrating.

Pursuant to the ESA, vessel noise during training activities as described under Alternative 1 will have no effect on piping plover critical habitat. Vessel noise during training activities as described under Alternative 1 may affect roseate terns, red knots, Bermuda petrels, piping plovers, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Vessel Noise Under Alternative 1 for Testing

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 within the Study Area typically consist of a single vessel involved in unit-level activity for a few hours, one or two small boats conducting testing, or during a larger training event. Navy vessel traffic could occur anywhere within the Study Area, primarily concentrated within the Jacksonville and Virginia Capes Range Complexes; the Northeast Range Complexes and adjacent inshore waters, especially near the Naval Underwater Warfare Center Newport Testing Range; and in the Gulf of Mexico, especially in areas near Naval Surface Warfare Center, Panama City Division Testing Range. There is no overlap of vessel noise and piping plover critical habitat.

A bird or bat in the open ocean could be exposed to vessel noise as the vessel passes. Birds and bats foraging or migrating through a testing area in the open ocean may respond by avoiding areas of temporarily concentrated vessel noise. Exposures to most birds and bats would be infrequent, based on the brief duration and dispersed nature of the vessels.

If a bird or bat responds to vessel noise, only short-term behavioral responses such as startle responses, head turning, or avoidance responses would be expected. Repeated exposures would be limited due to the transient nature of vessel use and regular movement of birds and bats. Because impacts to individual birds or bats, 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 bird or bat populations, and vessel noise will not have a significant adverse effect on populations of migratory bird species.

Coastal roseate terns, red knots, and piping plovers could be exposed to intermittent vessel noise along the coast. If present in the open water areas where testing activities involving vessel noise occur, roseate terns, red knots, Bermuda petrels, Indiana bats, and northern long-eared bats could be temporarily disturbed while foraging or migrating.

Pursuant to the ESA, vessel noise during testing activities as described under Alternative 1 will have no effect on piping plover critical habitat. Vessel noise during testing activities as described under Alternative 1 may affect roseate terns, red knots, Bermuda petrels, piping plovers, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

3.9.3.1.5.2 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.

Pursuant to the ESA, vessel noise during training activities as described under Alternative 2 will have no effect on piping plover critical habitat. Vessel noise during training activities as described under Alternative 2 may affect roseate terns, red knots, Bermuda petrels, piping plovers, Indiana bats, and northern long-eared bats.

Impacts from Vessel Noise Under Alternative 2 for Testing Activities

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.

Pursuant to the ESA, vessel noise during testing activities as described under Alternative 2 will have no effect on piping plover critical habitat. Vessel noise during testing activities as described under Alternative 2 may affect roseate terns, red knots, Bermuda petrels, piping plovers, Indiana bats, and northern long-eared bats.

3.9.3.1.5.3 Impacts from Vessel Noise Under No Action Alternative

Impacts from Vessel Noise Under No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the 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.

3.9.3.1.6 Impacts from Aircraft Noise

Birds and bats could be exposed to airborne noise associated with subsonic and supersonic fixed-wing aircraft and helicopter overflights while foraging or migrating in open water, nearshore, or coastal environments within the Study Area. Tilt-rotor impacts would be similar to fixed-wing or helicopter impacts depending which mode the aircraft is in. A description of aircraft noise produced during Navy activities is provided in Section 3.0.3.3.1.5 (Aircraft Overflight Noise).

Exposure to fixed-wing aircraft noise would be brief as an aircraft quickly passes overhead. Exposures would be infrequent based on the transitory and dispersed nature of the overflights; repeated exposure of individual birds and bats over a short period of time (hours or days) is unlikely. Birds repeatedly exposed to aircraft noise often become habituated to the noise and do not respond behaviorally (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). However, habituation seems unlikely in the Study Area given the widely dispersed and infrequent nature of the operations.

Common behavioral responses of wildlife to aircraft noise include no response or stationary alert behavior (Johnson & Reynolds, 2002), startle response, flying away, and increased vocalizations (Bowles, 1995; Larkin et al., 1996; National Park Service, 1994). In some instances, behavioral responses could interfere with breeding, raising young, foraging, habitat use, and physiological energy budgets, particularly when an animal continues to respond to repeated exposures. The potential for masking of calls in air is possible if a bird or bat remains in the area; however, due to the transitory nature of aircraft overflights, the duration of masking would be limited.

Some air combat maneuver training would involve high altitude, supersonic flight, which would produce sonic booms, but such airspeeds would be infrequent and are typically conducted at high altitudes and far from shore, limiting the areas where birds and bats could be exposed. Boom duration is generally less than 300 milliseconds. Sonic booms would cause seabirds to startle, but the exposure would be brief, and any reactions are expected to be short-term. Startle impacts range from altering behavior (e.g., stop feeding or preening), minor behavioral changes (e.g., head turning), or at worst, a flight response. Because most fixed-wing flights are not supersonic and birds, bats, and aircraft are transient in any area, exposure of birds and bats in the open ocean to sonic booms would be infrequent. It is unlikely that individual birds or bats would be repeatedly exposed to sonic booms in the open ocean.

Helicopters typically operate below 1,000 ft. (304.8 m) altitude and often occur as low as 75–100 ft. (22.9–30.5 m) altitude. This low-altitude increases the likelihood that birds and bats would respond to noise from helicopter overflights with reactions such as flushing (Stalmaster & Kaiser, 1997), although a large portion of birds may exhibit no reaction to nearby helicopters (Grubb et al., 2010). Helicopters travel at slower speeds (less than 100 knots) which increases the duration of noise exposure compared to fixed-wing aircraft. Helicopter flights are generally limited to locations closer to the coast, unless deployed onboard ships. Helicopter flights, therefore, are more likely to impact the greater numbers of birds and bats that forage in coastal areas than those that forage in open ocean areas. Nearshore areas of the coast are the primary foraging habitat for many bird species. The presence of dense aggregations of sea ducks, other seabirds, and migrating land birds is a potential concern during low-altitude helicopter activities. Although birds may be more likely to react to helicopters than to fixed-wing aircraft, Navy helicopter pilots avoid large flocks of birds to protect aircrews and equipment, thereby reducing disturbance to birds as well. Within the Virginia Capes Range Complex, during mine countermeasure and neutralization activities, helicopters will remain at least 1 nautical miles (NM) from the beach except when transiting offshore. When transiting from Norfolk Naval Station to waters offshore, helicopters will avoid overflying Fisherman Island National Wildlife Refuge off the coast of Cape Charles, Virginia by at least 3,000 ft. vertically and horizontally to avoid disturbing ESA-listed piping plovers and other birds. Noise from low-altitude helicopter overflights would only be expected to elicit short-term behavioral or physiological responses in exposed birds and bats.

Birds in areas that may experience repeated exposure often habituate and do not respond behaviorally (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). Throughout the Study Area, repeated exposure of individual birds or groups of birds is unlikely based on the dispersed nature of the overflights and the capability of birds to avoid or rapidly vacate an area of disturbance. Therefore, the general health of individual birds would not be compromised. Although no studies have been conducted specifically investigating the impact of aircraft noise on bats, bats are expected to adjust their call frequency when in the presence of high-frequency sounds within their own range of emissions as well as avoid areas of high levels of broadband background noise (Bates et al., 2008). Therefore, if the aircraft noise were within the bats' hearing range the area would be expected to be avoided or the bat would adjust their call frequency. Occasional startle or alert reactions to aircraft noise are not likely to disrupt major behavior patterns (such as migrating, breeding, feeding, and sheltering) or to result in serious injury to any birds or bats.

3.9.3.1.6.1 Impacts from Aircraft Noise Under Alternative 1

<u>Impacts form 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 overflights would usually occur near 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.

Most helicopter training would occur adjacent to fleet concentration areas at Naval Station Norfolk (including lower Chesapeake Bay and inshore estuarine areas) and at Naval Station Mayport, Jacksonville, Florida; in Onslow Bay, North Carolina; and in the waters off the coast of Naval Surface Warfare Center, Panama City Testing Range. Helicopters use the shortest route available and do not fly adjacent to the coastline when flying to the training and testing areas. Takeoffs and landings on vessels at sea would occur at unspecified locations throughout the Study Area.

Navy aircraft training activities over the Atlantic Ocean are concentrated near the outer continental shelf and the Gulf Stream. Pelagic birds that forage offshore may have greater presence in these productive areas. A bird in the open ocean could be exposed for a few seconds to fixed-wing aircraft noise as the aircraft quickly passes overhead. If present in the open water areas where training activities involving aircraft overflights occur, roseate terns, red knots, Bermuda petrels, Indiana bats, and northern long-eared bats could be temporarily disturbed while foraging or migrating. Birds foraging or migrating through a training area in the open ocean may respond by avoiding areas of temporarily concentrated aircraft noise. Exposures to most seabirds would be infrequent, based on the brief duration and dispersed nature of the overflights.

Most helicopter activities are transient in nature, although helicopters could also hover for extended periods. Activities involving helicopters would occur closer to the coast and in inshore estuarine locations. Activities involving helicopters may occur for extended periods of time, up to a couple of hours in some areas, increasing the potential for exposure. In addition to daytime activities, activities involving helicopters could also occur at night, increasing the potential for exposure to bats. 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. However, the likelihood that birds or bats would remain in the immediate vicinity while an aircraft or helicopter transits directly nearby 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 activities would be highly localized and concentrated in space and duration.

If a bird or bat responds to aircraft noise, only short-term behavioral responses such as startle responses, head turning, or avoidance responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of birds and bats. Because impacts to individual birds and bats, 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 bird or bat populations, and aircraft overflight noise will not have a significant adverse effect on populations of migratory bird species. Within the Virginia Capes Range Complex, during mine countermeasure and neutralization activities, helicopters will remain at least 1 NM from the beach except when transiting offshore. When transiting from Norfolk Naval Station to waters offshore, helicopters will avoid overflying Fisherman Island National Wildlife Refuge off the coast of Cape Charles, Virginia by at least 3,000 ft. vertically and horizontally to avoid disturbing ESA-listed piping plovers and other birds.

Critical habitat for wintering piping plovers is designated in the Marquesas Keys. Although there could be intermittent increases in ambient noise levels, aircraft overflights would not impact the ability of critical habitat designated in the Marquesas Keys to support roosting, refuge, or feeding of wintering piping plovers.

Pursuant to the ESA, aircraft noise during training activities as described under Alternative 1 will have no effect on piping plover critical habitat. Aircraft noise during training activities as described under Alternative 1 may affect roseate terns, red knots, piping plovers, Bermuda petrels, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Aircraft Noise Under Alternative 1 for Testing

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 near Navy airfields, installations, and in special use airspace within Navy range complexes. Testing activities with aircraft would be most concentrated in the Virginia Capes Range Complex.

Flights involving sonic booms would occur in the area of the Delmarva Peninsula in Virginia Capes, which has the potential to result in startle responses from foraging piping plovers, red knots, and roseate terns, as well as nesting piping plovers. These flights occur offshore and parallel to the peninsula, and up to 60 percent involve a turn towards shore. Of the scheduled flights, only 85 percent may actually go supersonic. Only 30 percent of the flights will be conducted below 20,000 ft., and none of these flights will be conducted below 5,000 ft.

Navy aircraft testing activities over the Atlantic Ocean are concentrated near the outer continental shelf and the Gulf Stream. Pelagic birds that forage offshore may have greater presence in these productive areas. A bird or bat in the open ocean could be exposed for a few seconds to fixed-wing aircraft noise as the aircraft quickly passes overhead. If present in the open water areas where testing activities involving aircraft overflights occur, roseate terns, red knots, Bermuda petrels, Indiana bats, and northern long-eared bats could be temporarily disturbed while foraging or migrating. Birds and bats foraging or migrating through a training area in the open ocean may respond by avoiding areas of temporarily concentrated aircraft noise. Exposures to most birds and bats would be infrequent, based on the brief duration and dispersed nature of the overflights.

Most helicopter activities are transient in nature, although helicopters could also hover for extended periods. Activities involving helicopters would occur closer to the coast and in inshore estuarine locations. Activities involving helicopters may occur for extended periods of time, up to a couple of hours in some areas, increasing the potential for exposure. In addition to daytime activities, activities involving helicopters could also occur at night, increasing the potential for exposure to bats. 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. However, the likelihood that birds or bats would remain in the immediate vicinity while an aircraft or helicopter transits directly nearby 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 activities would be highly localized and concentrated in space and duration.

If a bird or bat responds to aircraft noise, only short-term behavioral responses such as startle responses, head turning, or avoidance responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of birds and bats. Because impacts to individual birds or bats, 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 bird or bat populations, and aircraft overflight noise will not have a significant adverse effect on populations of migratory bird species.

Critical habitat for wintering piping plovers is designated in the Marquesas Keys. Although there could be intermittent increases in ambient noise levels, aircraft overflights would not impact the ability of critical habitat designated in the Marquesas Keys to support roosting, refuge, or feeding of wintering piping plovers.

Pursuant to the ESA, aircraft overflight noise during testing activities as described under Alternative 1 will have no effect on piping plover critical habitat. Aircraft noise during testing activities as described under Alternative 1 may affect roseate terns, red knots, piping plovers, Bermuda petrels, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

3.9.3.1.6.2 Impacts from Aircraft Noise Under Alternative 2

Impacts from Aircraft Noise Under Alternative 2 for Training Activities

There would be minor increase in aircraft overflights under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for training under Alternative 1.

Pursuant to the ESA, aircraft overflight noise during training activities as described under Alternative 2 will have no effect on piping plover critical habitat. Aircraft noise during training activities as described under Alternative 2 may affect roseate terns, red knots, piping plovers, Bermuda petrels, Indiana bats, and northern long-eared bats.

Impacts from Aircraft Noise Under Alternative 2 for Testing Activities

There would be a minor increase in aircraft overflights under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for testing under Alternative 1.

Pursuant to the ESA, aircraft overflight noise during testing activities as described under Alternative 2 will have no effect on piping plover critical habitat. Aircraft noise during testing activities as described under Alternative 2 may affect roseate terns, red knots, piping plovers, Bermuda petrels, Indiana bats, and northern long-eared bats.

3.9.3.1.6.3 Impacts from Aircraft Noise Under No Action Alternative

Impacts from Aircraft Noise Under No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the 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.

3.9.3.1.7 Impacts from Weapons Noise

Birds and bats may be exposed to sounds caused by the firing of weapons, objects in flight, and the impact of non-explosive projectiles on the water's surface. Other devices intentionally produce noise to serve as a non-lethal deterrent. These sounds are described in Section 3.0.3.3.1.6 (Weapons Noise). Navy training activities in the Study Area include firing or launching a variety of weapons, including missiles; rockets; and small-, medium-, and large-caliber projectiles. Most weapons firing activities occur far from shore, limiting most possible exposures to birds that forage or migrate greater than 3 NM offshore. In addition to noise from weapons firing and launching, birds and bats could be briefly disturbed by the impact of non-explosive practice munitions at the water surface. Because of the potential for blast injury due to explosives, the impacts due to explosive munitions and other explosives used during Navy activities are discussed in Section 3.9.3.2.2 (Impacts from Explosives).

Sounds produced by weapons firing (muzzle blast), launch boosters, and projectile travel are potential stressors to birds and bats. Sound generated by a muzzle blast is intense, but very brief. A bird or bat very close to a large weapons blast could be injured or experience hearing loss due to acoustic trauma or threshold shift. Sound generated by a projectile travelling at speeds greater than the speed of sound can produce a low amplitude bow shock wave in a narrow area around its flight path. Inert objects hitting the water surface would generate a splash and the noise may disturb nearby birds and bats. Bird and bat responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. Studies of impacts of weapons noise on raptors show that these birds show little reaction (e.g., head turn) and do not alter behavior in the presence of noise from weapons testing (Brown et al., 1999; Schueck et al., 2001; Stalmaster & Kaiser, 1997). Once surface weapons firing activities begin, birds and bats would likely disperse away from the area around the ship and the path of projectiles if disturbed.

Other activities in the general area that precede these activities, such as vessel movement or target setting, could potentially disperse birds away from the area in which weapons-firing noise would occur. Species such as frigatebirds and sooty terns seem to avoid vessels (Borberg et al., 2005; Hyrenbach, 2006). Increased ship activity could drive these and other species from their natural habitat at a critical time or in an important foraging area (Borberg et al., 2005). On the other hand, some birds commonly follow vessels, including certain species of gulls, storm petrels, and albatrosses (Hamilton, 1958; Hyrenbach, 2001, 2006). A number of bird species are attracted to ships because of the increased potential for foraging success (Dietrich & Melvin, 2004; Melvin et al., 2001). The propeller wake generated by all ships, but particularly larger ships, disrupts the water column, causing prey to be brought to the surface where it is more easily captured by a greater variety of bird species. Birds that are attracted to ships could be more likely to be exposed to weapons firing noise.

Airborne weapons firing at airborne targets typically occur at high altitudes of 15,000–25,000 ft. during air-to-air gunnery exercises. Noise generated by firing at such high altitudes is unlikely to generate a strong reaction in birds or bats migrating at lower altitudes or foraging at the surface. While several studies have shown that bats typically fly lower than 10 m above sea level (Ahlén et al., 2009; Pelletier et al., 2013), others have shown that migrating bats have been observed over 200 m above sea level (Hatch et al., 2013; Sjollema et al., 2014). The altitudes at which migrating birds fly can vary greatly based on the type of bird, where they are flying (over water or over land), and other factors such as weather. Approximately 95 percent of bird flight during migrations occurs below 10,000 ft. (3,048 m) with the majority below 3,000 ft. (914 m) (Lincoln et al., 1998). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152 m) and 1,000 ft. (305 m).

Literature on non-migratory flight altitudes for the four ESA protected species varies in availability. Perkins et al. (2004) found that during the breeding period, most common and roseate terns flew at altitudes below 21 m. The average height from which roseate terns plunge-dive for fish is 4.4 m above the water's surface (Duffy, 1986), and foraging flights rarely, if ever, exceed 12 m in height (Hatch & Kerlinger, 2004; Mostello, 2007). Perkins et al. (2004) recorded most terns (common and roseate) seen in Nantucket Sound (less than 10 mi. offshore) flying at altitudes of less than 30 m. Non-migratory piping plover flight altitude is normally below 120 m, except for courtship flights, which are land-based (U.S. Fish and Wildlife Service, 2008a). Red knot and Bermuda petrel information was not available for non-migratory flight heights.

