# Final Biological Report

# Final Rule to Revise the Critical Habitat Designation for Leatherback Sea Turtles

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# EXECUTIVE SUMMARY

Section 4 of the Endangered Species Act of 1973 (ESA) requires the designation of critical habitat for threatened and endangered species and provides for the revision of critical habitat based on the best scientific data available. This report contains a biological assessment in support of a proposed revision of critical habitat for the endangered leatherback turtle (*Dermochelys coriacea*).

This revision was prompted by a 2007 petition requesting that NOAA’s National Marine Fisheries Service (NMFS) revise the existing critical habitat designation to include large areas of marine habitat off the coasts of California and Oregon.  A critical habitat review team (CHRT) consisting of nine NMFS biologists was convened to evaluate critical habitat for this species. The CHRT was tasked with compiling and assessing the best available data to identify habitat features essential to the conservation of the species, determine the geographical area occupied by the species at the time it was listed, delineate specific areas within the geographical area occupied that contain at least one essential habitat feature, evaluate the need for special management considerations or protections for the essential habitat features within each area, and evaluate the conservation value of each specific area for leatherback turtles. The geographical area occupied by leatherbacks consists of vast circumglobal marine waters. Within this occupied area, the CHRT identified eight specific marine areas within and adjacent to the petitioned area for consideration as critical habitat. This report summarizes the available data on leatherback turtle presence, distribution, and use of each specific area and the CHRT’s evaluation of the conservation value ratings for each area. The assessment and findings provided in this report are used in conjunction with other agency analyses (e.g., economic analyses) to inform NMFS’ final determination to revise designated critical habitat for leatherback turtles.

## I. Background

The leatherback turtle (*Dermochelys coriacea*) was listed as endangered throughout its range on June 2, 1970 (35 FR 8491). Pursuant to a joint agreement, the U.S. Fish and Wildlife Service (USFWS) has jurisdiction over sea turtles on the land and the National Marine Fisheries Service (NMFS) over sea turtles in the marine environment. The USFWS initially designated critical habitat for leatherback turtles on September 26, 1978 (43 FR 43688). The critical habitat area consisted of a strip of land 0.2 miles wide (from mean high tide inland) in the U.S. Virgin Islands at Sandy Point Beach on the western end of the island of St. Croix. The following year, NMFS designated the marine waters adjacent to Sandy Point Beach as critical habitat from the hundred fathom curve shoreward to the level of mean high tide (Figure 1.)(44 FR 17710, March 23, 1979).

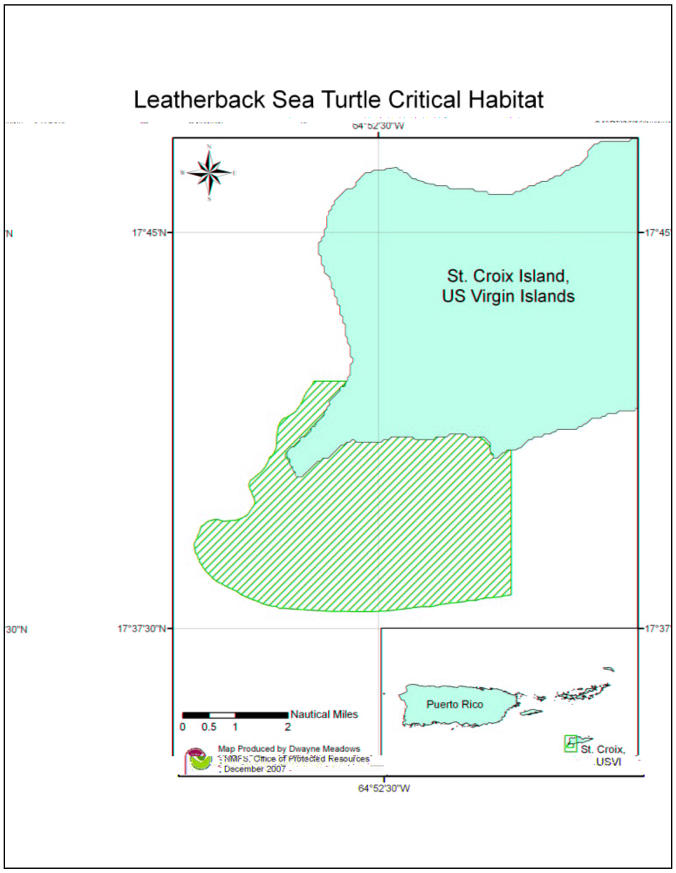

**Figure 1.** Leatherback critical habitat, St. Croix, U.S. Virgin Islands, designated in 1979.

On October 2, 2007, NMFS received a petition from the Center for Biological Diversity, Oceana, and Turtle Island Restoration Network ("Petitioners") to revise the leatherback turtle critical habitat designation. The Petitioners sought to revise the critical habitat designation to include the area currently managed under the authority of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act to reduce leatherback interactions in the California/Oregon drift gillnet fishery targeting swordfish and thresher shark. This area encompasses roughly 200,000 square miles (321,870 km$^2$) of the Exclusive Economic Zone from 45° N latitude (about 100 miles (160 km) south of the Washington/Oregon border) southward to

Pt. Sur and along a diagonal line due west of Pt. Conception, California, and west to 129° W longitude (Figure 2). Under the current regulations implementing the Highly Migratory Species Fishery Management Plan, drift gillnet gear is prohibited in this area from August 15th through November 15th (50 CFR 660.713).

On December 28, 2007 (72 FR 73745), NMFS announced its 90-day finding that the petition provided substantial scientific information indicating that the petitioned action may be warranted. The agency initiated a review of the critical habitat of the species to determine whether the petitioned action is warranted or some subset or adjacent areas along the U.S. West Coast qualify as critical habitat.

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## II: Critical Habitat Review Team

NMFS convened a critical habitat review team (CHRT) to assist in the assessment and evaluation of critical habitat areas for leatherback turtles. The CHRT consisted of nine NMFS biologists with experience and expertise on leatherback biology, consultations, and management, or on the critical habitat designation process. The CHRT used the best available scientific and commercial data and their best professional judgment to: (1) verify the geographical area occupied by the leatherbacks at the time of listing; (2) identify the physical and biological features essential to the conservation of the species; (3) identify specific areas within the occupied area containing those essential physical and biological features; (4) identify activities that may affect these essential features and trigger the need for special management considerations or protection within each specific area; and (5) evaluate the conservation value of each specific area.

The CHRT has completed work associated with the evaluation of critical habitat and the completion of the five tasks outlined above. First, the CHRT met to discuss the critical habitat designation process, identify and synthesize the best available scientific and commercial information regarding leatherback habitat use and distribution, and identify and verify the specific areas within the geographical area occupied. Second, the CHRT: identified and described two Principle Constituent Elements (PCEs), considered whether the PCEs could be found in each specific area, developed and applied a scoring system for evaluating the PCEs and a rating system for determining the overall conservation value (high, medium, or low) of each specific area. Third, NMFS published a proposed critical habitat rule based on the information and analyses provided by the CHRT. This proposed critical habitat revision is published in the *Federal Register* on January 5, 2010, and public comments were solicited. The CHRT then reconvened in July 2010 to review relevant comments received on the agency's proposal and consider additional information requiring consideration for the final critical habitat designation. During the July 2010 CHRT meeting and during subsequent smaller meetings and conference calls the CHRT has re-evaluated several aspects of the designation which are documented in this report, and in the final rule, which will be published in the *Federal Register*.

