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Overseas Environmental Impact Statement

Point Mugu Sea Range

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3.8 Sea Turtles

3.8.1 Introduction

This section provides a brief introduction to the five sea turtle species that are known to or have the potential to occur within the boundaries of the Point Mugu Sea Range (PMSR) Study Area (Study Area). The five species are green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), olive ridley sea turtle (*Lepidochelys olivacea*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*). The distributions of these species may overlap with stressors introduced into the environment by the Proposed Action. The analysis of impacts from those stressors on sea turtles is provided in Section 3.8.5 (Environmental Consequences). General characteristics relevant to all five sea turtle species are described in Section 3.8.4.1 (General Background), including information on behavior, hearing sensitivity, and natural and anthropogenic threats. Species-specific profiles are provided for each species in Section 3.8.4.2 (Sea Turtles in the Study Area). The profiles describe the status, geographic range, and population trends as well as other characteristics of each species.

The National Marine Fisheries Service (NMFS) and the United States (U.S.) Fish and Wildlife Service (USFWS) share jurisdictional responsibility for sea turtles under the Endangered Species Act (ESA). The USFWS has jurisdiction over sea turtles in the terrestrial environment (e.g., nesting beaches), whereas NMFS has jurisdiction over sea turtles in the marine environment.

3.8.2 Region of Influence

The region of influence for sea turtles consists of the PMSR and the offshore areas surrounding Point Mugu, San Nicolas Island, and the other Channel Islands. Refer to Chapter 2 (Description of Proposed Action and Alternatives) for more information on the PMSR Study Area.

3.8.3 Approach to Analysis

The analysis of potential impacts on sea turtles due to the Proposed Action was based on the review of scientific publications cited in this section and from recent U.S. Department of the Navy (Navy) documents that analyzed potential impacts from the same or similar activities on sea turtles (U.S. Department of the Navy, 2018b, 2018c).

A list of stressors potentially affecting sea turtles or sea turtle habitat was created by categorizing the different types of activities and the aircraft, vessels, ordnance, and expended materials proposed for use during those activities. Potential impacts on sea turtles resulting from exposure to these stressors would come primarily from direct physical injury and detrimental behavioral effects. Analysis of these stressors on sea turtles is presented in Section 3.8.5 (Environmental Consequences). Mitigation measures proposed as a result of the analysis and to reduce or avoid impacts on sea turtles are presented in Chapter 5 (Standard Operating Procedures and Mitigation).

3.8.4 Affected Environment

3.8.4.1 General Background

All sea turtles, are ectotherms, commonly referred to as "cold-blooded" animals. Ectotherms have adopted different strategies for regulating body temperature through external sources of heat (e.g., basking in the sun) to compensate for their lack of ability to regulate body temperature internally. As a result, sea surface temperature is a key factor in determining the distribution of sea turtle species

(Benson et al., 2011b; Coles & Musick, 2000; Crear, 2015; Crear et al., 2016; Etnoyer et al., 2006; James & Mrosovsky, 2004; Storch et al., 2005).

Sea turtles are highly migratory, long-lived reptiles that occur throughout the open-ocean and coastal regions of the Study Area. Generally, sea turtles are distributed throughout tropical to subtropical latitudes (i.e., in warmer waters closer to the equator), with some species extending poleward into temperate seasonal foraging areas. In general, sea turtles spend most of their time at sea, with the notable exception of mature females returning to land, primarily beaches, to nest. The habitat preferred by sea turtles and their distribution at sea varies by species and life stage (e.g., hatchling, juvenile, adult). Additional information on the biology, life history, population distribution, and conservation of sea turtle species can be found through the following organizations:

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

Detailed information about threats to sea turtles and their life histories can be found in the ESA listing documentation and species' recovery plans (44 *Federal Register* 75074; 52 *Federal Register* 21059; 72 *Federal Register* 13027; (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998a, 1998b, 1998c, 1998d, 1998e; U.S. Fish and Wildlife Service, 1999).

3.8.4.1.1 Group Size

Sea turtles are generally solitary animals at sea, but they tend to form groups during migrations and mating. In addition, multiple sea turtles may also be found at foraging areas, such as persistent oceanic gyres or frontal zones, which aggregate sea turtle prey (Benson et al., 2011b; Polovina et al., 2004; Polovina et al., 2000). Hatchlings, which often emerge from nesting beaches in groups, are solitary at sea until they are sexually mature (Bolten, 2003; Bowen et al., 2004; James et al., 2005a; Schroeder et al., 2003).

3.8.4.1.2 Habitat Use

There continues to be limited data on the in-water abundance and distribution of sea turtles. Although tagging studies of small numbers of turtles have been conducted, the results only provide an indication of habitat use at the population level and are mainly by female turtles tagged at nesting beaches (Benson et al., 2011b; Blumenthal et al., 2009; Eguchi et al., 2010; Gaos et al., 2011; Gaos & Yañez, 2008; Shillinger et al., 2008; Whiting & Miller, 1998; Witt et al., 2010). There is little assessment of the general presence of turtles in an area beyond their use of beaches, and, as such, many studies estimate sea turtle abundance by counting nesting individuals or the number of eggs in a nest (Cheng et al., 2008; Hitipeuw et al., 2007; Honarvar et al., 2008; Lopez-Castro et al., 2004; Patino-Martinez et al., 2008) or by recording instances of bycatch (Bartol & Ketten, 2006; Donoso & Dutton, 2010).

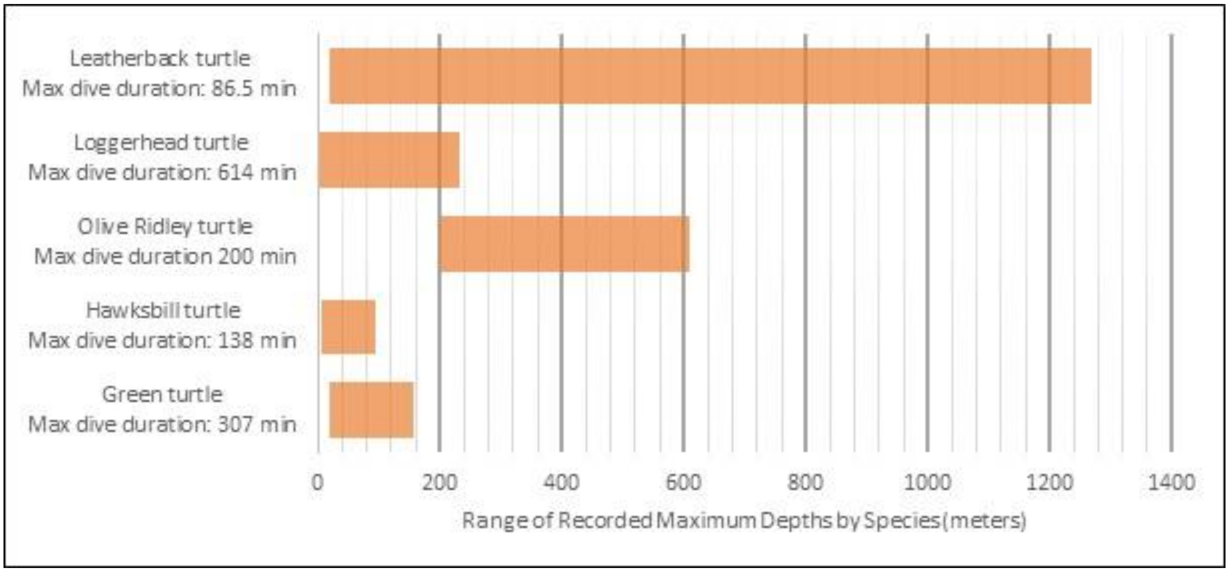
Sea turtles are dependent on access to sandy beaches for nesting habitat. The location of a nest must be far enough inland to avoid being inundated at high tide or during storm events before the hatchlings emerge. In the water, sea turtle habitat use varies by species and can be linked to dive patterns and foraging behavior as well as migration strategies (e.g., dive depth varies with the depth of preferred prey) (Rieth et al., 2011).

3.8.4.1.3 Dive Behavior

Sea turtle dive depth and duration varies by species, the age of the animal, the location of the animal, and the activity (e.g., foraging, resting, and migrating). Dive durations are often a function of turtle size, with larger turtles being capable of diving to greater depths and for longer periods. The diving behavior of a particular species or individual has implications for mitigation, monitoring, and development of beneficial conservation strategies. Distribution through the water column is also an important consideration in the analysis of potential impacts from acoustic sources and explosives.

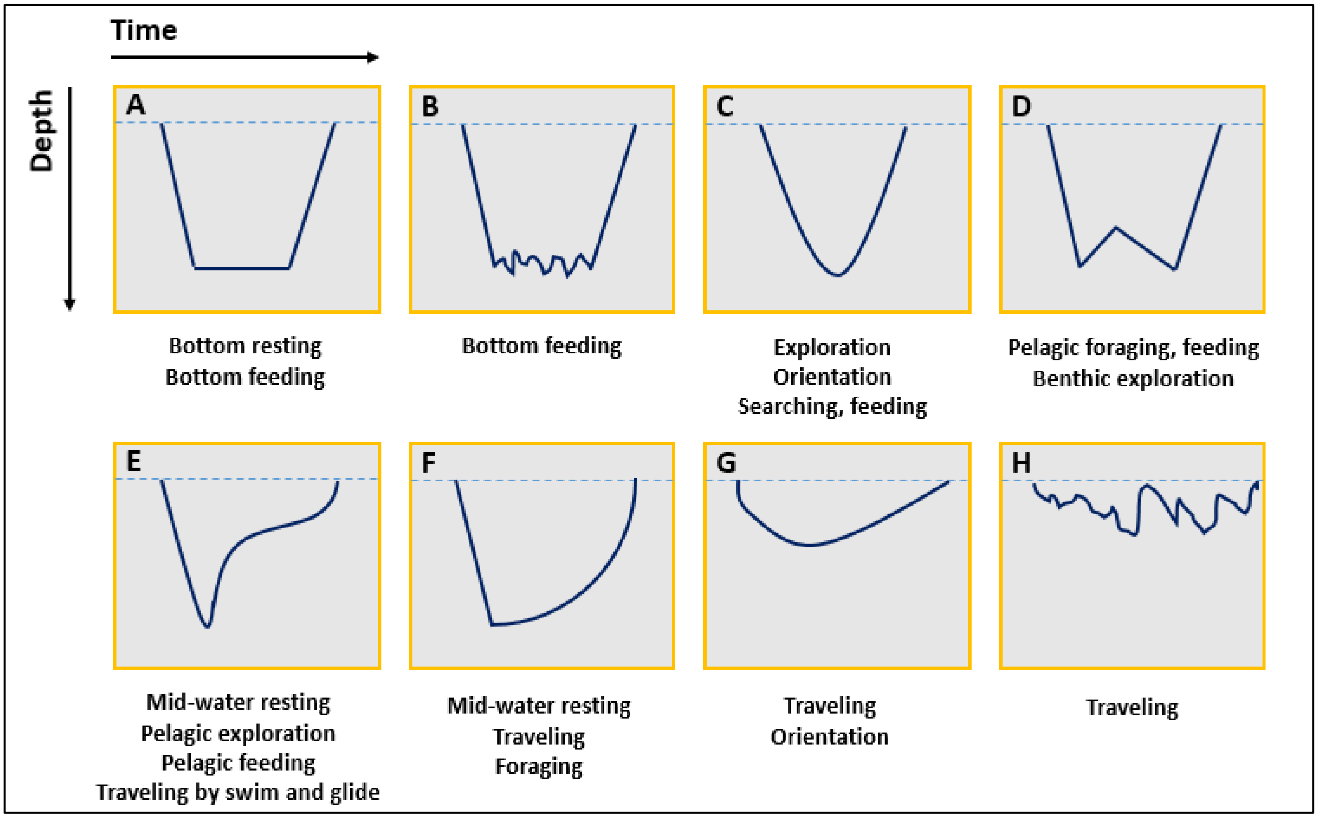
Scientific studies collecting data on sea turtles dive behaviors over several years have varied design, configuration of electronic satellite tags, the types of field data collected, and how data were analyzed. Hochscheid (2014) summarized data from 57 studies published between 1986 and 2013 that collected data on dive depths and durations from a combined total of 538 sea turtles of different species. Figure 3.8-1 presents the ranges of maximum dive depths for each sea turtle species found in the Study Area.

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



Sources: Hochscheid (2014); Sakamoto et al. (1993); Rice and Balazs (2008) ; Gitschlag (1996); Salmon et al. (2004)

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



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

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

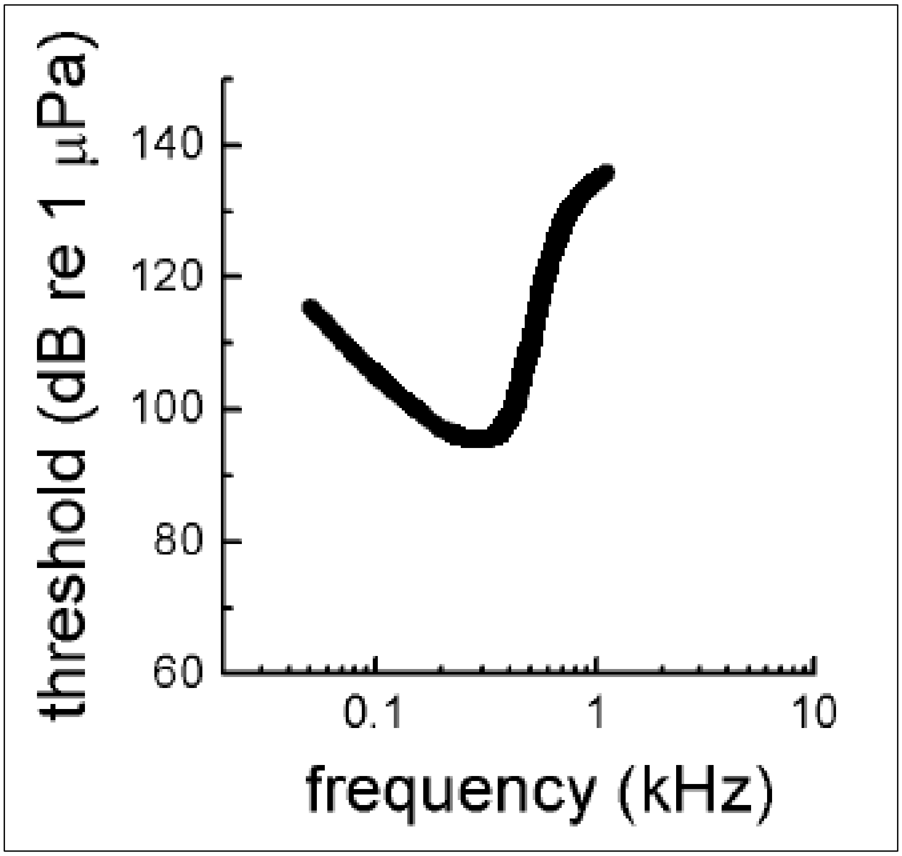
Figure 3.8-2: Generalized Dive Profiles and Activities Described for Sea Turtles

3.8.4.1.4 Hearing and Vocalization

Sea turtle ears are adapted for hearing underwater and in air, with auditory structures that may receive sound via bone conduction (Lenhardt et al., 1985), via resonance of the middle ear cavity (Willis et al., 2013), or via standard tympanic middle ear path (Hetherington, 2008). Studies measuring hearing sensitivity in multiple species of sea turtles show that they can detect sounds generally between 50 and 1600 hertz (Hz), with maximum sensitivity between 100 and 400 Hz, and that hearing sensitivity drops off rapidly at higher frequencies (Popper et al., 2014). Sea turtle hearing in air is also important, particularly for adult females who come to shore during nesting season. In-air hearing sensitivity is also limited to lower frequencies ranges. For example, juvenile green sea turtles have been shown to detect in-air sounds between 50 and 800 Hz, with maximum sensitivity between 300 and 400 Hz (Bartol & Ketten, 2006; Piniak et al., 2016).

Hearing sensitivity has primarily been studied in sub-adults, juveniles, and hatchlings from four sea turtle species, including green sea turtles (Bartol & Ketten, 2006; Ketten & Moein-Bartol, 2006; Piniak et al., 2016; Ridgway et al., 1969; Yudhana et al., 2010), Kemp's ridley sea turtles (Bartol & Ketten, 2006), loggerhead sea turtles (Bartol et al., 1999; Lavender et al., 2014; Martin et al., 2012), and leatherback sea turtles (Dow Piniak et al., 2012). Only one study examined the auditory capabilities of an adult sea turtle (Martin et al., 2012); the hearing range of the adult, a loggerhead sea turtle, was similar to the hearing ranges of juveniles and hatchlings, so the assumption made in this analysis is that hearing sensitivity is not substantially different in adults.

By compiling and analyzing existing data on sea turtle hearing sensitivity, the Navy developed a composite sea turtle audiogram for underwater hearing (Figure 3.8-3), as described in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017b). The composite audiogram shows that hearing sensitivity is greatest between about 200 and 600 Hz (0.2 and 0.6 kilohertz [kHz]), and that within that frequency range, sea turtles are capable of detecting sounds between 90 and 100 decibels referenced to 1 micropascal (dB re 1 μPa) (Figure 3.8-3).



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

Figure 3.8-3: Composite Underwater Audiogram for Sea Turtles

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

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

3.8.4.1.5 General Threats

3.8.4.1.5.1 Water Quality

Water quality in sea turtle habitats can be affected by a wide range of activities. Energy exploration and extraction activities, chemical pollution, and marine debris have the potential to degrade nearshore and offshore habitats. Marine debris, particularly floating plastics that can be mistaken for prey, are a great concern (Aguilar de Soto et al., 2008; Fukuoka et al., 2016; Jepson et al., 2016; Law et al., 2014; National Marine Fisheries Service, 2011, 2014; Ortmann et al., 2012; Peterson et al., 2015; Teuten et al., 2007). Refer to Section 3.2 (Sediments and Water Quality) for additional information on existing conditions in the Study Area. Life stage, geographic location relative to concentrations of pollutants, and feeding preferences affect the severity of impacts on sea turtles associated with chemical pollution in the marine environment.