If a bird or bat does not avoid the area of Navy activity and is in the vicinity of a muzzle blast from a large-caliber gun or the bow shock wave of a large supersonic projectile, the potential for auditory impacts exists. If in the immediate vicinity of a large gun muzzle blast, a bird could experience peak SPLs that have been shown to cause a permanent reduction in hearing sensitivity over the low-frequency portion of hearing range (see Section 3.9.3.1.1.2, Hearing Loss). Similarly, the bow shock waves of larger projectiles would create a zone around the path of the projectile where a bird or bat could experience auditory effects due to the near-instantaneous passing of a high peak pressure wave (subjectively a "crack" sound). The estimated range to peak sound levels shown to cause permanent reduction in hearing sensitivity over a portion of a bird's hearing range from the projectile path of a large-caliber gun projectile travelling at supersonic speed is about 10 m. Data for onset of PTS is unavailable, but the range to onset of PTS can be assumed to extend beyond 10 m from a large-caliber projectile path. The amplitude of the bow shock wave would increase with supersonic projectile size and speed. Because most projectiles spend all or part of their travel path at altitudes above 20 m, impacts to many low-flying seabirds would be minimal.

The impulsive sound caused by weapon firings would have limited potential to mask any important biological sound simply because the duration of the impulse is brief, even when multiple shots are fired in series.

3.9.3.1.7.1 Impacts from Weapons Noise Under Alternative 1

Impacts form Weapons Noise Under Alternative 1 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 weapons noise are described in Section 3.0.3.3.1.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for training under Alternative 1 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 weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.0.3.3.2, Explosive Stressors).

Use of weapons during training would typically 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 3 NM from shore.

Most sounds would be brief, lasting from less than a second for a blast or inert impact to a few seconds for other launch and object travel sounds. Most incidents of impulsive sounds produced by weapons firing, launch, or inert object impacts would be single events, with the exception of gunfire activities.

Variants of the Long Range Acoustic Device are used both on vessels and on piers. These devices communicate voice, tones, or prerecorded tracks within the range of human hearing and may reach birds within 3,000 m of the device. Birds have the potential to be briefly startled or temporarily displaced during training with this device, though it is unlikely this device will produce sounds within the hearing range of bats.

Birds and bats that migrate or forage in open ocean areas could be exposed to large-caliber weapons noise, including foraging and migrating Bermuda petrels, migrating roseate terns, and migrating red knots. All species could be exposed to small- and medium-caliber weapons noise that may occur closer to shore. Temporary disturbance due to weapons noise is not expected to result in major impacts on these ESA-listed species. Because large weapons firing would typically occur offshore, roseate tern nesting colonies in the Key West Range Complex are unlikely to be disturbed. Piping plovers would not be present in the offshore areas where weapons are fired; additionally, weapons firing noise would not overlap with piping plover critical habitat.

Because weapon firing occurs at varying locations over a short time period and seabird and bat presence changes seasonally and on a short-term basis, individual birds and bats would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds and bats related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent. Because impacts to individual birds and bats, 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 bird or bat populations, and weapons noise will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, weapons noise during training activities described under Alternative 1 will have no effect on piping plover critical habitat. Weapons noise during training activities described under Alternative 1 may affect Indiana bats, northern long-eared bats, piping plovers, Bermuda petrels, roseate terns, and red knots. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

Impacts from Weapons Noise Under Alternative 1 for Testing

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 weapons noise are described in Section 3.0.3.3.1.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for testing under Alternative 1 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 weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.9.3.2 (Explosive Stressors)].

Use of weapons during 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 3 NM from shore.

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 weapons firing, launch, or inert object impacts would be single events, with the exception of gunfire activities.

Birds and bats that migrate or forage in open ocean areas could be exposed to large-caliber weapons noise, including foraging and migrating Bermuda petrels, migrating roseate terns, and migrating red knots. All species could be exposed to small- and medium-caliber weapons noise that may occur closer to shore. Temporary disturbance due to weapons noise is not expected to result in major impacts on these ESA-listed species. Because large weapons firing would typically occur offshore, roseate tern nesting colonies in the Key West Range Complex are unlikely to be disturbed. Piping plovers would not be present in the offshore areas where weapons are fired; additionally, weapons firing noise would not overlap with piping plover critical habitat.

Because weapon firing occurs at varying locations over a short time period and seabird and bat presence changes seasonally and on a short-term basis, individual birds and bats would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds and bats related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent. Because impacts to individual birds and bats, 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 bird or bat populations, and weapons noise will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, weapons noise during testing activities described under Alternative 1 will have no effect on piping plover critical habitat. Weapons noise during testing activities described under Alternative 1 may affect Indiana bats, northern long-eared bats, piping plovers, Bermuda petrels, roseate terns, and red knots. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

3.9.3.1.7.2 Impacts from Weapons Noise Under Alternative 2

Impacts from Weapons Noise Under Alternative 2 for Training Activities

There would be minor increase in weapons use 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. Because impacts to individual birds or bats, 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 bird or bat populations, and weapons noise will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, weapons noise during training activities described under Alternative 2 will have no effect on piping plover critical habitat. Weapons noise during training activities described under Alternative 2 may affect Indiana bats, northern long-eared bats, piping plovers, Bermuda petrels, roseate terns, and red knots.

Impacts from Weapons Noise Under Alternative 2 for Testing Activities

There would be a minor increase in weapons use under Alternative 2 compared to Alternative 1; however, the types and locations of impacts would be the same as those described for testing under Alternative 1. Because impacts to individual birds or bats, 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 bird or bat populations, and weapons noise will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, weapons noise during testing activities described under Alternative 2 will have no effect on piping plover critical habitat. Weapons noise during testing activities described under Alternative 2 may affect Indiana bats, northern long-eared bats, piping plovers, Bermuda petrels, roseate terns, and red knots.

3.9.3.1.7.3 Impacts from Weapons Noise Under No Action Alternative

Impacts from Weapons Noise Under No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the training and testing activities in the AFTT Study Area. Various acoustic stressors (e.g., weapons 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.

3.9.3.2 Explosive Stressors

Explosions in the water, near the water surface, and in the air can introduce loud, impulsive, broadband sounds into the marine environment. But, unlike other acoustic stressors, explosives release energy at a high rate producing a shock wave that can be injurious and even deadly. Therefore, explosive impacts to birds and bats are discussed separately from other acoustic stressors, even though the analysis of explosive impacts will rely on data for bird and bat 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 Explosive Concepts).

This section begins with a summary of relevant data regarding explosive impacts to birds and bats in Section 3.9.2.1 (General 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 Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors), and this section follows that framework. Studies of the effects of sound and energy from explosives on birds and bats are limited, therefore, where necessary, knowledge of impacts to other species from explosives is used to assess impacts to birds and bats.

3.9.3.2.1 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 to birds and bats potentially resulting from Navy training and testing activities. A range of impacts could occur to a bird or bat 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.

3.9.3.2.2 Impacts from Explosives

3.9.3.2.2.1 Injury

If a bird or bat is close to an explosive detonation, the exposure to high pressure levels and sound impulse can cause barotrauma. Barotrauma is physical injury due to a difference in pressure between an air space inside the body and the surrounding air or water. Sudden very high pressures can also cause damage at tissue interfaces due to the way pressure waves travel differently through tissues with different material properties. Damage could also occur to the structure of the ear, considered to be the body part most susceptible to pressure damage. The differences between bird and bat respiratory systems indicate that bats may be more susceptible to pulmonary barotrauma than birds. Birds have compact, rigid lungs with strong pulmonary capillaries that do not change much in diameter when exposed to extreme pressure changes, while bats have large, pliable lungs that expand when exposed to a sudden drop in pressure causing tissue damage. Although the pressure reduction required to cause the type of internal injuries observed in bats is unknown, pressure differences as small as 4.4 kPa are lethal to Norway rats (*Rattus norvegicus*), which has been used as a surrogate species for bat barotrauma studies (Baerwald et al., 2008).

Detonations that occur underwater could injure, kill, or disturb diving birds, particularly pursuit divers that spend more time underwater than other foraging birds (Danil & St Leger, 2011). Studies show that birds are more susceptible to underwater explosions when they are submerged versus partially submerged on the surface. Two species of duck were exposed to explosive blasts while submerged 0.61 m and while sitting on the water surface. Onset of mortality (LD_1) was predicted to occur at an impulse exposure of 248 Pa-s (36 psi-ms) for birds underwater and 690 Pa-s (100 psi-ms) for birds at the water surface (Yelverton & Richmond, 1981). No injuries would be expected for birds underwater at blast pressures below 41 Pa-s (6 psi-msec) and for birds on the surface at blast pressures below 207 Pa-s (30 psi-msec) (Yelverton & Richmond, 1981). Tests of underwater explosive exposures to other taxa (fish, mammals) have shown that susceptibility to injury is related to animal mass, with smaller animals being more susceptible to injury (Yelverton & Richmond, 1981). It is reasonable to assume that this relationship would apply to birds as well. The range to these thresholds would be based on several factors including charge size, depth of the detonation, and how far the bird is beneath the water surface.

Detonations in air or at the water surface could also injure birds or bats while either in flight or at the water surface. Experiments that exposed small, medium, and large birds to blast waves in air were conducted to determine the exposure levels that would be injurious (Damon et al., 1974). Birds were assessed for internal injuries to air sacs, organs, and vasculature, as well as injury to the auditory tympanum, but internal auditory damage was not assessed. Results indicated that peak pressure exposure of 5 psi would be expected to produce no blast injuries, 10 psi would produce slight to extensive injuries, and 20 psi would produce 50 percent mortality. These results also suggested that birds with higher mass may be less susceptible to injury. In addition to the risk of direct blast injury, exposure to an explosion in air may cause physical displacement of a bird that could be injurious if the animal impacts a surface. The same study examined displacement injuries to birds (Damon et al., 1974). Results indicated that impulse exposures below 5 psi-msec would not be expected to result in injuries.

One experiment was conducted with birds in flight, showing how birds can withstand relatively close exposures to in-air explosions (Damon et al., 1974). Flying pigeons were exposed to a 64-lb net explosive weight explosion. Birds at 44 to 126 ft. from the blast exhibited no signs of injury, while serious injuries were sustained at ranges less than 40 ft. The no injury zone in this experiment was also for exposures less than 5 psi-msec impulse, similar to the results of the displacement injury study.

Ranges to the no injury threshold for a range of in-air explosives are shown in Table 3.9-5. Data for birds in this study is assumed to also be applicable to bats due to similar body size.

Table 3.9-5: Range to No Blast Injury for Birds and Bats Exposed to Aerial Explosives

Net explosive weight	*Range to 5 psi*
5 lb.	21 ft.
10 lb.	26 ft.
100 lb.	57 ft.

Notes: Ranges calculated using the methods in U.S. Department of the Navy (1975).

Another risk of explosions in air is exposure to explosive fragmentation, in which pieces of the casing of a cased explosive are ejected at supersonic speeds from the explosion. The risk of direct strike by fragmentation would decrease exponentially with distance from the explosion, as the worst case for strike at any distance is the surface area of the casing fragments, which ultimately would decrease their outward velocity under the influence of drag. It is reasonable to assume that a direct strike in air or at the water surface would be mortal. Once in water, the drag on any fragments would quickly reduce their velocity to non-hazardous levels (Swisdak & Montanaro, 1992).

The initial detonation in a series of detonations may deter birds and bats from subsequent exposures via an avoidance response, however, birds have been observed taking interest in surface objects related to detonation events and subsequently being killed by a following detonation [Stemp, R. in Greene et al. (1985)].

3.9.3.2.2.2 Hearing Loss

Exposure to intense sound may result in hearing loss which persists after cessation of the noise exposure. There are no data on hearing loss in birds or bats specifically due to explosives; therefore, the limited data on hearing loss due to impulsive sounds, described for acoustic stressors in Section 3.9.3.1.1.2 (Hearing Loss), apply to explosive exposures.

3.9.3.2.2.3 Physiological Stress

Birds and bats 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. Exposures to explosives have the potential to provide additional stressors beyond those that naturally occur, as described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors).

There are no data on physiological stress in birds or bats specifically due to explosives; therefore, the limited data on physiological stress due to impulsive sounds, described for acoustic stressors in Section 3.9.3.2.2.3 (Physiological Stress), apply to explosive exposures.

3.9.3.2.2.4 Masking

Masking occurs when one sound, distinguished as the ‘noise,’ interferes with the detection or recognition of another sound. Exposure to explosives may result in masking. There are no data on masking in birds or bats specifically due to explosives; therefore, the limited data on masking due to impulsive sounds, described for acoustic stressors in Section 3.9.3.2.2.4 (Masking), apply to explosive exposures. Due to the very brief duration of an explosive sound, any masking would be brief during an explosive activity.

3.9.3.2.2.5 Behavioral Reactions

Numerous studies have documented that birds and other wild animals respond to human-made noise, including aircraft overflights, weapons firing, and explosions (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). The limited data on behavioral reactions to impulsive sounds, described for acoustic stressors in Section 3.9.3.2.2.5 (Behavioral Reactions), apply to explosive exposures.

Because data on behavioral responses by birds and bats to explosions is limited, information on bird and bat responses to other impulsive sounds may be informative. Seismic surveys had no noticeable impacts on the movements or diving behavior of long-tailed ducks undergoing wing molt, a period in which flight is limited and food requirements are high (Lacroix et al., 2003). The birds may have tolerated the seismic survey noise to stay in preferred feeding areas. The sensitivity of birds to disturbance may also vary during different stages of the nesting cycle. Similar noise levels may be more likely to cause nest abandonment during incubation of eggs than during brooding of chicks because birds have invested less time and energy and have a greater chance of re-nesting (Knight & Temple, 1986).

3.9.3.2.2.6 Long-term Consequences

Long-term consequences to birds and bats due to explosive exposures are considered following the Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (see Section 3.0.3.6.1).

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 foraging and communication. 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 birds and bats 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. More research is needed to better understand the long-term consequences of anthropogenic stressors, although intermittent exposures to explosive noise are assumed to be less likely to have lasting consequences.

3.9.3.2.2.7 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 underwater 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 3.0.3.3.4.2 (Military Expended Materials). Under Alternative 1, there could be fluctuation in the amount of explosives use 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, Jacksonville, Navy Cherry Point, Gulf of Mexico, and Key West Range Complexes, and the lower Chesapeake Bay, although training activities could occur anywhere within the Study Area. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore however, some mine warfare and demolition activities could also occur in shallow water close to shore. Some surface detonations could occur near areas with the potential for relatively high concentrations of seabirds or bats near the western frontal boundary of the Gulf Stream, including gunnery, bombing, and missile exercises in either Virginia Capes or Navy Cherry Point Range Complexes. Any impacts on seabirds and bats may be greater in these areas. There is no overlap of explosives and piping plover critical habitat.

Sound and energy generated by most small underwater explosions are unlikely to disturb birds and bats above the water surface. If a detonation is sufficiently large or is near the water surface, however, pressure will be released at the air-water interface. Birds and bats above this pressure release could be injured or killed. Explosives detonated at or just above the water surface, such as those used in anti-surface warfare, would create blast waves that would propagate through both the water and air. Detonations in air could also injure birds and bats while either in flight or at the water surface. Detonations in air during anti-air warfare training would typically occur at much higher altitudes (greater than 3,000 ft. [914 m] above sea level) where seabirds, migrating birds, and bats are less likely to be present, although some events target incoming threats at lower altitudes. Detonations of bombs with larger net explosive weight, any event employing static targets, or multiple detonations could be more likely to cause seabird mortalities or injuries. If prey species, such as fish, are killed or injured as a result of detonations, some birds may continue to forage close to the area, or may be attracted to the area and be exposed to subsequent detonations in the same area within a single event, such as gunnery exercises, which involves firing multiple high-explosive 5-in. rounds at a target area; bombing exercises, which could involve multiple bomb drops separated by several minutes; or underwater detonations, such as multiple explosive ordnance disposal charges. However, a fleeing response to an initial explosion may reduce seabird and bat exposure to any additional explosions that occur within a short timeframe.

Detonations either in air or underwater have the potential to cause a permanent or TTS, which could affect the ability of a bird or bat to communicate with conspecifics or detect biologically relevant sounds.

An explosive detonation would likely cause a startle reaction, as the exposure would be brief and any reactions are expected to be short-term. Startle impacts range from altering behavior (e.g., stop feeding or preening), minor behavioral changes (e.g., head turning), or a flight response. The range of impacts could depend on the charge size, distance from the charge, and the animal's behavior at the time of the exposure. Any impacts related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent.

Bermuda petrels and roseate terns may be present near the Gulf Stream, where detonations could occur, although little is known about Bermuda petrel distribution. Although Bermuda petrels and roseate terns could be present in range complexes where explosives are used, the likelihood of an injurious exposure is expected to be low based on the limited in-air range of injury from explosions and the expected low density of these birds. Piping plovers may be briefly disturbed in the vicinity of nearshore activities; however, they would not forage or migrate in the open ocean areas where other detonations occur. Red knots could be present during migration over open ocean areas where detonations could occur. If a detonation occurred in the vicinity of migrating red knots, impacts would likely be limited to short-term startle reactions.

Because most events would consist of a limited number of detonations, exposures would not occur over long durations; and since events occur at varying locations, it is expected there would be an opportunity to recover from an incurred energetic cost and individual birds and bats would not be repeatedly exposed to explosive detonations. Indiana bats and northern long-eared bats may be briefly disturbed in the vicinity of nearshore activities, but do not forage or migrate in the open ocean areas where other detonations occur. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected, and explosives will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of explosives during training activities described under Alternative 1 will have no effect on piping plover critical habitat. The use of explosives during training activities described under Alternative 1 may affect Bermuda petrels, roseate terns, piping plovers, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

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 underwater 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).

Testing activities involving explosions would typically be conducted in the range complexes, with greater occurrence in the Virginia Capes, Jacksonville, Northeast, Gulf of Mexico, Key West, and Navy Cherry Point Range Complexes, as well as the Naval Surface Warfare Center, Panama City Testing Range. 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. 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 Range Complex or within the Gulf of Mexico. The Large Ship Shock Trial would occur once over 5 years. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore; the exception is the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is nearshore, partially within the surf zone. Some surface detonations could occur near areas with the potential for relatively high concentrations of seabirds and bats near the western frontal boundary of the Gulf Stream, including firing, bombing, and missile exercises in either Virginia Capes or Navy Cherry Point Range Complexes. Any impacts on seabirds or bats may be greater in these areas. There is no overlap of explosives and piping plover critical habitat. Although testing activities under Alternative 1 differ in number and location from training activities under Alternative 1 and include Ship Shock trials, the types and severity of impacts would not be discernible from those described above in Impacts from Explosives under Alternative 1 for Training Activities.