## III: Critical Habitat Requirements

Critical habitat is defined in section 3(5)(A) of the ESA (16 U.S.C. 1532(3)) as:

> "(1) the specific areas within the geographical area occupied by the species, at the time it is listed… on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and
>
> (2) specific areas outside the geographical area occupied by the species at the time it is listed… upon a determination by the Secretary [of Commerce] that such areas are essential for the conservation of the species."

Section 3(3) of the ESA defines "conservation" as the use of all methods and procedures needed to bring the species to the point at which listing under the ESA is no longer necessary.

Section 4(b)(2) of the ESA requires NMFS to designate critical habitat for threatened and endangered species "on the basis of the best scientific data available and after taking into consideration the economic impact, impact on national security, and any other relevant impact, of specifying any particular area as critical habitat." This section grants the Secretary discretion to exclude any area from critical habitat if he determines "the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat." The Secretary may not exclude an area if it "will result in the extinction of the species."

Regulations implementing ESA critical habitat designations (50 CFR 424) also specify that NMFS 'shall designate as critical habitat areas outside the geographical area presently occupied by a species only when a designation limited to its present range would be inadequate to ensure the conservation of the species."

Once critical habitat is designated, section 7 of the ESA requires Federal agencies to ensure that they do not fund, authorize, or carry out any actions that will destroy or adversely modify that habitat. This is in addition to the requirement under section 7 of the ESA that Federal agencies ensure their actions do not jeopardize the continued existence of listed species.

## IV: Leatherback Natural History

The leatherback is the sole remaining member of the taxonomic family Dermochelyidae.  All other extant sea turtles belong to the family Cheloniidae.  Leatherbacks are the largest marine turtle, with a curved carapace length (CCL) often exceeding 150 cm and front flippers that can span 270 cm (NMFS and USFWS, 1998).  The leatherback's slightly flexible, rubber-like carapace is distinguishable from other sea turtles that have carapaces with bony plates covered with horny scutes.  In adults, the carapace consists mainly of tough, oil-saturated connective tissue raised into seven prominent ridges and tapered to a blunt point posteriorly.  The carapace and plastron are barrel-shaped and streamlined.  Leatherbacks display several unique physiological and behavioral traits that enable this species to inhabit cold water, unlike other chelonid species.  These include a countercurrent circulatory system (Greer *et al*., 1973), a thick layer of insulating fat (Goff and Lien, 1988; Davenport *et al*., 1990), gigantothermy (Paladino *et al*., 1990), and the ability to elevate body temperature through increased metabolic activity (Southwood *et al*., 2005; Bostrom and Jones, 2007).  These adaptations enable leatherbacks to extend their geographic range further than other species of sea turtles.

The leatherback life cycle is broken into several stages: (1) egg/hatchling; (2) post-hatchling; (3) juvenile; (4) sub-adult; and (5) adult.  There is still uncertainty regarding the age at first reproduction.  The most recent study, based on skeletochronological data from scleral ossicles, suggests that leatherbacks in the western North Atlantic may not reach maturity until 29 years of age (Avens *et al*., 2009), which is longer than earlier estimates (Pritchard and Trebbau, 1984: 2-3 years; Rhodin, 1985: 3-6 years; Zug and Parham, 1996: 13-14 years for females; Dutton *et al*., 2005: 12-14 years for leatherbacks nesting in the U.S. Virgin Islands).  The average size of reproductively active females is generally 150-162 cm CCL for Atlantic, western Pacific, and Indian Ocean populations, and 140-150 cm CCL for eastern Pacific populations (Hirth *et al*., 1993; Starbird and Suarez, 1994; Benson *et al*., 2007a; Benson *et al*., 2007d).  However, females as small as 105-125 cm CCL have been observed nesting at various sites (Stewart *et al*., 2007).  Rhodin *et al.* (1996) speculated that extreme rapid growth may be possible in leatherbacks due to a mechanism that allows fast penetration of vascular canals into the fast growing cartilaginous matrix of their bones.  Whether the vascularized cartilage in leatherbacks serves to facilitate rapid growth, or some other physiological function, has not yet been determined.

Female leatherbacks typically nest on sandy, tropical beaches at intervals of 2 to 4 years (McDonald and Dutton, 1996; Garcia and Sarti, 2000; Spotila *et al*., 2000).  Females lay clutches of approximately 100 eggs several times during a nesting season, typically at 8-12 day intervals.  Female leatherbacks appear to exhibit more variable nesting site fidelity than cheloniids and may nest at more than one beach in a single season (Eckert *et al*., 1989a; Keinath and Musick, 1993; Steyermark *et al*., 1996; Dutton *et al*., 2005).  This nesting behavior has been observed in the western Pacific Ocean; one female nesting on Jamursba-Medi, Indonesia was observed nesting approximately 30 km east on Wermon, Indonesia a few weeks later (S. Benson, NMFS, April 2006, pers. comm.).

A comparison of sex ratios at the nesting beach between Atlantic and some Pacific populations suggests that Pacific populations may be more female biased (Binckley *et al*. 1998) than Atlantic populations (Godfrey *et al*. 1996, Turtle Expert Working Group, 2007). However, caution is necessary when making basin-wide comparisons. Only one study was conducted in the Pacific (Binckley *et al*. 1998), and sex ratios may vary by beach or even clutch. Other studies support a narrower temperature regime for sex determination in the Atlantic. Chevalier *et al*. (1999) compared temperature-dependent sex determination patterns between the Atlantic (French Guiana) and the Pacific (Playa Grande, Costa Rica) and found that the range of temperatures producing both sexes was significantly narrower for the Atlantic population. Nearshore and onshore strandings data from the United States' Atlantic and Gulf of Mexico coasts indicate that 60 percent of strandings were females, and that the proportion of females among adults (57 percent; >145 cm CCL) and juveniles (61 percent; 100-145 cm CCL ) was similar for these areas (Turtle Expert Working Group, 2007). James *et al.* (2007) collected size and sex data from 152 leatherbacks off Nova Scotia from 1999 through 2006 and concluded that this aggregation comprised mainly large sub-adults and adults, based on their size distribution (mean size of 148.1 cm CCL). The authors found a female biased sex ratio (1.86:1) that was less evident in regions of the Mediterranean, United Kingdom, and France (James *et al.*, 2007). Benson *et al* (2011) reported size data from 27 female and 10 male leatherbacks sampled in coastal central California waters during 2000-2007 and concluded no significant difference in size between male and female turtles (female mean CCL = 158.0 cm, SE=1.3; male CCL = 155.2 cm, SE = 1.7

Reliable estimates of survival and mortality at different life history stages are not easily obtained. The annual mortality for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 34.6 percent in 1993-1994 and 34.0 percent in 1994-1995 (Spotila *et al*., 2000). Leatherbacks nesting in French Guiana and St. Croix had estimated annual survival rates of 91 percent (Rivalan *et al*., 2005b) and 89 percent (Dutton *et al*., 2005) respectively. For the St. Croix population, the average annual juvenile survival rate was estimated to be approximately 63 percent, and the total survival rate from hatchling to first year of reproduction for a female was estimated to be between 0.4 and 2 percent, given an assumed age at first reproduction between 9 and 13 years (Eguchi *et al*., 2006). Spotila *et al*. (1996) estimated first year survival rates for leatherbacks at 6.25 percent. Individual female leatherbacks have been observed to reproduce as long as 25 years (Hughes, 1996; D. Dutton, Ocean Planet Research, Inc., August 2009, pers. comm.). The data suggest that leatherbacks follow a life history strategy similar to many other long-lived species that delay age of maturity, have low and variable survival in the egg and juvenile stages, and have relatively high and constant annual survival in the subadult and adult life stages (Spotila *et al*., 1996; 2000; Crouse, 1999; Heppell *et al*., 1999; 2003; Chaloupka, 2002).