3.8.4.1.5.2 Commercial Industries

One comprehensive study estimates that worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries around the world (Wallace et al., 2010b). Lewison et al. (2014) compared bycatch using three different gear types (longline, gillnet, and trawling nets) for sea turtles, marine mammals, and seabirds. Of the three species groups, sea turtles were most susceptible to bycatch, and fisheries in the Mediterranean Sea and off the Atlantic coast of South America reported the highest number of sea turtle mortalities (primarily through trawling) (Lewison et al., 2014). In U.S. fisheries, Finkbeiner et al. (2011) estimated that bycatch resulted in 71,000 sea turtle deaths per year prior to effective regulations that protect sea turtles (e.g., regulations adopted since the mid-1990s in different U.S. fisheries for turtle exclusion devices). Current mortality estimates are 94 percent lower (4,600 deaths) than pre-regulation estimates (Finkbeiner et al., 2011). The trend in bycatch reductions continues throughout the Study Area and the larger U.S. Pacific coast (Carretta et al., 2017). For example, Eguchi et al. (2017) determined that current restrictions in West Coast fisheries (e.g., time-area closures for West Coast drift gill net fishery) have been effective and suggested that if the fixed time-area closure regulation existed in the 1990s, 18 of 19 observed bycatch events in this fishery could have been avoided. Researchers have continued to advance strategies to further reduce bycatch while still maintaining robust and sustainable fisheries. One such advancement is the development of a tool that uses satellite-based observations of ocean conditions to define dynamic fisheries closures with near real-time precision (Hazen et al., 2018). Initial results indicate implementing such a management tool would reduce the size of fisheries closures compared with current static closures and would still maintain protection for species, including sea turtles, which are susceptible to bycatch.

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

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

Onshore development can lead to nesting habitat loss or degradation. Construction activities can facilitate erosion or inhibit natural sediment deposition need to form or replenish beaches. Once facilities are operational, artificial lighting, noise, and other stressors can degrade nesting habitats (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011; Seminoff et al., 2015). An increasing trend in offshore energy development, particularly technologies using ocean waves and subsurface currents to generate electricity, may present a cumulative threat to sea turtles if installations occur in areas with higher sea turtle concentrations. The anticipated increase in renewable wind energy development in coastal waters and deeper sites on the continental shelf will require increased vessel traffic, seismic surveys, and possibly pile driving activities for the turbine footings (Pacific Fishery Management Council, 2011), all of which may potentially stress sea turtles and their habitats.

3.8.4.1.5.3 Disease and Parasites

Fibropapillomatosis is a disease affecting sea turtles that results in the production of tumors, both external and internal, that are considered benign but may obstruct crucial functions, such as swimming, feeding, sight, and buoyancy, and can lead to death (Balazs, 1986; Chaloupka et al., 2009; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Patrício et al., 2016; Work & Balazs, 2013). The disease was first noticed in 1928 but was not observed again until the 1970s (McCorkle, 2016). The disease is most prevalent in green sea turtles (Patrício et al., 2016). It spread rapidly through the 1980s, becoming endemic in both Florida and Hawaii in green sea turtle populations (Chaloupka et al., 2009; McCorkle, 2016; Work & Balazs, 2013). By 1995, the disease seems to have reached its climax and has declined in prevalence ever since (Patrício et al., 2016).

Edmonds et al. (2016) lists 16 parasites known to occur in sea turtles, with the most common and significant (in terms of impacts on health) being blood flukes and flatworms (Watson et al., 2017). Some of the common external parasites found on sea turtles include leeches and a number of different species that reside on the shell called epibiota (Suzuki et al., 2014). Leeches are usually seen where the flippers attach to the rest of the body. Parasitic isopods (e.g., sea lice) can attach themselves to sea turtle soft tissue on the outside and within the mouth (Júnior et al., 2015).

3.8.4.1.5.4 Invasive Species

Impacts on sea turtles from invasive species have been both harmful and beneficial and primarily concern nest predation and prey base. Engeman et al. (2016) reported on the predation of invasive swine on sea turtle eggs and measures taken to reduce the impacts. In foraging grounds, sea turtles have been shown to adapt their foraging preferences for invasive seagrass and algae. Becking et al.

(2014) observed a green sea turtle foraging on the invasive seagrass, *Halophila stipulacea*, in the Caribbean.

3.8.4.1.5.5 Climate Change

Sea turtles are particularly susceptible to the effects of climate change, because their life history, physiology, and behavior are closely linked and sensitive to temperature changes in their environment both at sea and on land (Fuentes et al., 2013). Even small elevations of a few degrees in the temperature of nests could result in the feminization (i.e., becoming increasingly female) of turtle populations or, to counter that phenomenon, sea turtles may need to seek out cooler nesting beaches in more temperate locations (Jensen et al., 2018; Reneker & Kamel, 2016). Increases in environment temperatures could result in decreased reproductive success (Clark & Gobler, 2016; Hawkes et al., 2006; Laloë et al., 2016; Pike, 2014), shifts in reproductive periodicity and latitudinal ranges (Birney et al., 2015; Pike, 2014), disruption of hatchling dispersal and migration, behavioral changes (Storch et al., 2005; Van Houtan et al., 2015), and indirect effects on the availability of food (Witt et al., 2010). Warming ocean temperatures may force sea turtles to alter transoceanic migrations or traditional foraging areas, because sea surface temperature and gradients in sea surface temperature (or fronts), perhaps more than any other environmental factor, define habitat preferences for sea turtles (Coles & Musick, 2000; Crear et al., 2016; Etnoyer et al., 2006; James et al., 2006; Montero et al., 2016).

Climate change models predict sea level rise and increased intensity of storms and hurricanes in tropical sea turtle nesting areas (Patino-Martinez et al., 2008). These factors could significantly increase beach inundation and erosion, reducing nesting habitat worldwide (Patino-Martinez et al., 2008; Patino-Martinez et al., 2014; Pike et al., 2015). While rising temperatures may initially result in increased female population sizes, the reduction in the number of male turtles will ultimately impact the overall fertility of females in the population (Jensen et al., 2018). For example, breeding male sea turtles show a strong natal tendency to return to their birthplaces to mate (Roden et al., 2017; Shamblin et al., 2015). With fewer available breeding males, it is unlikely that males would travel to non-natal breeding locations to be available to mate with females at male-depleted breeding areas (Jensen et al., 2018).

As humans enact strategies to protect coastal infrastructure in response to rising sea levels, such as the construction of shoreline stabilization structures (e.g., sea walls or revetments), the loss of nesting beach habitat could be accelerated. Many shoreline armoring structures, like sea walls, protect upland areas but accelerate the erosion of adjacent sandy beaches that sea turtles need as nesting habitat (Lutcavage et al., 1997). Shoreline stabilization structures like breakwaters may hold in place beach sediments at the intended location, but transport by alongshore currents and changes in sediment deposition locations can reduce natural replenishment of beaches downstream at sites where sea turtle nesting occurs (Boyer et al., 1999; Fish et al., 2008).

3.8.4.1.5.6 Marine Debris

Ingestion of marine debris, particularly plastics, can cause mortality or injury to sea turtles. Jambeck et al. (2015) estimated that 4–12 million metric tons of plastic waste entered or “leaked into” the marine environment from land-based sites in 2010 alone. This estimate, however, does not account for cataclysmic events, such as the 2011 Japanese tsunami estimated to have generated 1.5 million tons of floating debris (Murray et al., 2015). Plastic is the primary type of debris found in marine and coastal environments, and plastics are the most common type of marine debris ingested by sea turtles (Schuyler et al., 2014). Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherback sea turtles to have ingested various types of plastic (Mrosovsky et al., 2009), and Narazaki et al. (2013)

noted an observation of a loggerhead exhibiting hunting behavior on approach to a plastic bag, possibly mistaking the bag for a jellyfish. Even small amounts of plastic ingestion can cause an obstruction in a sea turtle's digestive track and subsequent mortality (Bjorndal, 1997; Bjorndal et al., 1994), and hatchlings are at risk for ingesting small plastic fragments. Ingested plastics can also release toxins, such as bisphenol-A (commonly known as "BPA") and phthalates, or absorb heavy metals from the ocean and release those into tissues (Fukuoka et al., 2016; Teuten et al., 2007). Life stage and feeding preference affects the likelihood of ingestion. Sea turtles living in oceanic or coastal environments and feeding in the open ocean or on the seafloor may encounter different types and densities of debris, and may therefore have different probabilities of ingesting plastic debris. In 2014, Schuyler et al. (2014) reviewed 37 studies of debris ingestion by sea turtles, showing that young oceanic sea turtles are more likely to ingest debris (particularly plastic) than sea turtles foraging in shallow coastal waters, and that oceanic green and leatherback sea turtles are the most at risk for lethal and sub-lethal impacts from ingesting debris.

3.8.4.2 Sea Turtles in the Study Area

As shown in Table 3.8-1, there are five sea turtle species listed as endangered or threatened under the ESA with potential occurrence in the eastern North Pacific. Out of the five, only two species, leatherback and loggerhead sea turtles, are likely to occur in the PMSR. The other three species (green, olive ridley, and hawksbill) are unlikely to occur in the PMSR, with the possible exception of a rare or extralimital occurrence of an individual beyond the species' typical distribution. Given the rarity of occurrence, it is highly unlikely that these three species would be impacted by the Proposed Action; therefore, those three species are not analyzed further in this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS). Determinations of effect pursuant to the ESA were made for leatherback, loggerhead, and green sea turtles. Green sea turtles were included in the determination of effects based on stranding records; however, strandings do not necessarily indicate the presence of live sea turtles, and, as discussed further in Section 3.8.4.2.1.1 (Green Sea Turtle [*Chelonia Mydas*]), green sea turtles are considered very unlikely to occur in the offshore waters of the PMSR where the proposed testing and training activities would take place. As such, they are not analyzed further in this EIS/OEIS.

Brief descriptions of the occurrence and distribution of green, olive ridley, and hawksbill sea turtles are provided in Section 3.8.4.2.1.1 (Green Sea Turtle [*Chelonia mydas*]), Section 3.8.4.2.1.2 (Hawksbill Sea Turtles [*Eretmochelys imbricata*]), and Section 3.8.4.2.1.3 (Olive Ridley Sea Turtle [*Lepidochelys olivacea]*). More detailed descriptions of the life histories of leatherback and loggerhead sea turtles are provided in Section 3.8.4.2.2.1 (Loggerhead Sea Turtle [*Caretta caretta*]) and Section 3.8.4.2.2.2 (Leatherback Sea Turtle [*Dermochelys coriacea*]).

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

Species Name and Regulatory Status				*Presence in Study Area*[4]
Common Name	***Scientific Name***	***Endangered Species Act Status***	***Critical Habitat***	
Family Cheloniidae (hard-shelled sea turtles)				
Green (East Pacific DPS)	*Chelonia mydas*	Threatened[1]	Not designated in the Study Area	Offshore, primarily south of the PMSR. Occasionally along the coast landward of the PMSR near artificially warmed waters (e.g., near power plant effluent).
Hawksbill	*Eretmochelys imbricata*	Endangered	Not designated in the Study Area	Extralimital. Species prefers warmer tropical waters.
Olive Ridley (Pacific breeding population)	*Lepidochelys olivacea*	Endangered[2]	Not designated	Extralimital. Species prefers warmer tropical waters.
Loggerhead (North Pacific DPS)	*Caretta*	Endangered[3]	Not designated in the Study Area	Occasionally in offshore waters of the PMSR. Occurrence is more likely during anomalously warm conditions (e.g., during an El Niño event)
Family Dermochelyidae (leatherback sea turtle)				
Leatherback[5]	*Dermochelys coriacea*	Endangered	Designated in the Study Area (see Section 3.8.4.2.2.2, Status and Management)	Likely occurrence in offshore and nearshore waters of the PMSR.

[1] On April 6, 2016, NMFS and USFWS listed the Central West Pacific, Central South Pacific, and Mediterranean DPSs as endangered, while listing the other eight DPSs (Central North Pacific, East Indian-West Pacific, East Pacific, North Atlantic, North Indian, South Atlantic, Southwest Indian, and Southwest Pacific) as threatened. The Study Area shares portions of the geographic extent identified for the East Pacific DPS.

[2] NMFS and U.S. Fish and Wildlife Service only consider the breeding populations of Mexico's Pacific coast as Endangered. Other populations found in east India, Indo-Western Pacific, and Atlantic are listed as Threatened.

[3] The only DPS of loggerheads that occurs in the Study Area—the North Pacific Ocean DPS—is listed as Endangered.

[4] Extralimital means there may be a small number of sighting or stranding records within the Study Area, but the Study Area is outside the species current and expected range of normal occurrence. Generally, offshore is beyond the continental shelf (> 200 m depth), and nearshore is over the continental shelf (< 200 m depth).

[5] Leatherbacks are currently listed as a single population, but USFWS and NMFS recently identified seven DPSs. However, the DPSs have not yet been listed under the ESA. Only leatherbacks from the West Pacific DPS occur in the Study Area.

Note: DPS = Distinct Population Segment

3.8.4.2.1 Sea Turtle Species Unlikely to Occur in the Study Area

3.8.4.2.1.1 Green Sea Turtle (*Chelonia mydas*)

Status and Management

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

Only the East Pacific Ocean DPS occurs within the Study Area. This segment is listed as threatened under the ESA. Only this DPS is discussed further in the document; however, it should be noted that minimal mixing may occur (gene flow) with other population segments (Seminoff et al., 2015). Counts of adult females at nesting sites in Mexico, Costa Rica, and Ecuador used by the East Pacific DPS were used to estimate an abundance of over 20,000 nesters (Seminoff et al., 2015).

There is no critical habitat designated for the green sea turtle in the Study Area.

Habitat and Geographic Range

The green sea turtle is distributed worldwide across tropical and subtropical coastal waters generally between 45 degrees (°) north (N) and 40° south. After emerging from the nest, green sea turtle hatchlings swim to offshore areas where they float passively in major current systems; however, laboratory and modeling studies suggest that dispersal trajectories might also be shaped by active swimming (Putman & Mansfield, 2015). Post-hatchling green sea turtles forage and develop in floating algal mat habitats of the open ocean. At the juvenile stage (estimated at five to six years), they leave the open-ocean habitat and retreat to protected lagoons and open coastal areas that are rich in seagrass or marine algae (Bresette et al., 2006), where they will spend most of their lives (Bjorndal & Bolten, 1988). The optimal developmental habitats for late juveniles and foraging habitats for adults are warm shallow waters (3–5 meters [m]), with abundant submerged aquatic vegetation and located close to nearshore reefs or rocky areas (Holloway-Adkins, 2006; Seminoff et al., 2003). Climate change and ocean warming trends may impact the habitat and range of this species over time (Fuentes et al., 2013), as discussed in Section 3.8.4.1.5.5 (Climate Change). Green sea turtles prefer waters where the sea surface temperature exceeds 22° Celsius (C) (Van Houtan et al., 2015). As shown in Figure 3.3-2 in Section 3.3 (Marine Habitats), average annual sea surface temperature in the Study Area ranges from about 12°C up to 14°C with cooler waters located closer to shore and to the north of the PMSR, and warmer waters, ranging up to 16°C, found farther offshore and southwest of the PMSR. Sea surface temperatures in the PMSR are generally cooler than temperatures preferred by green sea turtles, which become inactive when temperatures fall below 15°C (Crear, 2015)Green turtles are known to congregate in coastal areas and bays where anthropogenic activity (e.g., discharge from power plants) warms waters that would otherwise be too cold for extended occupancy (Crear et al., 2017; Crear et al., 2016; Eguchi et al., 2010; MacDonald et al., 2012). One study documented movements of green turtles in the San Gabriel River, Anaheim Bay, and the 7th Street Basin within the Seal Beach National Wildlife Refuge, collectively located approximately 40 mi. shoreward of the easternmost portion of the PMSR. The movements of the sea turtles showed that they sought out warmer waters adjacent to and downstream of the two power plants in the San Gabriel River in winter, when water temperatures were colder, and ventured farther up river in summer when water temperatures were within their preferred range. Two tagged sea turtles were able to tolerate colder water temperatures ranging between 12.6 and 14.5°C as they transited from the 7th Street Basin to the warmer San Gabriel River; however, the time spent transiting the 7.2 km was 27 and 19 hours, respectively, suggesting the sea turtles took a relatively direct route to warmer waters (Crear et al., 2017; Crear et al., 2016). Despite their proximity to the Action Area, it is highly unlikely that green sea turtles would venture farther offshore into the colder waters characteristic of the PMSR.

Crear et al. (2016) believe that the population utilizing the San Gabriel River, Anaheim Bay, and 7th Street Basin is the northernmost resident population of green sea turtles occurring along the U.S. West Coast. Because of its dependence on anthropogenically warmed waters, the population is expected to shift southward and farther from the PMSR when the two power plants located on the river cease operations in 2029.

The green sea turtle is not known to nest anywhere on the U.S. West Coast, but it ranges widely in nearshore waters from Baja California as far as British Columbia (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2007a) with high concentrations in the subtropical coastal waters of southern Baja California, Mexico, and Central America (Chaloupka et al., 2004). Green sea turtles occurring in or shoreward of the Study Area are likely from Mexican nesting populations (Seminoff et al., 2015).

Ocean waters off central and Southern California are considered areas of occurrence because of the presence of nearshore rocky ridges and channels and floating kelp habitats suitable for green sea turtle foraging and resting (Stinson, 1984); however, as noted above, these waters are often at temperatures below the thermal preferences of this primarily tropical species, and turtles found in these waters are likely transiting to warmer waters (Crear et al., 2016). In 2017, the Department of Defense published a comprehensive inventory and analysis of amphibian and reptile species occurring on Department of Defense installations, including Naval Base Ventura County, which included Point Mugu, Port Hueneme, and San Nicolas Island (Petersen et al., 2017). Green sea turtles were not listed among reptile species present at those installations.