Sound and energy generated by most small underwater explosions are unlikely to disturb birds and bats above the water surface. If a detonation is sufficiently large or is near the water surface, however, pressure will be released at the air-water interface. Birds and bats above this pressure release could be injured or killed. Explosives detonated at or just above the water surface, such as those used in anti-surface warfare, would create blast waves that would propagate through both the water and air. Detonations in air could also injure birds and bats while either in flight or at the water surface. Detonations in air during anti-air warfare testing would typically occur at much higher altitudes (greater than 3,000 ft. [914 m] above sea level) where seabirds, migrating birds, and bats are less likely to be present, although some events target incoming threats at lower altitudes. Detonations of bombs with larger net explosive weights, any event employing static targets, or multiple detonations could be more likely to cause seabird mortalities or injuries. If prey species, such as fish, are killed or injured as a result of detonations, some birds may continue to forage close to the area, or may be attracted to the area, and be exposed to subsequent detonations in the same area within a single event, such as firing exercises, which involves firing multiple high-explosive 5-in. rounds at a target area; bombing exercises, which could involve multiple bomb drops separated by several minutes; or underwater detonations, such as multiple explosive ordnance disposal charges. However, a fleeing response to an initial explosion may reduce seabird or bat exposure to any additional explosions that occur within a short timeframe.

Detonations either in air or underwater have the potential to cause a permanent or TTS, which could affect the ability of a bird to communicate with conspecifics or detect biologically relevant sounds.

An explosive detonation would likely cause a startle reaction, as the exposure would be brief and any reactions are expected to be short-term. Startle impacts range from altering behavior (e.g., stop feeding or preening), minor behavioral changes (e.g., head turning), or a flight response. The range of impacts could depend on the charge size, distance from the charge, and the animal's behavior at the time of the exposure. Any impacts related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent.

Bermuda petrels and roseate terns may be present near the Gulf Stream, where detonations could occur, although little is known about Bermuda petrel distribution. Although Bermuda petrel and roseate tern could be present in range complexes where explosives are used, the likelihood of an injurious exposure is expected to be low based on the limited in-air range of injury from explosions and the expected low density of these birds. Piping plovers may be briefly disturbed in the vicinity of nearshore activities; however, they would not forage or migrate in the open ocean areas where other detonations occur. Red knots could be present during migration over open ocean areas where detonations could occur. If a detonation occurred in the vicinity of migrating red knots, impacts would likely be limited to short-term startle reactions.

Because most events would consist of a limited number of detonations, exposures would not occur over long durations, and events occur at varying locations, it is expected there would be an opportunity to recover from an incurred energetic cost and individual birds and bats would not be repeatedly exposed to explosive detonations. Indiana bats and northern long-eared bats may be briefly disturbed in the vicinity of nearshore activities, but do not forage or migrate in the open ocean areas where other detonations occur. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected, and explosives will not have a significant adverse effect on populations of migratory bird species. The Navy will implement mitigation to avoid potential impacts on birds during ship shock trials, including ceasing the detonation if flocks of seabirds are observed during the activity, as discussed in Chapter 5 (Mitigation).

Pursuant to the ESA, the use of explosives during testing activities described under Alternative 1 will have no effect on piping plover critical habitat. The use of explosives during testing activities described under Alternative 1 may affect Bermuda petrels, roseate terns, piping plovers, red knots, Indiana bats, and northern long-eared bats . The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard.

3.9.3.2.2.8 Impacts from Explosives Under Alternative 2

Impacts from Explosives Under Alternative 2 for Training Activities

There would be a minor increase in explosives use under Alternative 2 compared to Alternative 1; however, the types and locations of impacts would be the same as those described for training under Alternative 1. Most impacts to individual birds and bats, if any, are expected to be minor and limited. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected, and explosives will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of explosives during training activities described under Alternative 2 will have no effect on piping plover critical habitat. The use of explosives during training activities described under Alternative 2 may affect Bermuda petrels, roseate terns, piping plovers, red knots, Indiana bats, and northern long-eared bats.

Impacts from Explosives Under Alternative 2 for Testing Activities

There would be minor increase in explosives use 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. Most impacts to individual birds and bats, if any, are expected to be minor and limited. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected, and explosives will not have a significant adverse effect on populations of migratory bird species.

Pursuant to the ESA, the use of explosives during testing activities described under Alternative 1 will have no effect on piping plover critical habitat. The use of explosives during testing activities described under Alternative 2 may affect Bermuda petrels, roseate terns, piping plovers, red knots, Indiana bats, and northern long-eared bats.

3.9.3.2.2.9 Impacts from Explosives Under the No Action Alternative

Impacts from Explosives Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the 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.

3.9.3.3 Energy Stressors

This section analyzes the potential impacts of the various types of energy stressors that can occur during training and testing activities within the Study Area. This section includes analysis of the potential impacts from (1) in-water electromagnetic devices, (2) in-air electromagnetic devices, and (3) high-energy lasers. As discussed in Section 3.0.3.3.3.3 (Lasers, subsection on Low-Energy Lasers), analysis has shown that low-energy lasers would not affect animals and therefore do not require further analysis.

3.9.3.3.1 Impacts from In-Water Electromagnetic Devices

Several different types of in-water electromagnetic devices are used during training and testing activities. In-water electromagnetic training and testing activities include an array of magnetic measuring components used in mine countermeasure operations in the Study Area. For information on the types of activities that use in-water electromagnetic devices, see Appendix B (Activity Stressor Matrices), Table B-1. For information on where they are used, and how many activities would occur under each alternative, see Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), Tables 3.0-14 and 3.0-15. Aspects of in-water electromagnetic stressors that are applicable to marine organisms in general are presented in Section 3.0.3.6.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities). Potential impacts of those activities on birds and bats are applicable to everywhere in the Study Area that in-water electromagnetic devices are used.

The kinetic energy weapon referred to as a rail gun is an in-water electromagnetic device that will be tested and eventually used in training events aboard surface vessels, firing non-explosive projectiles at land- or sea-based targets. This system charges for approximately two minutes and discharges in less than a second. The duration of the firing event is extremely short (about 8 milliseconds), which makes it quite unlikely that a bird or bat would fly over at the precise moment of firing. The short duration of each firing event also means that the likelihood of affecting any animal using magnetic fields for orientation is extremely small. Further, the high magnetic field levels experienced within 80 ft. of the launcher quickly dissipate and return to background levels beyond 80 ft. The magnetic field levels outside of the 80 ft. buffer zone would be below the most stringent guidelines for humans (i.e., people with pacemakers or active implantable medical devices). Therefore, the electromagnetic impacts would be temporary in nature and not expected to result in impacts on organisms (U.S. Department of the Navy, 2009), and are not analyzed further in this section.

Birds are known to use the Earth's magnetic field as a navigational cue during seasonal migrations (Akesson & Hedenstrom, 2007; Fisher, 1971; Haftorn et al., 1988; Wiltschko & Wiltschko, 2005). Birds use numerous other orientation cues to navigate in addition to magnetic fields. These include position of the sun, celestial cues, visual cues, wind direction, and scent (Akesson & Hedenstrom, 2007; Fisher, 1971; Haftorn et al., 1988; Wiltschko & Wiltschko, 2005). It is believed that birds are able to successfully navigate long distances by using a combination of these cues. A magnetite-based (magnetic mineral) receptor mechanism in the upper beak of birds provides information on position and compass direction (Wiltschko & Wiltschko, 2005).Towed in-water electromagnetic device impacts to birds would only occur underwater and would only impact diving species or species on the surface in the immediate area where the device is deployed. There is no information available on how birds react to electromagnetic fields underwater.

Since bats do not dive into water, in-water electromagnetic devices would not affect bats. As such, impacts to bats from in-water electromagnetic devices will not be discussed further.

3.9.3.3.1.1 Impacts from In-Water Electromagnetic Devices Under Alternative 1

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

As indicated in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices) and Table 3.0-14, and described further in Appendix A (Navy Activity Descriptions), under Alternative 1, training activities involving in-water electromagnetic devices would occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as Gulf Stream Open Ocean Area—specifically within the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes. Use of in-water electromagnetic devices would be concentrated within the Virginia Capes Range Complex. Activities would also occur in one or more of the following bays or inshore waters (Table 3.0-15): Boston, Massachusetts;, Earle, New Jersey; Hampton Roads, Virginia; Delaware Bay, Delaware; Beaufort Inlet Channel, Morehead City, North Carolina; Wilmington, North Carolina; Savannah, Georgia; Kings Bay, Georgia; Mayport, Florida; Port Canaveral, Florida; Tampa, Florida; Sabine Lake, Beaumont, Texas; and Corpus Christi Bay, Corpus Christi, Texas.

The distribution of birds in these portions of the Study Area is patchy (Fauchald et al., 2002; Nevitt & Veit, 1999; Savoca, 2016; Schneider & Duffy, 1985). Exposure of birds would be limited to those foraging at or below the surface (e.g., terns, cormorants, loons, petrels, or grebes) because that is where the devices are used. Birds that forage onshore (e.g., piping plover or red knot) would not be exposed to these in-water electromagnetic stressors because in-water electromagnetic devices are not used in areas close to shore and are used only underwater. Also, the in-water electromagnetic fields generated would be distributed over time and location near mine warfare ranges and harbors, and any influence on the surrounding environment would be temporary and localized. More importantly, the in-water electromagnetic devices used are typically towed by a helicopter, surface ship, or unmanned vehicle. It is likely that any birds in the vicinity of an approaching vehicle towing an in-water electromagnetic device would be dispersed by the sound and disturbance generated by the vehicle (Section 3.9.3.4.1, Impacts from Vessels and In-Water Devices, and Section 3.9.3.4.2, Impacts from Aircraft and Aerial Targets) and therefore move away from the vehicle and device before any exposure could occur.

Designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems; however, none of these areas overlap with the use of in-water electromagnetic devices in the Study Area. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where in-water electromagnetic devices are used. Therefore, none of the in-water electromagnetic stressors would affect piping plover critical habitat.

Impacts on birds from potential exposure to in-water electromagnetic devices would be temporary and inconsequential based on the: (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 656 ft. [200 m] from the source), (2) very localized potential impact area,

(3) temporary duration of the activities (hours), (4) occurrence only underwater, and (5) the likelihood that any birds in the vicinity of the approaching vehicles towing an in-water electromagnetic devices would move away from the vehicle and device before any exposure could occur. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities as described under Alternative 1 would have no effect on Indiana bats, northern long-eared bats, piping plovers, red knots, or piping plover critical habitat; but may affect Bermuda petrels and roseate terns. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

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

As indicated in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices) and Table 3.0-14, under Alternative 1, testing activities involving in-water electromagnetic devices would occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as Gulf Stream Open Ocean Area—specifically within the Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes as well as the Naval Undersea Warfare Center Newport Testing Range, Naval Surface Warfare Center Carderock Division's South Florida Ocean Measurement Facility, and Naval Surface Warfare Center Panama City Testing Range. Activities using in-water electromagnetic devices would be concentrated within the Naval Undersea Warfare Center Newport Testing Range. Activities would also occur in the inshore waters at Little Creek, Virginia (Table 3.0-15).

Birds that forage on shore (e.g., piping plover or red knot) would not be exposed to these in-water electromagnetic stressors because in-water electromagnetic devices are not used in areas close to shore and are only used underwater. As mentioned in the training activities discussion above, it is likely that any birds in the vicinity of an approaching vehicle towing an in-water electromagnetic device would be dispersed by the sound and disturbance generated by the vehicle (Section 3.9.3.4.1, Impacts from Vessels and In-Water Devices, and Section 3.9.3.4.2, Impacts from Aircraft and Aerial Targets) and would therefore move away from the vehicle and device before any exposure could occur. Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of in-water electromagnetic devices in the Study Area. Therefore, for reasons stated in the training activities, no long-term or population-level impacts to birds are expected and none of the in-water electromagnetic stressors will affect piping plover critical habitat.

Pursuant to the ESA, the use of in-water electromagnetic devices during testing activities as described under Alternative 1 would have no effect on Indiana bats, northern long-eared bats, or piping plover critical habitat; but may affect Bermuda petrels, piping plovers, roseate terns, and red knots. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.3.1.2 Impacts from In-Water Electromagnetic Devices Under Alternative 2

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

The number and distribution of training activities using in-water electromagnetic devices under Alternative 2 would be the same as under Alternative 1 (Tables 3.0-14 and 3.0-15); therefore, the impacts would be the same as for Alternative 1.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities as described under Alternative 2 would have no effect on Indiana bats, northern long-eared bats, or piping plover critical habitat; but may affect Bermuda petrels, piping plovers, roseate terns, and red knots.

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

The number and distribution of testing activities using in-water electromagnetic devices under Alternative 2 would be the same as for Alternative 1 (Tables 3.0-14 and 3.0-15); therefore, impacts would be the same as for Alternative 1.

Pursuant to the ESA, the use of in-water electromagnetic devices during testing activities as described under Alternative 2 would have no effect on Indiana bats, northern long-eared bats, or piping plover critical habitat; but may affect Bermuda petrels, piping plovers, roseate terns, and red knots.

3.9.3.3.1.3 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.

3.9.3.3.2 Impacts from In-Air Electromagnetic Devices

Several different types of in-air electromagnetic devices are used during training and testing activities, including an array of communications transmitters, radars, and electronic countermeasures transmitters. For information on the types of activities that use in-water electromagnetic devices, see Appendix B (Activity Stressor Matrices), Table B-1. For a information on where they are used, and how many activities would occur under each alternative, see Section 3.0.3.3.3.2 (In-Air Electromagnetic Devices). Aspects of in-air electromagnetic stressors that are applicable to marine organisms in general are presented in Section 3.0.3.6.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

As discussed in Section 3.0.3.3.3.2 (In-Air Electromagnetic Devices), most of the transmissions from in-air electromagnetic devices (e.g., for routine surveillance, communications, and navigation) will be at low power. Based on human standards, high-power in-air electromagnetic devices are those that produce peak pulses of 200 kilovolts per meter in a single pulse (U.S. Department of Defense, 2009); there are no federal standards for electromagnetic radiation exposure on wildlife (Manville, 2016; U.S. Department of Defense, 2009). In-air electromagnetic devices can also be characterized as "near-field" or "far-field" (i.e., near to, or far from, the source of electromagnetic radiation).

Studies conducted on in-air electromagnetic sensitivity in birds have typically been associated with land, and little information exists specifically on seabird response to in-air electromagnetic changes at sea. Based on these studies, in-air electromagnetic effects can be categorized as thermal (i.e., capable of causing damage by heating tissue) or non-thermal. Thermal effects are most likely to occur when near high-power systems. Should such effects occur, they would likely cause birds and bats to temporarily avoid the area receiving the electromagnetic radiation until the stressor ceases (Ahlén et al., 2009; Manville, 2016; Nicholls & Racey, 2007, 2009). For example, studies have found that bat activity and foraging effort is substantially reduced in the vicinity of radar (Ahlén et al., 2009; Nicholls & Racey, 2007, 2009). Heat energy produced during flight makes bats susceptible to overheating, and (Nicholls & Racey, 2007); Nicholls and Racey (2009) theorize that the large surface area of bats' wing membranes may absorb electromagnetic radiation, thereby increasing the risk of hyperthermia and causing bats to avoid sources of electromagnetic radiation.

Currently, questions exist about far-field, non-thermal effects from low power, in-air electromagnetic devices. Manville (2016) performed a literature review of this topic. Although findings are not always consistent, Manville (2016) reported that several peer-reviewed studies have shown non-thermal effects can include (1) affecting behavior by preventing birds from using their magnetic compass, which may in turn affect migration; (2) fragmenting the DNA of reproductive cells, decreasing the reproductive capacity of living organisms; (3) increasing the permeability of the blood-brain barrier; (4) other behavioral effects; (5) other molecular, cellular, and metabolic changes; and (6) increasing cancer risk.

Cucurachi et al. (2013) also performed a literature review of 113 studies and reported that (1) few field studies were performed (the majority were conducted in a laboratory setting); (2) 65% of the studies reported ecological effects both at high as well as low dosages (i.e., those that are compatible with real field situations, at least on land); (3) no clear dose-effect relationship could be discerned but that studies finding an effect applied higher durations of exposure and focused more on mobile phone frequency ranges; and (4) a lack of standardization and a limited number of observations limited the possibility of generalizing results from an organism to an ecosystem level.

Many bird species return to the same stopover, wintering, and breeding areas every year and often follow the exact same or very similar migration routes (Akesson, 2003; Alerstam et al., 2006), and ample evidence exists that displaced birds can successfully reorient and find their way when one or more cues are removed (Akesson, 2003; Haftorn et al., 1988). For example, Haftorn et al. (1988) found that after removal from their nests and release into a different area, snow petrels (*Pagodrama nivea*) were able to successfully navigate back to their nests even when their ability to smell was removed. Furthermore, Wiltschko and Wiltschko (2005) report that in-air electromagnetic pulses administered to birds during an experimental study on orientation do not deactivate the magnetite-based receptor mechanism in the upper beak altogether but instead cause the receptors to provide altered information, which in turn causes birds to orient in different directions. However, these impacts were temporary, and the ability of the birds to correctly orient themselves eventually returned. Similar results were found by a subsequent study by Wiltschko et al. (2011) on European robins (*Erithacus rubecula*) that tested the effects of exposure to specific wavelengths of visible light. Therefore, in the unlikely event that a bird is temporarily disoriented by an electromagnetic device, it is expected that it would still be able to reorient using its internal magnetic compass to aid in navigation once the stressor ceases or the bird and stressor are separated by sufficient distance. Therefore, any temporary disorientation experienced by birds from electromagnetic changes caused by training activities in the Study Area may be considered a short-term impact and would not hinder bird navigation abilities. Furthermore, other orientation cues may include position of the sun and moon, visual cues, wind direction, infrasound, and scent; these cues would not be affected by in-air electromagnetic devices.

The Environmental Assessment for the Upgraded AEGIS Combat System concluded that the rapid increase of the bird population around a newly constructed radar installation "indicates that any negative effects of the radiation zone overhead have been negligible." Another study on the impacts of extremely low-frequency in-air electromagnetic fields on breeding and migrating birds around the Navy's extra-low-frequency communication system antenna in Wisconsin found no evidence that bird distribution or abundance was impacted by in-air electromagnetic fields produced by the antenna. In addition, radars, including X-band systems, are frequently used to track bird movements as it has been demonstrated that they do not affect bird behavior. Moreover, previous studies have consistently determined that the chances that a bird or bat will move in the same direction and at the same speed as a constant beam of electromagnetic radiation (e.g., while an in-air electromagnetic device tracks a target), and therefore be exposed to radiation that could cause thermal damage, are extremely small.