Leatherbacks have the most extensive range of any living reptile and have been reported circumglobally throughout the oceans of the world (Marquez, 1990; NMFS and USFWS, 1998). Leatherbacks can forage in the cold temperate regions of the oceans, occurring at latitudes as high as 71° N. and 47° S.; however, nesting is confined to tropical and subtropical latitudes. In the Pacific Ocean, significant nesting aggregations occur primarily in Mexico, Costa Rica, Indonesia, the Solomon Islands, and Papua New Guinea. In the Atlantic Ocean, significant leatherback nesting aggregations have been documented on the west coast of Africa, from Guinea-Bissau south to Angola, with dense aggregations in Gabon. In the wider Caribbean Sea, leatherback nesting is broadly distributed across 36 countries or territories with major nesting colonies (>1000 females nesting annually) in Trinidad, French Guiana, and Suriname (Dow *et al*., 2007). In the Indian Ocean, nesting aggregations are reported in South Africa, India and Sri Lanka. Leatherbacks have not been reported to nest in the Mediterranean Sea.

Migratory routes of leatherbacks are not entirely known. However, recent satellite telemetry studies have documented transoceanic migrations between nesting beaches and foraging areas in the Atlantic and Pacific Ocean basins (Ferraroli *et al*., 2004; Hays *et al*., 2004; James *et al*., 2005; Eckert, 2006; Eckert *et al*., 2006; Benson *et al*., 2007a; Benson *et al*., 2011). In a single year, a leatherback may swim more than 10,000 kilometers (Eckert, 2006; Eckert *et al*., 2006; Benson *et al*., 2007a; Benson *et al*., 2011). Leatherbacks nesting in Central America and Mexico migrate thousands of miles into tropical and temperate waters of the South Pacific (Eckert and Sarti, 1997; Shillinger *et al*., 2008). After nesting, females from Jamursba-Medi, Indonesia, make long-distance migrations into the central and eastern North Pacific, westward to the Sulawasi and Sulu and South China Seas, or northward to the Sea of Japan (Benson *et al*., 2007a; Benson *et al*., 2011). Turtles tagged after nesting in July at Jamursba-Medi arrived in waters off California Oregon during July-August (Benson *et al*., 2007a; 2011) coincident with the development of seasonal aggregations of jellyfish (Shenker, 1984; Suchman and Brodeur, 2005; Graham, 2009). Other studies similarly have documented leatherback sightings along the Pacific coast of North America during the summer and fall months, when large aggregations of jellyfish form (Bowlby, 1994; Starbird *et al*., 1993; Benson *et al*., 2007b; Graham, 2009). Leatherbacks primarily forage on cnidarians (jellyfish and siphonophores) and, to a lesser extent, tunicates (pyrosomas and salps) (NMFS and USFWS, 1998). Leatherbacks forage widely in temperate and tropical waters and exploit diverse open-ocean and coastal habitats characterized by oceanic processes that aggregate prey, such as convergence zones, coastal retention areas, or mesoscale eddies (Morreale *et al*., 1994; Eckert, 1998; 1999; Benson *et al*., 2011).

## V: Physical and Biological Features

### *ESA Regulations*

Joint NMFS-U.S. Fish and Wildlife Service regulations at 50 CFR 424.12(b) state that in determining what areas are critical habitat, the agencies “shall consider those physical and biological features that are essential to the conservation of a given species and that may require special management considerations or protection.” Features to consider may include, but are not limited to:

(1) Space for individual and population growth, and for normal behavior;
(2) Food, water, air, light, minerals, or other nutritional or physiological requirements;
(3) Cover or shelter;
(4) Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally;
(5) Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The regulations also require agencies to “focus on the principle biological or physical constituent elements” (hereafter referred to as “Primary Constituent Elements” or PCEs) within the specific areas considered for designation, which “may include, but are not limited to, the following:… spawning sites, feeding sites, seasonal wetland or dryland, water quality or quantity, … geological formation, vegetation type, tide, and specific soil types.”

### *Physical or Biological Features Essential for Conservation*

The northeastern Pacific Ocean is a highly variable environment where the habitat upon which leatherbacks and other marine species depend can change rapidly. Although some relatively permanent features are present, transient oceanographic features, such as eddies or fronts, are strong drivers of ecological interactions. The major current of the region is the southward-flowing California Current, which is the eastern boundary current within the North Pacific Ocean (Huyer, 1983; Hickey, 1979; 1998). The California Current is subject to significant variations in seasonal (Barber and Smith, 1981; Hutchings *et al*., 1995; Castelao *et al*., 2006), inter-annual (e.g. El Niño: Barber and Chavez, 1983), and decadal (e.g. Pacific Decadal Oscillation (PDO) cycles: McGowan *et al*., 1998; 2003) time scales, adding variability to local productivity resulting from upwelling (Longhurst, 1996).

Wind-driven coastal upwelling drives primary productivity within waters off the U.S. West Coast. As nutrient-rich water comes to the surface, phytoplankton blooms occur and are transported offshore. Productivity dissipates as upwelled waters move offshore (away from regions of upwelling) and phytoplankton deplete available nutrients (Thomas and Strub, 2001). Episodic intrusions of offshore, nutrient depleted water and offshore movement of nutrient-rich water occur throughout the year. The characteristics of coastal upwelling vary over the extent of the California Current, with upwelling north of Cape Blanco (~42.8° N.) confined to a narrower band than upwelling further south (Huyer, 1983; Brodeur *et al*., 2004). Seasonally, upwelling begins earlier and lasts longer in the southern California Current. The peak time of leatherback sightings (July-September) in neritic waters corresponds to the period when intermittent relaxation of upwelling causes sea surface temperatures to increase to their warmest annual levels (Starbird *et al.* 1993; Benson *et al.* 2007b; 2011). During these relaxation events, there is less mixing of nutrient rich upwelled waters and greater retention of these waters near the coast.

Eddy and frontal features are also critical elements of regional productivity. The interaction of the California Current and topographic features, such as banks, canyons, and other submerged features, as well as shoreline features, such as Cape Blanco, result in the formation of eddies, jets, and squirts (Barth *et al*., 2000). The most prominent regional eddy is the Juan de Fuca Eddy, which develops offshore of northern Washington at the mouth of the Strait of Juan de Fuca as a result of wind-driven current interaction with the continental slope (Hickey and Banas, 2003). The eddy is persistent from the spring through the fall and delivers nutrient-rich waters to the surface (Freeland and Denman, 1982; Hickey and Banas, 2003). Where eddy features interact with coastal waters, oceanic fronts are often found. Off Oregon and Washington, these frontal features tend to reoccur in the same places, such as near Cape Blanco in Oregon or off Vancouver Island and the coast of Washington (Freeland and Denman, 1982).