3.8.4.2.1.2 Hawksbill Sea Turtle (*Eretmochelys imbricata*)

Status and Management

The hawksbill sea turtle is listed as endangered under the ESA (35 *Federal Register* 8491). While the current listing as a single global population remains valid, data may support separating populations at least by ocean basin under the DPS policy (Seminoff et al., 2015). The most recent status review document was released in 2013 by the NMFS and USFWS (Hill et al., 2017). In the eastern North Pacific, counts of adult females at nesting sites in Mexico, Costa Rica, Guatemala, El Salvador, Nicaragua, and Ecuador were used to estimate an abundance of about 285 nesters, with declines predicted for all nesting sites (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013a).

There is no critical habitat designated for hawksbill sea turtles in the Study Area.

Habitat and Geographic Range

The hawksbill is the most tropical of the world’s sea turtles, rarely occurring above 35° N or below 30° south (Witzell, 1983). While hawksbills are known to occasionally migrate long distances in the open ocean, they are primarily found in coastal habitats and use nearshore areas more exclusively than other sea turtles. Hatchlings in the North Pacific may show different habitat and range preferences than hatchlings in other regions, where the general progression is hatchlings in open ocean environments move into coastal habitats as they enter the juvenile-phase of development.

Less is known about the hawksbill's oceanic stage, but it is thought that neonates live in the oceanic zone where water depths are greater than 200 m. Distribution in the oceanic zone may be influenced by surface gyres, which are associated with prey aggregations (Gaos, 2011; Leon & Bjorndal, 2002). Hawksbill sea turtles primarily occupy areas where the sea surface temperature is between 23 and 30°C (Gaos, 2011; Storch et al., 2005). Thirteen adult female hawksbills, fitted with satellite tags, spent 91 percent of the time in waters within that temperature range. Three of the tagged hawksbills spent between 6 and 16 percent of their time in cooler waters ranging from 19 to 24°C, and only one hawksbill spent time in colder waters, between 16 and 18°C (Gaos, 2011). As shown in Figure 3.3-2 in Section 3.3 (Marine Habitats), average annual sea surface temperature in the Study Area ranges from about 12°C up to 14°C with cooler waters located closer to shore and to the north of the PMSR, and warmer waters, ranging up to 16°C, found farther offshore and southwest of the PMSR. Sea surface temperatures in the PMSR are generally much colder than temperatures tolerated by hawksbill sea turtles, which prefer warm, shallow tropical waters south of the Study Area. Hawksbills also do not typically range far from nesting sites, which are located off Central and South America (Gaos, 2011). Occurrence of hawksbills in the PMSR would be rare and infrequent with only slightly increased potential during unusually warm conditions, such as during an El Niño event.

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

3.8.4.2.1.3 Olive Ridley Sea Turtle (*Lepidochelys olivacea*)

Status and Management

Olive ridley sea turtles that nest along the Pacific coast of Mexico are listed as endangered under the ESA, while all other populations are listed under the ESA as threatened (43 *Federal Register* 32800). Based on genetic data, the worldwide olive ridley population is composed of four main lineages: east India, Indo-Western Pacific, Atlantic, and eastern Pacific Ocean (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014; Shankar et al., 2004). Off of California, olive ridleys are thought to be within the eastern Pacific Ocean lineage (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014).

The olive ridley is the most abundant sea turtle in the world, with the most recent at-sea estimates of density and abundance providing a population range of 1.15–1.62 million olive ridley sea turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014). The number of olive ridley sea turtles occurring in U.S. territorial waters is believed to be small (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998e, 2014). At-sea abundance surveys conducted along the Mexican and Central American coasts between 1992 and 2006 provided an estimate of 1.39 million turtles in the region, which was consistent with the increases seen on the eastern Pacific Ocean nesting beaches between 1997 and 2006.

There is no critical habitat designated for olive ridley sea turtles in the Study Area.

Habitat and Geographic Range

The olive ridley has a global tropical distribution, occurring in the Atlantic, Pacific, and Indian oceans (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014). In the eastern Pacific, olive ridley typically occur in tropical and subtropical waters, as far south as Peru and as far north as California, but occasionally have been documented as far north as Alaska. Major arribada beaches on the eastern Pacific Ocean include Nancite and Ostinal in Costa Rica and La Escobilla in Mexico. The term "arribada" is derived from Spanish and refers to the synchronized large-scale nesting activity demonstrated by Kemp's ridley and olive ridley sea turtles. As many as 500,000 female olive ridley sea turtles arrive at the nesting beaches on La Escobilla and Ostinal over a few days to lay their eggs. Major arribada beaches are also located in Gahirmatha, Rushikulya, and Devi River in India and Eilanti in Suriname (Spotila, 2004). Several minor arribada beaches in the eastern Pacific host between a few thousand and 20,000 olive ridleys: La Flor and Chacocente in Nicaragua; Isla Cañas in Panama, and Ixtapilla in Mexico. Smaller-scale nesting also occurs in Guatemala, Honduras, and El Salvador (Spotila, 2004). No nesting occurs along the U.S. West Coast.

Studies from different populations of olive ridley sea turtles show a strong preference for neritic waters (shallow, nearshore waters overlying the continental shelf) (Plot et al., 2015; Polovina et al., 2004; Rees et al., 2016). However, deep water foraging has been documented in the North Pacific, where prey items are scattered and less predictable and migrate widely from nesting locations (Polovina et al., 2004). Comparing olive ridley habitat use in different regions, Plot et al. (2015) suggest that the differing migration patterns observed (i.e., oceanic migrations versus neritic movements) may be attributed to specific environmental conditions of the areas in close proximity to nesting sites.

Olive ridley sea turtles primarily occupy areas where the sea surface temperature is between 23 and 28°C (Polovina et al., 2004) and most frequently around 27°C (Eguchi et al., 2007). Between 10 and 13.5°C, olive ridleys become cold stunned (Mrosovsky, 1980). As shown in Figure 3.3-2 in Section 3.3 (Marine Habitats), average annual sea surface temperature in the Study Area ranges from about 12°C up to 14°C with cooler waters located closer to shore and to the north of the PMSR, and warmer waters, ranging up to 16°C, found farther offshore and southwest of the PMSR. Sea surface temperatures in the PMSR are expected to be cooler than temperatures preferred by olive ridley sea turtles, and the occurrence of olive ridleys in the PMSR would only be expected during unusually warm temperatures, such as during an El Niño event (Spotila, 2004).

3.8.4.2.2 Sea Turtle Species Likely to Occur in the Study Area

3.8.4.2.2.1 Loggerhead Sea Turtle (*Caretta caretta*)

Status and Management

In 2009, a status review conducted for the loggerhead (the first turtle species subjected to a complete stock analysis) identified nine DPSs within the global population (Conant et al., 2009). In a September 2011 rulemaking, the NMFS and USFWS listed five of these DPSs as endangered and kept four as threatened under the ESA, effective as of October 24, 2011 (76 *Federal Register* 58868). The North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea DPSs of the loggerhead sea turtle are classified as endangered under the ESA, and the Southeast

Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean DPSs are classified as threatened. Only the North Pacific Ocean DPS occurs within the Study Area; however, mixing is known to occur between other populations in the Pacific and Indian Oceans, enabling a limited amount of gene flow with other DPSs (Gaos, 2011).

There is no critical habitat designated for loggerhead sea turtles within the Study Area.

Habitat and Geographic Range

Loggerhead sea turtles occur in U.S. waters in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Dodd, 1988). Loggerheads typically nest on beaches close to reef formations and in close proximity to warm currents (Dodd, 1988), preferring beaches facing the ocean or along narrow bays (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998c; Rice et al., 1984). Most of the loggerheads observed in the eastern North Pacific Ocean are believed to come from beaches in Japan where the nesting season is late May to August. Aschettino et al. (2015) found that most loggerheads that use the Southern California Bight are more similar, using stable isotope analysis, to loggerheads in the Central North Pacific, as opposed to loggerheads that nest in Baja California, Mexico. Migratory routes can be coastal or can involve crossing deep ocean waters (Schroeder et al., 2003). The species can be found hundreds of kilometers (km) out to sea, as well as in inshore areas, such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. The nearshore zone provides crucial foraging habitat, as well as habitat during nesting season and overwintering habitat.

Pacific Ocean loggerheads appear to use the entire North Pacific Ocean during development (Briscoe et al., 2016; Polovina et al., 2000). There is substantial evidence that the North Pacific Ocean stock makes two transoceanic crossings. The first crossing (west to east) is made immediately after they hatch from the nesting beach in Japan, while the second (east to west) is made when they reach either the late juvenile or adult life stage at the foraging grounds in Mexico. Offshore, juvenile loggerheads forage in or migrate through the North Pacific Subtropical Gyre as they move between North American developmental habitats and nesting beaches in Japan (Briscoe et al., 2016). Seminoff et al. (2014) carried out aerial surveys for loggerhead sea turtles along the Pacific coast of the Baja California Peninsula, Mexico, confirming that the area is an important foraging habitat for loggerheads in the North Pacific DPS. Based on the results of the survey, the authors estimated a density of 0.205 to 0.265 loggerheads per square kilometer (km^2) (depending on distance from shore) and a mean annual abundance of 43,226 loggerheads in the study area. In 2015, (Eguchi et al., 2018) conducted an aerial survey of the southern California Bight extending approximately from Pt. Conception to south of the U.S.-Mexico border and offshore as far as 123 N. The surveyed area overlaps with the southeast portion of the PMSR. Over 200 loggerheads were encountered during the survey, which coincided with anomalously high sea surface temperatures and a strong El Niño. El Niño conditions in the eastern North Pacific coupled with other large scale ocean-atmosphere circulations in the western tropical Pacific resulted in anomalously warm sea surface temperatures in the region and affected the ranges of numerous marine species (Bond et al., 2015).

A previous survey in the same region conducted in 2011 during a La Niña (anomalously cold) year encountered no loggerheads. (Eguchi et al., 2018) estimated an offshore density of 0.24 loggerheads per km^2, which is comparable to the density estimated off the Baja Peninsula (Seminoff et al., 2014), and suggests that loggerheads that typically forage off the Baja Peninsula may take advantage of productive foraging habitat to the north when anomalously warm water temperatures persist. It is also possible that loggerheads foraging off southern California are part of the Central Pacific foraging group, which may follow warmer waters eastward into the California Current Ecosystem (Abecassis et al., 2013; Allen et al., 2013; Eguchi et al., 2018). The higher density and abundance of loggerheads in the southern California Bight would only be expected during similar environmental conditions; however, increasing ocean temperatures associated with climate change may, over time, allow foraging loggerheads to expand their range north on a more regular basis (Eguchi et al., 2018).

While loggerheads, primarily juveniles, are known to occur at sea off central and southern California, they do not nest on California beaches. Based on multiple studies conducted in the North Pacific, loggerhead sea turtles are known to occur in areas where sea surface temperature ranges between 10 and 28.7°C; however, mean sea surface temperatures, which are more indicative of preferred habitat, ranged between 16.3 and 24°C (Eguchi et al., 2018). Below 15°C, loggerheads become lethargic and inactive, and when temperatures fall to 10°C, they become cold-stunned (Mrosovsky, 1980). As shown in Figure 3.3-2 in Section 3.3 (Marine Habitats), average annual sea surface temperature in the Study Area ranges from about 12°C up to 14°C with cooler waters located closer to shore and to the north of the PMSR, and warmer waters, ranging up to 16°C, found farther offshore and southwest of the PMSR. Sea surface temperatures in the PMSR are generally cooler than temperatures preferred by loggerhead sea turtles, except for periods (e.g., during El Niño conditions) when water temperatures can be as much as 4 to 5°C warmer than during “normal” conditions. Occurrence of loggerheads would only be expected during summer and fall when water temperatures are more likely to be within their preferred range.

In waters off of the U.S. West Coast, most records of loggerhead sightings, stranding events, and incidental bycatch have been of juveniles documented from the nearshore waters. In general, sea turtle sightings increase during the summer, peaking from July to September off Southern California and southwestern Baja California, with fewer loggerheads expected farther north in the PMSR.

Population Trends

No loggerhead nesting occurs within the Study Area. The largest nesting aggregation in the Pacific Ocean occurs in southern Japan, where approximately 2,300 females breed annually (Eguchi et al., 2018). Despite historic long-term declines at nesting beaches in Japan of 50–90 percent, since the year 2000 nesting populations in Japan appear to be gradually increasing or remaining stable (Chapman & Seminoff, 2016; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2007b).

Predator and Prey Interactions

Loggerhead sea turtles are primarily carnivorous in both open ocean and nearshore habitats, although they also consume some algae (Bjorndal, 1997). Diet varies with age class (Godley et al., 1998) and by location, with some loggerheads specializing or favoring certain prey groups in specific regions (Besseling et al., 2015; Biggs et al., 2000). For post hatchlings that tend to be grouped in masses of *Sargassum* and other floating habitats, analyses of gut contents show that hatchlings forage on *Sargassum*, zooplankton, jellyfish, larval shrimp and crabs, and gastropods (Browlow et al., 2016; Burkholder et al., 2004; Carr & Meylan, 1980; Richardson & McGillivary, 1991). Both juveniles and adults forage in coastal habitats, where they feed primarily on the bottom, although they also capture prey throughout the water column (Bjorndal, 2003). Adult loggerheads feed on a variety of bottom-dwelling animals, such as crabs, shrimp, sea urchins, sponges, and fish. Their powerful jaws enable them to crush hard-shelled prey, such as whelks and conch. During trans-Pacific migrations through the open sea, loggerheads feed on jellyfish, molluscs, flying fish, and squid (Besseling et al., 2015; Rice et al., 1984; Spotila, 2004).

Common predators of eggs and hatchlings on nesting beaches include ghost crabs, raccoons, feral pigs, foxes, coyotes, armadillos, and fire ants (Campbell, 2016; Dodd, 1988; Engeman et al., 2016). Eriksson and Burton (2003) have shown that management interventions for feral pigs and raccoons can significantly increase nest success in Florida, one of the main nesting concentrations of Atlantic loggerheads. In the water, hatchlings are susceptible to predation by birds and fish. Sharks are the primary predator of juvenile and adult loggerhead sea turtles (Fergusson et al., 2000).

Species-Specific Threats

In addition to the general threats described previously in Section 3.8.4.1.5 (General Threats), loggerheads that occur within the Study Area primarily originate from nesting grounds in Japan, migrate across the North Pacific, and forage in the California Current Ecosystem. Species-specific threats are limited to these geographic regions. A primary threat to North Pacific loggerheads is the high degree of juvenile and adult mortality off the Baja California Peninsula due to fisheries bycatch (Abecassis et al., 2013; Conant et al., 2009). As discussed previously, this location is considered a biological hotspot for loggerheads in a location where bycatch and human consumption present significant threats (Fisheries and Oceans Canada, 2011, 2016b). Mortality associated with shrimp trawls has been a substantial threat to juvenile loggerheads because these trawls operate in the nearshore habitats commonly used by this species. Although shrimping nets have been modified with turtle excluder devices to allow sea turtles to escape, the overall effectiveness of these devices has been difficult to assess (Bugoni et al., 2008; Ellis, 2016). Shrimp trawl fisheries account for the highest number of loggerhead sea turtle fishery mortalities; however, loggerheads are also captured and killed in other trawls, traps and pots, longlines, and dredges (Fisheries and Oceans Canada, 2011; Peckham et al., 2008).

3.8.4.2.2.2 Leatherback Sea Turtle (*Dermochelys coriacea*)

Status and Management

The leatherback sea turtle is currently listed as a single population and is classified as endangered under the ESA (35 *Federal Register* 8491). However, USFWS and NMFS completed a review of the status of the leatherback in 2020 and have identified seven leatherback DPSs based on nesting locations and foraging distribution: Northwest Atlantic, Southwest Atlantic, Southeast Atlantic, Southwest Indian, Northeast Indian, West Pacific, and East Pacific (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020). While USFWS and NMFS have identified and defined the seven DPSs, the population has not been established and listed as DPSs under the ESA, which requires official rulemaking and publication in the Federal Register (16 United States Code 1533(a)(1)). Recent information on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies) have led to an increased understanding and refinement of the global population structure and supported the separation of the population into DPSs (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020; Wallace et al., 2010a). Only leatherbacks from the West Pacific DPS would occur in the Study Area.

In 2012, NMFS designated critical habitat for the leatherback sea turtle in California waters (from Point Arena to Point Arguello) out to the 3,000 m isobath. Critical habitat was also designated north of the Study Area from Cape Flattery, Washington, to Winchester Bay, Oregon, out to the 2,000 m isobath (National Marine Fisheries Service, 2012). A portion of the California critical habitat designation overlaps the northeastern portion of the PMSR (Figure 3.8-4).