Studies have found that bat activity and foraging effort is substantially reduced in the vicinity of radar (Ahlén et al., 2009; Nicholls & Racey, 2007, 2009). Heat energy produced during flight makes bats susceptible to overheating, and Nichols & Racey theorize that the large surface area of bats' wing membranes may absorb electromagnetic radiation, thereby increasing the risk of hyperthermia and causing bats to avoid sources of electromagnetic radiation (Nicholls & Racey, 2007, 2009). As such, bats may temporarily avoid the general vicinity where training or testing activities that generate in-air electromagnetic radiation and the potential to for in-air electromagnetic radiation to injure a bat is negligible. Given the infrequent and seasonal use of the Study Area by bats (Section 3.9.2.1.2, Habitat Use), the localized nature of the area affected by in-air electromagnetic radiation, and that impacts would be limited to temporary behavioral responses and displacement from the affected area, few, if any, individual bats would be affected, and exposure would not have persistent or accumulating effects.

Given (1) the information provided above; (2) the dispersed nature of Navy testing and training activities at sea; and (3) the relatively low-level and dispersed use of these systems at sea, the following conclusions are reached:

1. The chance that in-air electromagnetic devices would cause thermal damage to an individual bird or bat is extremely low;
2. It is possible, although unlikely, that some bird or bat individuals would be exposed to levels of electromagnetic radiation that would cause discomfort, in which case they would likely avoid the immediate vicinity of testing and training activities;
3. The strength of any avoidance response would decrease with increasing distance from the in-air electromagnetic device; and
4. No long-term or population-level impacts would occur.

3.9.3.3.2.1 Impacts from In-Air Electromagnetic Devices Under Alternative 1

Impacts from In-Air Electromagnetic Devices Under Alternative 1 for Training Activities

As indicated in Section 3.0.3.3.3.2 (In-Air Electromagnetic Devices) and Tables 3.0-18 and 3.0-37, under Alternative 1, training activities involving in-air electromagnetic devices would occur throughout the Study Area but would be concentrated in the Virginia Capes Range Complex, Navy Cherry Point Range Complex, Jacksonville Range Complex, and inshore waters. For the reasons described above, however, no long-term or population-level impacts to birds or bats would occur.

Pursuant to the ESA, the use of in-air electromagnetic devices during training activities as described under Alternative 1 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

Impacts from In-Air Electromagnetic Devices Under Alternative 1 for Testing Activities

As indicated in Section 3.0.3.3.3.2 (In-Air Electromagnetic Devices) and Tables 3.0-18 and 3.0-37, under Alternative 1, testing activities involving in-air electromagnetic devices would occur throughout the Study Area but would be concentrated in the Northeast Range Complexes, Virginia Capes Range Complex, Navy Cherry Point Range Complex, Jacksonville Range Complex, and Naval Undersea Warfare

Center Newport Testing Range. For the reasons described above, however, no long-term or population-level impacts to birds or bats would occur.

Pursuant to the ESA, the use of in-air electromagnetic devices during testing activities as described under Alternative 1 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.3.2.2 Impacts from In-Air Electromagnetic Devices Under Alternative 2

Impacts from In-Air Electromagnetic Devices Under Alternative 2 for Training Activities

The number and distribution of training activities using in-air electromagnetic devices under Alternative 2 would differ slightly from Alternative 1 insofar as the average number of total vessel and aircraft activities within the Study Area would increase slightly (by approximately 1.0 percent for vessel activities, and a fraction of a percent for aircraft activity) over a 5-year period (Tables 3.0-18 and 3.0-37, respectively). Given the foregoing analysis, this difference is inconsequential and the impacts would be essentially the same as for Alternative 1.

Pursuant to the ESA, the use of in-air electromagnetic devices during training activities as described under Alternative 2 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats.

Impacts from In-Air Electromagnetic Devices Under Alternative 2 for Testing Activities

The number and distribution of testing activities using in-air electromagnetic devices under Alternative 2 would differ slightly from Alternative 1 insofar as the average number of total vessel and aircraft activities within the Study Area would increase slightly (by approximately 1.1 percent for both vessel and aircraft activity) over a 5-year period (Tables 3.0-18 and 3.0-37, respectively). The majority of the increase in activity would occur at the Virginia Capes Range Complex. Given the foregoing analysis, this difference is inconsequential and the impacts would be essentially the same as for Alternative 1.

Pursuant to the ESA, the use of in-air electromagnetic devices during testing activities as described under Alternative 2 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats.

3.9.3.3.2.3 Impacts from In- Air Electromagnetic Devices Under the No Action Alternative

Impacts from In- Air 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-air 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.

3.9.3.3.3 Impacts from High-Energy Lasers

This section analyzes the potential impacts of high-energy lasers on birds and bats. As discussed in Section 3.0.3.3.3.3 (Lasers), high energy laser weapons are designed to disable targets, rendering them immobile. The primary concern is the potential for a bird or bat to be directly struck with the laser beam, which could result in injury or death, depending on the wavelength of the laser and where and for how long the beam contacts the animal. Tissue damage results primarily from thermal effects of the radiation. The eyes and areas of thin, exposed skin are the tissues most susceptible to damage from lasers.

Birds or bats could be exposed to a laser only if they fly through the beam at the instant the laser is fired. This has a very low probability of occurrence because of the limited use of high-energy lasers in the Study Area and the fact that the energy of the laser is concentrated within a very small area for only a few seconds. For a bird or bat in flight – the circumstance under which contact with a laser beam is most likely, the possibility that parts of the animal most susceptible to damage, especially the eyes, would cross the beam is remote.

3.9.3.3.3.1 Impacts from High-Energy Lasers Under Alternative 1

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

Under Alternative 1, training activities using high-energy lasers would occur 4 times per year at the Virginia Capes and Jacksonville Range Complexes (Table 3.0-16). ESA-listed bird and bat species that could occur in these areas include the Bermuda petrel, piping plover, roseate tern, red knot, Indiana bat, and northern long-eared bat. The likelihood of a bird or bat crossing the laser beam at the instant the laser is fired is extremely remote but possible.

No long-term or population-level impacts are expected. Neither birds nor bats are likely to be exposed to high energy lasers based on the: (1) relatively low number of activities, (2) very localized potential impact area of the laser beam, and (3) temporary duration of potential impact (seconds). The likelihood that an ESA-listed bird or bat species would be struck by a high-energy laser beam is so small as to be discountable; no impacts to ESA-listed species are anticipated.

Pursuant to the ESA, the use of high-energy lasers during training activities as described under Alternative 1 would have no effect on piping plover critical habitat, piping plovers, or red knots; but may affect Bermuda petrels, roseate terns, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

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

High-energy laser testing activities would occur predominantly in the Virginia Capes Range Complex, and to a lesser degree at other Navy range complexes and facilities (Northeast Range Complexes, Navy Cherry Point Range Complex, Jacksonville Range Complex, Key West Range Complex, Gulf of Mexico Range Complex, Naval Undersea Warfare Center Newport Testing Range, Naval Surface Warfare Center Carderock Division's South Florida Ocean Measurement Facility, and Naval Surface Warfare Center Panama City Testing Range), although not in the inshore waters, within the Study Area (Table 3.0-16). The likelihood of a bird or bat crossing the laser beam at the instant the laser is fired is extremely remote but possible.

No long-term or population-level impacts are expected. Neither birds nor bats are likely to be exposed to high energy lasers based on the: (1) relatively low number of activities, (2) very localized potential impact area of the laser beam, and (3) temporary duration of potential impact (seconds). The likelihood that an ESA-listed bird or bat species would be struck by a high-energy laser beam is so small as to be discountable; no impacts to ESA-listed species are anticipated.

Pursuant to the ESA, the use of high-energy lasers during testing activities as described under Alternative 1 would have no effect on piping plover critical habitat, piping plovers, or red knots; but may affect Bermuda petrels, roseate terns, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.3.3.2 Impacts from High-Energy Lasers Under Alternative 2

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

The use of high energy lasers under Alternative 2 for training activities would be the same as under Alternative 1 (Table 3.0-16); therefore, impacts would be the same.

Pursuant to the ESA, the use of high-energy lasers during training activities as described under Alternative 2 would have no effect on piping plover critical habitat, piping plovers, or red knots; but may affect Bermuda petrels, roseate terns, Indiana bats, and northern long-eared bats.

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

The use of high-energy lasers under Alternative 2 for testing activities would be the same as under Alternative 1 (Table 3.0-16); therefore, impacts would be the same.

Pursuant to the ESA, the use of high-energy lasers during testing activities as described under Alternative 2 would have no effect on piping plover critical habitat, piping plovers, or red knots; but may affect Bermuda petrels, roseate terns, Indiana bats, and northern long-eared bats.

3.9.3.3.3.3 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 and 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.

3.9.3.4 Physical Disturbance and Strike Stressors

This section describes the potential impacts to birds and bats by aircraft and aerial target strikes, vessels (disturbance and strike), and military expended material strike. For a list of Navy activities that involve this stressor refer to Appendix B (Activity Stressor Matrices). Aircraft include fixed-wing and rotary-wing aircraft; vessels include various sizes and classes of ships, and other boats; in-water devices include devices that are towed, unmanned surface, and underwater vehicles; military expended materials include non-explosive practice munitions, target fragments, decelerators/parachutes, and other objects.

Physical disturbance and strike risks, primarily from aircraft, have the potential to impact all taxonomic groups found within the Study Area (Table 3.9-1). In addition to the potential for injury and mortality, impacts of physical disturbance include behavioral responses such as temporary disorientation, change in flight direction, and avoidance response behavior. Physical disturbances (discussed in Section 3.9.3.4.2, Impacts from Aircraft and Aerial Targets) may elicit short-term behavioral or physiological responses in birds or bats such as alert response, startle response, cessation of feeding, fleeing the immediate area, and a temporary increase in heart rate. These disturbances can also result in abnormal behavioral, growth, or reproductive impacts in nesting birds and can cause foraging and nesting birds to flush from or abandon their habitats or nests (Andersen et al., 1989; Komenda-Zehnder et al., 2003). Aircraft strikes often result in bird or bat mortalities or injuries (Dolbeer, 2006).

Although birds and bats likely hear and see approaching vessels and aircraft, they cannot avoid all collisions. Nighttime lighting on vessels, specifically high-powered searchlights used for navigation in icy waters off of Greenland, has caused birds to become confused and collide with naval vessels, cargo vessels, and trawlers (Gehring et al., 2009; Merkel & Johansen, 2011; Poot et al., 2008). Bats are also known to collide with buildings and communication towers (Cryan & Brown, 2007; Hatch et al., 2013) and therefore may also collide with vessels. Collisions with vessels can result in bird or bat mortalities or injuries.

3.9.3.4.1 Impacts from Vessels and In-Water Devices

Vessels

The majority of the training and testing activities in the Study Area involve vessels. For a discussion of the types of vessels used as well as the number and location of activities that include vessels under each alternative, see Section 3.0.3.3.4.1 (Vessels and In-Water Devices). Table 3.0-17 provides representative vessel types and their sizes and typical operating speeds; Table 3.0-18 provides the number and locations of activities that include vessels; Table 3.0-19 provides the number and location of activities in inshore waters that include vessels; and Table 3.0-20 provides the location and annual number of high speed vessel hours for small crafts in inshore waters. Appendix B (Activity Stressor Matrices) provides the types of activities that use vessels.

Potential impacts of those activities on birds and bats are applicable to everywhere in the Study Area that vessels are used. Training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines. The number of Navy ships and smaller vessels in the Study Area varies based on training and testing schedules. Activities involving vessel movements occur intermittently, ranging from a few hours to a few weeks. Events involving large vessels are widely spread over the open ocean, while smaller vessels are more active and more concentrated in nearshore areas.

Direct collisions with most Navy vessels (or a vessel's rigging, cables, poles, or masts) are unlikely but may occur, especially at night. Lighting on boats and vessels has also contributed to bird fatalities in open ocean environments when birds are attracted to these lights, usually in inclement weather conditions (Merkel & Johansen, 2011). Birds can become disoriented at night in the presence of artificial light (Favero et al., 2011; Hamilton, 1958; Hyrenbach, 2001, 2006), and lighting on vessels may attract some birds, increasing the potential for harmful encounters. Other impacts to birds would be the visual and behavioral disturbance from a vessel. Birds respond to moving vessels in various ways. Some birds, including certain species of gulls, storm petrels, and albatrosses, commonly follow vessels; while other species such as plovers, curlews, frigatebirds, and sooty terns seem to avoid vessels (Borberg et al., 2005; Hyrenbach, 2006). There could be a slightly increased risk of impacts during the winter, or fall/spring migrations when migratory birds use celestial clues during night time flight and are concentrated in coastal areas. However, despite this concentration, most birds would still be able to avoid collision with a vessel. Vessel movements could elicit short-term behavioral or physiological responses (e.g., alert response, startle response, fleeing the immediate area, temporary increase in heart rate).

Navy aircraft carriers, surface combatant vessels, and amphibious warfare ships are minimally lighted for tactical purposes. For vessels of this type there are two white lights that shine forward and one that shines aft; these lights must be visible for at least 6 NM. A single red and a single green light are located on the port and starboard sides of vessels, respectively. These lights are visible for a minimum of 3 NM. Solid white lighting appears more problematic for birds, especially nocturnal migrants (Gehring et al., 2009; Poot et al., 2008). Navy vessel lights are mostly solid, but sometimes may not appear solid because of the constant movement of the vessel (wave action), making vessel lighting potentially less problematic for birds in some situations.

Cryan and Brown (2007) suggested that bats may be attracted to tall and highly visible landmarks (e.g., crowns of trees, islands, and wind turbines), and Thompson et al. (2015) provided anecdotal evidence that a flock of *Myotis* sp. may temporarily roost overnight on a fishing vessel at sea. To date, however, no studies have suggested that bats are attracted to ships at sea. Regardless, since bats (especially migratory bats) are known to collide with buildings and communication towers (Cryan & Brown, 2007; Hatch et al., 2013), and insects (which bats in the Study Area prey upon) can be attracted to ships at sea during certain weather conditions (Ahlén et al., 2009), it is possible that bats may collide with naval vessels at sea. However, the likelihood that this could occur is considered low given the infrequent, seasonal use of the Study Area by bats and that bats may be deterred from getting too close to naval vessels by behavioral responses to in-air electromagnetic devices (refer to Section 3.9.3.3.2, Impacts from In-Air Electromagnetic Stressors).

While some potential exists for birds or bats to be struck by vessels as they are foraging, resting, or flying near the water surface, most birds and bats would be expected to see or hear an oncoming vessel and to fly or swim away to avoid a potentially harmful encounter. Injury or mortality could occur if a bird or bat were struck, but most bird or bat encounters with vessels would be expected to result in a brief behavioral and physiological response as described above. It should be noted that such responses involve at the least a temporary displacement of birds or bats (to a lesser degree, since bats are most active from dusk to dawn) from foraging areas, resulting in energetic costs to the animals. Birds and bats would be expected to return and resume foraging soon after the vessel passed through the area, or to forage elsewhere, and the fitness of individual animals would probably not be compromised.

Other harmful bird-vessel interactions are commonly associated with commercial fishing vessels because birds are attracted to concentrated food sources around these vessels. However, these concentrated food sources are not associated with Navy vessels, so birds following Navy vessels would be very unlikely.

Amphibious vessel movements could elicit short-term behavioral or physiological responses such as alert response, startle response, cessation of feeding, fleeing the immediate area, nest abandonment, and a temporary increase in heart rate. There could be a slightly increased risk of impacts during the winter, or fall/spring migrations and during the nesting season when migratory birds or bats are concentrated in coastal areas where amphibious vessels have the potential to disturb nesting or foraging shorebirds or foraging or migrating bats. The general health of individual birds or bats would not be compromised, unless a direct strike occurred. However, it is highly unlikely that a bird or bat would be struck in this scenario because most foraging shorebirds and bats in the vicinity of the approaching amphibious vessel would likely be dispersed by the sound of its approach before it could come close enough to strike a bird or bat (Section 3.9.3.1.5, Impacts from Vessel Noise).

Large vessel movement primarily occurs within the U.S. Exclusive Economic Zone, with the majority of the traffic flowing in a direct line between Naval Stations Norfolk and Mayport. There would be a higher likelihood of vessel strikes over the continental shelf portions than in the open ocean portions of the Study Area because of the concentration of vessel movements in those areas. Even in areas of concentrated vessel use, the probability of bird/vessel or bat/vessel interaction is low because of the high mobility of birds and bats, and because bats are most active from dusk to dawn and are unlikely to be found in open ocean areas.

Under a worst-case scenario, vessel movements could cause the localized, temporary movement of birds or bats to areas that are less desirable, resulting in some energetic cost which may or may not be important to an individual's survival and reproduction. However, it is unlikely that impacts would occur to the point that birds or bats would be permanently displaced from important habitats that were not already subject to heavy ongoing use. As such, no long-term or population-level impacts are expected.

In-Water Devices

Section 3.0.3.3.4.1 (Vessels and In-water Devices) provides information on the types, sizes and speeds of in-water devices, and Table 3.0-22 provides the locations where they would be used. For a list of activities by name that include the use of in-water devices, see Appendix B (Activity Stressor Matrices). In-water devices include surface and underwater unmanned vehicles, torpedoes and towed devices, and their use occurs virtually throughout the Study Area.

As discussed in Section 3.0.3.3.4.1 (Vessels and In-water Devices), these devices are self-propelled and unmanned or towed through the water from a variety of platforms, including helicopters, unmanned underwater vehicles, and surface ships. In-water devices are generally smaller than most Navy vessels, ranging from several in. to about 50 ft. These devices can operate anywhere from the water surface to the benthic zone. Most of these devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most unmanned undersea vehicles) or are closely monitored by observers manning the towing platform (e.g., most towed devices) who ensure the towed in-water device does not run into objects in the water. Unmanned surface vehicles, because of their size and potential operating speed, have the potential to strike living marine resources. Unmanned surface vehicles are remotely operated, fast-moving, agile vehicles that may operate at speeds up to 50+ knots (Table 3.0-21), thus the potential for disturbance exists. The likelihood of a strike, however is very low because they are operated only in conditions of good visibility.

Mine warfare devices that are towed through the water (or the aircraft and cables that connect the aircraft to the device) and remotely operated underwater vehicles used during mine neutralization training and testing could also strike seabirds or bats. No documented instances of seabirds or bats being struck by towed devices have occurred in the Study Area. Additionally, based on the low altitudes and relatively slow air speeds, seabirds and bats would be able to detect and avoid the aircraft and cables that connect the aircraft to the towed device.