Leatherbacks are often described as a pelagic species; however, it is becoming increasingly evident that they aggregate in productive coastal areas to forage on preferred prey, scyphomedusae (Houghton *et al*., 2006; Benson *et al*., 2007b; Witt *et al*., 2007; Benson *et al*., 2011). While their range spans the entire Pacific, occupation of the California Current is highly seasonal. Most of our current knowledge of leatherback turtle use of the California Current comes from recent and ongoing telemetry studies, aerial surveys, and ship-based research conducted primarily in the nearshore areas off central California. The telemetry work has documented trans-Pacific migrations between the western tropical Pacific and the California Current; however, it is difficult to define specific migratory corridors.

There is likely an important temporal component to the arrival and departure of leatherbacks to and from key nearshore foraging areas. Current research has shown that leatherbacks clearly target the dense aggregations of brown sea nettle (*Chrysaora fuscescens*) that occur near the central California coast and north through Washington during summer and fall (Peterson *et al*., 2006; Harvey *et al*., 2006; Benson *et al*., 2006; 2007b; 2011). Leatherbacks have also been observed foraging on other scyphomedusae in this area, particularly moon jellies (*Aurelia labiata*) (Eisenberg and Frazier, 1983; S. Benson, NMFS, September 2007, pers. comm.). The CHRT hypothesized that leatherbacks are primarily transiting through offshore areas to get to these dense nearshore aggregations of scyphomedusae, and that the boundary between primary coastal foraging habitat and the offshore areas may vary seasonally and inter-annually with changing oceanographic conditions. In some years, the primary foraging habitat may be poor, or oceanographic features may deter migration into the nearshore habitat (Benson *et al*., 2007c), resulting in a more diffuse or offshore leatherback distribution.

Although jellyfish blooms are seasonally and regionally predictable, their fine-scale local distribution is patchy and dependent upon oceanographic conditions. Some descriptive studies have been conducted on the distribution of scyphomedusae along the West Coast of North America; however, much more information is needed to characterize the temporal variability from seasonal patterns to long-term climate-linked variations. Moreover, it is ultimately the benthic polyp stages that contribute to seasonal and annual population variation of the adult medusae, and little information exists on their populations in open coastal systems, including the California Current upwelling system (W.M. Graham, University of South Alabama, September 2009, pers. comm.). Graham *et al*. (2001) found that jellyfish tend to collect along boundaries: mesoscale oceanic fronts, local circulation patterns, thermoclines, haloclines, etc., and that scyphomedusae (specifically *C. fuscescens*) are closely linked to the physical structure of the water column and the dynamics of upwelling-related circulations. An important example is the Columbia River plume which can act to aggregate and retain jellyfish in the northern California Current (Shenker, 1984). These hydrographic features can be persistent or recurrent (seasonally) in space and time (Castelao *et al*., 2006).

Prey concentrating forces may also be fixed in space and time associated with geomorphologic features (e.g. headlands, capes, seamounts, and canyons). Upwelling shadows (e.g. north Monterey Bay) are areas of sustained high productivity (Graham and Largier, 1997) and these areas are favorable for leatherback prey (Graham, 1994; Benson *et al*., 2007b). Features such as the Monterey Bay upwelling shadow often persist longer than other coastal fronts of similar length scale (Graham, 1993). *C. fuscescens* are highly abundant north of Cape Blanco off the

Oregon Coast (Suchman and Brodeur, 2005; Reese, 2005) where leatherback occurrence has been documented from sighting records and telemetry studies (Bowlby, 1994; Benson *et al*., 2007a; 2007c; 2011). Reese (2005) found that *A. labiata* was frequently abundant south of Cape Blanco, off the coast of Crescent City, CA (~42 º N). Reese (2005) also described areas of persistent jellyfish abundance north and south of Cape Blanco and further north along the Oregon coast inshore of Heceta Bank (~44º N), all inshore of the 100m isobath line. The abundance of jellyfish close to shore may be enhanced by their need for substrate during the benthic stage of their lifecycle (Suchman and Brodeur, 2005). Jellyfish are largest and most abundant in coastal waters of California, Oregon, and Washington during late summer-early fall months (Shenker, 1984; Suchman and Brodeur, 2005; Graham, 2009), which overlaps with the time when turtles are most frequently sighted near Monterey Bay (Starbird, 1993; Benson *et al*., 2007b; 2011) and in Oregon and Washington waters (Bowlby, 1994; Benson *et al*., 2011).

There is evidence that prey-concentrating hydrographic features can be influenced by El Nino and other climate forcing. Survey data has shown a poleward and offshore re-distribution of *C. fuscescens* during El Nino events (Lenarz *et al*., 1995). However, it is likely that the reliable availability of prey associated with fixed or recurrent physical features is the reason for the leatherbacks trans-Pacific migration from Western Pacific nesting beaches and their presence in neritic west coast waters during summer and fall.

Jellyfish, and to a lesser extent tunicates (pyrosomas and salps), have a low nutritive value per unit biomass, although the nutritional value of the entire organism can be quite high in the case of large scyphomedusae (Doyle *et al*., 2007). Davenport and Balazs (1991) debated the hypothesis that the source of nutrients for leatherbacks may be from the stomach contents of the prey, rather than from the medusae and tunicates themselves. Leatherbacks consuming *C. fuscescens* might also ingest additional prey items found in the stomach contents of this jellyfish (Suchman *et al*., 2008). Regardless, leatherbacks must eat a massive amount of jellyfish per day, approximately 20-30 percent of their body weight compared to cheloniids, which eat approximately 2-3 percent of their body weight (Davenport and Balazs, 1991). It has been estimated that an adult leatherback would need to eat about 50 large jellyfish (equivalent to approximately 200 liters) per day to maintain its nutritional needs (Bjorndal, 1997). It is likely that leatherbacks target the California Current to exploit available dense aggregations of jellyfish prey, thereby obtaining the energy reserves necessary for growth, migration, and reproduction. Leatherbacks have been observed at or near the surface consuming *C. fuscescens* within upwelling shadows or oceanographic retention areas within neritic waters off central California (Benson *et al*., 2003; 2007b); however, satellite-linked time-depth recorders suggest foraging can also occur at deeper offshore waters of the U.S. West Coast (S. Benson, NMFS, February 2006, pers. comm.). Foraging at depth has also been reported in adult females during the inter-nesting interval in St. Croix, U.S. Virgin Islands (Eckert *et al.* 1989b), and post-nesting in open pelagic waters of the Atlantic Ocean (Hays *et al.* 2004). Leatherbacks likely select *C. fuscescens* as prey over other scyphomedusae species in neritic central California waters because *C. fuscescens* is larger and more nutritionally beneficial than other available scyphomedusae species (Graham, 2009). The CHRT considered areas as primary foraging habitat if they contain great densities of *C. fuscescens*; secondary foraging habitat if they contain *A. labiata* and some scattered *C. fuscescens*; and tertiary foraging habitat if they contain only scattered *A. labiata*.