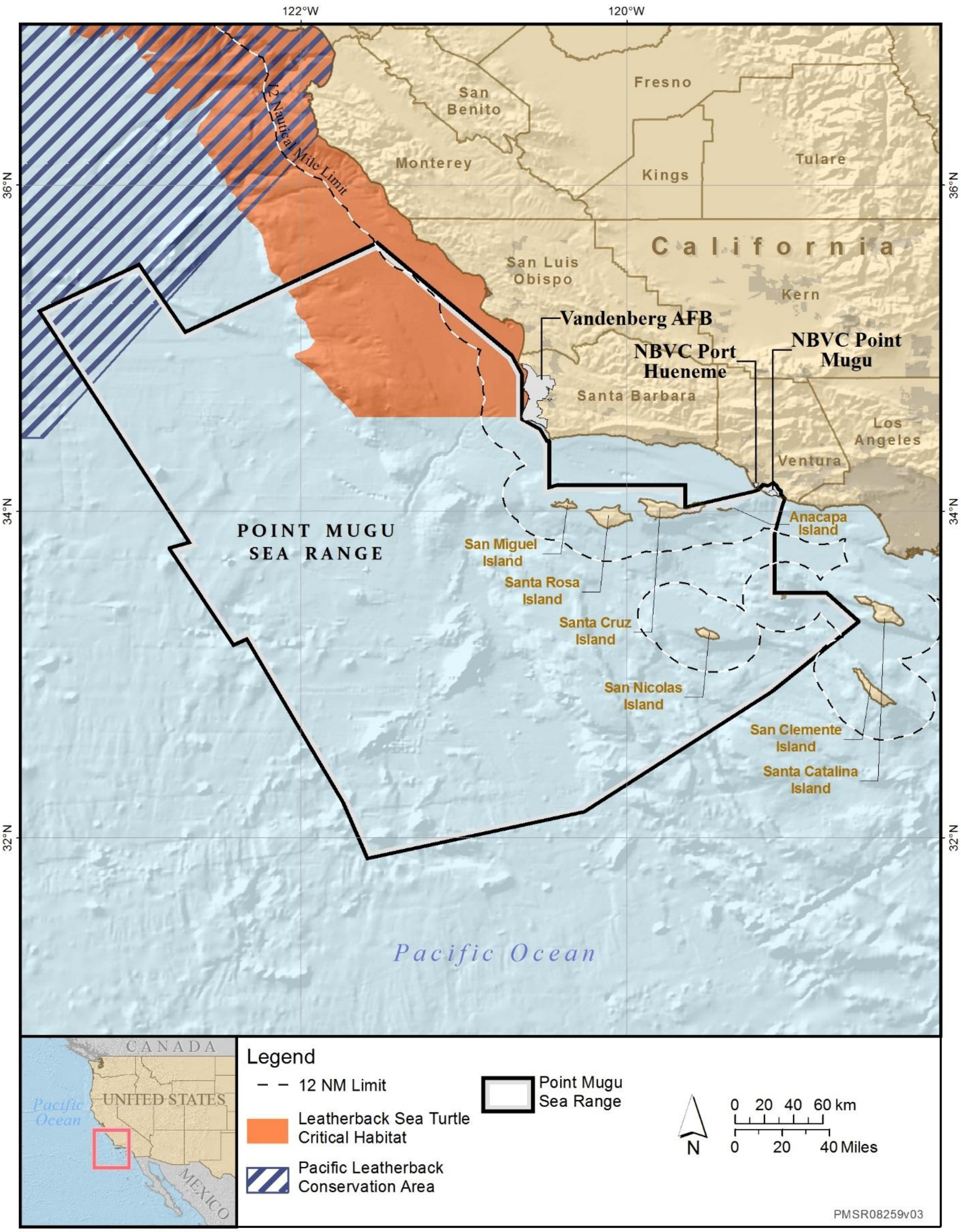


Figure 3.8-4: Leatherback Sea Turtle Critical Habitat in the Study Area

The primary constituent elements defining leatherback critical habitat are "the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora, Aurelia*, *Phacellophora*, and *Cyanea*), of sufficient condition, distribution, diversity, abundance, and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks…" (50 Code of Federal Regulations [CFR] 226.207)

<u>Habitat and Geographic Range</u>

The leatherback sea turtle has the most expansive distribution of any adult sea turtle species; it is found from tropical to subpolar oceans ranging from 71° N to 47° south (Eckert, 1995; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020). The geographic distribution of leatherback nesting locations is limited primarily to tropical and occasionally subtropical beaches, with the majority of major nesting sites located in southeastern Asia (Hebshi et al., 2008; Myers & Hays, 2006; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1992). Leatherback sea turtles do not nest in the Study Area. Leatherbacks are also the most migratory sea turtles, with populations traversing the Pacific, Atlantic, and Indian oceans between nesting and foraging grounds and migratory routes extending into subpolar regions (Bailey et al., 2012; Gaspar & Lalire, 2017; Spotila, 2004). Thermoregulatory adaptations such as a counter-current heat exchange system, high oil content, metabolic rate, and large body size allow leatherbacks to maintain a core body temperature higher than that of the surrounding water enabling them to tolerate colder water temperatures than other sea turtle species. (Casey et al., 2014; Hughes et al., 1998; James & Mrosovsky, 2004).

Pacific leatherbacks are split into western and eastern Pacific subpopulations based on their distribution and biological and genetic characteristics (Bailey et al., 2012). Eastern Pacific leatherbacks nest along the Pacific coast of the Americas, primarily in Mexico and Costa Rica, and forage throughout coastal and pelagic habitats of the eastern tropical Pacific. Western Pacific leatherbacks nest in the Indo-Pacific, primarily in Indonesia, Papua New Guinea, and the Solomon Islands, disperse after hatching into the central North Pacific along the North Pacific Transition Zone, and forage in the eastern North Pacific as juveniles and adults (Bailey et al., 2012; Gaspar & Lalire, 2017). Only juvenile and adult leatherbacks would be expected in the Study Area.

Leatherback sea turtles are regularly seen off the west coast of the United States, with the greatest densities found in waters off central California during summer and fall when sea surface temperatures are warmer. In a study analyzing the movements of 135 leatherbacks fitted with satellite tracking tags, the turtles were found to inhabit waters with sea surface temperatures ranging from 11.3 to 31.7°C (mean of 24.7°C) (Bailey et al., 2012). The study also found that oceanographic features such as mesoscale eddies, convergence zones, and areas of upwelling attracted foraging leatherbacks, because these features are often associated with aggregations of prey (e.g., jellyfish). Mrosovsky (1980) noted that leatherbacks remain active even at water temperatures as low as 6 or 7°C. As shown in Figure 3.3-2 in Section 3.3 (Marine Habitats), average annual sea surface temperature in the Study Area ranges from about 12°C up to 14°C with cooler waters located closer to shore and to the north of the PMSR, and warmer waters, ranging up to 16°C, found farther offshore and southwest of the PMSR. Sea surface temperatures in the PMSR are within the range observed by Bailey et al. (2012) as characteristic of habitat used by leatherback sea turtles.

Hebshi et al. (2008) analyzed telemetry data from 126 leatherbacks identifying migratory patterns and associations with similar oceanographic features such as current boundaries and stationary fronts. The data recorded year-long, transoceanic migrations from nesting beaches in the western North Pacific to the California Current Ecosystem where leatherbacks come to forage (Benson et al., 2007; Hebshi et al., 2008; Kobayashi et al., 2008). The high energetic cost of transiting the Pacific Ocean to forage off the U.S. West Coast may require leatherbacks for remain on foraging grounds for multiple years before returning to natal nesting beaches to mate and nest (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020). Leatherback turtles leaving nesting beaches in the eastern Pacific Ocean off Mexico and Costa Rica generally migrate south into the southern hemisphere and forage in waters off Peru and Chile (Benson et al., 2011a; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b). An aerial survey conducted in October 2015 in the Southern California Bight did not record any leatherback turtle sightings (Eguchi, 2015).

Hazen et al., (2018) developed a habitat suitability model to predict leatherback occurrence in the California Current Ecosystem. The model incorporated satellite tracking data from 20 tagged leatherbacks to aid in characterizing the type of habitat coincident with leatherback occurrence. The bathymetry (i.e., water depth and seafloor features) and sea surface temperature were the most informative habitat features in predicting the occurrence of leatherbacks in the California Current Ecosystem. Within the Study Area, the most suitable habitat for leatherbacks is located south of Point Conception and along the Santa Rosa-Cortez Ridge where persistent upwelling occurs. Refer to Section 3.3.4.1.1 (Physical Characteristics of the Marine Environment Relevant to Biological Resources) for information on the bathymetry and unique seafloor features in the Study Area

Population Trends

Most leatherback nesting populations in the Pacific Ocean are faring poorly and have declined by more than 80 percent since the 1980s. Because the threats to smaller subpopulations have not been eliminated, the International Union for Conservation of Nature has predicted a decline of 96 percent for the western Pacific subpopulation and a decline of nearly 100 percent for the eastern Pacific subpopulation by 2040 (Clark et al., 2010; National Marine Fisheries Service, 2016; Sarti-Martinez et al., 1996). Along the U.S. West Coast, which serves as a major foraging ground for leatherbacks, a recent study concluded that the number of leatherbacks foraging off the coast declined by 5.6 percent annually between 1990 and 2017, representing an 80 percent decline in the foraging population over that time period (Benson et al., 2020). From 1990 to 2003, Benson et al. (2020) estimated that an average of 128 leatherbacks foraged in Central California waters, whereas from 2004 to 2017, the number declined to an average of 55 leatherbacks. The decline in the number of foraging leatherbacks off California continued despite favorable foraging conditions and the availability of prey (brown sea nettle), suggesting other factors are perpetuating the long-term decline (Benson et al., 2020).

Causes for the decline in the Pacific include the intensive egg harvest at leatherback rookeries and high levels of mortality through the 1980s associated with bycatch in the gill net fisheries (Fisheries and Oceans Canada, 2016a; Florida Fish and Wildlife Conservation Commission, 2015). The trend in the foraging population off Central California is similar to declines of about 6 percent annually in the nesting population on Indonesian beaches (Benson et al., 2020).

Predator and Prey Interactions

Leatherbacks lack the crushing chewing plates characteristic of hard-shelled sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied open-ocean prey such as jellyfish and salps (Aki et al., 1994; Bjorndal, 1997; James & Herman, 2001; Salmon et al., 2004). Engelhaupt et al. (2016) conducted gastrointestinal analysis on two leatherbacks southeast of Hawaii and found 94 percent of stomach contents to be comprised of salps; the remaining portion were unidentifiable invertebrates. Leatherback sea turtles feed throughout the water column and can dive to depths over 1,000 m (Davenport, 1988; Eckert et al., 1989; Eisenberg & Frazier, 1983; Grant & Ferrell, 1993; James et al., 2005b; Salmon et al., 2004).

Predators of leatherback nests are common to other sea turtle species (e.g., terrestrial mammals and invertebrates). Fais et al. (2015) found that nesting female leatherbacks expend a significant amount of time and energy to obscure their nests, despite increased risk of direct predation while on land. After laying eggs in her nest and covering them with sand, a female leatherback will often take a non-linear route back to the ocean in an apparent attempt at decoy behavior as a further measure to protect the clutch. In the water, hatchlings are susceptible to predation by birds and fish. Sharks are the primary predators of juvenile and adult leatherback sea turtles (National Marine Fisheries Service, 2016).

Species-Specific Threats

In addition to the general threats to sea turtles described previously, bycatch in commercial fisheries is a threat particularly relevant to leatherback sea turtles. Incidental capture in longline and coastal gillnet fisheries has caused a substantial number of leatherback sea turtle deaths, likely because leatherback sea turtles dive to the same depths targeted by longline fishermen and are less maneuverable than other sea turtle species (Eguchi et al., 2017; Tapilatu et al., 2013). Natural factors, including the 2004 tsunami in the Indian Ocean and the tsunami that affected Japan in 2011, may have impacted leatherback nesting beach habitat through encroachment, erosion, or increased inundation with debris accumulating in foraging habitats and migratory routes (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013b). Eckert and Sarti-Martinez (1997) attributed the decline in the population of leatherbacks foraging off Mexico to the growth of the longline and coastal gillnet fisheries in the Pacific. Leatherbacks from this population forage in waters off in the southeastern Pacific where these fisheries operate. To help reduce bycatch of leatherbacks, the National Marine Fisheries Service established the Pacific Leatherback Conservation Area in 2001, which extends from central Oregon to central California and overlaps a small area of the northwest portion of the Study Area (see Figure 3.8-4). From August 15 to November 15, large mesh drift gillnets, which are used mainly to target swordfish and some shark species, cannot be used in the conservation area. An assessment of the effectiveness of the closure indicates that it has significantly reduced bycatch of leatherbacks in the California Current Ecosystem (Eguchi et al., 2017).

In addition to the effects from climate change described for all sea turtle species (see Section 3.8.4.1.5.5, Climate Change), Robinson et al. (2013) suggest that climate change impacts are contributing to declines in the Pacific leatherback population by causing a shift in the median nesting date for Pacific leatherbacks to later in the year, which increases the likelihood that hatchlings will be exposed to potentially fatal hot and dry conditions. Climate change may also impact the at-sea distribution of leatherbacks by shifting the occurrence and distribution of jellyfish aggregations. The distribution of these largely planktonic prey species are driven by physical dynamics in the oceans, which are expected to be affected by rising ocean temperatures (Pike, 2014).

3.8.4.3 Current Environmental Baseline Conditions

Leatherback and loggerhead sea turtles are currently exposed to explosions occurring at or above the water's surface and associated underwater impulsive sounds penetrating the water's surface from munitions such as bombs and missiles. Testing and training activities involving explosives could be conducted throughout the Study Area; however, most activities that use explosives do not occur within 3 nautical miles (NM) of shore. Explosive sources quantitatively analyzed for the PMSR are shown in Table 3.0-7. Because explosions from Navy testing and training activities only occur at or above the water's surface, only leatherback and loggerhead sea turtles located near the surface at the time of a detonation and in close proximity to the detonation site are likely to experience effects.

3.8.4.3.1 Explosives

3.8.4.3.1.1 Leatherback Sea Turtles

Leatherback sea turtles may behaviorally respond to the sound of an explosive. A behavioral response to a single detonation or explosive cluster is expected to be limited to a short-term (seconds to minutes) startle response, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (see Section 3.8.5.2.1.1, Background, subsection on Behavioral Reactions) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. Because the duration of most explosive events is brief, the potential for masking biologically important sounds is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions.

The quantitative analysis using the Navy Acoustic Effects Model predicted that no leatherback sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause Temporary Threshold Shifts (TTSs), Permanent Threshold Shifts (PTSs), or injury during baseline testing and training activities. However, the model did predict that leatherback sea turtles would be exposed to the levels that could result in three behavioral responses per year during baseline testing and training activities.

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

Leatherback sea turtle critical habitat occurs in the northeastern portion of the Study Area (see Figure 3.8-4), as described in Section 3.8.4.2.2.2 (Leatherback Sea Turtle [*Dermochelys coriacea*]), but would have little or no overlap with areas typically used for testing and training activities with explosives. The activities with the greatest potential to affect leatherback critical habitat are aerial gunnery activities, which expend predominately 20-millimeter projectiles into the marine environment. However, aerial gunnery activities typically take place in Subarea 6C of W-532S (see Chapter 2, Description of Proposed Action and Alternatives), which is seaward of leatherback critical habitat.

3.8.4.3.1.2 Loggerhead Sea Turtles

As noted in Section 3.8.4.2.2.1 (Habitat and Geographic Range), the abundance and density of loggerhead sea turtles at the southern extent of the Study Area can be relatively high, but this would only occur when sea surface temperatures are anomalously warm, such as during the 2015–2016 strong El Niño event. Loggerhead sea turtles are not expected in the Study Area during normal oceanographic conditions (Eguchi et al., 2018; Eguchi & Zickel, 2020). The El Niño phase of the El Niño Southern Oscillation (ENSO) cycle occurs every few years, limiting any potential exposures of individual loggerheads to stressors associated with explosives and further limiting repeated exposures to any individual.

Loggerhead sea turtles are unlikely to be exposed to impacts from the use of explosives on the PMSR. Loggerhead sea turtles were not quantitatively analyzed using the Navy Acoustic Effects Model, because their infrequent occurrence in the Study Area did not allow for a representative estimate of species density that would be appropriate for estimating annual exposures to testing and training activities. The quantitative analysis for leatherback sea turtles, which are expected to occur regularly in the Study Area, predicted three behavioral responses per year. Considering that leatherback sea turtles consistently occur in the Study Area from year to year, and the Navy's acoustic effects analysis predicted just three behavioral exposures, it is reasonable to expect fewer exposures to loggerhead sea turtles, which may occur sporadically in the Study Area in association with anomalously warm-water conditions. Under normal oceanographic conditions, loggerheads are not known to be present in the PMSR, favoring instead warmer habitat south of the PMSR. With no occurrence in the PMSR, there is no potential for impacts. Even during the anomalously warm conditions associated with the 2015–2016 El Niño event, loggerheads that moved north beyond their traditional range were concentrated south of the PMSR. Some loggerheads could be present in the southern portion of the PMSR at some point in the future when unusually warm conditions similar to those in 2015–2016 persist; however, based on the best available data, their density is likely to be low in the PMSR, and their distribution would be limited to the southernmost extent of the PMSR (Eguchi et al., 2018; Eguchi & Zickel, 2020). Given their irregular and unpredictable occurrence, the probability of loggerhead sea turtles being exposed to explosive stressors is extremely low.

3.8.4.3.2 Physical Disturbance and Strike

There are a number of ongoing testing and training activities that include the use of vessels or boats that have the potential to strike or disturb a sea turtle at or near the water's surface. Strikes can cause permanent injury or death from bleeding or other trauma, paralysis and subsequent drowning, infection, or inability to feed. Apart from the severity of the physical strike, the likelihood and rate of a turtle's recovery from a strike may be influenced by its age, reproductive state, and general condition. Much of what is written about recovery from vessel strikes is inferred from observing individuals some time after a strike. Numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al., 2007; Lutcavage & Lutz, 1997; Lutcavage et al., 1997). Fresh wounds on some stranded animals may strongly suggest a vessel strike as the cause of death. The actual incidence of recovery versus death is not known, given available data.

Sea turtles spend a majority of their time submerged (Renaud & Carpenter, 1994; Sasso & Witzell, 2006), although Hazel et al. (2009) and Hazel et al. (2007) showed most species of sea turtles staying within the top 3 m of water despite deeper water being available. Leatherback sea turtles in the Study Area are more likely to occur at or near the surface in open-ocean areas, whereas loggerheads are more likely to occur in shallower, nearshore areas. Both species must come to the surface to breathe and may come to the surface to forage and rest.