3.9.3.4.1.1 Impacts from Vessels and In-Water Devices Under Alternative 1

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

Vessels

The potential for interaction is greater in coastal areas than pelagic areas where Navy vessel use is less concentrated. However, even in areas of concentrated vessel use, the probability of seabird/vessel or bat/vessel interaction is low because the high mobility of seabirds and bats allows them to move away from an oncoming vessel. Flushing of birds is expected to be greatest when vessels, towed devices, and unmanned surface vehicles are operated at relatively high speeds (as described in Tables 3.0-17 through 3.0-23). While such flushing or other impacts of vessels on individual birds may occur, and bats may be temporarily displaced from a foraging area, none of these temporary impacts are expected to have an impact on the long-term fitness of individual birds or bats or have population-level impacts.

Amphibious vessels and especially amphibious landings could potentially impact bird species, specifically shorebirds that nest and forage along the shoreline. These activities also have a greater probability of temporarily displacing bats from foraging in these areas, since bats are forage more frequently near land than in open ocean areas in the Study Area. Amphibious landings would occur at traditionally used beaches in the Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes (Table 2.3-3). The ESA-listed species that would be potentially impacted at these locations would be piping plover, roseate tern, red knot, and northern long-eared bat.

The locations where amphibious landing activities occur at Onslow Beach and Seminole Beach are not considered optimal habitat for piping plovers (U.S. Fish and Wildlife Service, 2009b). Piping plovers have been documented foraging within the intertidal shoreline at Onslow Beach and Seminole Beach during the winter, spring, and fall migration periods and during the nesting season, although no nests have been found to date (U.S. Fish and Wildlife Service, 2009b). Roseate terns and red knots could use these beaches as a resting area and could be found foraging in the waters near the beach. Northern long-eared bats could use these beaches as foraging areas during spring and fall migration. While they could be present, it is highly unlikely that a piping plover, roseate tern, red knot, or northern long-eared bat would be struck in this scenario because most foraging or resting shorebirds, or foraging bats, in the vicinity of the approaching amphibious vessel would likely be dispersed by the sound of its approach before it could come close enough for a collision to take place (Section 3.9.3.1.6, Impacts from Aircraft Noise). Furthermore, Marine Corps Base Camp Lejeune, and Naval Station Mayport have specific Integrated Natural Resource Management Plans for addressing ESA-listed bird species, and those plans already include project avoidance and minimization actions that reduce threats from military activities to wintering and migrating piping plovers to a minimal level (U.S. Fish and Wildlife Service, 2009b).

There is no overlap of vessels with designated critical habitat for piping plover. Additionally no critical habitat is designated at Onslow Beach or Seminole Beach. However, critical habitat does exist on the opposite (north) side of the St. Johns River from Seminole Beach. This area of critical habitat is outside the boundary of the Study Area. No long-term or population-level impacts are expected.

In-Water Devices

In-water devices used are typically towed by a boat or helicopter, unmanned vehicles or fired from a ship. As discussed for electromagnetic devices (Section 3.9.3.3.2, Impacts from In-Air Electromagnetic Devices), it is likely that any birds or bats in the vicinity of the approaching boat, helicopter, unmanned vehicle or ship firing torpedoes would be dispersed by their sound (Section 3.9.3.1.6, Impacts from Aircraft Noise) and move away from the in-water device before any exposure could occur. Therefore, the use of in-water devices is expected to have only short-term impacts on individual birds and bats, with very low potential for injury or mortality, and no population-level impacts.

Pursuant to the ESA, the use of vessels and in-water devices during training activities as described under Alternative 1 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this 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), Navy vessel and in-water activities associated with testing activities would be fewer than those associated with training. While there is considerable overlap between training and testing activities, test activities would occur more frequently in established test areas that are relatively closer to shore, including the Newport and Panama City Testing Ranges and South Florida Ocean Measurement Facility (Tables 3.10-17 through 3.0-23).

The potential for interaction is greater in coastal areas than pelagic areas where Navy vessel use is less concentrated. However, even in areas of concentrated vessel use, the probability of seabird/vessel or bat/vessel interaction is low because of the high mobility of seabirds and bats that would allow them to move away from an oncoming vessel. Flushing of birds is expected to be greatest when vessels, towed devices, and unmanned surface vehicles are operated at relatively high speeds (as described in Tables 3.0-17 through 3.0-23). While such flushing or other impacts of vessels on individual birds may occur, and bats may be temporarily displaced from foraging areas, none of these temporary impacts are expected to have an impact on the long-term fitness of individual birds or bats or have population-level impacts.

Disturbance or strike from vessels or in-water devices are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird or bat populations. Similarly, vessels and in-water devices would not result in impacts to critical habitat for piping plover because there is no overlap of the stressor with designated critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities as described under Alternative 1 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.4.1.2 Impacts from Vessels and In-Water Devices Under Alternative 2

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

Under Alternative 2, potential impacts to birds or bats resulting from vessels and in-water devices associated with training activities would be similar to those of Alternative 1, but would be expected to occur with slightly greater frequency. Training over a 5-year period under Alternative 2 would have approximately 2.1 percent more vessel activities (Tables 3.0-18 and 3.0-19) and 5.3 percent more in-water device activities (Tables 3.0-22 and 3.0-23). Refer to Section 3.9.3.4.1.1 (Impacts from Vessels and In-Water Devices under Alternative 1) for a discussion of potential impacts. The potential for disturbance to individual birds or bats, and the number of individuals affected, would increase proportionately, but these impacts would still be temporary and unlikely to affect the long-term fitness of individuals or have population-level impacts.

Pursuant to the ESA, the use of vessels and in-water devices during training activities as described under Alternative 2 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats.

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

Under Alternative 2, potential impacts to birds or bats resulting from vessels and in-water devices associated with testing activities would be similar to those of Alternative 1, but would be expected to occur with greater frequency. Testing over a 5-year period under Alternative 2 would have approximately 7.0 percent more vessel activities (Table 3.0-18 and Table 3.0-19) and 8.5 percent more in-water device activities (Tables 3.0-22 and 3.0-23). Refer to Section 3.9.3.4.1.1 (Impacts from Vessels and In-Water Devices under Alternative 1) for a discussion of potential impacts. The potential for disturbance to individual birds or bats and the number of individuals affected would increase proportionately, but these impacts would still be temporary and unlikely to affect the long-term fitness of individuals or have population-level impacts.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities as described under Alternative 2 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats.

3.9.3.4.1.3 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.

3.9.3.4.2 Impacts from Aircraft and Aerial Targets

Information on aircraft and aerial target use is provided in Section 3.0.3.3.4.4 (Aircraft) and Appendix A (Navy Activity Descriptions). Bird or bat strikes could occur during training and testing activities that use aircraft, particularly in nearshore areas, where birds and bats are more concentrated in the Study Area. Training and testing activities where aircraft are used typically occur further offshore, within the range complexes.

Bird-aircraft strikes are a serious concern for the Navy because these incidents can result in injury to aircrews as well as damage equipment and injure or kill birds (Bies et al., 2006). The Naval Aviation Safety Program Instruction, Chief of Naval Operations Instruction 3750.6R, identifies measures to evaluate and reduce or eliminate bird/animal aircraft strike hazards to aircraft, aircrews, and birds and requires the reporting of all strikes when damage or injuries occur as a result of a bird/aircraft strike. From 2006 to 2015, the Navy Bird/Animal Aircraft Strike Hazard program recorded 10,496 bird strikes Navy-wide with the majority occurring during the fall period from September to November. During the 10-year period, bird strikes were greatest in the year 2015 with 1,283 strikes, and lowest in the year 2008 with 755 (Naval Safety Center, 2017). However, the numbers of bird deaths that occur annually from all Navy activities are insignificant from a bird population standpoint. Since 2006, naval aviators reported 10,496 bird strikes at a cost of approximately $105 million (Naval Safety Center, 2017). About 90 percent of wildlife/aircraft damaging collisions involving commercial and military aircraft involve large birds or large flocks of smaller birds (Federal Aviation Administration, 2003). ESA-listed seabird strikes reported in the aircraft strike database include a roseate tern in the East China Sea in 2007; western snowy plovers at Naval Air Station Point Mugu in 2009 and 2014; a least tern in Kingsville, Texas in 2014; and a California least Tern at Naval Air Station North Island in 2008.

Bird or bat strike potential is greatest in foraging or resting areas, in migration corridors at night, and at low altitudes during the periods around dawn and dusk. For example, birds can be attracted to airports because they often provide foraging and nesting resources. Approximately 97 percent of the reported civilian aircraft-wildlife damaging strikes from 1990 to 1999 involved common, large-bodied birds or large flocks of small birds. Almost 70 percent of these events involved gulls, waterfowl, and raptors (Federal Aviation Administration, 2003). Nicholls and Racey (2009) and Ahlén et al. (2009) found that bat foraging activity is substantially reduced in the vicinity of radar; as such, bats may avoid airports because of the radar used to track aircraft.

As described in Section 2.1.1.3 (Standard Operating Procedures), the Navy implements standard operating procedures for aircraft safety. Pilots of Navy aircraft make every attempt to avoid large flocks of birds to reduce the safety risk involved with a potential bird strike. Since 2011, the Navy has required that all Navy flying units report all bird strikes through the Web-Enabled Safety System Aviation Mishap and Hazard Reporting System. The standard operating procedures for aircraft safety will benefit birds and bats through a reduction in the potential for aircraft strike.

While wildlife strikes can occur anywhere aircraft are operated, Navy data indicate that they occur most often within the airfield environment – i.e. over land or close to shore (Naval Air Station Jacksonville, 2012). Dolbeer (2006) reports that about 90 percent of aircraft-wildlife strikes occur on or near airports, when aircraft are below altitudes of 3,500 ft. For military rotary-wing aircraft, wildlife strikes happened most frequently when the aircraft were traveling en route (flying [moving forward] at an altitude greater than 1,000 ft. above ground level) or were engaged in terrain flight (flying at an altitude less than 1,000 ft. above ground level), as opposed to (1) hovering (off the ground at less than 1,000 ft. above ground level, and stationary), (2) on approach (in the early stages of the landing process at greater than 100 ft. above ground level and moving forward), (3) landing (the final stages of landing at less than 100 ft. above ground level), (4) taxiing (moving along the ground, or at less than 10 ft. above ground level, in transition from one part of the airport to another), (5) taking off (leaving the ground and ascending upward at less than 100 ft. above ground level), or (6) climbing out (for rotary-wing aircraft in the later stages of taking off at greater than 100 ft. above ground level) (Washburn et al., 2014). The potential for bird strikes to occur in offshore areas is relatively low because Navy activities are widely dispersed and above 3,000 ft. (for fixed-wing aircraft) where bird densities are low. The potential for bat strikes to occur in offshore areas is substantially lower than that for birds because bat densities are substantially lower than bird densities in these areas.

For the majority of fixed-wing activities, flight altitudes would be above 3,000 ft., with the exception of sorties associated with air-to-surface bombing exercises and sonobuoy drops. Typical flight altitudes during air-to-surface bombing exercises are from 500 to 5,000 ft. above ground level. Most fixed-wing aircraft flight hours (greater than 90 percent) occur at distances greater than 12 NM offshore.

Helicopter flights would occur closer to the shoreline where sheltering, roosting, and foraging birds and bats occur. Helicopters can hover and fly low, and would be used to tow electromagnetic devices as well as for other military activities at sea. This combination would make helicopter bird or bat strikes more likely than for fixed-wing aircraft. Additional details on typical altitudes and characteristics of aircraft used in the Study Area are provided in Chapter 2 (Description of Proposed Action and Alternatives) and Section 3.0.3.3.4.4 (Aircraft).

Approximately 95 percent of bird flight during migration occurs below 10,000 ft., with the majority below 3,000 ft. (U.S. Geological Survey, 2006). Aircraft encounters with birds or bats are more likely to occur during aircraft takeoffs and landings than when the aircraft is engaged in low-level flight. In a study that examined 38,961 bird and aircraft collisions, Dolbeer (2006) found that the majority (74 percent) of collisions occurred below 500 ft. However, collisions have been recorded at elevations as high as 12,139 ft. (Dove & Goodroe, 2008).

Bird and bat populations may consist of hundreds or thousands of individuals, ranging across a large geographical area. In this context, the loss of a small number of birds or bats due to physical strikes does not constitute a population-level effect. Bird or bat exposure to a strike potential would be relatively brief as an aircraft transits the area. Strike potential is further decreased by Navy aircrafts' active avoidance of large flocks of birds.

In addition to manned aircraft, aerial targets such as unmanned drones could also incur a bird or bat strike, however, evidence from returned drones indicate the probability is low.In a bird strike study for the U.S. Air Force, vultures were the most hazardous group to aircraft, followed by geese, pelicans, and buteo hawks, based on the number of bird strikes reported (Zakrajsek & Bissonette, 2005). These species groups occur within the Study Area but are generally found in nearshore areas (Mowbray et al., 2002; Shields et al., 2002). The potential for bird or bat strikes to occur in offshore areas is relatively low because activities are widely dispersed and occur at relatively high altitudes (above 3,000 ft. for fixed-wing aircraft) where seabird or bat occurrences are generally low.

3.9.3.4.2.1 Impacts from Aircraft and Aerial Targets Under Alternative 1

Impacts from Aircraft and Aerial Targets Under Alternative 1 for Training Activities

Aircraft use in the Study Area is described in Section 3.0.3.3.4.4 (Aircraft). Approximately 131,000 training activities involving aircraft would occur annually in the Study Area under Alternative 1, with activities concentrated in the Virginia Capes, Navy Cherry Point, Jacksonville, and Key West Range Complexes (Tables 3.0-37 and 3.0-38). Aerial targets used in the Study Area are described in Appendix A (Navy Activity Descriptions) (A.1.3, Targets) and include expendable rocket-powered missiles and recoverable radio-controlled drones, as well as air-launched decoys (A.2.3.6, Missile Exercise Air-to-Air). Under Alternative 1 for Training Activities, approximately 207 air targets (decoy) and 55 air targets (drone) would be expended annually (Table 3.0-29).

Some individual bird or bat strikes and associated bird or bat mortalities or injuries could occur as a result of aircraft and aerial target use in the Study Area under the Alternative 1; however, population-level impacts to birds would not likely result. ESA-listed species could be impacted by aircraft disturbance or strikes while in flight in areas where low-altitude operations are taking place. However, no ESA-listed bird or bat strikes have been reported during training activities.

Although piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, it does not overlap with fixed-wing aircraft training which would take place further than 1 NM from shore. While aircraft overflights could occur near piping plover critical habitat, the altitudes of their flight paths would be high enough to not pose a direct strike risk to piping plovers while sheltering, roosting, or feeding. Potential impacts from aircraft and aerial targets would have no effect on critical habitat for the piping plover.

Helicopters can hover and fly low as well as out over the open ocean. The combination of helicopters hovering and flying low over the open ocean could result in possible strikes to ESA-listed piping plover, roseate tern, red knot, Bermuda petrel, or northern long-eared bat. As described in Section 5.3 (Procedural Mitigation to be Implemented), the Navy will implement mitigation to avoid potential impacts from rotary-wing aircraft overflight noise on piping plovers and other nesting birds during explosive ordnance disposal activities, including maneuvering to maintain a specified distance from the beach within the Virginia Capes Range Complex (except when transiting from Norfolk Naval Station to waters offshore) and from Fisherman Island National Wildlife Refuge off the coast of Cape Charles, Virginia (when transiting from Norfolk Naval Station to waters offshore). The mitigation for aircraft overflight noise will consequently help avoid potential physical disturbance and strike impacts on birds that occur in these locations.

Bird or bat exposure to strike potential would be relatively brief as an aircraft quickly passes. Disturbance by aircraft and aerial targets would be temporary and inconsequential to the long-term fitness of individuals. Bird or bat strikes may occur to a relatively small number of individuals, but no population-level impacts would occur, especially when considering the Navy's standard operating procedures for aircraft safety (see Section 2.1.1.3, Standard Operating Procedures) and mitigation (see Chapter 5, Mitigation).

Pursuant to the ESA, the use of aircraft and aerial targets during training activities as described under Alternative 1 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

Impacts from Aircraft and Aerial Targets Under Alternative 1 for Testing Activities

Aircraft use in the Study Area is described in Section 3.0.3.3.4.4 (Aircraft). Approximately 7,700 testing activities involving aircraft would occur annually in the Study Area under Alternative 1, with activities especially concentrated in the Virginia Capes Range Complex (Tables 3.0-37 and 3.0-38). Under Alternative 1 for testing activities, 7 air targets (decoy) and 316 air targets (drone) would be expended annually (Table 3.0-31). Impacts from testing activities would be similar to those of training activities, but would occur in proportion to the number of activities, i.e., less frequent interactions with aircraft, more frequent interactions with targets as compared to training. Disturbance by aircraft and aerial targets would be temporary and inconsequential to long-term fitness of individuals. Bird or bat strikes may occur to a relatively small number of individuals, but no population-level impacts would occur, especially when considering the Navy's standard operating procedures for aircraft safety (see Section 2.1.1.3, Standard Operating Procedures).

Pursuant to the ESA, the use of aircraft and aerial targets during testing activities as described under Alternative 1 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.4.2.2 Impacts from Aircraft and Aerial Targets Under Alternative 2

Impacts from Aircraft and Aerial Targets Under Alternative 2 for Training Activities

The use of aircraft and aerial targets under Alternative 2 for training would be virtually identical to what would occur under Alternative 1 (Tables 3.0-37, 3.0-38, and 3.0-29); therefore, the same impact conclusions apply.

Pursuant to the ESA, the use of aircraft and aerial targets during training activities as described under Alternative 2 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats.

Impacts from Aircraft and Aerial Targets Under Alternative 2 for Testing Activities

Compared to Alternative 1, the use of aircraft under Alternative 2 for testing would be slightly greater (5.3 percent difference over a 5-year period) (Tables 3.0-37 and 3.0-38) but would be the same for targets (Table 3.0-31). Therefore, impacts would be slightly greater under Alternative 2, but would still be inconsequential due to the relatively small number of individuals affected and the lack of population-level effects.

Pursuant to the ESA, the use of aircraft and aerial targets during testing activities as described under Alternative 2 would have no effect on piping plover critical habitat, but may affect Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, and northern long-eared bats.

3.9.3.4.2.3 Impacts from Aircraft and Aerial Targets Under the No Action Alternative

Impacts from Aircraft and Aerial Targets 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., aircraft and aerial targets) 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.

3.9.3.4.3 Impacts from Military Expended Materials

This section analyzes the strike potential to birds and bats from the following categories of military expended materials: (1) all sizes of non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than munitions, such as sonobuoys, and expendable targets. See Appendix F (Military Expended Materials and Direct Strike Impact Analyses) for more information on the locations, types and quantities of military expended materials proposed to be used.