Although leatherbacks are capable of deep diving (Lutcavage and Lutz, 1997; Hays *et al*., 2004), the majority of their time is spent at or near the surface. Depth profiles developed for four leatherbacks tagged and tracked from Monterey Bay in 2000 and 2001 (using satellite-linked dive recorders) showed that most dives were to depths of less than 100 meters and those leatherbacks spent most of their time shallower than 80 meters. Dutton (NMFS, January 2004, pers. comm.) estimated that leatherbacks spend 75-90 percent of their time at depths of less than 80 meters based on preliminary data analysis. Within neritic central California waters, leatherbacks spend approximately 50 percent of their time at or within one meter of the surface while foraging and over 75 percent of their time within the upper five meters of the water column (Benson *et al*., 2007b). Leatherback turtles also appear to spend almost the entire dive time traveling to and from maximum depth, suggesting that efficient transit of the water column is of paramount importance (Eckert *et al*., 1989b). Leatherbacks have been observed periodically resting on the surface, presumably to replenish oxygen stores after repeated dives (Harvey *et al*., 2006; Benson *et al*., 2007b).

*Identification of Primary Constituent Elements*

In light of the aforementioned information the CHRT identified one PCE that is essential for the conservation of leatherbacks in marine waters of the U.S. West Coast:

> 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 for growth and success of leatherback sea turtles.

In its proposed rule, NMFS also proposed a second PCE "migratory pathway conditions to allow for safe and timely passage and access to/from/within high use foraging areas." Based on the public comments received and our further review of the proposed rule, the CHRT re-evaluated the use of a passage PCE in this critical habitat designation.

At this time, the CHRT cannot identify any known and consistent geographically defined migratory corridors for leatherbacks off the U.S. West Coast. Movement into Pacific Northwest waters has been associated with a seasonal warming of sea surface temperatures (Benson *et al.* 2011), and turtles appear to be associated with 14-16$^{o}$C waters when approaching or leaving this region; however, sample sizes are still small (n=4). Likewise, leatherbacks that approach the lower California Current in the spring appear to move from warmer southern California Bight waters into central California waters as sea surface temperatures increase north of Point Conception. Although this pattern has been consistent across several years, sample sizes are insufficient for a 'corridor' designation. Furthermore, the pattern is highly dependent upon when a leatherback would reach the California Current. Some turtles have been found to move northward from the southern California Bight during April-July, while turtles that arrive later (i.e. August) will often approach the central California coast from various directions (west, southwest, northwest). Leatherbacks arriving from western Pacific nesting beaches, or from equatorial eastern Pacific overwintering areas, are sensitive to water temperature, generally avoiding SST's <12$^{o}$C. Movement into the US EEZ foraging areas appears to be influenced by seasonal and inter-annual variability of upwelling and relaxation. Thus, based on the range of arrival and departure times and the dynamic nature of the California Current, there is no single migratory pathway for leatherbacks foraging in this region.

In order to fully evaluate the potential for migratory corridors, additional data on leatherback sea turtle movements and habitat use will be required. In our proposed rule, we used leatherback presence as a proxy to determine migratory corridors, however, at this time, the CHRT is not satisfied that the data set available supports a determination on the likely occurrence and location of migratory corridors. With eatherback presence is our only way to predict migration pathways, we have determined that we cannot: reasonably define the physical or biological feature itself, determine whether it occurs within specific areas, or deem it essential to conservation of the species. Including broad corridors based primarily on leatherback presence would not be an effective way to educate the public or inform future Section 7 consultations the habitat essential to the conservation of the species.

The CHRT also considered a third PCE, water quality to support normal growth, development, viability, and health. This PCE would encompass bioaccumulation of contaminants and pollutants in prey and subsequent accumulation in leatherbacks, as well as the direct ingestion and contact with contaminants and pollutants. The CHRT eliminated this option because knowledge on how water quality affects scyphomedusae was lacking, and, where data were available, the CHRT believed prey condition, distribution, diversity, and abundance would encompass water quality considerations regarding bioaccumulation. The CHRT also felt that direct ingestion and contact with contaminants and pollutants would be encompassed in a direct effects analysis for the listed species through section 7 consultations and the jeopardy standard. Indirect effects, the CHRT felt, would primarily occur through the condition, availability and abundance of prey species which is encompassed in the prey PCE and will thus be considered in future consultations for Federal actions with the potential to result in adverse modification to the prey feature through impacts to water quality.

When considering a potential water quality PCE, the CHRT examined ocean acidification as a possible management consideration affecting water quality and prey. The Class Scyphozoa, which includes *C. fuscescens* and *A. labiata*, have calcium sulfate hemihydrate statoliths, which may be affected by acidification. Winans and Purcell (2010) found no pH effect on production of new medusae (ephyrae); statoliths were not decreased in number, but were smaller in low pH. Iglesias-Rodriquez et al. (2008) found increases in biogenic calcification in phytoplankton with increased $CO_2$ using methods they argued were more realistic than those used in previous studies that showed decreased calcification with increasing $PCO_{2.}$ Attrill et al. (2007) suggested that lower pH in parts of the North Sea opened an ecological niche leading to an increase in jellyfish abundance. Yet, Richardson and Gibbons (2008) repeated and expanded the work of Attrill et al. (2007) and found no correlation between ocean acidification and scyphomedusae abundance. Given equivocal or sparse data, the CHRT recommends that water quality and ocean acidification be evaluated in the future to determine whether a revision to the leatherback critical habitat designation might be appropriate.

### *Geographical Area Occupied*

One of the first steps in the critical habitat revision process was to define the geographical area occupied by the species at the time of listing. As described above, leatherbacks are distributed circumglobally throughout the oceans of the world, and along the West Coast (including the petitioned area) within the U.S. Exclusive Economic Zone (EEZ). After defining the geographic occupied by the species, the CHRT reviewed a variety of data sources to identify specific areas within and adjacent to the petitioned area predicted to  contain one or more PCE that might require special management considerations or protection.  Information reviewed included: turtle distribution data from nearshore aerial surveys (Peterson *et al*., 2006; Benson *et al*., 2006; 2007b; NMFS unpublished data); offshore ship sightings and fishery bycatch records (Bowlby, 1994; Starbird *et al*., 1993; Bonnell and Ford, 2001; NMFS SWR Observer Program, unpublished data); satellite telemetry data (Benson *et al*., 2007a; 2007b; 2007c; 2011; NMFS unpublished data); distribution and abundance information on the preferred prey of leatherbacks (Peterson *et al*., 2006; Harvey *et al*., 2006; Benson *et al*., 2006; 2007b); bathymetry (Benson *et al*., 2006; 2007b); and regional oceanographic patterns along the U.S. West Coast (Parrish *et al*., 1983; Shenker, 1984; Graham, 1994; Suchman and Brodeur, 2005; Benson *et al*., 2007b).  Areas outside of U.S. jurisdiction cannot be designated as critical habitat (50 CR 424.12(h)) and were therefore excluded from our analysis.  Thus, the occupied geographic area under consideration for this designation was limited to areas along the West Coast within the U.S. EEZ from the Washington/Canada border to the California/Mexico border.