Loggerheads are considered to be the most generalist of sea turtle species in terms of foraging behavior, apparently exhibiting varied dive behavior that is linked to the quantity and quality of available prey. Foley et al. (2011) found that loggerheads spent 7.3 percent of time at the surface (associated with breathing), 42 percent of time under the surface but close to the surface within one body length, and 44 percent of time within the water column (the remaining time observed at or near the seafloor). Leatherback sea turtles are more likely to feed at or near the surface in open-ocean areas. It is important to note that leatherbacks can forage for jellyfish at depth but bring them to the surface to ingest (Benson et al., 2007; Fossette et al., 2007; James & Herman, 2001). Basking on the water's surface is common for both species as a strategy to thermoregulate, and the reduced activity associated with basking may pose higher risks for sea turtle strikes because of a likely reduced capacity to avoid cues.

Significant commercial and other non-military vessel traffic occurs in the Study Area. Commercial vessels transport shipments of goods to major U.S. West Coast ports, including the ports of Long Beach and Los Angeles, and smaller vessels transport goods and passengers along the coast to numerous smaller ports. Vessel traffic data described in Section 3.0.5.5.1 (Vessel Noise) indicates that Navy vessels make up only 4 percent of total vessel traffic in Southern California.

There is not a high level of sea turtle stranding data on the U.S. West Coast (National Marine Fisheries Service, 2008). This does not necessarily indicate vessel strike is uncommon off the U.S. West Coast compared with other areas. Ocean currents, vessel sizes, or other factors may simply affect the likelihood a struck turtle will strand. Regardless, this lack of stranding data makes estimating the frequency of sea turtle vessel strike off the U.S. West Coast difficult. Most observations of stranded sea turtles in Southern California since 1990 have occurred within San Diego Bay, where a population of green sea turtles resides. As a term and condition of NMFS's Reinitiated Biological Opinion for the Hawaii-Southern California EIS/OEIS, the Navy prepared an analysis of all sea turtle strandings within Southern California for 2015. Only seven strandings of sea turtles were reported. Four of these strandings were green sea turtles, two were loggerheads, and one was an olive ridley. Only three of the stranded sea turtles were reported as struck by vessels, and all were green sea turtles, which are not expected to occur in the PMSR. These vessel strike strandings were reported within San Diego Bay and were located in areas that are not used by the Navy (National Marine Fisheries Service, 2015).

Disturbance of sea turtles from vessel movements, including surface targets, is expected to occur with more frequency than actual strikes but is still expected to be a relatively rare event. The likelihood of a disturbance is dependent on a Navy vessel and a leatherback or loggerhead sea turtle occurring in close proximity. Given the limited distribution of leatherbacks and the infrequent occurrence of loggerheads in the Study Area, the probability that a sea turtle would encounter a Navy vessel is presumed to be low. In the event that an encounter does occur, visual cues from nearby vessels and vessel noise would likely induce short-term behavioral changes, such as cessation of foraging activities or moving away from the disturbance in both species. No long-term impacts on the fitness of a sea turtle disturbed by a vessel is anticipated.

There are a number of ongoing testing and training activities that result in military materials being expended into the marine environment and potentially creating a physical disturbance or strike on a leatherback or loggerhead sea turtle (Table 3.0-12). While disturbance or strike from expended materials as they sink through the water column is possible, it is not very likely for any of these objects to strike a sea turtle, because expended materials generally sink through the water column slowly and would be avoided by most, if not all sea turtles. Sea turtles at or just below the surface would be most susceptible to injury from strikes; however, the probability of a munition or other expended material directly striking a sea turtle at the surface is extremely low given the low density of leatherback and loggerhead sea turtles in the Study Area and the number and distribution of testing and training activities that would expend military materials (referenced in Appendix D, Military Expended Material and Direct Strike Impact Analyses). The velocity of materials expended above the surface would rapidly decrease upon contact with the water and as they travel through the water column. Most sea turtles would have ample time to detect and avoid approaching munitions or fragments as they fall through the water column. The probability of directly striking a sea turtle with small-caliber projectiles within a single gunnery box is extremely low (Appendix D, Military Expended Material and Direct Strike Impact

Analyses). Since most military expended materials are less abundant than small-caliber projectiles, the risk of strike by expended materials is exceedingly low for sea turtles overall.

3.8.4.3.3 Ingestion

A number of ongoing testing and training activities introduce military expended material that would potentially be small enough for a leatherback or loggerhead sea turtle to ingest (Table 3.0-12). Floating materials are more likely to be eaten by leatherback sea turtles that prefer feeding on gelatinous prey (e.g., jellyfish or salps) typically found near the surface, while materials that sink to the seafloor present a higher risk to loggerhead sea turtles, which would typically forage on benthic prey (e.g., crabs and urchins) when in the Study Area. Fragments from explosive munitions or targets may break apart or remain largely intact in irregularly shaped pieces—some of which may be small enough for a sea turtle to ingest. The majority of expended materials would readily sink to the seafloor after entering the water (e.g., materials with metal components and low buoyancy), and leatherbacks are unlikely to encounter these materials after they leave the surface. Items such as small parachutes may remain at the surface long enough for a leatherback to encounter the item, and it is conceivable that a small parachute could be mistaken for a jellyfish should one be encountered. However, small parachutes used in military testing and training activities are weighted and designed to sink rapidly from the surface, reducing the probability of encounter. Even small parachutes are several feet in diameter and would exceed the size of typical prey, further reducing the likelihood that a leatherback would mistakenly ingest an expended parachute.

Loggerhead sea turtles may encounter small expended materials and fragments of materials on the seafloor. Loggerheads feed on crustaceans that have hard, sharp, or irregular parts when crushed, which may reduce the risk of an impact should they ingest an expended item or fragment. Most other expended materials would be too large for a loggerhead to mistake for a food item and ingest. Furthermore, a loggerhead might taste an item and then expel it instead of ingesting it, in the same manner that a loggerhead feeding off the bottom would temporarily take in sand or shell, then expel it. Based on these factors, the number of leatherback and loggerhead sea turtles potentially impacted by ingestion of military expended materials would be low, and neither individual nor population-level impacts are likely to occur.

3.8.4.3.4 Entanglement

Several types of larger parachutes are used in ongoing testing and training activities that include aerial targets (or drones) (see Section 3.0.5.9, Entanglement Stressors). Aerial targets use large parachutes (between 30 and 50 feet [ft.] in diameter) and extra-large parachutes (80 ft. in diameter) with suspension lines that vary in length from 40 to 70 ft. for large parachutes and up to 82 ft. for extra-large parachutes. Each large parachute has up to 28 lines, and the extra-large parachutes have up to 64 lines. Unlike the small- and medium-sized decelerators/parachutes, drone parachutes do not have weights attached and may remain near the surface or suspended in the water column for a period of time prior to eventual settlement on the seafloor.

Approximately 104 aerial targets (or drones) are used annually on the PMSR (Table 3.0-12), and on average 22 of those targets are not recovered after use (82 are recovered). If present at the time of recovery, the parachute is recovered along with the drone. The long suspension lines of large and extra-large parachutes would pose an entanglement risk to leatherback and loggerhead sea turtles in the event that a turtle encountered a parachute either before a vessel or helicopter arrived to recover the drone and parachute, or the parachute detached from the drone and was not recovered, and the sea turtle encountered the parachute before it sank to the seafloor. It is extremely unlikely that a parachute would land directly on a sea turtle. Direct observations by Rees et al., (2018) while exploring the use of a drone as a sea turtle observation platform showed a leatherback turtle reacting to the shadow cast by a drone by retreating from a beach into the water. This suggests that a descending parachute that casts a shadow over a leatherback or loggerhead sea turtle at the surface may cause the sea turtle to submerge prior to the aerial target and parachute reaching the water's surface.

Entanglement could also occur when a sea turtle encounters a parachute before the parachute sinks to the seafloor when the suspension lines are extended within the water column. Prior to reaching the seafloor, the parachute could be carried along in a current, or snagged on a hard structure near the bottom and remain wholly or partially in the water column for some time. The probability of a sea turtle encountering a parachute that is not recovered in the water column would be low given the low density of leatherback and loggerhead sea turtles in the Study Area and the number and distribution of testing and training activities that would use aerial targets with large and extra-large parachutes. While there are no official records on how long it takes for parachutes to sink below the surface, anecdotal reports indicate that drone parachutes can sink within 20 minutes of detaching from the drone, suggesting that sea turtles would only be at risk of encountering a parachute for a brief period of time. The time it takes for a parachute to sink below the depth at which a sea turtle might encounter it is likely highly variable and would depend on a number of factors, including weather, sea state, and parachute size and weight. Ultimately, the parachute would settle to the bottom and become buried in soft sediment, which would stabilize the canopy and suspension lines and reduce the potential for reintroduction as an entanglement risk.

Loggerhead sea turtles, which most likely forage on the bottom in the Study Area, would occur predominantly in nearshore areas over the continental shelf (< 200 m in depth) rather than farther offshore where large and extra-large parachutes are typically used, making it unlikely that loggerheads would encounter parachutes once they reach the seafloor. As shown in Figure 3.8-1, loggerheads typically dive to depths of approximately 200 m. Any parachutes that sink below 200 m are unlikely to be encountered by loggerheads. While leatherback sea turtles dive to depths greater than 1,200 m, the duration of their dives is relatively short (a maximum of about 86 minutes), limiting the likelihood of encountering a parachute and reducing the potential for entanglement with suspension lines in the water column.

3.8.4.3.5 Energy

As discussed in Section 3.0.5.7 (Energy Stressors), energy impacts on sea turtles are likely from the ongoing use of in-air electromagnetic devices or low-energy lasers. High-energy lasers and high-power microwave systems are used at short ranges, and although unlikely, sea turtles at or near the water's surface could be susceptible to injury by these DE systems. In prior Navy analyses (U.S. Department of the Navy, 2018c), high-energy lasers aimed at surface targets (e.g., a small vessel) were assessed for their potential to strike a sea turtle by assuming the laser beam would miss the target and the beam would then strike a sea turtle at the surface. The Navy has reconsidered this extremely conservative approach given the following reasons: (1) precision targeted high-energy lasers firing over relatively short ranges should not miss a target, (2) sea turtles spend the majority of their time submerged (see Section 3.8.5.4.2, Physical Disturbance and Strike), (3) sea turtles are unlikely to remain stationary at the surface for long periods of time and may avoid the target area during set-up activity prior to and during the testing or training activity, (4) the very small diameter of the laser beam limits the area of the sea turtle that could be exposed to laser energy, and (5) the laser should not miss a target given the system's tracking ability and automated shutdown if target-lock is lost. The same approach to the analysis applies to similar DE systems, including high-power microwave systems.

3.8.5 Environmental Consequences

The U.S. Navy considered all potential stressors resulting from the proposed testing and training activities and identified the following stressors as potentially affecting sea turtles:

- Acoustic (explosives, aircraft noise, vessel noise, and weapon noise)
- Physical disturbance and strike (vessels, military expended materials)
- Ingestion (non-explosive practice munitions; fragments from explosive munitions; military expended materials [MEM] other than munitions)
- Entanglement (decelerators/parachutes)
- Energy (directed energy [DE] systems)
- Secondary Stressors (prey availability)

This section evaluates how and to what degree the testing and training activities described in Chapter 2 (Description of Proposed Action and Alternatives) and Section 3.0.5 (Overall Approach to Analysis) could impact sea turtles in the Study Area. Specifically, the section analyzes the potential effects of the stressors listed above on leatherback and loggerhead sea turtles occurring in the Study Area. Based on the descriptions of sea turtle habitat preferences in Section 3.8.4.2 (Sea Turtles in the Study Area), specifically a species' preferred range of sea surface temperatures and tolerance for colder water temperatures, only leatherback and loggerhead sea turtles are expected to occur regularly in the Study Area. Furthermore, large numbers of loggerhead sea turtles would only occur during the El Niño phase of the ENSO when warmer surface waters from the central Pacific enter the Study Area and coastal upwelling of cooler waters is suppressed. The El Niño phase occurs cyclically, typically every few years rather than annually, and varies in strength and duration, which likely influences the occurrence and abundance of loggerheads in the Study Area (see Section 3.8.4.2.2.1, Habitat and Geographic Range, for more information).

The analysis of impacts in the following sections is focused on the potential effects of the proposed testing and training activities on leatherback sea turtles, critical habitat for leatherbacks, and to a lesser extent on loggerhead sea turtles given that their less-frequent occurrence in the Study Area reduces the likelihood that they would be impacted. No impacts on green, hawksbill, and olive ridley sea turtles are expected due to their rare or extralimital occurrence in the Study Area.

3.8.5.1 Assessment of Non-Acoustic Stressors

Non-acoustic stressors include physical disturbance and strike by vessels or MEM; ingestion of non-explosive practice munitions, fragments from explosive munitions, or MEM; entanglement in the lines of smaller decelerators/parachutes or larger parachutes used with aerial targets; energy from DE systems; and secondary stressors resulting from the availability of prey species. Impacts from non-acoustic stressors associated with Navy testing and training activities have been assessed in multiple previous analyses undertaken by the Navy since 2001, and the Navy has repeatedly determined that non-acoustic stressors are likely to have only discountable, insignificant, or negligible impacts on sea turtles. (U.S. Department of the Navy, 2002, 2008a, 2010a, 2013a, 2013b, 2013c, 2015a, 2015b, 2015c, 2018b, 2018c). Biological Opinions from NMFS and USFWS have previously concluded the probability of impacts or effects from non-acoustic stressors on sea turtles, including leatherback and loggerhead sea turtles, are discountable and not significant (National Marine Fisheries Service, 2017, 2020; U.S. Fish and

Wildlife Service, 2015). In a recently completed analysis of effects by these stressors on sea turtles, NMFS concluded that non-acoustic stressors were not anticipated to result in appreciable reductions in overall reproduction, abundance, or distribution of sea turtles in the Southern California Range Complex (SOCAL), which is adjacent to the southern border of the PMSR and includes a small area of overlap with the PMSR (National Marine Fisheries Service, 2018).

There are no significant differences in the testing and training activities proposed for the PMSR compared to the activities analyzed and occurring in the SOCAL. The differences in the physical environment and habitat (e.g., average sea surface temperature and bathymetry) that distinguish the PMSR from the SOCAL would not alter the conclusions of prior analyses by the Navy, NMFS, and USFWS. If anything, conditions in the PMSR are less suitable for sea turtles (with the exception of leatherbacks) than in the warmer waters of the SOCAL. Both loggerhead and green sea turtles are more likely to occur in the SOCAL Range Complex than in the PMSR given both species' preferences for warmer water. Furthermore, the conclusions reached by the Navy, NMFS, and USFWS regarding these stressors were not dependent on the number of activities associated with the stressors, but instead were predicated on the nature of each stressor, which had been determined to have at most a discountable, negligible, or insignificant impact on sea turtles. There has been no emergent science that would call into question the conclusions reached by the Navy, NMFS, or USFWS in these previous analyses. For these reasons, non-acoustic stressors will not be analyzed in detail in the following section, and the analysis will focus on potential impacts from certain acoustic stressors.

3.8.5.2 Assessment of Acoustic Stressors

Over approximately the last decade and for multiple Navy range complexes, including SOCAL, which borders the PMSR to the south, the Navy has analyzed impacts on marine species, including sea turtles, due to Navy activities that are very similar to the testing and training activities proposed in this EIS/OEIS (U.S. Department of the Navy, 2008b, 2010b, 2013c, 2015b, 2017a, 2018a, 2018c). In these prior analyses and based on the best available science and past consultations with NMFS, the Navy determined that all acoustic stressors, other than stressors associated with sonar and other active acoustic transducers and explosives, used during testing and training activities have had *de minimis*, discountable, negligible, or no impacts on sea turtles. These stressors include weapons firing, launch, and impact noise; vessel noise; and aircraft noise. For a detailed discussion of these acoustic stressors and the analysis of impacts on sea turtles refer to U.S. Department of the Navy (2018c).

The NMFS and USFWS have reviewed the Navy's analyses and conclusions in each of the aforementioned documents regarding these stressors and found the conclusions to be complete and supportable (National Marine Fisheries Service, 2017, 2018; U.S. Fish and Wildlife Service, 2015). Based on these consistent determinations, no further analysis on impacts from weapons firing, launch, and impact noise; vessel noise; and aircraft noise will be provided in this section.

NMFS has found that sonar and other active acoustic stressors may affect or impact sea turtles; however, no sonar and other active acoustic transducers are proposed for use in the PMSR. Therefore, the only acoustic stressor potentially affecting sea turtles, specifically leatherback and loggerhead sea turtles, would result from the use of explosives in the PMSR.

All the ways in which an exposure resulting from the use of explosives could result in immediate effects or lead to long-term consequences for a sea turtle are explained in detail in previous Navy documents (U.S. Department of the Navy, 2018b, 2018c) and NMFS recent Biological Opinion (National Marine Fisheries Service, 2018) for SOCAL. These effects are associated with the same types of testing and training activities using explosives that are proposed to occur in the PMSR, and the same populations of leatherback and loggerhead sea turtles occur in both the PMSR and SOCAL. Therefore, it is reasonable to conclude that the impacts from the use of explosives would be the same as those predicted to occur in the previous Navy documents (National Marine Fisheries Service, 2018; U.S. Department of the Navy, 2018c).

Injury in a sea turtle from exposure to an explosion, were it to occur, would consist of primary blast injury, which usually refers to barotrauma resulting from the compression of gas-containing structures (e.g., lung and gut) or structural damage to the auditory system, from exposure to a blast wave (Greaves et al., 1943; Office of the Surgeon General, 1991; Richmond et al., 1973).

The underwater acoustic effects on sea turtles from the use of explosives were recently modeled (U.S. Department of the Navy, 2018c) to quantitatively estimate impacts. The modeling results predicted that there would be no non-auditory injury (i.e., no lung or digestive tract injuries) or mortality due to Navy activities in SOCAL or Hawaii using explosives. The only injury effects predicted by the Navy's analysis were PTSs (i.e., permanent damage to the auditory system resulting in loss of hearing sensitivity). Other predicted effects were TTSs (i.e., temporarily impaired hearing or loss of hearing sensitivity) and behavioral reactions. Background information on these effects and their impacts on sea turtle hearing and behavior are summarized in the following sections and are available in detail in U.S. Department of the Navy (2018c) for reference. Based on the assessment of non-acoustic stressors and acoustic stressors described above, a summary of potential impacts and ESA determinations is provided in Table 3.8-2.