Exposure of birds or bats to military expended materials during Navy training and testing activities could result in physical injury or behavioral disturbances to birds or bats in air, at the surface, or underwater during foraging dives. Although a quantitative analysis is not possible due to the absence of bird or bat density information in the Study Area, an assessment of the likelihood of exposure to military expended materials was conducted based on general bird and bat distributions in the Study Area.

The widely dispersed area in which bombs and missiles would be expended in the Study Area annually (see Chapter 2, Description of Proposed Action and Alternatives), coupled with the often patchy distribution of seabirds (Fauchald et al., 2002; Haney, 1986a; Schneider & Duffy, 1985) and the infrequent use of the Study Area by foraging bats (Ahlén et al., 2009; Bureau of Ocean Energy Management, 2013; Johnson et al., 2011; U.S. Department of Energy, 2016), suggest that the probability of these types of ordnance striking a seabird or bat would be low. The number of small-caliber projectiles that would be expended annually during various activities (e.g., gunnery exercises) is much higher than the number of large-caliber projectiles and other large munitions. However, the total number of rounds expended is not a good indicator of strike probability during gunnery exercises because multiple rounds of large-caliber projectiles and other large munitions are generally fired at individual targets during a single event.

Human activity such as vessel or boat movement, aircraft overflights, and target placement, could cause birds or bats to flee a target area before the onset of firing, thus avoiding harm. If birds or bats were in the target area, they would likely flee the area prior to the release of military expended materials or just after the initial rounds strike the target area. Additionally, the force of military expended material fragments dissipates quickly once the pieces hit the water, so direct strikes on birds foraging below the surface would not be likely. Also, munitions would not be used in shallow/nearshore areas. The potential likelihood of individual birds or bats being struck by munitions is very low; thus, impacts on bird or bat populations would not be expected.

3.9.3.4.3.1 Impacts from Military Expended Materials Under Alternative 1

Impacts from Military Expended Materials Under Alternative 1 for Training Activities

Table B-1 in Appendix B (Actvivity Stressor Matrices) provides a breakdown of the different activities that generate these military expended materials for training. Tables 3.0-24, 3.0-25, 3.0-27, 3.0-29, 3.0-30, and 3.0-32 in Section 3.0.3.3.4.2 (Military Expended Materials) provide a breakdown of the types of materials expended and the loctations of where they are expended under both action alternatives for training. Training activities would occur throughout the Study Area. Appendix F (Military Expended Materials and Direct Strike Impact Analyses) provides details on the types, numbers and footprints of expended materials by location.

The potential impact of military expended materials on birds or bats in the Study Area is dependent on the ability of birds or bats to detect and avoid foreign objects through their sensory systems and the relatively fast flying speeds and maneuverability of most bird and bat species. The potential for impact is related to the probability of a bird or bat and a projectile meeting in the same space at the same time. The amount of materials expended over the vast area over which training and testing activities occur, combined with the ability of birds and bats to flee disturbance and the infrequent use of the Study Area by foraging bats (Ahlén et al., 2009; Bureau of Ocean Energy Management, 2013; Johnson et al., 2011; U.S. Department of Energy, 2016), would make direct strikes unlikely. Individual birds or bats may be impacted, but strikes would have no impact on species or populations.

Direct strikes from firing weapons (projectiles) or air-launched devices (e.g., sonobuoys, torpedoes) are a potential stressor to seabirds and bats. Seabirds in flight, resting on the water's surface, or foraging just below the water surface, as well as bats in flight, would be vulnerable to a direct strike. Strikes have the potential to injure or kill seabirds or bats in the Study Area. However, there would not be long-term population-level impacts. The footprint calculations in Appendix F (Military Expended Materials and Direct Strike Impact Analyses, Tables F-2 through F-7) indicate relatively small areas of impact and, consequently, a low probability of strikes to birds by the types of materials that pose the greatest risk to birds (e.g., projectiles, torpedoes, surface targets) on an annual or cumulative 5-year basis. Since bats occur in the Study Area much less frequently than birds, it is expected that the likelihood of a bat strike is proportionally less than that for a bird strike. Furthermore, the vast area over which training activities occur combined with the ability of seabirds and bats to flee disturbance, would make direct strikes unlikely. Individual seabirds or bats may be affected, but strikes would have no impact on species or populations.

If ESA-listed species were in the immediate area where military expended materials are present, they could be impacted by military expended material strikes. It is highly unlikely that a bird or bat would be struck by military expended materials because most birds and bats in the vicinity of the approaching aircraft or vessel, from which the military expended materials are released, would likely be dispersed by the sound of its approach before it could come close enough for an impact from a strike or a disturbance to take place. Therefore, activities that release military expended materials would not likely cause any potential strike risk to birds or bats in the Study Area.

Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of military expended materials in the Study Area. Behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Therefore, none of the military expended materials will affect piping plover critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of military expended materials during training activities as described under Alternative 1 would have no effect on piping plover critical habitat, Indiana bats, or northern long-eared bats; but may affect Bermuda petrels, piping plovers, roseate terns, and red knots. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

Impacts from Military Expended Materials Under Alternative 1 for Testing Activities

Table B-2 in Appendix B (Actvivity Stressor Matrices) provides a breakdown of the different activities that generate these military expended materials for testing. Tables 3.0-26, 3.0-28, 3.0-31, and 3.0-33 in Section 3.0.3.3.4.2 (Military Expended Materials) provide a breakdown of the types of materials expended and the loctations of where they are expended under both action alternatives for testing. Testing activities would occur throughout the Study Area. Appendix F (Military Expended Materials and Direct Strike Impact Analyses) provides details on the types, numbers and footprints of expended materials by location.

The potential impact of military expended materials on birds or bats in the Study Area is dependent on the ability of birds or bats to detect and avoid foreign objects through their sensory systems and the relatively fast flying speeds and maneuverability of most bird and bat species. The potential for impact is related to the probability of a bird or bat and a projectile meeting in the same space at the same time. The amount of materials expended over the vast area over which training and testing activities occur, combined with the ability of birds and bats to flee disturbance and the infrequent use of the Study Area by foraging bats (Ahlén et al., 2009; Bureau of Ocean Energy Management, 2013; Johnson et al., 2011; U.S. Department of Energy, 2016), would make direct strikes unlikely. Individual birds or bats may be impacted, but strikes would have no impact on species or populations.

Direct strikes from firing weapons (projectiles) or air-launched devices (e.g., sonobuoys, torpedoes) are a potential stressor to seabirds and bats. Seabirds in flight, resting on the water's surface, or foraging just below the water surface, as well as bats in flight, would be vulnerable to a direct strike. Strikes have the potential to injure or kill seabirds or bats in the Study Area. However, there would not be long-term population-level impacts. The footprint calculations in Appendix F (Military Expended Materials and Direct Strike Impact Analyses, Tables F-14 through F-17) indicate relatively small areas of impact and, consequently, a low probability of strikes to birds by the types of materials that pose the greatest risk to birds (e.g., projectiles, torpedoes, surface targets) on an annual or cumulative 5-year basis. Since bats occur in the Study Area much less frequently than birds, it is expected that the likelihood of a bat strike is proportionally less than that for a bird strike. Furthermore, the vast area over which testing activities occur combined with the ability of seabirds and bats to flee disturbance, would make direct strikes unlikely. Individual seabirds or bats may be affected, but strikes would have no impact on species or populations.

If ESA-listed species were in the immediate area where military expended materials are present, they could be impacted by military expended material strikes. It is highly unlikely that a bird or bat would be struck by military expended materials because most birds and bats in the vicinity of the approaching aircraft or vessel, from which the military expended materials are released, would likely be dispersed by the sound of its approach before it could come close enough for an impact from a strike or a disturbance to take place. Therefore, activities that release military expended materials would not likely cause any potential strike risk to birds or bats in the Study Area.

Pursuant to the ESA, the use military expended materials during testing activities as described under Alternative 1 would have no effect on piping plover critical habitat, piping plovers, red knots, Indiana bats, or northern long-eared bats; but may affect Bermuda petrels and roseate terns. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.4.3.2 Impacts from Military Expended Materials Under Alternative 2

Impacts from Military Expended Materials Under Alternative 2 for Training Activities

The differences in expended materials between Alternatives 1 and 2 for training activities are relatively small and inconsequential with respect to the types of materials that pose the greatest risk to birds (Appendix F, Military Expended Materials and Direct Strike Impact Analyses, Tables F-2 through F-7). Since bats occur in the Study Area much less frequently than birds, it is expected that the likelihood of a bat strike is proportionally less than that for a bird strike. As a result, impacts of military expended materials from training activities under Alternative 2 would be essentially the same as those of Alternative 1.

Pursuant to the ESA, the use of military expended materials during training activities as described under Alternative 2 would have no effect on piping plover critical habitat, Indiana bats, or northern long-eared bats; but may affect Bermuda petrels, piping plovers, roseate terns, and red knots.

Impacts from Military Expended Materials Under Alternative 2 for Testing Activities

The differences in expended materials between Alternatives 1 and 2 for testing activities are relatively small and inconsequential with respect to the types of materials that pose the greatest risk to birds (Appendix F, Military Expended Materials and Direct Strike Impact Analyses, Tables F-14 through F-17). Since bats occur in the Study Area much less frequently than birds, it is expected that the likelihood of a bat strike is proportionally less than that for a bird strike. As a result, impacts of military expended materials from testing activities under Alternative 2 would be essentially the same as those of Alternative 1.

Pursuant to the ESA, the use of military expended materials during testing activities as described under Alternative 2 would have no effect on piping plover critical habitat, piping plovers, red knots, Indiana bats, or northern long-eared bats; but may affect Bermuda petrels and roseate terns.

3.9.3.4.3.3 Impacts from Military Expended Materials Under the No Action Alternative

Impacts from Military Expended Materials Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various physical disturbance and strike stressors (e.g., military expended materials) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.9.3.4.4 Impacts from Seafloor Devices

As discussed in Section 3.0.3.3.4.3 (Seafloor Devices), seafloor devices that are used during training and testing activities are deployed onto the seafloor in shallow water and later recovered. Because these devices are stationary or very slow moving, they do not pose a risk of physical disturbance or strike to birds, including ESA-listed species. Since bats do not occur in the water column, there is no potential for seafloor devices and bats to interact. Because of this, seafloor devices would have no impacts to birds or bats and will not be discussed further. Pursuant to the ESA, the use of seafloor devices during training and testing activities as described under Alternatives 1 and 2 would have no effect on piping plover critical habitat, Bermuda petrels, piping plovers, red knots, roseate terns, Indiana bats, or northern long-eared bats. The Navy has consulted on Alterntive 1 with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.4.5 Impacts from Pile Driving

There would be no pile driving or vibratory pile extraction associated with testing activities. Therefore, pile driving related to testing is not analyzed in this subsection. Section 3.9.3.1.4 (Impacts from Pile Driving) describes the impacts from noise to birds and bats that would occur from the installation and removal of piles in the vicinity of training events involving the construction of an Elevated Causeway System, a temporary pier that allows the offloading of ships in areas without a permanent port. Human activity such as vessel or boat movement, and equipment setting and movement, is expected to cause birds and bats to flee the activity area before the onset of pile driving. If birds or bats were in the activity area, they would likely flee the area prior to, or just after, the initial strike of the pile at the beginning of the ramp-up procedure. Pile driving during training is, therefore, not considered physical disturbance or strike stressor for birds or bats. Pursuant to the ESA, pile driving during training activities as described under Alternatives 1 and 2 would have no effect on piping plover critical habitat, Bermuda petrels, piping plovers, red knots, roseate terns, Indiana bats, or northern long-eared bats. The Navy has consulted on Alterntive 1 with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.5 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 of three types of military expended materials, including: (1) wires and cables, (2) decelerators/parachutes, and (3) biodegradable polymers. Aspects of entanglement stressors that are applicable to marine organisms in general are presented in Section 3.0.3.3.5 (Entanglement Stressors). The annual numbers and locations of expended wires, cables, parachutes, and activities using biodegradable polymers are provided in Tables 3.0-32 through 3.0-34.

Along the continental U.S. and near Hawaii, at least 44 species of seabirds are known to become entangled in plastic or marine debris. From 2001–2005, entanglement rates ranged from 0.2% to 1.2% for all seabirds observed by beach monitoring programs in California, Oregon, and Washington. Common murres and western gulls were the most common species found entangled. While the vast majority of entanglements involved fishing gear (e.g., monofilament line and hooks), approximately 8.3% of the entanglements were from non-fishery-related items (e.g., plastics and other synthetic materials that they may gather for making nests). Cormorants in Maine have been observed making nests from such plastic marine debris, including net fragments and fishing line. It is thought that the biggest threat of entanglement from using debris as nesting material is to the chicks, but no such entanglements have been observed (National Oceanic and Atmospheric Administration, 2016).

Given the limited amount of time that wires and cables would remain suspended in air and the ability of birds and bats to detect and avoid parachutes in-air, the likelihood that a bird or bat would become entangled in-air is considered remote and discountable. As such, this analysis is focused on the potential for entanglement at the water surface, in the water column, or on the seafloor.

The cables, wires, decelerators/parachutes, and biodegradable polymer are relatively conspicuous in contrast to fishing lines, do not form long loops of line that are hard to break, do not tend to snag animals that swim through them, and do not persist for a long time in the water column. The Navy-expended materials sink gradually (0.24 m/second in the case of guidance wires) to the bottom. These materials would be readily avoided by visually oriented seabirds that could be foraging or resting in the water. Unlike fishing gear, the Navy's equipment does not capture fish and therefore decreases the attractiveness to foraging seabirds. Additional information is provided in the sections below.

Since bats considered in this analysis do not occur in the water column, rarely occur at the water surface in the Study Area, and would not be attracted to cables, wires, or decelerators/parachutes, few, if any, impacts to bats are anticipated from these entanglement stressors. As discussed in Section 3.9.2.1.3 (Dive Behavior), the Mexican bulldog bat (or fishing bat) primarily eats fish caught with its relatively large feet and long, sharp claws near the water's surface and would not be expected to become entangled with any entanglement stressor. Furthermore, this species occurs outside of the Study Area in Mexico, Puerto Rico, and the U.S. Virgin Islands (Jones et al., 1973; Placer, 1998) and is expected to venture into the Study Area while foraging only infrequently. Therefore, bats are not evaluated further for entanglement stressors.

3.9.3.5.1 Impacts from Wires and Cables

Table B-1 in Appendix B (Actvivity Stressor Matrices) provides a breakdown of the different activities that have wires and cables for training. Table 3.0-39 in Section 3.0.3.3.5.1 (Wires and Cables) provides a breakdown of the types of wires and cables used and the quantities and loctations of where they are used under both action alternatives for training. These items include fiber optic cables, guidance wires, and sonobuoy components.

Fiber optic cables are flexible cables that can range in size up to 300 m in length. The length of guidance wires would generally be equal to the distance the torpedo or missile travels to impact the target, which may increase entanglement risk to birds with long wires (over 1,000 m) expended into the environment. 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 cable, which is then wrapped by a hollow rubber tubing or bungee in a spiral configuration. The length of cable that extends out is no more than 1500 ft. and is dependent on the water depth and type of sonobuoy. The hydrophone components maybe 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. While longer cables present a higher likelihood of bird interactions, and therefore present an increased risk of entanglement of a bird, these cables should be readily avoidable by birds that could be foraging or resting in the water.

The entanglement risk from these components would only occur when a bird and these components were in close proximity at the water surface, in the water column, or on the seafloor. As stated above, however, these materials would be readily avoided by visually oriented seabirds that could be foraging or resting in the water and do not pose the same entanglement risks as fishing gear. 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, however, 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.

3.9.3.5.1.1 Impacts from Wires and Cables under Alternative 1

Impacts from Wires and Cables under Alternative 1 for Training Activities

As discussed in Section 3.0.3.3.5.1 (Wires and Cables), under Alternative 1 training activities, fiber optic cables, guidance wires, and sonobuoy components that would pose an entanglement risk to birds would be expended primarily in the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes. However, given that these stressors are widely dispersed over vast areas and do not persist or accumulate at the surface or in the water column where seabirds forage, encounters with seabirds would be infrequent. This is coupled with a remote likelihood that a bird encountering the expended material would become entangled, as described above. As a result, the potential for entanglement from wires and cables to lead to injury or mortality is negligible. Therefore, no long-term or population-level impacts to birds would occur.

Pursuant to the ESA, the use of wires and cables during training activities as described under Alternative 1 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this 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 birds would be expended primarily in the Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes, along with testing ranges (Naval Undersea Warfare Center Newport, South Florida Ocean Measurement Facility, and Naval Surface Warfare Center Panama). However, given that these stressors are widely dispersed over vast areas and do not persist or accumulate at the surface or in the water column where seabirds forage, encounters with seabirds would be infrequent. This is coupled with a remote likelihood that a bird encountering the expended material would become entangled, as described above. As a result, the potential for entanglement from wires and cables to lead to injury or mortality is negligible. Therefore, no long-term or population-level impacts to birds would occur.

Pursuant to the ESA, the use of wires and cables during testing activities as described under Alternative 1 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.5.1.2 Impacts from Wires and Cables under Alternative 2

Impacts from Wires and Cables under Alternative 2 for Training Activities

As discussed in Section 3.0.3.3.5.1 (Wires and Cables), under Alternative 2 training activities, fiber optic cables, guidance wires, and sonobuoy components would be expended in the same areas as Alternative 1, with increases in the number of expended items that would pose an entanglement risk. Under Alternative 2, increases in sonobuoy component releases would occur in Virginia Capes, Navy Cherry Point, Jacksonville, and Gulf of Mexico Range Complexes. Fiber optic cable releases would increase under Alternative 2 in Virginia Capes, Jacksonville, and Gulf of Mexico Range Complexes, while there would be no change in the number or locations of guidance wire releases compared to Alternative 1. Given the foregoing analysis, however, the impacts would be essentially the same as for Alternative 1. Therefore, no long-term or population-level impacts to birds would occur.

Pursuant to the ESA, the use of wires and cables during training activities as described under Alternative 2 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat.

Impacts from Wires and Cables under Alternative 2 for Testing Activities

As discussed in Section 3.0.3.3.5.1 (Wires and Cables), under Alternative 2 testing activities, fiber optic cables, guidance wires, and sonobuoy components would be expended in the same areas as Alternative 1, with increases to the number of expended items that would pose an entanglement risk. Under Alternative 2, increases in sonobuoy component releases would occur in Northeast, Virginia Capes, Navy Cherry Point, Jacksonville, Key West, and Gulf of Mexico Range Complexes. Fiber optic cable releases would increase under Alternative 2 in Virginia Capes Range Complex and Naval Surface Warfare Center Panama, while there would be no change in the number or locations of guidance wire releases compared to Alternative 1. Given the foregoing analysis, however, the impacts would be essentially the same as for Alternative 1. Therefore, no long-term or population-level impacts to birds would occur.