The occupied geographic area under review is within the California Current, one of the most productive marine ecosystems in the world. Dominated by wind-driven upwelling, these cool, nutrient-rich waters support abundant year-round residents and attract far-ranging migratory species that forage here seasonally, including seabirds, baleen whales, sharks, and large predatory fishes. The distribution, abundance, and foraging success of top trophic level predators in marine systems are determined by large-scale oceanographic patterns and their effects on prey distribution and abundance (Ainley *et al*. 1995, Sydeman and Allen 1999). Variability in the physical features can be seasonal (Barber and Smith 1981, Hutchings *et al*. 1995, Castelao *et al*. 2006 ), interannual, (e.g. El Niño; Barber and Chavez 1983), and decadal (McGowan *et al*. 1998, 2003). Such perturbations bring changes in nutrient upwelling, primary productivity, and zooplankton biomass within coastal upwelling systems (Chavez 1996, McGowan *et al*. 1998).

The CHRT recognized that leatherback habitat use appears to vary seasonally and spatially.  The boundaries chosen to define each specific area represent the CHRT’s best estimate of where these turtles transition from foraging to migrating or where prey composition or abundances change.  Most leatherback sightings occur in marine waters within the neritic zone.  The species may pursue prey as far as the extent of mean lower low water (S. Benson, NMFS, September 2000, unpublished) so the CHRT considered this as the shoreward extent of distribution in those specific areas with documented nearshore distribution.

The following paragraphs describe each specific area (see Figures 3 and 4) and summarize the data used to determine that each area is occupied by leatherbacks and if each area contains the prey PCE.

**Area 1:** Neritic waters between Point Arena and Point Sur, California extending offshore to the 200 meter isobath.  The specific boundaries are the area bounded by Point Sur (36° 18′22″ N./ 121° 54′9″ W.) then north along the shoreline following the line of mean lower low water to Point Arena, California (38° 57′14″ N./ 123° 44′26″ W.) then west to 38° 57′14″ N./ 123° 56′44″

W. then south along the 200 meter isobath to 36° 18′46″ N./ 122° 4′43″ W. then east to the point of origin at Point Sur. Leatherback presence is based on aerial surveys, shipboard sightings, and telemetry studies.

This area is a principal California foraging area (Benson *et al*. 2007b) characterized by high densities of the primary prey species, brown sea nettle (*C. fuscescens*), particularly within upwelling shadows and retention areas. (Graham 1994). This area has been identified as the principal foraging area off the coast of California and, based upon the best available scientific information, contains features which produce abundant prey of sufficient condition, distribution, diversity and density to provide for foraging that is essential to the conservation of the species, thus this area contains the prey PCE.

**Area 2:** Nearshore waters between Cape Flattery, Washington, and Cape Blanco, Oregon extending offshore to the 2000 meter isobath. The specific boundaries are the area bounded by Cape Blanco (42° 50′4″ N./ 124° 33′44″ W.) north along the shoreline following the line of mean lower low water to Cape Flattery, Washington (48° 23′10″ N./ 124° 43′32″ W.) then north to the U.S./Canada boundary at 48° 29′38″ N./ 124° 43′32″ W. then west and south along the line of the U.S. EEZ to 47° 57′38″ N./ 126° 22′54″ W. then south along a line approximating the 2,000 meter isobath that passes through points at 47° 39′55″ N./ 126° 13′28″ W., 45° 20′16″ N. / 125° 21′ W. to 42° 49′59″ N./ 125° 8′ 10″ W. then east to the point of origin at Cape Blanco. Leatherback presence is based on aerial surveys, shipboard surveys, fishery interaction data, and telemetry studies.

This area is the principal Oregon/Washington foraging area and includes important habitat associated with the Columbia River Plume, and Heceta Bank, Oregon. Great densities of primary prey species, brown sea nettle (*C. fuscescens*), occur seasonally north of Cape Blanco (Suchman and Brodeur 2005; Reese 2005; Shenker 1984). Jellyfish densities south of Cape Blanco appear to be dominated by moon jellies (*Aurelia labiata*) and egg yolk jellies (*Phacellophora camtschatica*; Suchman and Brodeur 2005; Reese 2005). Cape Blanco is a well-documented “break” in coastal ocean physical and biological properties due to differences in primary bottom types and current patterns that influence the dispersal and retention of larval fishes and invertebrates (Barth et al., 2000; McGowan et al., 1999; Peterson and Keister, 2002).

Based upon the best available scientific information, the features of this area produce prey of sufficient condition, distribution, diversity abundance and density to provide for foraging that is essential to the conservation of the species, thus this area contains the prey PCE.

**Area 3**: Nearshore waters between Cape Blanco, Oregon and Point Arena, California extending offshore to the 2000 meter isobath. This line runs from 42° 49′59″ N./ 125° 8′10″ W. through 42° 39′3″ N./ 125° 7′37″ W., 42° 24′49″ N./ 125° 0′13″ W., 42° 3′17″ N./ 125° 9′51″ W., 40° 49′38″ N./ 124° 49′29″ W., 40° 23′33″ N./ 124° 46′32″ W., 40° 22′37″ N./ 154° 44′19″ W., to 38° 57′14″ N./ 124° 11′50″ W. then east to Point Arena. Leatherback presence is based on a few aerial observations. This area includes upwelling centers between Cape Blanco, Oregon and Point Arena, California and is characterized by cold sea surface temperatures (<13$^{o}$ C).

This area has features that produce an abundance of jellies, particularly during seasonal upwelling; however, species composition is dominated by moon jellies (*A. labiata*) and egg yolk jellies (*Phacellophora camtschatica*; Suchman and Brodeur 2005; Reese 2005). Aerial surveys of leatherbacks and jelly prey indicate that moon jellies are also the dominant jelly species north of Point Arena, California. These species are not the preferred prey for leatherbacks, although they may be consumed when brown sea nettles are not available. A recent publication analyzing movement of leatherbacks along the U.S. West Coast indicates that foraging behavior was not observed in Area 3 (Benson et al. 2011). The water in this area (i.e. south of Cape Blanco, the boundary between Area 2 and Area 3) is colder than waters in adjacent Areas 1 and 7 to the south and Area 2 to the north. Cape Blanco is a coastal promontory which protrudes further to the west than any other feature in the relatively straight coastline of the U.S. northwest. The environmental variability associated with this feature suggests habitat partitioning between prey species. For example, Suchman and Brodeur (2005) found that brown sea nettles were more likely to be caught in waters north of Cape Blanco, while south of Cape Blanco, moon jellies were more prevalent. Thus, Area 3 may not be utilized by leatherbacks as a foraging region because it is energetically inefficient for leatherbacks to consume low caloric content prey (i.e. moon jellies) while maintaining their core body temperatures through swimming. Densities of brown sea nettles are likely insufficient to support regular foraging in the cold waters of Area 3.

Based upon the best available scientific information, the oceanographic features of this area do not produce prey of sufficient condition, distribution, diversity, abundance and density to provide for foraging that is essential to the conservation of the species, thus this area does not contain the prey PCE.