3.8.5.2.1 Explosives

Explosions at or near the water's surface can introduce loud, impulsive, broadband sounds into the marine environment and potentially affect sea turtles in the vicinity of the explosion. Unlike other types of acoustic stressors, explosions release energy at a high rate, producing a shock wave that can result in injury or mortality of marine species depending, essentially, on the distance between the animal and the detonation location.

Explosives are usually described in terms of their net explosive weight, which is a measure of the amount of explosive material (in pounds [lb.]) used in the ordnance or munition.

3.8.5.2.1.1 Background

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

Table 3.8-2: Summary of Stressors Analyzed, Impacts, and ESA Determinations for Leatherback, Loggerhead, and Green Sea Turtles from Testing and Training Activities Within the Point Mugu Sea Range

Activity Category	Stressor	Potential Impacts	ESA Determination[1]
Air-to-Air	Acoustic – aircraft noise	Behavioral response from sea turtles at the surface during aircraft overflight	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – weapons noise	Behavioral response from sea turtles at the surface during weapons firing	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Physical Disturbance and Strike	Mortality, injury, or behavioral disturbance resulting from MEM falling from the air and directly striking a sea turtle or striking in close proximity to a sea turtle at or near the surface or a vessel striking or nearly striking a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Ingestion	Injury or reduced fitness if MEM is ingested by a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Entanglement	Injury and potential mortality if sea turtle becomes entangled in decelerator/parachute suspension lines	Discountable or insignificant and not likely to adversely affect ESA-listed species
Air-to-Surface	Acoustic – aircraft noise	Behavioral response from sea turtles at the surface during aircraft overflight	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – vessel noise	Behavioral response from sea turtles at the surface during vessel operations	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – weapons noise	Behavioral response from sea turtles at the surface during weapons firing	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – explosives at or near the surface	Potential injury, hearing impairment, or behavioral disturbance of a sea turtle	May affect and likely to adversely affect ESA-listed leatherback sea turtles, and discountable or insignificant and not likely to adversely affect ESA-listed loggerhead and green sea turtles
	Physical Disturbance and Strike	Mortality, injury, or behavioral disturbance resulting from MEM falling from the air and directly striking a sea turtle or striking in close proximity to a sea turtle at or near the surface or a vessel striking or nearly striking a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Ingestion	Injury or reduced fitness if MEM is ingested by a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species

Table 3.8-2: Summary of Stressors Analyzed, Impacts, and ESA Determinations for Leatherback, Loggerhead, and Green Sea Turtles from Testing and Training Activities Within the Point Mugu Sea Range (continued)

Activity Category	Stressor	Potential Impacts	ESA Determination[1]
Surface-to-Air	Acoustic – aircraft noise	Behavioral response from sea turtles at the surface during aircraft overflight	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – vessel noise	Behavioral response from sea turtles at the surface during vessel operations	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – weapons noise	Behavioral response from sea turtles at the surface during weapons firing	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Physical Disturbance and Strike	Mortality, injury, or behavioral disturbance resulting from MEM falling from the air and directly striking a sea turtle or striking in close proximity to a sea turtle at or near the surface or a vessel striking or nearly striking a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Ingestion	Injury or reduced fitness if MEM is ingested by a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Entanglement	Injury and potential mortality if sea turtle becomes entangled in decelerator/parachute suspension lines	Discountable or insignificant and not likely to adversely affect ESA-listed species
Surface-to-Surface	Acoustic – aircraft noise	Behavioral response from sea turtles at the surface during aircraft overflight	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – vessel noise	Behavioral response from sea turtles at the surface during vessel operations	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – weapons noise	Behavioral response from sea turtles at the surface during weapons firing	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – explosives at or near the surface	Potential injury, hearing impairment, or behavioral disturbance of a sea turtle	May affect and likely to adversely affect ESA-listed leatherback sea turtle, and discountable or insignificant and not likely to adversely affect ESA-listed loggerhead and green sea turtles
	Physical Disturbance and Strike	Mortality, injury, or behavioral disturbance resulting from MEM falling from the air and directly striking a sea turtle or striking in close proximity to a sea turtle at or near the surface or a vessel striking or nearly striking a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Ingestion	Injury or reduced fitness if MEM is ingested by a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species

Table 3.8-2: Summary of Stressors Analyzed, Impacts, and ESA Determinations for Leatherback, Loggerhead, and Green Sea Turtles from Testing and Training Activities Within the Point Mugu Sea Range (continued)

Activity Category	Stressor	Potential Impacts	ESA Determination[1]
Subsurface-to-Surface	Acoustic – aircraft noise	Behavioral response from sea turtles at the surface during aircraft overflight	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – vessel noise	Behavioral response from sea turtles at the surface during vessel operations	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – weapons noise	Behavioral response from sea turtles at the surface during weapons firing	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – explosives at or near the surface	Potential injury, hearing impairment, or behavioral disturbance of a sea turtle	May affect and likely to adversely affect ESA-listed leatherback sea turtle, and discountable or insignificant and not likely to adversely affect ESA-listed loggerhead and green sea turtles
	Physical Disturbance and Strike	Mortality, injury, or behavioral disturbance resulting from MEM falling from the air and directly striking a sea turtle or striking in close proximity to a sea turtle at or near the surface or a vessel striking or nearly striking a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Ingestion	Injury or reduced fitness if MEM is ingested by a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species
Electronic Warfare	Acoustic – aircraft noise	Behavioral response from sea turtles at the surface during aircraft overflight	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Acoustic – vessel noise	Behavioral response from sea turtles at the surface during vessel operations	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Physical Disturbance and Strike	Injury or behavioral disturbance resulting from MEM falling from the air and directly striking a sea turtle or striking in close proximity to a sea turtle at or near the surface	Discountable or insignificant and not likely to adversely affect ESA-listed species
	Ingestion	Injury or reduced fitness if MEM is ingested by a sea turtle	Discountable or insignificant and not likely to adversely affect ESA-listed species

Table 3.8-2: Summary of Stressors Analyzed, Impacts, and ESA Determinations for Leatherback, Loggerhead, and Green Sea Turtles from Testing and Training Activities Within the Point Mugu Sea Range (continued)

Activity Category	Stressor	Potential Impacts	ESA Determination[1]
Directed Energy Weapons	Acoustic – aircraft noise	Behavioral response from sea turtles at the surface during aircraft overflight	No effect on ESA-listed species
	Acoustic – vessel noise	Behavioral response from sea turtles at the surface during vessel operations	No effect on ESA-listed species
	Energy (HEL and HPM)	Injury if sea turtle is at the surface at the same time HEL or HPM system is off target (i.e., malfunctions) and energy is incident upon the surface	No effect on ESA-listed species
	Physical Disturbance and Strike	Mortality, injury, or behavioral disturbance resulting from MEM falling from the air and directly striking a sea turtle or striking in close proximity to a sea turtle at or near the surface or a vessel striking or nearly striking a sea turtle	No effect on ESA-listed species
	Ingestion	Injury or reduced fitness if MEM is ingested by a sea turtle	No effect on ESA-listed species
	Entanglement	Injury and potential mortality if sea turtle becomes entangled in decelerator/parachute suspension lines	No effect on ESA-listed species

[1] ESA Determinations apply to all three species unless otherwise specified.

Notes: MEM = military expended materials, ESA = Endangered Species Act, HEL = High Energy Laser, HPM = High Power Microwave

Injury

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

If an animal is exposed to an explosive blast underwater, the likelihood of injury depends on the charge size, the geometry of the exposure (distance to the charge, depth of the animal and the charge), and the size of the animal. In general, an animal would be less susceptible to injury near the water's surface because the pressure wave reflected off the surface is likely to interfere with the direct path pressure wave, reducing the positive pressure amplitude (Nelms et al., 2016). Conversely, it is also possible that a rapid under-pressure caused by the negative surface-reflected pressure wave above an underwater detonation may create a zone of cavitation that may contribute to potential injury. In general, blast injury susceptibility would increase with depth, until normal lung collapse (due to increasing hydrostatic pressure) and increasing ambient pressures again reduce susceptibility.

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

Data on observed injuries to sea turtles from explosions is generally limited to animals found following explosive removal of offshore structures (Viada et al., 2008), which can attract sea turtles for feeding opportunities or shelter. Klima et al. (1988) observed a turtle mortality subsequent to an oil platform removal blast, although sufficient information was not available to determine the animal’s exposure. Klima et al. (1988) also placed small sea turtles at varying distances (less than 7 km) from piling detonations. Some of the turtles were immediately knocked unconscious or exhibited dilation in blood vessels, resulting in low blood pressure, over the following weeks, but others at the same exposure distance exhibited no effects.

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

Hearing Loss and Auditory Injury

An underwater explosion produces broadband, impulsive sound that can cause noise-induced hearing loss, typically quantified as threshold shift, which persists after cessation of the noise exposure. This noise-induced hearing loss may manifest as TTS or PTS. Generally sea turtles are not known to depend heavily on acoustic cues for vital biological functions, such as feeding or navigating (Nelms et al., 2016; Popper et al., 2014). Therefore, the likelihood that the loss of hearing sensitivity in a sea turtle would impact its fitness (i.e., survival or reproduction) is relatively low when compared to other species groups, such as marine mammals (National Marine Fisheries Service, 2018).

Little is known about how sea turtles use sound in their environment. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) do not suggest numeric sound exposure thresholds for auditory effects on sea turtles due to lack of data. Rather, the guidelines qualitatively advise that sea turtles are less likely to incur TTS or PTS with increasing distance from an explosion. The guidelines also suggest that data from fishes may be more relevant than data from marine mammals when estimating auditory impacts on sea turtles, because, in general, fish hearing ranges are more similar to the limited, lower frequency hearing capabilities of sea turtles. As shown in Section 3.8.4.1.4 (Hearing and Vocalization), sea turtle hearing is most sensitive between 100 and 400 Hz in water, is limited over 1 kHz, and is much less sensitive than that of any marine mammal, which rely heavily on hearing capabilities for navigation and foraging.

Physiological Stress

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

Marine animals naturally experience stressors within their environment and as part of their life histories. A stress response is an adaptive process that helps an animal cope with changing external and internal environmental conditions, such as changes in 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 of these conditions contribute to stress and generally illicit a stress response. Anthropogenic sound-producing activities have the potential to provide additional stressors beyond those that naturally occur.

If a sound is detected (i.e., heard or sensed) by an animal, a stress response can occur. The severity of the stress response depends on the received sound level by the animal, the details of the sound-producing activity, the animal's life history stage (e.g., juvenile or adult), the behavior the animal is engaged in (e.g., breeding or feeding), and past experience with the stimuli. An animal's life history stage is a factor, because it relates important information such as its level of physical maturity (e.g., adults have more mass than juveniles) and the primary activity in which it may be engaged, such as mating, feeding, or migrating. Prior experience with a stressor may be of particular importance, because repeated experience with a stressor may dull the stress response via acclimation (St. Aubin & Dierauf, 2001) or increase the response via sensitization. Additionally, if an animal suffers injury or hearing loss, a physiological stress response will occur.

An acute stress response is traditionally considered part of the startle response and is hormonally characterized by the release of the catecholamines. Annoyance type reactions may be characterized by the release of either or both catecholamines and glucocorticoid hormones. Regardless of the physiological changes that make up the stress response, the stress response may contribute to an animal's decision to alter its behavior.

Elevated stress levels may occur whether or not an animal exhibits a behavioral response. Even while undergoing a stress response, competing stimuli (e.g., food or mating opportunities) may overcome any stress-induced behavioral response. Regardless of whether the animal displays a behavioral response, this tolerated stress could incur a cost to the animal. Reactive oxygen compounds produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can lead to damage of lipids, proteins, and nucleic acids at the cellular level (Berlett & Stadtman, 1997; Sies, 1997; Touyz, 2004).

Frequent physiological stress responses may accumulate over time, increasing an animal's chronic stress level. Each component of the stress response is variable in time, and stress hormones return to baseline levels at different rates. Elevated chronic stress levels are usually a result of a prolonged or repeated disturbance. Chronic elevations in the stress levels (e.g., cortisol levels) may produce long-term health consequences that can reduce lifetime reproductive success.

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

Masking

Masking occurs when the noise from an activity interferes with an animal's ability to detect, understand, or recognize biologically relevant sounds of interest. Any unwanted sound above ambient noise and within an animal's hearing range may potentially cause masking. Biologically relevant sounds include those from conspecifics such as offspring, mates, and competitors; sounds from predators; natural, abiotic sounds (e.g., waves crashing) that may aid in navigation; and reverberation, which can give an animal information about its location and orientation within the ocean. The probability that a noise will result in masking increases as the noise level increases and as biologically relevant sound increases in similarity to the noise (e.g., overlapping frequencies). Masking only occurs during the sound exposure; therefore, the frequency, received level (the sound level of the noise where the animal is located), and the duty cycle (the percentage of time the noise is "on" for non-continuous sounds) of the noise determines the potential degree of masking.

Masking occurs in all vertebrate groups and can effectively limit the distance over which an animal can communicate using sound and detect biologically relevant sounds. The effect of masking has not been studied for sea turtles. The potential for masking in sea turtles would be limited to exposure to broadband, low-frequency sounds within their hearing range (approximately 200–1600 Hz) (see Section 3.8.4.1.4, Hearing and Vocalization). Only continuous human-generated sounds that have significant low-frequency content, are longer in duration (i.e., have a high duty cycle), and are of sufficient received level would create a meaningful masking situation. While explosions produce intense, broadband sounds with significant low-frequency content, these sounds are very brief with limited potential to mask relevant sounds. Short duration or intermittent noises would enable an animal to receive continuous or repeated biologically relevant sounds between reoccurring masking noises.

There is evidence that sea turtles may rely primarily on senses other than hearing for interacting with their environment (Popper et al., 2014), such as vision (Narazaki et al., 2013) and magnetic orientation (Avens, 2003; Putman et al., 2015). Any effect of masking may be mediated by reliance on other environmental inputs.

Behavioral Reactions

There are no observations of behavioral reactions by sea turtles from exposure to explosives. Impulsive sound sources, like explosives, have a rapid rise time and higher instantaneous peak pressure than other sound sources (like sonar or vessel noise), making them more likely to cause a startle response or an avoidance response in animals within a certain distance from the detonation site. Air guns, which are often used for at-sea oil exploration during seismic surveys, are another type of impulsive sound source.

Although explosives release more energy than air guns, there are a few studies that report on the responses of sea turtles to air guns, which may be indicative of the types of behavioral responses that sea turtles may have towards explosions (Nelms et al., 2016).

Behavioral responses fall into two major categories: alterations in natural behavior patterns and avoidance. These types of reactions are not mutually exclusive, and the overall reaction to the stimulus may be a combination of behaviors or a sequence of behaviors. The severity of a behavioral response can vary drastically from a minor and brief reorientation of the animal to investigate the sound to a severe reaction, such as aggression or prolonged flight. The type and severity of the behavioral response will determine the cost to the animal. The total number and net explosive weight of explosives involved during an activity, the proximity between the detonation site and any sea turtles in the vicinity, and the duration of the activity are important considerations when predicting the potential for a behavioral response.

As noted above (see the section on Physiological Stress), a physiological stress response such as a startle reaction may cause an animal to change its behavior. Any exposure that produces an injury or hearing loss is also assumed to increase the severity or likelihood of a behavioral reaction. Both an animal's experience and competing and reinforcing stimuli (e.g., feeding or mating) can affect an animal's behavioral response. The response can result in three general types of behavioral reactions: no response, avoidance (i.e., flight or not returning to an area for a period of time), or alteration of a natural behavior, such as feeding.

Other stimuli present in the environment can influence an animal’s behavioral response to an unexpected stimulus, like an explosion. These stimuli may be conspecifics or predators in the area or the drive to engage in a natural behavior. Other stimuli can also reinforce the behavioral response caused by acoustic stimuli. For example, the awareness of a predator in the area coupled with an explosion may elicit a stronger reaction than the activity alone would have.

An animal may reorient, become more vigilant, or investigate if it detects a sound-producing activity. These behaviors all require the animal to divert attention and resources, therefore slowing or stopping their presumably beneficial natural behavior (e.g., feeding, breeding, sheltering, and migrating). This can be a very brief diversion, or an animal may not resume its natural behaviors until after the sound-producing activity has concluded. An animal may choose to leave or avoid an area where a sound-producing activity is taking place. A more severe form of this comes in the form of flight or evasion. Avoidance of an area can help the animal avoid further effects by avoiding or reducing further exposure. Conversely, an animal may also choose not to respond to a sound-producing activity and continue natural behaviors in an area.

An animal that alters its natural behavior in response to stress or an auditory stimulus may slow or cease its behavior and instead expend energy reacting to the sound-producing activity. For example, the cost of disrupting a foraging activity depends on the energetic requirements of individuals and the potential amount of food missed during the disruption. Alteration in breeding behavior can result in delaying reproduction. The costs of a brief interruption to migrating or sheltering are less clear. The amount of energy expended depends on the severity of the behavioral response.

Long-Term Consequences

Long-term consequences to individual sea turtles or to populations of sea turtles in the Study Area due to acoustic exposures have not been studied.

Long-term consequences to a population can be determined by examining changes in the population growth rate over multiple years. Physical effects that could lead to a reduction in the population growth rate include mortality, which removes individual animals from the reproductive pool; injury, which could remove an animal from the reproductive pool; and permanent hearing impairment, which could impact navigation and an animal's ability to successfully mate and return to its natal nesting beach. The long-term consequences, if any, due to discrete behavioral reactions to short-term (seconds to minutes) instances of physiological stress are especially difficult to predict. Repeated behavioral reactions to a stressor may evolve into long-term changes in behavior, or an animal may habituate to the regular presence of a particular stressor and cease to react.