Pursuant to the ESA, the use of wires and cables during testing activities as described under Alternative 1 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat.

3.9.3.5.1.3 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 and 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.

3.9.3.5.2 Impacts from Decelerators/Parachutes

Section 3.0.3.3.5.2 (Decelerators/Parachutes) describes the use and platforms where decelerators/parachutes would be released into the marine environment and therefore present an entanglement risk to birds. Aircraft-launched sonobuoys, lightweight torpedoes (such as the MK 46 and MK 54), illumination flares, and targets use nylon decelerators/parachutes ranging in size from 1.5 to 82 feet in diameter. The majority are relatively small cruciform shape decelerators/parachutes associated with sonobuoys (18 to 48 inches in diameter). Once a sonobuoy hits the water surface, its decelerator/parachute is designed to produce drag at the surface for 5–15 seconds, allowing for deployment of the sonobuoy, then the decelerator/parachute separates and sinks. The decelerator/parachute assembly contains metallic components and could be at the surface for a short period before sinking to the seafloor. Sonobuoy decelerators/parachutes are designed to sink within 15 minutes, but 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. Decelerators/parachutes or decelerator/parachute lines may be a risk for birds to become entangled, particularly while at the surface. As stated above, however, these materials would be readily avoided by visually oriented seabirds that could be foraging or resting in the water and do not pose the same entanglement risks as fishing gear.

If the decelerator/parachute and its lines sink to the seafloor in an area where the bottom is calm, it would remain there undisturbed. Over time, it 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. If bottom currents are present, the canopy may billow and pose an entanglement threat to birds that feed in benthic habitats. Bottom-feeding birds tend to forage in nearshore areas rather than offshore, where these decelerators/parachutes are used; therefore, birds are not likely to encounter decelerators/parachutes once they reach the seafloor. The potential for a bird to encounter an expended decelerator/parachute at the surface or in the water column is extremely low, it is even less probable at the seafloor given the general improbability of a bird being near the deployed decelerator/parachute as well as the general behavior of birds. Depending on how quickly the decelerator/parachute may degrade, the risk may increase with time if the decelerator/parachute remains intact. 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.

3.9.3.5.2.1 Impacts from Decelerators/Parachutes under Alternative 1

Impacts from Decelerators/Parachutes under Alternative 1 for Training Activities

As detailed in Table 3.0-32, under Alternative 1 training activities, decelerators/parachutes that would pose an entanglement risk to birds would be expended primarily in the Northeast, Virginia Capes, Navy Cherry Point, and Jacksonville Range Complexes. However, given that these stressors are widely dispersed over vast areas and do not persist or accumulate at the surface or in the water column where seabirds forage, encounters with seabirds would be infrequent. This is coupled with a remote likelihood that a bird encountering the expended material would become entangled, as described above. As a result, the potential for entanglement from decelerators/parachutes to lead to injury or mortality is negligible. Therefore, no long-term or population-level impacts to birds would occur.

Pursuant to the ESA, the use of decelerators/parachutes during training activities as described under Alternative 1 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

Impacts from Decelerators/Parachutes under Alternative 1 for Testing Activities

As detailed in Table 3.0-34, under Alternative 1 testing activities, decelerators/parachutes that would pose an entanglement risk would be used throughout the range complexes and testing ranges of the Study Area. However, given that these stressors are widely dispersed over vast areas and do not persist or accumulate at the surface or in the water column where seabirds forage, encounters with seabirds would be infrequent. This is coupled with a remote likelihood that a bird encountering the expended material would become entangled, as described above. As a result, the potential for entanglement from decelerators/parachutes to lead to injury or mortality is negligible. Therefore, no long-term or population-level impacts to birds would occur.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities as described under Alternative 1 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.5.2.2 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 about 2.8 percent larger than under Alternative 1. This difference reflects the addition of training activities using decelerators/parachutes in the Gulf of Mexico Range Complex (Table 3.0-32). This would proportionally increase the possibility of entanglement relative to Alternative 1, but, the likelihood of injury or mortality is still considered negligible, and the impact conclusion for decelerators/parachutes under Alternative 2 training activities is the same as for Alternative 1.

Pursuant to the ESA, the use of decelerators/parachutes during training activities as described under Alternative 2 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat.

Impacts from Decelerators/Parachutes under Alternative 2 for Testing Activities

Under Alternative 2, the number of decelerators/parachutes that would be expended during testing activities would be about 8.6 percent larger than under Alternative 1, with the same general distribution of activities throughout the Study Area (Table 3.0-34). This would proportionally increase the possibility of entanglement relative to Alternative 1, but, the likelihood of injury or mortality is still considered negligible, and the impact conclusion for decelerators/parachutes under Alternative 2 testing activities is the same as for Alternative 1.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities as described under Alternative 2 would have no effect on Bermuda petrels, piping plovers, roseate terns, red knots, Indiana bats, or northern long-eared bats, and would have no effect on piping plover critical habitat.

3.9.3.5.2.3 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 and 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.

3.9.3.5.3 Impacts from Biodegradable Polymers

The possibility of entanglement in the biodegradable polymer is considered remote and discountable given the fact that the material is only deployed on a small-scale in test locations (Table 3.0-42), is short-lived in the water, and that diving birds routinely navigate through floating vegetation without becoming entangled (unlike boat propellers which the polymer is designed to entangle). The biodegradable polymer is, therefore, not considered an entanglement stressor for birds.

3.9.3.6 Ingestion Stressors

As described in Section 3.0.3.3.6 (Ingestion Stressors), the types of expended materials that are potentially a source of ingestion stressors include non-explosive practice munitions (small and medium caliber), fragments from high-explosive munitions, fragments from targets, chaff, plastic end caps from chaff cartridges, the plastic compression pads, end caps from pistons and flares, small decelerators/parachutes, and biodegradable polymers (discussed in Section 3.0.3.3.5.3, Biodegradable

Polymer). Other types of expended materials are too large to be mistaken for food items and consumed by birds. Since bats considered in this analysis do not occur in the water column and rarely feed at the water surface in the Study Area, few, if any, impacts to bats are anticipated from ingestion stressors. As such, impacts to bats from ingestion stressors will not be discussed further.

3.9.3.6.1 Impacts from Military Expended Materials - Munitions

Two types of munitions are potentially a source of ingestion stressors: non-explosive practice munitions (small and medium caliber) and fragments from high-explosive munitions. Both types of munitions sink rapidly through the water column and settle to the bottom. Munitions are not used in nearshore-shallow areas and, because of their density, are likely to bury in the bottom and are unlikely to be transported from offshore to nearshore. It is thus highly unlikely that munitions would accumulate where benthic nearshore or intertidal foraging would occur. Rapidly sinking munitions and fragments are unlikely to be accessible or attractive as potential food items to diving birds that feed on fish and invertebrates in the water column. Accordingly, there are no potential impacts to birds feeding in the water column or on the bottom from this category of ingestion stressors and it will not be discussed further.

3.9.3.6.2 Impacts from Military Expended Materials - Other Than Munitions

The analysis in this section includes the potential ingestion of military expended materials other than munitions, all of which are expended away from nearshore habitats and close to the water surface. Tables 3.0-24 through 3.0-28; 3.0-32 through 3.0-34; and 3.0-43 and 3.0-44 describe the annual quantities and locations where these materials would be generated by training and testing activities under Alternatives 1 and 2. Appendix A (Navy Activity Descriptions) provides more specific information on the activities that may result in ingestion stressors, and the typical locations where these activities occur.

While it has been widely documented that a wide range of marine organisms (including zooplankton, baleen whales, and seabirds) will ingest plastic, the mechanism that causes these organisms to do so was discovered only recently (Savoca, 2016; Savoca et al., 2016). Procellariiformes, or tube-nosed seabirds (e.g., albatrosses, shearwaters and petrels) utilize a highly developed sense of smell to find food that is patchily distributed in offshore and open ocean environments. Specifically, these birds are attracted to dimethyl sulfide, which is produced when the cell walls of algae are damaged (e.g., when marine herbivores such as krill eat it), thereby alerting the seabirds that food (e.g., krill) are nearby. Through a literature review, Savoca et al. (2016) demonstrated that seabirds that utilize dimethyl sulfide as a foraging cue consumed plastic nearly six times more frequently than species that were not attracted to dimethyl sulfide. Savoca et al. (2016) also performed field studies that confirmed that algae growing on three of the most common types of plastic debris (polypropylene and low- and high-density polyethylene) can produce dimethyl sulfide within three weeks at concentrations at least four orders of magnitude above the behavioral detection threshold for Antarctic prions (*Pachyptila desolata*), thereby creating an “olfactory trap.”

Birds could potentially ingest expended materials other than munitions used by the Navy during training and testing activities within the Study Area. The Navy expends the following types of materials that could become ingestion stressors for birds during training and testing in the Study Area: missile components, target fragments, chaff and flare endcaps/pistons, and decelerators/parachutes. Biodegradable polymers generated during countermeasures testing are also considered. Ingestion of expended materials by birds could occur in all large marine ecosystems and open ocean areas and would occur either at the surface or just below the surface portion of the water column, depending on the size and buoyancy of the expended object and the feeding behavior of the birds. Floating material of ingestible size could be eaten by birds that feed at or near the water surface, while materials that sink pose a potential risk to diving birds that feed just below the water's surface (Titmus & Hyrenbach, 2011). Some items, such as decelerators/parachutes or sonobuoys are too large to be ingested and will not be discussed further. Also, decelerators/parachutes sink rapidly to the seafloor.

Physiological impacts to birds from ingestion include blocked digestive tracts and subsequent food passage, blockage of digestive enzymes, lowered steroid hormone levels, delayed ovulation (egg maturation), reproductive failure, nutrient dilution (nonnutritive debris displaces nutritious food in the gut), exposure to indirect effects from harmful chemicals found in and on the plastic material, and altered appetite satiation (the sensation of feeling full), which can lead to starvation (Azzarello & Van Vleet, 1987; Provencher et al., 2014). While ingestion of marine debris has been linked to bird mortalities, sublethal impacts are more common (Moser & Lee, 1992).

Many species of seabirds are known to ingest floating plastic debris and other foreign matter while feeding on the surface of the ocean (Auman et al., 1997; Provencher et al., 2014; Yamashita et al., 2011). A recent review of the literature documented the ingestion of marine debris by 122 species of seabirds (Gall & Thompson, 2015). Evidence indicates that physical and toxicological impacts from plastic ingestion by seabirds are widespread among species and pervasive in terms of the number of individuals affected, and that impacts are increasing (Wilcox et al., 2016). For example, 21 of 38 seabird species (55 percent) collected off the coast of North Carolina from 1975 to 1989 contained plastic particles (Moser & Lee, 1992). The mean particle sizes of ingested plastic were positively correlated with the birds' size though the mean mass of plastic found in the stomachs and gizzards of 21 species was below 3 grams. Some seabirds have used plastic and other marine debris for nest building which may lead to ingestion of that debris (Votier et al., 2011). Indirect ingestion of plastic also occurs from consuming prey such as fish that ingest plastic.

Plastic is often mistaken for prey, and the incidence of plastic ingestion appears to be related to a bird's feeding mode and diet (Henry et al., 2011; Provencher et al., 2014). Seabirds that feed by pursuit diving, surface-seizing, and dipping tend to ingest plastic, while those that feed by plunging or piracy typically do not ingest plastic (Azzarello & Van Vleet, 1987; Provencher et al., 2014). Birds of the order Procellariiformes, which include petrels, shearwaters, and albatrosses, tend to accumulate more plastic than other species (Azzarello & Van Vleet, 1987; Moser & Lee, 1992; Pierce et al., 2004; Provencher et al., 2014). Some birds, including gulls and terns, commonly regurgitate indigestible parts of their food items such as shell and fish bones. However, the structure of the digestive systems of most Procellariiformes makes it difficult to regurgitate solid material such as plastic (Azzarello & Van Vleet, 1987; Moser & Lee, 1992; Pierce et al., 2004).

As summarized by Pierce et al. (2004), Auman et al. (1997), and Azzarello and Van Vleet (1987), documented consequences of plastic ingestion by seabirds include blockage of the intestines and ulceration of the stomach, reduction in the functional volume of the gizzard leading to a reduction of digestive capability, and distention of the gizzard leading to a reduction in hunger. Dehydration has also been documented in seabirds that have ingested plastic (Sievert & Sileo, 1993). Studies have also found negative correlations between body weight and plastic load, as well as between body fat (a measure of energy reserves), and the number of pieces of plastic in a seabird's stomach (Auman et al., 1997; Sievert & Sileo, 1993). Other possible concerns that have been identified include toxic plastic additives and toxic contaminants that could be adsorbed to the plastic from ambient seawater. Pierce et al. (2004)

described two cases where plastic ingestion caused seabird mortality from starvation. The examination of a deceased adult northern gannet revealed that a 1.5 in. diameter plastic bottle cap lodged in its gizzard blocked the passage of food into the small intestine, which resulted in its death from starvation. Northern gannets are substantially larger, and dive deeper than the ESA-listed birds in the Study Area. Also, since gannets typically utilize flotsam in nest building (Votier et al., 2011), they may be more susceptible to ingesting marine debris than other species as it gathers that material. Dissection of an adult greater shearwater's gizzard revealed that a 1.5 in. by 0.5 in. fragment of plastic blocked the passage of food in the digestive system, which also resulted in death from starvation.

Species such as storm-petrels, albatrosses, shearwaters, fulmars, and noddies that forage by picking prey from the surface may have a greater potential to ingest any floating plastic debris. Ingestion of plastic military expended materials by any species from the 10 taxonomic groups found within the Study Area (Table 3.9-1) has the potential to impact individual birds. Ocean currents concentrate plastic debris, making birds that feed along frontal zones more susceptible (Azzarello & Van Vleet, 1987). While some seabird mortality could occur, these factors indicate that a small number of birds would be affected and that population-level effects would not be expected.

Items of concern are those of ingestible size that remain floating at the surface, including lighter items such as plastic end caps from chaff and flares, pistons, and chaff, that may be caught in currents and gyres or snared in floating *Sargassum* before sinking.

Target-Related Materials. As described in Section 3.0.3.3.6.3 (Military Expended Materials Other Than Munitions), at-sea targets are usually remotely-operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. However, if they are used during activities that utilize high-explosives then they may result in fragments. Expendable targets that may result in fragments would include air-launched decoys, surface targets (e.g., marine markers, paraflares, cardboard boxes, and 10 ft. diameter red balloons), and mine shapes. Most target fragments would sink quickly to the seafloor. Floating material, such as Styrofoam, may be lost from target boats and remain at the surface for some time. Only targets that may result in smaller fragments that do not immediately sink are included in the analyses of ingestion potential.

There are additional types of targets discussed previously, but only surface targets, subsurface targets, air targets, sinking exercise ship hulks, and mine shapes would be expected to result in fragments when high-explosive munitions are used.

Chaff. As described in Section 3.0.3.3.6.3 (Military Expended Materials Other Than Munitions), large areas of air space and open water within the Study Area would be exposed to chaff at very low concentrations. This same section also provides a general discussion of chaff as an ingestion stressor and concludes that chaff poses little risk to organisms, except at concentrations substantially higher than those that could reasonably occur from military training. Additional information is provided below.

It is unlikely that chaff would be selectively ingested (U.S. Air Force, 1997). Ingestion of chaff fibers is not expected to cause substantial damage to a bird's digestive tract based on the fibers' small size (ranging in lengths of 0.25–3 in. with a diameter of about 40 micrometers) and flexible nature, as well as the small quantity that could reasonably be ingested. In addition, concentrations of chaff fibers that could reasonably be ingested are not expected to be toxic to birds. Scheuhammer (1987) reviewed the metabolism and toxicology of aluminum in birds and mammals. Intestinal adsorption of orally ingested aluminum salts was very poor, and the small amount adsorbed was almost completely removed from the body by excretion. Dietary aluminum normally has minor impacts on healthy birds and mammals, and often high concentrations (greater than 1,000 milligrams per kilogram) are needed to induce effects such as impaired bone development, reduced growth, and anemia (U.S. Department of the Navy, 1999). A bird weighing 2.2 pounds (lb.) would need to ingest more than 83,000 chaff fibers per day to receive a daily aluminum dose equal to 1,000 milligram per kilogram; this analysis was based on chaff consisting of 40 percent aluminum by weight and a 5-ounce chaff canister containing 5 million fibers. As an example, an adult herring gull weighs about 1.8–2.7 lb. (Cornell Lab of Ornithology, 2009). It is highly unlikely that a bird would ingest a toxic dose of chaff based on the anticipated environmental concentration of chaff (i.e., 1.8 fibers per square foot for an unrealistic, worst-case scenario of 360 chaff cartridges simultaneously released at a single drop point).

Flares. A general discussion of flares as an ingestion stressor is presented in Section 3.0.3.3.6.3 (Military Expended Materials Other Than Munitions). Ingestion of flare compression pads or pistons 1.3 in. in diameter and 0.13 in. thick (U.S. Air Force, 1997) by birds may result in gastrointestinal obstruction or reproductive complications. Based on the information presented above, if a seabird were to ingest a compression pads or pistons, the response would vary based on the species and individual bird. The responses could range from none, to sublethal (reduced energy reserves), to lethal (digestive tract blockage leading to starvation). Ingestion of compression pads or pistons by species that regularly regurgitate indigestible items would likely have no adverse impacts. However, compression pads or pistons are similar in size to those plastic pieces described above that caused digestive tract blockages and eventual starvation. Therefore, ingestion of compression pads or pistons could be lethal to some individual seabirds. Species with small gizzards and anatomical constrictions that make it difficult to regurgitate solid material would likely be most susceptible to blockage (such as Procellariiformes). Based on available information, it is not possible to accurately estimate actual ingestion rates or responses of individual birds.

Biodegradable Polymer. The biodegradable polymer used in countermeasure testing could theoretically be ingested by birds; however, the likelihood is low because the material would persist only until the polymer degrades. Some of the polymer constituents would dissolve within two hours of immersion and it is anticipated that the material will breakdown into small pieces within a few days to weeksof deployment (discussed in Section 3.0.3.3.5.3, Biodegradable Polymer). Therefore, the biodegradable polymer is not considered an ingestion stressor for birds and will not be discussed further.

3.9.3.6.2.1 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 indicated in Section 3.0.3.3.6.3 (Military Expended Materials Other Than Munitions), the use of chaff, flares, and targets would occur and could generate expended materials constituting ingestion stressors throughout the Study Area. Although chaff fibers and pieces of biodegradable polymer are too small for birds to confuse with prey, there is some potential for chaff and biodegradable polymer to be incidentally ingested along with other prey items. If ingested, neither chaff nor biodegradable polymer are expected to impact birds, due to the low concentration that would be ingested and the small size of the fibers.