**Area 4:** Offshore waters west and adjacent to Area 2. Includes waters west of the 2000-meter isobath line from 47° 57′38″ N./ 126° 22′54″ W. south to 43° 44′59″ N./ 125° 16′55″ W. Includes waters west to 43° 44′59″ N./128° 59′36″ W. Leatherback presence is based on aerial surveys and telemetry studies.

Although there is limited information available regarding presence of jellyfish in this area, the recent study by Benson et al. (2011) indicates that minimal feeding behavior does occur in the area. Due to distance from the coast and lack of persistent frontal habitat, prey species are likely limited to low densities of moon jellies (*A. labiata*) and salps. Small densities of low caloric prey resources in this area may be sufficient for body maintenance, counteracting calorie loss due to movements associated with the search for prey or migrating to/from Area 2; however, it likely that densities of brown sea nettles are insufficient to provide sufficient energy for leatherback growth or reproduction.

Based upon the best available scientific information, the oceanographic features of this area do not produce prey of sufficient condition, distribution, diversity, abundance and density to provide for foraging that is essential to the conservation of the species, thus this area does not contain the prey PCE.

**Area 5:** Offshore waters south and adjacent to Area 4, and north of a line consistent with the California/Oregon border. Includes US EEZ waters west of the 2000-meter isobath. Leatherback presence is based on aerial surveys, telemetry studies, and a fishery interaction. The eastern edge of this area is  influenced by an oceanographic front west of Cape Blanco, Oregon. The position and intensity of the front is variable, dependent on the strength of upwelling at Cape Blanco, and can be located within the extreme eastern edge of Area 5 during strong upwelling events. The front is a means of cross-shelf transport from the coast to the deep ocean and may act as an aggregation mechanism for zooplankton, however, no information is available about jelly densities. Given its distance offshore, jelly densities are likely variable and dominated by moon jellies that may be advected from nearby coastal waters (Suchman and Brodeur 2005; Reese 2005), therefore, importance as a foraging area to leatherbacks is secondary.

Recent work by Benson et al. (2011) showed that no leatherbacks foraged in Area during their study period 2000 through 2008.. While prey may be present in Area 5, based upon the best available scientific information we could not find areas that had prey of sufficient condition, distribution, diversity, abundance and density to provide for foraging that is essential to the conservation of the species, thus this area does not contain the prey PCE.

**Area 6:** Offshore waters south and adjacent to Area 5, west and adjacent to the southern portion of Area 3, offshore to a line connecting N42.000/W129.000 and N38.95/W126.382, with the eastern boundary beginning at the 2000 meter isobath (42º3′6″ N./ 125º 9′53″ W.). Leatherback presence is based on aerial surveys, telemetry studies, and fishery interactions. Offshore waters south of the Mendocino Escarpment are characterized by frontal habitat created by the Cape Mendocino upwelling center. Similar to Area 5, frontal intensity is variable and dependent on the strength of upwelling at Cape Mendocino (Castelao et al.2006). No information is available about jelly densities in the Area 6; however, given its distance offshore, jelly densities are likely low, dominated by moon jellies, and of secondary importance to leatherbacks as a foraging area.

Recent work by Benson et al. (2011) showed that no leatherbacks foraged in Area 6 during their study period 2000 through 2008.  While prey may be present in Area 6, based upon the best available scientific information, we could not find areas that have prey of sufficient condition, distribution, diversity, abundance and density to provide for foraging that is essential to the conservation of the species, thus this area does not contain the prey PCE.

**Area 7:** Offshore waters between the 200 and 3000 meter isobaths from Point Arena to Point Sur, California and waters between the coastline and the 3000 meter isobath from Point Sur to Point Arguello, California. Leatherback presence is based on based on aerial surveys, telemetry studies, and fishery interaction data.

A quasi-stationary front occurs in this area near the 2000 m – 3000 m isobaths as warm offshore waters meet cooler coastal upwelled water.  As upwelling winds relax, this front moves closer to the coast and likely aggregates sea nettles that have been advected from nearby coastal waters (Area 1).  The neritic waters between Point Sur and Point Arguello are also strongly influenced by coastal upwelling processes that produce abundant and dense aggregations of leatherback prey.  Point Arguello is a well-documented “break” in coastal ocean physical and biological properties along the U.S. west coast, separating newly upwelled waters of the central California coast from upwelled-modified and warm, lower salinity waters of the southern California Bight.

The recurrent oceanographic features at the edge of the continental shelf are occupied by aggregations of moon jellies (*A. labiata*) and lower densities of brown sea nettles (*C. fuscescens*). The southern portion of the region includes Morro and Avila Bays where large densities of brown sea nettles have been observed seasonally in fisheries monitoring surveys and trawl surveys. Recent work by Benson et al. (2011) indicatesthat this area is utilized for foraging by leatherbacks, particularly if foraging opportunities in Area 1 are poor. Telemetry data shows that leatherbacks are spending more time engaged in ARS behavior in this area than in Areas 3, 4, 5, 6, 8 or 9. Based upon the best available scientific information, the oceanographic features of this area produce prey of sufficient condition, distribution, diversity, abundance and density to provide for foraging that is essential to the conservation of the species, thus this area contains the prey PCE.

**Area 8:** Offshore waters west and adjacent to Area 6, and west of the 3000-meter isobath adjacent to Areas 7 and 9, between Point Arena, California and the U.S. EEZ/Mexico maritime border. Leatherback presence is based on aerial surveys, telemetry studies, and fishery interactions.

Although eddies and meanders originating from coastal capes and headlands may be present in this region after particularly strong upwelling events, frontal features are not abundant and the region is primarily characterized by warm, low salinity offshore waters. Due to its distance from the coast and lack of persistent frontal habitat, prey species are likely limited to low densities of moon jellies (*A. labiata*) and salps. Unlike Area 7, frontal features are less abundant and more ephemeral in Area 8.

Recent work by Benson et al. (2011) indicates that foraging behavior is rare and inconsistent in this area. Additional information from Benson (unpublished data, 2008) indicated that during a ship-based survey within these waters, an offshore front was observed over 100 miles from shore. Brown nettles were found in poor condition (small and dying) that were likely advected from coastal waters to the offshore front. Although leatherbacks could potentially attempt to feed in this area, the relatively low densities and poor condition of brown sea nettles in this area would likely not provide adequate energy for leatherback growth and reproduction. Based upon the best available scientific information, the oceanographic features of this area do not produce prey of sufficient condition, distribution, diversity, abundance and density to provide for foraging that is essential to the conservation of the species, thus this area does not contain the prey PCE.

**Area 9:** Southern California Bight waters extending from the coast to the 3000-meter isobath between Point Arguello and Point Vicente, and from Point Vicente to N32.589/W117.463 extending to the 3000 meter isobath. Leatherback presence is based on aerial surveys, telemetry studies, and a fishery interaction. Upwelling originating from Point Conception creates offshore frontal features near the northern Santa Barbara Channel Islands (San Miguel, Santa Rosa, Santa Cruz, and Anacapa) extending to San Nicolas Island; however, most of this region is characterized by warm, low salinity waters.

Little information is available on the presence of jellies in the area; however, trawl samples performed by the California Cooperative Fisheries Investigations (CalCOFI) suggest that moon jellies are dominant; therefore, this area is of secondary importance to leatherbacks as a foraging area.