It is more likely that any long-term consequences to an individual would be a result of physiological costs accumulated over a season, year, or life stage from repeated behavioral or stress responses. Conversely, sea turtles may habituate to or become tolerant of repeated acoustic exposures over time, learning to ignore a stimulus that in the past did not accompany any overt threat. For example, loggerhead sea turtles exposed to air guns with a sound pressure level (SPL) of 179 dB re 1 µPa initially exhibited avoidance reactions. However, they may have habituated to the sound source after multiple exposures since a habituation behavior was retained when exposures were separated by several days (Moein Bartol et al., 1995).

3.8.5.2.1.2 Impacts from Explosives

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

<u>Methods for Analyzing Impacts from Explosives</u>

Potential impacts considered are mortality, injury, hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior. The Navy's quantitative analysis to determine impacts on sea turtles and marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. The steps of this quantitative analysis are described in U.S. Department of the Navy (2019), which takes into account:

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

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

Mortality and Injury from Explosives

As discussed above in Section 3.8.5.2.1.1 (Background, subsection on Injury), two metrics have been identified as predictive of injury: impulse and peak pressure. Peak pressure contributes to the "crack" or "stinging" sensation of a blast wave, compared to the "thump" associated with received impulse. Older military reports documenting exposure of human divers to blast exposure generally describe peak pressure exposures around 100 pounds per square inch (237 dB re 1 µPa SPL peak) to feel like slight pressure or stinging sensation on skin, with no enduring effects (Christian & Gaspin, 1974).

Two sets of thresholds are provided for use in non-auditory injury assessment. The exposure thresholds are used to estimate the number of animals that may be affected during Navy training and testing activities (Table 3.8-3). The thresholds for the farthest range to effect are based on the received level at which 1 percent risk is predicted and are useful for assessing mitigation effectiveness. Increasing animal mass and increasing animal depth both increase the impulse thresholds (i.e., decrease susceptibility), whereas smaller mass and decreased animal depth reduce the impulse thresholds (i.e., increase susceptibility). For impact assessment, sea turtle populations are assumed to be 5 percent adult and 95 percent sub-adult. This adult to sub-adult population ratio is estimated from what is known about the population age structure for sea turtles. Sea turtles typically lay multiple clutches of 100 or more eggs with little parental investment and generally have low survival in early life. However, sea turtles that are able to survive past early life generally have high age-specific survival in later life.

Table 3.8-3: Criteria to Quantitatively Assess Non-Auditory Injury due to Underwater Explosions

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

[1] Impulse delivered over 20% of the estimated lung resonance period. See U.S. Department of the Navy (2019).
[2] Threshold for 1% risk used to assess mitigation effectiveness.
Note: dB re 1 µPa = decibels referenced to 1 micropascal, SPL = sound pressure level

The derivation of these injury criteria and the species mass estimates are provided in U.S. Department of the Navy (2019).

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

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used. Auditory weighting functions are mathematical functions that adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges with less or no auditory sensitivity. The adjusted received sound level is referred to as a weighted received sound level. The derivation of the auditory weighting function used for sea turtles in the analysis of acoustic impacts from explosives is described in detail in U.S. Department of the Navy (2019).

Hearing Loss from Explosives

No studies of hearing loss have been conducted on sea turtles. Therefore, sea turtle susceptibility to hearing loss due to an acoustic exposure is evaluated using knowledge about sea turtle hearing abilities in combination with non-impulsive auditory effect data from other species (marine mammals and fish). This yields sea turtle exposure functions, which are mathematical functions that relate the sound exposure levels (SELs) for the onset of TTS or PTS to the frequency of the sound exposure. The derivation of the sea turtle exposure functions and the TTS and PTS thresholds for sea turtles used in the analysis of acoustic impacts from explosives is described in detail in U.S. Department of the Navy (2019).

For impulsive sounds, hearing loss in other species has also been observed to be related to the unweighted peak pressure of a received sound. Because this data does not exist for sea turtles, unweighted peak pressure thresholds for TTS and PTS were developed by applying relationships observed between impulsive peak pressure TTS thresholds and auditory sensitivity in marine mammals to sea turtles. This results in dual-metric hearing loss criteria for sea turtles for impulsive sound exposure: the SEL-based exposure functions and the peak pressure thresholds in Table 3.8-4. The derivation of the sea turtle impulsive peak pressure TTS and PTS thresholds are provided in U.S. Department of the Navy (2019).

Table 3.8-4: TTS and PTS Peak Pressure Thresholds Derived for Sea Turtles Exposed to Impulsive Sounds

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

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

Behavioral Responses from Explosives

As noted in Section 3.8.5.2.1.1 (Background, subsection on Behavioral Reactions), there are limited studies of responses by sea turtles to sounds from impulsive sources. All data come from sea turtles exposed to seismic air guns. Although air guns are not proposed for use during testing or training activities in the PMSR Study Area, the studies of sea turtle responses to air guns are used to inform this EIS/OEIS analysis given a lack or other applicable data.

The available studies involve exposures to multiple air gun shots, either in close proximity or over long durations, so it is likely that observed sea turtle responses to air gun shots may over-estimate responses to single or short-duration impulsive exposures, such as a single explosion from an explosive ordnance. O'Hara and Wilcox (1990) attempted to create a sound barrier at the end of a canal using seismic air guns. They reported that loggerhead sea turtles kept in a 300 m by 45 m enclosure in a 10 m deep canal maintained a minimum standoff range of 30 m from air guns fired simultaneously at intervals of

15 seconds, with strongest sound components within the 25–1,000 Hz frequency range. McCauley et al. (2000) estimated that the received SPL at which turtles avoided sound in the O'Hara and Wilcox (1990) experiment was 175–176 dB re 1 µPa.

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

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

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

Based on the limited sea turtle behavioral response data discussed above, sea turtle behavioral responses to impulsive sounds could consist of temporary avoidance, increased swim speed, or changes in depth, or there may be no observable response. Based on the behavioral response severity scale developed by Southall et al. (2007), the severity of these responses can be categorized as non-existent, low, and moderate.

As described in U.S. Department of the Navy (2017b) and per discussions with NMFS, the received sound level at which sea turtles are expected to actively avoid air gun exposures is 175 dB re 1 µPa SPL (root mean squared) (McCauley et al., 2000), and this threshold is also expected to be the received sound level at which sea turtles would actively avoid events with multiple underwater explosions during Navy activities. This threshold may over-estimate the potential for sea turtles to avoid some explosions, as the durations of most explosive activities are much shorter than the durations of air gun exposures in the air gun studies cited above.

3.8.5.2.1.3 Impact Ranges for Explosives

Ranges to effect (e.g., a TTS effect) were developed in the Navy Acoustic Effects Model based on the thresholds for TTS, PTS, injury, and mortality discussed above and in described in detail in U.S. Department of the Navy (2019). Generally, ranges to mortality and non-auditory injury are shorter (i.e., closer to the explosive source) than ranges to auditory impacts (i.e., PTS and TTS) and behavioral reactions. Ranges to effects also vary by the net explosive weight of the explosive ordnance, such that the greater the net explosive weight, the farther the range to effect. For example, an explosive in the

E5 bin would generally have a greater range to a PTS effect than an explosive in the E1 bin. Refer to Appendix E (Underwater Range to Effects for Explosives at or Near the Surface in the Point Mugu Sea Range) for tables presenting the ranges to effects for sea turtles.

3.8.5.2.2 Physical Disturbance and Strike

This section analyzes the potential impacts of the various types of physical disturbance and strike stressors used by Navy during testing and training activities within the Study Area. The physical disturbance and strike stressors that may impact sea turtles include (1) Navy vessels; and (2) military expended materials, including non-explosive practice munitions and fragments from high-explosive munitions.

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

If a sea turtle reacts to physical disturbance, the individual must stop its activity and divert its attention in response to the stressor. The energetic costs of reacting to a stressor will depend on the specific situation, but one can assume that the caloric requirements of a response may reduce the amount of energy available for other biological functions. For sea turtles who have resident home ranges near Navy activities, the relative concentration of Navy vessels would cause sea turtles to respond repeatedly to the exposure. This repeated response would interrupt normal daily routines (e.g., foraging activities) more often than resident nearshore turtles not near Navy installations or in open ocean areas where Navy vessel traffic is less concentrated, though animals may become habituated to repeated stimuli. If a strike does occur, the cost to the individual could range from slight injury to mortality.

3.8.5.2.3 Ingestion

This section analyzes the potential impacts of the various types of ingestion stressors used during testing and training activities within the Study Area. This analysis includes the potential impacts from military expended materials, including non-explosive ordnance (small- and medium-caliber projectiles), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), and decelerators/parachutes. For a discussion on the types of activities that use these materials refer to Chapter 2 (Description of Proposed Action and Alternatives), and for more detail on ingestion stressors refer to Section 3.0.5.10 (Ingestions Stressors).

The potential impacts from ingesting these materials are dependent upon the probability of a sea turtle encountering these items in their environment, which is primarily contingent on where the items are expended and how a sea turtle feeds. Sea turtles commonly mistake debris for prey (Schuyler et al., 2014). Recent observations and studies on sea turtle ingestion of non-prey items are summarized in Section 3.8.4.1.5.6 (Marine Debris). The risk is prolific throughout sea turtle habitats; ingestion of expended materials by sea turtles could occur in all large marine ecosystems and open ocean areas and can occur at the surface, in the water column, or at the seafloor, depending on the size and buoyancy of the expended object and the feeding behavior of the turtle. Susceptibility of sea turtles to ingestion risk is a factor of the life stage of the individual sea turtle, foraging habits of the species, the location of the item within the water column, and the type of debris. For example, floating material could be eaten by turtles such as leatherbacks, juveniles, and hatchlings of all species that feed at or near the water surface, while materials that sink to the seafloor pose a risk to bottom-feeding turtles such as loggerheads. The variety of items eaten by juvenile and hatchling sea turtles of all species and adult leatherbacks that feed are prone to ingesting non-prey items (Fujiwara & Caswell, 2001; Hardesty & Wilcox, 2017; Mitchelmore et al., 2017; Schuyler et al., 2014; Schuyler et al., 2016).

The consequences of ingestion could range from temporary and inconsequential to long-term physical stress or even death. Ingestion of these items may not be directly lethal; however, ingestion of plastic and other fragments can restrict food intake and have sub-lethal impacts caused by reduced nutrient intake (McCauley & Bjorndal, 1999). Poor nutrient intake can lead to decreased growth rates, depleted energy, reduced reproduction, and decreased survivorship. These long-term sub-lethal effects may lead to population-level impacts, but this is difficult to assess because the affected individuals remain at sea and the trends may only arise after several generations have passed. Schuyler et al. (2014) determined that most sea turtles at some point will ingest some amount of debris. Because bottom-feeding occurs in nearshore areas, materials that sink to the seafloor in the open ocean are less likely to be ingested due to their location. While these depths may be within the diving capabilities of most sea turtle species, especially leatherback sea turtles, bottom-foraging species (i.e., loggerheads in the Study Area) are more likely to forage in the shallower waters less than 200 m in depth. This overlaps with only a small portion of the depth range at which military expended materials ultimately reside.

3.8.5.2.4 Entanglement

This section analyzes the potential entanglement impacts of the various types of expended materials used by the Navy during testing and training activities within the Study Area. This analysis includes the potential impacts of expended decelerators/parachutes and larger drone parachutes as an entanglement stressor. The number and location of testing and training exercises that involve the use of items that may pose an entanglement risk are provided in Section 3.0.5.9 (Entanglement Stressors).

Decelerators/parachutes, larger parachutes used with drones and aerial targets, and their suspension lines could be encountered by sea turtles, and if encountered, have the potential to entangle sea turtles in the Study Area at the surface, in the water column, or along the seafloor. Risk factors for entanglement of sea turtles include animal size (and life stage), sensory capabilities, and foraging methods. Most entanglements discussed in the literature are attributable to sea turtle entrapments with fishing gear or other non-military materials that float or are suspended at the surface.

Entanglement events are difficult to detect from land or from a boat as they may occur at considerable distances from shore and typically take place underwater. Juvenile turtles, given their smaller size, are inherently less likely to be detected than larger adult sea turtles. The likelihood of witnessing an entanglement event is therefore typically low.

3.8.5.2.5 Energy

This section analyzes the potential impacts from the use of DE systems by the Navy during testing and training activities within the Study Area. The number and location of testing and training activities that involve the use of DE systems are provided in Section 3.0.5.7 (Energy Stressors).

DE can include light amplification by stimulated emission of radiation (laser) and high-power microwave systems. The laser systems proposed for use in the Study Area can be organized into two categories: (1) low-energy lasers, and (2) high-energy lasers. Low-energy lasers are used to illuminate or designate targets, measure the distance to a target, guide weapons, and aid in communication. High-energy lasers are used as weapons to create critical failures on air and surface targets. The Navy has determined that devices categorized as low-energy lasers would have an extremely low potential for impacting sea turtles (see Section 3.0.5.7, Energy Stressors, for details). High-energy laser weapons testing and training involves the use of DE as a weapon against small surface vessels and airborne targets. Sea turtles at or near the ocean surface and within range of the laser system could be susceptible to injury by high-energy lasers; however, sea turtles below the water's surface would be much less susceptible to impacts because energy from the laser system attenuates rapidly through absorption and other physical processes rapidly in the water column.

3.8.5.3 No Action Alternative

Under the No Action Alternative, proposed testing and training activities would not occur within the PMSR. Other military activities not associated with this Proposed Action would continue to occur. Physical disturbance and strike stressors, as listed above, would not be introduced into the marine environment. Therefore, existing environmental conditions would either remain unchanged or would improve slightly after cessation of ongoing testing and training activities.

Discontinuing the testing and training activities would result in fewer stressors within the marine environment where testing and training activities have historically been conducted. Therefore, discontinuing testing and training activities under the No Action Alternative would lessen the potential for impacts on sea turtles, but would not measurably improve the overall distribution or abundance of sea turtles.

3.8.5.4 Alternative 1 (Preferred Alternative)

A comparison of operational tempo proposed for each alternative, and proposed types and level of activities, are provided in Section 2.2 (Proposed Action).

3.8.5.4.1 Explosives

Under Alternative 1, leatherback and loggerhead sea turtles would be exposed to an increased level of underwater impulsive sounds from explosive ordnance compared to the existing baseline conditions (Table 3.0-7). Testing and training activities involving surface explosives could be conducted throughout the Study Area, although activities do not normally occur within 3 NM of shore. The number and types of testing and training activities that use explosives under Alternative 1 is shown in Table 2-2.

Because explosions from the proposed testing and training activities only occur at or near the water's surface, only leatherback and loggerhead sea turtles at or near the surface at the time of a detonation and in close proximity to the detonation site are likely to experience effects.

3.8.5.4.1.1 Impacts from Explosives on Leatherback Sea Turtles Under Alternative 1

Although the probability is low, should an individual leatherback be in close proximity to a detonation and experience PTS, its ability to hear environmental cues (e.g., sounds a predator might make or an approaching vessel) would be reduced, if the frequencies of the cue and the impairment are within the same range. For some individuals this may result in a slight decrease in the probability of survivorship or reproductive success (e.g., if hearing impairment effects navigation to nesting beaches) (National Marine Fisheries Service, 2018).

The quantitative analysis using the Navy Acoustic Effects Model predicts that no leatherback sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury under Alternative 1.

Leatherback sea turtles may behaviorally respond to the sound of an explosive. A behavioral response to a single detonation or explosive cluster is expected to be limited to a short-term (seconds to minutes) startle response, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (see Section 3.8.5.2.1.1, Background, subsection on Behavioral Reactions) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. Because the duration of most explosive events is brief, the potential for masking biologically important sounds is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions.

The quantitative analysis using the Navy Acoustic Effects Model predicts that leatherback sea turtles would be exposed to the levels of explosive sound and energy that could result in 10 behavioral responses per year under Alternative 1.

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

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Standard Operating Procedures and Mitigation), and the low number of estimated impacts for leatherback sea turtles during explosives use, long-term consequences for the population would not be expected.

Leatherback sea turtle critical habitat occurs in the northeastern portion of the Study Area (see Figure 3.8-4), as described in Section 3.8.4.2.2.2 (Leatherback Sea Turtle [*Dermochelys coriacea*]), but would have little or no overlap with areas typically used for testing and training activities with explosives. The activities with the greatest potential to affect leatherback critical habitat are aerial gunnery activities, which expend predominately 20-millimeter projectiles into the marine environment. However, aerial gunnery activities typically take place in Subarea 6C of W-532S (see Chapter 2, Description of Proposed Action and Alternatives), which is seaward of leatherback critical habitat. Even if projectiles or other items or materials were expended within leatherback critical habitat, they would quickly sink to the seafloor, where depths exceed 1,000 m in most of the subareas of the PMSR that would be used for testing and training.

In its 2012 *Final Rule to Revise the Critical Habitat Designation for the Endangered Leatherback Sea Turtle* (77 *Federal Register* 4169-4201), NMFS concluded that the types of Navy activities conducted in the PMSR are not the types of activities that may adversely modify critical habitat designated for the leatherback, specifically the prey primary constituent element, which is the basis for the critical habitat designation.

Pursuant to the ESA, use of explosives during testing and training activities as described under Alternative 1 may affect and is likely to adversely affect the ESA-listed leatherback sea turtle but would not result in the destruction or adverse modification of leatherback sea turtle critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.5.4.1.2 Impacts from Explosives on Loggerhead and Green Sea Turtles Under Alternative 1 (Preferred Alternative)

As noted in Section 3.8.4.2.2.1 (Habitat and Geographic Range), the abundance and density of loggerhead sea turtles at the southern extent of the Study Area can be relatively high, but this would only occur when sea surface temperatures are anomalously warm, such as during the 2015-2016 strong El Niño event. Loggerhead sea turtles are not expected in the Study Area during normal oceanographic conditions (Eguchi et al., 2018; Eguchi & Zickel, 2020). The El Niño phase of the ENSO cycle occurs every few years, limiting any potential exposures of loggerheads to stressors associated with explosives. Given that the probability of an exposure is low and that the likelihood that any exposure, even a PTS, would impact the overall fitness of an individual sea turtle is also low, significant impacts on leatherback and loggerhead sea turtles are not anticipated from the use of explosives.