The plastic materials associated with flare compression pads or pistons sink in saltwater (U.S. Department of the Navy, 1999), which reduces the likelihood of ingestion by seabirds. However, some of the material could remain at or near the surface if it were to fall directly on a dense *Sargassum* mat. Actual environmental concentrations would vary based on actual release points and dispersion by wind and water currents. The number of compression pads and pistons that would remain at the surface in *Sargassum* mats, and would potentially be available to seabirds, is expected to be an extremely small percentage of the total.

Although the overall concentration of military expended materials would be low, and Navy standard practice is to collect and remove as much Styrofoam as possible when retrieving a degraded target, military expended materials would not be evenly distributed. Similarly, seabirds are not evenly distributed in the Study Area (Fauchald et al., 2002; Haney, 1986a, 1986b; Schneider & Duffy, 1985). As noted previously, there is some potential for expended materials that float (e.g., some types of target fragments or chaff end caps or flare compression pads and pistons) to become concentrated along frontal zones, along with food resources that tend to attract foraging seabirds, resulting in the incidental ingestion of such materials, most likely as very small fragments. Military expended materials would constitute a minute portion of the floating debris that seabirds would be exposed to and may accidentally consume in such situations, but could nevertheless contribute to harmful effects of manmade debris on some seabirds. The overall likelihood that individual birds would be negatively impacted by ingestion of military expended materials in the Study Area under Alternative 1 for training is considered low, but not discountable. Population-level effects would be very unlikely given the relatively small quantities and limited persistence of military expended materials in habitats where birds are most likely to forage. This conclusion applies to ESA-listed bird species as well.

If foraging in an area where military expended materials are present on the sea surface, roseate terns and Bermuda petrels could ingest military expended materials. The odds of this are low because of the very low density of birds and large areas over which they forage, combined with the low density of Navy activities and expended materials across the vast Study Area. Piping plovers and red knots may encounter expended materials on beaches (e.g., along the James River and tributaries where up to 20,400 flares would be expended per year [Table 3.0-33]). A bird's consumption of a piece of Navy-expended material may or may not be harmful, but if added to the burden of marine debris from other sources (Wilcox et al., 2016), harmful effects would be more likely. Effects to individuals are thus possible, but it is unlikely that populations of these ESA-listed species would be affected. The same considerations apply to the rare but unlisted black-capped petrel. No long-term or population-level impacts are expected.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during training activities as described under Alternative 1 would have no effect on Indiana bats, northern long-eared bats, or piping plover critical habitat; but may affect Bermuda petrels, piping plovers, red knots, and roseate terns. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

Impacts from Military Expended Materials - Other Than Munitions Under Alternative 1 for Testing Activities

Testing activities under Alternative 1 would generate the same types of ingestible materials generated by training activities. As shown in Tables 3.0-26, 3.0-28, 3.0-31, 3.0-34, and 3.0-42, the quantity of materials used during testing activities would generally be substantially less than those used during training activities (except for mine shapes, which would be used substantially more frequently during testing activities). Testing activities would also occur in other areas not used for training activities (e.g., Naval Undersea Warfare Center Newport Testing Range, Naval Surface Warfare Center Carderock Division's South Florida Ocean Measurement Facility, and Naval Surface Warfare Center Panama City

Testing Range). Therefore, testing activities would have similar, but generally reduced, impacts to those of training activities under Alternative 1.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during testing activities as described under Alternative 1 would have no effect on Indiana bats, northern long-eared bats, piping plovers, red knots, or piping plover critical habitat; but may affect Bermuda petrels and roseate terns. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.6.2.2 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

Training activities under Alternative 2 would generate the same types of ingestible materials generated by training activities under Alternative 1. While the quantities and locations of some expended materials would change slightly, the vast majority would be the same under Alternative 2 as under Alternative 1 (Tables 3.0-24, 3.0-25, 3.0-29, 3.0-30, and 3.0-32). Therefore, the implementation of Alternative 2 would have similar impacts to those of training activities under Alternative 1.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during training activities as described under Alternative 2 would have no effect on Indiana bats, northern long-eared bats, or piping plover critical habitat; but may affect Bermuda petrels, piping plovers, red knots, and roseate terns.

Impacts from Military Expended Materials - Other Than Munitions Under Alternative 2 for Testing Activities

Testing activities under Alternative 2 would generate the same types of ingestible materials generated by testing activities under Alternative 1. While the quantities and locations of some expended materials would change slightly, the vast majority would be the same under Alternative 2 as under Alternative 1 (Tables 3.0-26, 3.0-28, 3.0-31, 3.0-34, and 3.0-42). Therefore, the implementation of Alternative 2 would have similar impacts to those of testing activities under Alternative 1.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during testing activities as described under Alternative 2 would have no effect on Indiana bats, northern long-eared bats, piping plovers, red knots, or piping plover critical habitat; but may affect Bermuda petrels and roseate terns.

3.9.3.6.2.3 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 and testing activities in the AFTT Study Area. Various physical disturbance and strike 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.

3.9.3.7 Secondary Stressors

This section analyzes potential impacts on birds exposed to stressors indirectly through impacts to habitat and prey availability (e.g., sediment, water and air quality). Since these stressors also affect primary elements of bird habitat, firm distinctions between indirect impacts and habitat impacts are difficult to maintain. 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 or its ecosystem.

Stressors from Navy training and testing activities could pose secondary or indirect impacts on birds via impacts to habitat, sediment, or water quality. Disturbing sediment or impacting water quality could also impact the food-chain, which in turn could largely impact vital seabird habitat and prey availability. Components of these stressors that could pose indirect impacts are detailed in Tables 2.6-1 to 2.6-5, and analyses of their potential impacts are discussed in Section 3.2 (Sediments and Water Quality), Section 3.4 (Invertebrates), Section 3.5 (Habitats), and Section 3.6 (Fishes).

Since bats considered in this analysis do not occur in the water column and rarely feed at the water surface in the Study Area, few, if any, impacts to bats are anticipated from secondary stressors. As such, impacts to bats from secondary stressors will not be discussed further.

3.9.3.7.1 Impacts on Habitat

The potential of water, air quality, and abiotic habitat stressors associated with training and testing activities to indirectly affect birds, as a secondary stressor, was analyzed. The assessment of potential water, air quality, and abiotic habitat stressors is discussed in previous sections in this DEIS/OEIS (Section 3.1, Air Quality; Section 3.2, Sediments and Water Quality; and Section 3.5, Habitats). These analyses addresses specific activities in local environments that may affect bird habitats. At-sea activities that may impact water and air include general emissions, and at-sea activities that may affect habitats include explosives and physical disturbance and strike.

As noted in Sections 3.1 (Air Quality), Section 3.2 (Sediments and Water Quality), and Section 3.5 (Habitats), implementation of the No Action Alternative, Alternative 1, or Alternative 2 would minimally impact sediments, water, air quality, or habitats, and therefore would not indirectly impact seabirds as secondary stressors. Furthermore, any physical impacts on seabird habitats would be temporary and localized because training and testing activities would occur infrequently. These activities would not be expected to indirectly impact birds or bird habitats.

Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap activities that could potentially impact sediments, water, or air quality. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where military activities occur that have any potential to impact sediments, water, or air quality. Therefore, secondary stressors will not affect piping plover critical habitat.

Indirect impacts on sediments, water, or air quality under Alternative 1 or Alternative 2 would have no effect on ESA-listed bird species due to: (1) the temporary nature of impacts on sediments, water, or air quality, (2) the distribution of temporary sediments, water, or air quality impacts, (3) the wide distribution of birds in the Study Area, and (4) the dispersed spatial and temporal nature of the training and testing activities that may have temporary sediments, water, or air quality impacts. No long-term or population-level impacts are expected.

Pursuant to the ESA, secondary impacts on habitat during training or testing activities as described under Alternative 1 would have no effect on piping plover critical habitat, Bermuda pretrels, piping plovers, red knots, and roseate terns. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.3.7.2 Impacts on Prey Availability

As noted in Section 3.4 (Invertebrates) and Section 3.6 (Fishes), implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not adversely impact populations of invertebrate or fish prey resources (e.g., crustaceans, bivalves, worms, sand lance, herring, etc.) of birds and therefore would not indirectly impact birds as secondary stressors. Any impacts on seabird prey resources would be temporary and localized. Furthermore, as discussed above, these activities are expected to have minimal impacts to bird habitats. Additional detail is provided below.

As discussed in Section 3.4.3.7 (Secondary Stressors), impacts on invertebrate prey availability resulting from explosives, explosives byproducts, unexploded munitions, metals, and chemicals would likely be negligible overall and population-level impacts on marine invertebrates are not expected. Because individuals of many invertebrate taxa prey on other invertebrates, mortality resulting from explosions or exposure to metals or chemical materials would reduce the number of invertebrate prey items available. A few species prey upon fish, and explosions and exposure to metals and chemical materials could result in a minor reduction in the number of fish available. However, the effect is expected to be small and discountable. Any vertebrate or invertebrate animal killed or significantly impaired by Navy activities could potentially represent an increase in food availability for scavenging invertebrates. None of the effects described above would likely be detectable at the population or subpopulation level.

As noted in Section 3.6.3.7.2, (Fishes, Impacts on Prey Availability), 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 (Hanlon & Messenger, 1996). The sound from underwater explosions might induce startle reactions and temporary dispersal of schooling fishes if they are within close proximity to an explosion (Popper et al., 2014; Wright, 1982), which in turn could make them more visible to predators (Kastelein et al., 2008). The abundances of fish and invertebrate prey species near the detonation point could be diminished for a short period of time before being repopulated by animals from adjacent waters. Alternatively, any prey species that would be directly injured or killed by the blast could draw in scavengers from the surrounding waters that would feed on those organisms, who in turn could be susceptible to becoming directly injured or killed by subsequent explosions. Any of these scenarios would be temporary, only occurring during activities involving explosives, and no lasting impact on prey availability or the food web would be expected. Indirect impacts of underwater detonations and high-explosive munitions use under the Proposed Action would not result in a decrease in fish populations in the Study Area.

Based on Sections 3.4 (Invertebrates) and 3.6 (Fishes), project-related stressors would not impact populations of invertebrates and fishes that support birds in the Study Area. Therefore, no secondary impacts to birds associated with prey availability are expected. Furthermore, 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 potential impacts on bird prey that inhabits shallow-water coral reefs, live hard bottom, artificial reefs, and shipwrecks.

Pursuant to the ESA, secondary impacts on prey availability during training or testing activities as described under Alternative 1 would have no effect on piping plover critical habitat, Bermuda pretrels, piping plovers, red knots and roseate terns. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in this regard.

3.9.4 Summary of Potential Impacts on Birds and Bats

3.9.4.1 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 stressors from the Proposed Action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the sections above and, for ESA-listed species, summarized in Section 3.9.5 (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 aggregate exposure to all stressors and the repetitive or additive consequences of exposure over multiple years. The individual stressor analyses provided previously indicate that the vast majority of exposures to stressors are non-lethal. Hence the analysis of combined effects focuses on consequences potentially impacting the organism's fitness (e.g., physiology, behavior, reproductive potential).

Most of the birds in the Study Area are relatively long-lived and wide-ranging seabirds, making it likely that individuals would be exposed to multiple activities and stressors over the course of their lifespans. Multiple stressors can affect individual birds in two ways: 1) from exposure to multiple sources of stress during a single event or activity; and 2) from exposure to a combination of stressors over the course of the bird's life. Both general scenarios are more likely to occur where training and testing activities are concentrated. The key difference between the two scenarios is the amount of time between exposures to stressors. Time is an important factor because subsequent disturbances or injuries often increase the time needed for the organism to recover to baseline behavior or physiology, extending the time that the organism's fitness is impacted. On the other hand, bats are not relatively long-lived and occur in the Study Area only infrequently while foraging. As such, individual bats are unlikely to be exposed to a combination of stressors over the course of its lifetime.

Birds and bats are susceptible to multiple stressors (see Section 3.9.2.1.5, General Threats), and the susceptibility of many species could be enhanced by additive or synergistic effects of multiple stressors. As discussed in the analyses above, birds and bats are not particularly susceptible to energy, entanglement, or ingestion stressors resulting from Navy activities; therefore, the opportunity for Navy stressors to result in additive or synergistic consequences is most likely limited to acoustic/explosive, and physical strike and disturbance stressors. The potential for impacts associated with combined acoustic/explosive and physical strike and disturbance stressors is lessened by the fact that most activities are conducted offshore in areas where birds, and especially bats, occur at relatively low concentrations.

Despite uncertainty in the nature of consequences resulting from combined impacts, the location of potential combined impacts can be predicted with more certainty because combinations are much more likely in locations where training and testing activities are concentrated. However, analyses of the nature of potential consequences of combined impacts of all stressors on birds and bats remain largely qualitative and speculative. For example, an individual bird or bat that becomes injured or disoriented from an acoustic or explosive exposure may be less able to avoid subsequent exposure to physical disturbance and strike. Where multiple stressors coincide with high abundances of birds (bats do not occur in the Study Area in high abundance), the possibilities of negative consequences are increased, but not enough is known about the potential additive or synergistic effects to predict them with any confidence. Stressors vary in intensity, with injuries or mortality occurring rarely, and most exposures not having persistent or accumulating effects to individuals or populations. In general, combined impacts will depend upon the coincidence of multiple stressors affecting the same individuals at the same place and time. Such occurrences are relatively infrequent because the activities and stressors are widely dispersed, affecting very small portions of the Study Area and relatively small numbers of individuals at any given time.

It is also likely that Navy stressors will combine with non-Navy stressors, as qualitatively discussed in Chapter 4 (Cumulative Impacts).

3.9.4.2 Combined Impacts of All Stressors Under Alternative 2

Combined impacts of all stressors under Alternative 2 would be largely the same as, but incrementally greater than, those of Alternative 1. Given the slightly larger number of activities overall and proportionately greater exposure of birds and bats to most types of stressors, the potential for additive or synergistic effects is slightly greater under Alternative 2 than Alternative 1. However, as for Alternative 1, the nature of combined impacts is difficult to predict or quantify. Activities and the resultant stressors are widely dispersed, affecting very small portions of the Study Area and relatively small numbers of individuals at any given time.

3.9.4.3 Combined Impacts of All Stressors Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the AFTT Study Area. Various stressors would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.9.5 Endangered Species Act Determinations

Pursuant to the ESA, the Navy identified Alternative 1 as the preferred alternative under the proposed action. As identified in section 3.9.3 (Environmental Consequences), under Alternative 1, Navy training and testing activities may affect ESA-listed bird or bat species and will have no effect on designated critical habitat because the proposed action does not have any elements with the potential to modify such habitat. In all cases for which a “may affect” determination was reached, the Navy determined that the corresponding activities are not likely to adversely affect the species. The Navy has consulted with the USFWS as required by section 7(a)(2) of the ESA in that regard. The Navy’s ESA determinations for the effects of specific stressors on birds and bats under Alternative 1 are summarized in Table 3.9 6 and Table 3.9 7, respectively. USFWS concurred with all Navy determinations.

3.9.6 Migratory Bird Treaty Act Determinations

The Navy has determined that the Proposed Action may result in the “take” of migratory birds. The term “take” as defined by the USFWS for Migratory Bird Treaty Act purposes means to “pursue, hunt, shoot, wound, kill, trap, capture, or collect” (50 CFR part 10.12). The Proposed Action, however is a military readiness activity; therefore, “take” is in compliance with the Migratory Bird Treaty Act. Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 CFR Part 21), the

USFWS has promulgated a rule that authorizes the incidental take of migratory birds provided they do not result in a significant adverse effect on a population of a migratory seabird species. These proposed training and testing activities would not result in a significant adverse impact on any population of a migratory bird species.

Table 3.9-6: Bird Effect Determinations for Training and Testing Activities Under the Proposed Action

		Effect Determinations by Stressor																			
		Acoustic						Explo-sives	Energy			Physical Disturbance and Strike					Entanglement			Ingestion	
Species	Designation Unit	Sonar and Other Transducers	Air Guns	Pile Driving	Vessel Noise	Aircraft Noise	Weapons Noise	Explosives	In-water Electromagnetic Devices	In-air Electromagnetic Devices	High-energy Lasers	Vessels	In-water Devices	Aircraft and Aerial Targets	Military Expended Materials	Seafloor Devices	Wires and Cables	Decelerators/Parachutes	Biodegradable Polymer	Military Expended Materials - Munitions	Military Expended Materials - Other Than Munitions
Training Activities																					
Bermuda petrel	Throughout range	NLAA	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	N/A	NE	NLAA
Piping plover	Throughout range	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	N/A	NE	NLAA
	Critical habitat	NE	N/A	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	N/A	NE	NE
Red knot	Throughout range	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	N/A	NE	NLAA
Roseate tern	Northeast Region	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	N/A	NE	NLAA
	Southeast Region	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	N/A	NE	NLAA
Testing Activities																					
Bermuda petrel	Throughout range	NLAA	NLAA	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NLAA
Piping plover	Throughout range	NE	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NLAA	NLAA	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	NE	NE
Red knot	Throughout range	NE	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NE	NE
Roseate tern	Northeast Region	NE	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NLAA
	Southeast Region	NE	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	NLAA

Note: 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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Table 3.9-7: Bat Effect Determinations for Training and Testing Activities under the Proposed Action

Species	Designation Unit	*Effect Determinations by Stressor*																				
		Acoustic						*Explo-sives*	*Energy*			*Physical Disturbance & Strike*						*Entanglement*			*Ingestion*	
		Sonar and Other Transducers	*Air Guns*	*Pile Driving*	*Vessel Noise*	*Aircraft Noise*	*Weapons Noise*	*Explosives*	*In-water Electromagnetic Devices*	*In-air Electromagnetic Devices*	*High-energy Lasers*	*Vessels*	*In-water Devices*	*Aircraft and Aerial Targets*	*Military Expended Materials*	*Seafloor Devices*	*Pile Driving*	*Wires and Cables*	*Decelerators/Parachutes*	*Biodegradable Polymer*	*Military Expended Materials - Munitions*	*Military Expended Materials - Other Than Munitions*
Training Activities																						
Indiana bat	Throughout range	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	N/A	NE	NE
Northern long-eared bat	Throughout range	NE	N/A	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	NE	NE	NE	N/A	NE	NE
Testing Activities																						
Indiana bat	Throughout range	NE	NE	N/A	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	N/A	NE	NE	NE	NE	NE
Northern long-eared bat	Throughout range	NE	NE	N/A	NLAA	NLAA	NLAA	NLAA	NE	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE	N/A	NE	NE	NE	NE	NE

Note: 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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