A recent report on telemetry work on leatherbacks indicates some limited foraging behavior around the Channel Islands, and within the southern California Bight by a single individual during spring while moving toward Areas 1 and 7 (Benson et al. 2011). We have no information to indicate where brown sea nettles are found in sufficient abundance or density to allow for efficient foraging by leatherbacks.  Based upon the best available scientific information we could not find areas that had prey of sufficient condition, distribution, diversity, abundance and density to provide for foraging that is essential to the conservation of the species, thus this area does not contain the prey PCE.

Based on the information described above, Areas 1, 2 and 7 contain the prey PCE which has been identified as essential to the conservation of the species. Therefore, only these three areas will be discussed further in this report.

**Figure 3.** Geographic Occupied Areas with Depth Lines and U.S. West Coast EEZ

**Figure 4.** Geographic Areas with Sightings and Telemetry Data

## VI: Special Management Considerations

An occupied area may be designated as critical habitat if it contains physical and biological features that "may require special management considerations or protection." Joint NMFS and

USFWS regulations (50 CFR 424.02(j)) define “special management considerations or protection” to mean “any methods or procedures useful in protecting physical and biological features of the environment for the conservation of listed species.” The CHRT identified a number of activities that may threaten the identified PCE, as impacts to the PCE also impact the physical and biological feature essential to conservation of the species. The CHRT grouped these activities into eight activity types: pollution from point sources (e.g. National Pollution Discharge Elimination System (NPDES)); runoff from agricultural pesticide use; oil spills; power plants; aquaculture; desalination plants; tidal energy or wave energy projects; and liquid natural gas (LNG) projects. All of these activities have the potential to affect the PCE by altering prey abundance and prey contamination levels (Table 1). Some of these activities may also have the potential to impact the prey PCE positively (e.g. infrastructure for aquaculture may provide substrate and habitat for the benthic polyp stages of medusae).

**Table 1.** Summary of occupied specific areas, surface area covered, the PCE present, and activities that may affect the PCE within each area such that special management considerations or protection may be required.

| Specific Area | PCE Present | Est. Area (sq. mi) | Activities that may impact the PCE Prey |
|---|---|---|---|
| Area 1 | Yes | 3,807<br>(9,862 sq. km) | point pollution (NPDES permitting), pesticide application, oil spill response, power plants, desalination plants, tidal and wave energy projects |
| Area 2 | Yes | 25,004<br>(64,760 sq. km) | point pollution (NPDES permitting), pesticide application, oil spill response, tidal, wave and wind energy projects, LNG |
| Area 7 | Yes | 13,102<br>(33,936 sq. km) | point pollution (NPDES permitting), pesticide application, oil spill response, power plants, desalination plants |

## VII: Area Conservation Values

To determine the conservation value of each area based on the prey PCE, we scored each area for its importance in four main prey categories: density of prey; composition of prey species; aggregation mechanism present; and inter-annual variation. We also acknowledge that these categories should be weighted for their relative importance in creating optimal foraging habitat. Therefore, density of prey was weighted at 40 percent of the total area conservation score, while prey species composition, aggregation mechanism, and inter-annual variability were weighted at 25 percent, 25 percent, and 10 percent, respectively.

We first scored each area from 1-5 for each prey category, with 5 representing a very high conservation value. Then each score was weighted based on its particular category. For example, in Area 1, prey concentration was given a score of 5, meaning that it has a very high concentration of prey. The prey concentration category is weighted at 40 percent importance overall, so the weighted score for prey concentration in Area 1 is 2. All weighted scores across categories were added to calculate a total weighted score for each area, as shown in Table 2. Finally, the conservation value was assigned to each area based on the total weighted score. Scores from 4.0 to 5.0 were given a high conservation value, scores from 3.0 to 3.9 were given a medium conservation value, and all scores of 2.9 or lower were given a low conservation value. All three of our particular areas scored a high conservation value, which is consistent with scientific literature and observations of a high level of leatherback foraging in these areas.

**Table 2**: The scores for each area based on the four prey categories, the weighted adjustment to scores based on the overall importance of each prey category, and the conservation rating.

| **Area** | **Density of Prey (0.4)** | **Prey Species Composition (0.25)** | **Aggregating Mechanism (0.25)** | **Inter-annual Variability (0.1)** | **Total Score (Value 1-20)** | **Total Weighted Score** | **Conserv-ation Value** |
|---|---|---|---|---|---|---|---|
| **1** | 5 (2.0) | 5 (1.3) | 5 (1.3) | 4 (0.4) | 19 | 4.9 | High |
| **2** | 4 (1.6) | 5 (1.25) | 4 (1) | 4 (0.4) | 17 | 4.25 | High |
| **7** | 4 (1.6) | 4 (1) | 4 (1) | 4 (0.4) | 16 | 4 | High |

As described above, our conservation values consider only the prey and oceanographic features that allow for sufficient foraging habitat. However, we also looked at available scientific data to describe the use of each area by leatherbacks. This information is not included in the Conservation Value assigned to each area, but is major factor that required our evaluation.

*Leatherback Foraging Use*

Leatherbacks in the Pacific expend tremendous time and energy migrating to and along the U.S. West Coast to forage on jellyfish. To gain insights into potential preferences, we reviewed the available data and literature to help quantify the use of each specific area for foraging. NOAA's Southwest Fisheries Science Center, (Benson *et al.* 2011), has been investigating leatherback use of the coastal waters of California, Oregon, and Washington. Satellite transmitters have been applied to leatherback sea turtles at western Pacific nesting beaches and at California foraging grounds. Benson *et al.* (2011), modeled the daily position estimates for tagged animals and then used movement data from each independent transmitter to infer if the turtle was engaged in "Area Restricted Search" (foraging) or "Transit" (directed travel between areas). This new research, in coordination with other data on foraging behavior, has provided additional information regarding the usage of each specific area and is summarized below.

- Area 1: Satellite data indicate foraging behavior between Bodega Bay and northern Monterey Bay, and between Bodega Bay and Point Arena when warmer water extends northward from Point Reyes (usually during September). Data were used from individuals that were captured off the central California coast, and that returned the following year.
- Area 2: Satellite data indicate foraging in shelf waters between the 200 m and 2000 m isobaths. These data come from four individuals that moved into this area one year after

the transmitters were deployed at Jamursba-Medi (Papua Barat, Indonesia). While this is a small sample size, it reflects the best available data at this time.

- Area 7: Satellite data indicate that foraging behavior occurred near the 2000 meter isobath, west of Monterey Bay and Big Sur, and west of Morro and Avila Bays. Foraging typically occurs in Area 7 during the spring and early summer, when neritic waters are cool. Turtles that foraged in this area eventually moved further east or north, into Area 1 during the late summer.

## VIII: Unoccupied Areas

Section 3(5)(A)(ii) of the ESA authorizes designation of "specific areas outside the geographical areas occupied by the species at the time it is listed" if those areas are determined to be essential to the conservation of the species. Joint NMFS and USFWS regulations (50 CFR 424.12(e)) emphasize that the agency shall designate as critical habitat areas outside the geographical area presently occupied by a species only when a designation limited to its present range would be inadequate to ensure the conservation of the species. At the present time the CHRT has not identified additional specific areas outside the geographic area occupied by leatherbacks that may be essential for the conservation of the species.

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