Loggerhead sea turtles were not quantitatively analyzed using the Navy Acoustic Effects Model, because their infrequent occurrence in the Study Area did not allow for an accurate estimate of species density that would be appropriate for estimating annual exposures to testing and training activities. The quantitative analysis for leatherback sea turtles, which are expected to occur regularly in the Study Area, predicted 10 behavioral responses per year. Considering that leatherback sea turtles are likely to occur in the Study Area consistently from year to year and would have fewer than 10 behavioral exposures, it is reasonable to expect fewer or no exposures to loggerhead sea turtles, which are very unlikely to occur in the PMSR under normal oceanographic conditions, favoring instead warmer habitat south of the PMSR. Even during the anomalously warm conditions associated with the 2015–2016 El Niño event, loggerheads that moved north beyond their traditional range were concentrated south of the PMSR. Some loggerheads could be present in the southern portion of the PMSR at some point in the future when unusually warm conditions similar to those in 2015-2016 persist; however, based on the best available data, their density is likely to be low and their distribution would be limited to the southernmost extent of the PMSR (Eguchi et al., 2018; Eguchi & Zickel, 2020). Given their irregular and unpredictable occurrence, the probability of loggerhead sea turtles being exposed to explosive stressors is extremely low.

Therefore, the impacts on loggerhead sea turtles from the use of explosives under Alternative 1 would be less than significant and similar to impacts from ongoing baseline activities. Pursuant to the ESA, Navy use of explosives may affect but is not likely to adversely affect ESA-listed loggerhead sea turtles. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that the use of explosives may affect but is not likely to adversely affect ESA-listed green sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.5.4.2 Physical Disturbance and Strike

Under Alternative 1, the number of vessels, boats, surface targets, or military expended materials that have the potential to strike or disturb a sea turtles at or near the water's surface is greater than under existing conditions. As described in Section 3.8.4.3.2 (Physical Disturbance and Strike), the potential for vessel strike or disturbance on leatherback or loggerhead sea turtles during a testing and training activity is low given that (1) Navy vessel traffic makes up a very small percentage of vessel traffic in the Study Area, (2) the likelihood of a Navy vessel encountering a leatherback or loggerhead sea turtle is low based on the estimated distribution and occurrence of both species in the Study Area, and (3) the probability of a munition or other expended material directly striking a sea turtle at the surface is low given the low density of leatherback and loggerhead sea turtles in the Study Area and the number and distribution of testing and training activities that would expend military materials (referenced in Appendix D, Military Expended Material and Direct Strike Impact Analyses).

Therefore, impacts on leatherback and loggerhead sea turtles from physical disturbance and strike by vessels or military expended materials under Alternative 1 would be less than significant and similar to impacts from ongoing activities. Pursuant to the ESA, physical disturbance and strike from military expended materials including ordnance and vessels may affect but is not likely to adversely affect ESA-listed leatherback and loggerhead sea turtles. Physical disturbance and strike stressors would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the availability and occurrence of prey species.

Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that physical disturbance and strike from military expended materials, including ordnance and vessels, may affect but is not likely to adversely affect ESA-listed green sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.5.4.3 Ingestion

Under Alternative 1, the amount of military expended material of ingestible size would increase compared to the number under existing conditions (Table 3.0-12). However, based on the information provided in Section 3.8.4.3.3 (Ingestion), impacts on leatherback and loggerhead sea turtles from ingestion of military expended materials under Alternative 1 would be less than significant and similar to impacts from ongoing activities.

Pursuant to the ESA, ingestion of military expended materials including ordnance may affect but is not likely to adversely affect ESA-listed leatherback and loggerhead sea turtles. Ingestion stressors would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the occurrence and availability of prey species. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that ingestion of military expended materials including ordnance may affect but is not likely to adversely affect ESA-listed green sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.5.4.4 Entanglement

Under Alternative 1, several types of larger parachutes would be used in activities that include aerial targets (drones) (see Section 3.0.5.9, Entanglement Stressors). The number of aerial drones used under Alternative 1 would increase from 104 to 176 per year (Table 3.0-12). Some aerial targets (drones) would not be recovered after use, based on the known percentage of unrecovered targets. The increase in unrecovered aerial targets under Alternative 1 would pose a greater entanglement risk to sea turtles compared to current aerial target usage. However, based on the information presented in Section 3.8.4.3.4 (Entanglement), impacts on leatherback and loggerhead sea turtles from entanglement with large and extra-large parachutes and their suspension lines would be less than significant and similar to impacts from ongoing activities.

Pursuant to the ESA, Navy use of decelerators/parachutes, including large and extra-large drone parachutes, may affect but is not likely to adversely affect ESA-listed leatherback and loggerhead sea turtles. Entanglement stressors would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the occurrence and availability of prey species. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that use of decelerators/parachutes, including large and extra-large drone parachutes, may affect but is not likely to adversely affect ESA-listed green sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.5.4.5 Energy

As discussed in Section 3.8.4.3.5 (Energy), impacts from DE systems on leatherback and loggerhead sea turtles would be less than significant and similar to impacts from ongoing activities. Pursuant to the ESA, Navy use of DE systems would have no effect on ESA-listed leatherback and loggerhead sea turtles. DE systems would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the occurrence and availability of prey species. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that use of DE systems would have no effect on ESA-listed green sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.5.5 Alternative 2

A comparison of operational tempo proposed for each alternative, and proposed types and level of activities, are provided in Section 2.2 (Proposed Action).

3.8.5.5.1 Explosives

Under Alternative 2, leatherback and loggerhead sea turtles would be exposed to a decrease in underwater impulsive sounds from high-explosive ordnance compared with Alternative 1 (with the exception of explosives in the E7 bin) (Table 3.0-7). Compared with baseline conditions, leatherback and loggerhead sea turtles would be exposed to an increase in underwater impulsive sounds from high-explosive ordnance (with the exception of explosives in bins E5 and E6, which would remain the same, and bin E10, which would decrease) under Alternative 2. Testing and training activities involving near-surface explosives could be conducted throughout the Study Area, although activities do not normally occur within 3 NM of shore. The number and types of explosives under each alternative is shown in Table 3.0-7.

Because explosions from Navy testing and training activities would only occur at or near the water's surface, only leatherback and loggerhead sea turtles present near the surface at the time of a detonation and in close proximity to the detonation site are likely to experience effects.

3.8.5.5.1.1 Impacts from Explosives on Leatherback Sea Turtles Under Alternative 2

Although the probability is low, should an individual leatherback be in close proximity to a detonation and experience PTS, its ability to hear environmental cues (e.g., sounds a predator might make or an approaching vessel) would be reduced, if the frequencies of the cue and the impairment are within the same range. For some individuals this may result in a slight decrease in the probability of survivorship or reproductive success (e.g., if hearing impairment effects navigation to nesting beaches) (National Marine Fisheries Service, 2018).

The quantitative analysis using the Navy Acoustic Effects Model predicts that no leatherback sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury under Alternative 2.

Leatherback sea turtles may behaviorally respond to the sound of an explosive. A behavioral response to a single detonation or explosive cluster is expected to be limited to a short-term (seconds to minutes) startle response, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (see Section 3.8.5.2.1.1, Background, subsection on Behavioral Reactions) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. Because the duration of most explosive events is brief, the potential for masking biologically important sounds is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions.

The quantitative analysis using the Navy Acoustic Effects Model predicts that leatherback sea turtles would be exposed to the levels of explosive sound and energy that could result in four behavioral responses per year under Alternative 2.

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

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Standard Operating Procedures and Mitigation), and the low number of estimated impacts for leatherback sea turtles during explosives use, long-term consequences for the population would not be expected.

Leatherback sea turtle critical habitat occurs in the northeastern portion of the Study Area (see Figure 3.8-4), as described in Section 3.8.4.2.2.2 (Leatherback Sea Turtle [*Dermochelys coriacea*]), but would have little or no overlap with areas typically used for testing and training activities with explosives. The activities with the greatest potential to affect leatherback critical habitat are aerial gunnery activities, which expend predominately 20-millimeter projectiles into the marine environment. However, aerial gunnery activities typically take place in Subarea 6C of W-532S (see Chapter 2, Description of Proposed Action and Alternatives), which is seaward of leatherback critical habitat. Even if projectiles or other items or materials were expended within leatherback critical habitat, they would quickly sink to the seafloor, where depths exceed 1,000 m in most of the subareas of the PMSR that would be used for testing and training.

In its 2012 *Final Rule to Revise the Critical Habitat Designation for the Endangered Leatherback Sea Turtle* (77 *Federal Register* 4169-4201), NMFS concluded that the types of Navy activities conducted in the PMSR are not the types of activities that may adversely modify critical habitat designated for the leatherback, specifically the prey primary constituent element, which is the basis for the critical habitat designation.

Pursuant to the ESA, use of explosives during testing and training activities as described under Alternative 2 may affect and is likely to adversely affect the ESA-listed leatherback sea turtle but would not result in the destruction or adverse modification of leatherback sea turtle critical habitat.

3.8.5.5.1.2 Impacts from Explosives on Loggerhead and Green Sea Turtles Under Alternative 2

As noted in Section 3.8.4.2.2.1 (Habitat and Geographic Range), the abundance and density of loggerhead sea turtles at the southern extent of the Study Area can be relatively high, but this would only occur when sea surface temperatures are anomalously warm, such as during the 2015-2016 strong El Niño event. Loggerhead sea turtles are not expected in the Study Area during normal oceanographic conditions (Eguchi et al., 2018; Eguchi & Zickel, 2020). The El Niño phase of the ENSO cycle occurs every few years, limiting any potential exposures of loggerheads to stressors associated with explosives. Given that the probability of an exposure is low and that the likelihood that any exposure, even a PTS, would impact the overall fitness of an individual sea turtle is also low, significant impacts on leatherback and loggerhead sea turtles are not anticipated from the use of explosives.

Loggerhead sea turtles were not quantitatively analyzed using the Navy Acoustic Effects Model, because their infrequent occurrence in the Study Area did not allow for an accurate estimate of species density that would be appropriate for estimating annual exposures to testing and training activities. The quantitative analysis for leatherback sea turtles, which are expected to occur regularly in the Study Area, predicted 10 behavioral responses per year. Considering that leatherback sea turtles are likely to occur in the Study Area consistently from year to year and would have fewer than 10 behavioral exposures, it is reasonable to expect fewer or no exposures to loggerhead sea turtles, which are very unlikely to occur in the PMSR under normal oceanographic conditions, favoring instead warmer habitat south of the PMSR. Even during the anomalously warm conditions associated with the 2015–2016 El Niño event, loggerheads that moved north beyond their traditional range were concentrated south of the PMSR. Some loggerheads could be present in the southern portion of the PMSR at some point in the future when unusually warm conditions similar to those in 2015-2016 persist; however, based on the best available data, their density is likely to be low and their distribution would be limited to the southernmost extent of the PMSR (Eguchi et al., 2018; Eguchi & Zickel, 2020). Given their irregular and unpredictable occurrence, the probability of loggerhead sea turtles being exposed to explosive stressors is extremely low.

Therefore, the impacts on loggerhead sea turtles from the use of explosives under Alternative 2 would be less than significant and similar to impacts from ongoing baseline activities. Pursuant to the ESA, Navy use of explosives may affect but is not likely to adversely affect ESA-listed loggerhead sea turtles. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that the use of explosives may affect but is not likely to adversely affect ESA-listed green sea turtles.

3.8.5.5.2 Physical Disturbance and Strike

Under Alternative 2, the number of vessels or boats that have the potential to strike or disturb a sea turtles at or near the water's surface is the same as under both Alternative 1 and slightly greater than existing conditions (Table 3.0-11). As described in Section 3.8.4.3.2 (Physical Disturbance and Strike), the potential for vessel strike or disturbance on leatherback or loggerhead sea turtles during a testing and training activity is low given that (1) Navy vessel traffic makes up a very small percentage of vessel traffic in the Study Area, (2) the likelihood of a Navy vessel encountering a leatherback or loggerhead sea turtle is low based on the estimated distribution and occurrence of both species in the Study Area, and (3) the probability of a munition or other expended material directly striking a sea turtle at the surface is low given the low density of leatherback and loggerhead sea turtles in the Study Area and the number and distribution of testing and training activities that would expend military materials (referenced in Appendix D, Military Expended Material and Direct Strike Impact Analyses).

Therefore, impacts on leatherback and loggerhead sea turtles from physical disturbance and strike by vessels or military expended materials under Alternative 2 would be less than significant and similar to impacts from ongoing activities and under Alternative 1. Pursuant to the ESA, physical disturbance and strike from military expended materials including ordnance and vessels may affect but is not likely to adversely affect ESA-listed leatherback and loggerhead sea turtles. Physical disturbance and strike stressors would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the availability and occurrence of prey species. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that physical disturbance and strike from military expended materials, including ordnance and vessels, may affect but is not likely to adversely affect ESA-listed green sea turtles.

3.8.5.5.3 Ingestion

Under Alternative 2, the amount of military expended material of ingestible size would increase compared to the number under existing conditions and under Alternative 1 (Table 3.0-12). However, based on the analysis provided in Section 3.8.4.3.3 (Ingestion), impacts on leatherback and loggerhead sea turtles from ingestion of military expended materials under Alternative 2 would be less than significant and similar to impacts from ongoing activities and under Alternative 1.

Pursuant to the ESA, ingestion of military expended materials including ordnance may affect but is not likely to adversely affect ESA-listed leatherback and loggerhead sea turtles. Ingestion stressors would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the occurrence and availability of prey species. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that ingestion of military expended materials including ordnance may affect but is not likely to adversely affect ESA-listed green sea turtles.

3.8.5.5.4 Entanglement

Under Alternative 2, several types of larger parachutes would be used in activities that include aerial targets (drones) (see Section 3.0.5.9, Entanglement Stressors). The number of aerial drones used under Alternative 2 would increase from 104 to 169 per year (Table 3.0-12) compared with ongoing activities. Some aerial targets would not be recovered after use, based on the known percentage of unrecovered targets. The increase in unrecovered aerial targets under Alternative 2 would pose a greater entanglement risk to sea turtles compared to current aerial target usage. However, based on the analysis presented in Section 3.8.4.3.4 (Entanglement), impacts on leatherback and loggerhead sea turtles from entanglement with large and extra-large parachutes and suspension lines would be less than significant and similar to impacts from ongoing activities and activities under Alternative 1. Pursuant to the ESA, Navy use of decelerators/parachutes, including large and extra-large drone parachutes, may affect but is not likely to adversely affect ESA-listed leatherback and loggerhead sea turtles. Entanglement stressors would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the occurrence and availability of prey species. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that use of decelerators/parachutes, including large and extra-large drone parachutes, may affect but is not likely to adversely affect ESA-listed green sea turtles.

3.8.5.5.5 Energy

As discussed in Section 3.8.4.3.5 (Energy), impacts from DE systems on leatherback and loggerhead sea turtles would be less than significant and similar to impacts from ongoing activities. Pursuant to the ESA, Navy use of DE systems would have no effect on ESA-listed leatherback and loggerhead sea turtles. DE systems would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the occurrence and availability of prey species. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that use of DE systems would have no effect on ESA-listed green sea turtles.

3.8.5.6 Indirect Effects

Indirect effects (secondary stressors) on leatherback and loggerhead sea turtles are mainly associated with the occurrence and availability of prey species. As discussed in Section 3.8.4.2.2.1 (Loggerhead Sea Turtles [*Caretta caretta*]), loggerheads, depending on life stage, feed on a wide variant of animals, including zooplankton, jellyfish, larval shrimp and crabs, and gastropods. Juveniles and adults forage in coastal habitats, where they feed primarily on the bottom, capturing prey such as crabs, shrimp, sea urchins, sponges, and fish. During trans-Pacific migrations through the pelagic habitat, loggerheads feed in the water column on jellyfish, molluscs, flying fish, and squid. As discussed in Section 3.8.4.2.2.2 (Leatherback Sea Turtles [*Dermochelys coriacea*]), leatherbacks prey mainly on various types of jellyfish. Furthermore, in its 2012 *Final Rule to Revise the Critical Habitat Designation for the Endangered Leatherback Sea Turtle* (77 FR 4169-4201), NMFS concluded that the types of Navy activities conducted in the PMSR are not the types of activities that may adversely modify critical habitat designated for the leatherback, specifically the prey species, which are the basis for the critical habitat designation.

The occurrence and distribution of jellyfish and several other types of zooplankton (e.g., larval shrimp and crabs) preyed on by leatherback and loggerhead sea turtles are dependent on the physical oceanographic conditions in the California Current Ecosystem. Large-scale features of the habitat that determine prey distribution include the equatorward flowing California Current; the parallel, northward flowing California Countercurrent located closer to shore; bathymetric features such as the ridges, basins, and escarpments that form the continental borderland; upwelling, driven in part by bathymetry; and prevailing winds. See Section 3.3.4.1 (General Background) for a more detailed discussion on how the physical environment influences biological resources in the Study Area. The distribution of benthic prey species targeted by loggerheads are less influenced by the physical characteristics of the water column (e.g., currents). However, to be available to loggerheads as prey, the occurrence of these species would be limited to water depths of 200 m or less, which excludes the vast majority of the Study Area.

Therefore, the availability of prey species would not be impacted as a result of implementation of any of the action alternatives. Pursuant to the ESA, indirect or secondary stressors may affect but are not likely to adversely affect ESA-listed leatherback and loggerhead sea turtles. Indirect effects would not result in the destruction or adverse modification of leatherback sea turtle critical habitat, which is based primarily on the occurrence and availability of prey species, primarily jellyfish and salps. Although no impacts are expected on green sea turtles as analyzed under NEPA due to their very unlikely occurrence in the PMSR, in consultation with NMFS and pursuant to the ESA, the Navy has determined that indirect effects may affect but are not likely to adversely affect ESA-listed green sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

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