Revision of Critical Habitat for Leatherback Sea Turtles

Biological Report

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National Marine Fisheries Service
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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 the 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, delineate specific areas within the geographical area occupied that contain at least one essential habitat feature, identify special management considerations or protections required 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 support NMFS' proposal to revise the areas designated as critical habitat for leatherback turtles.

PART 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).

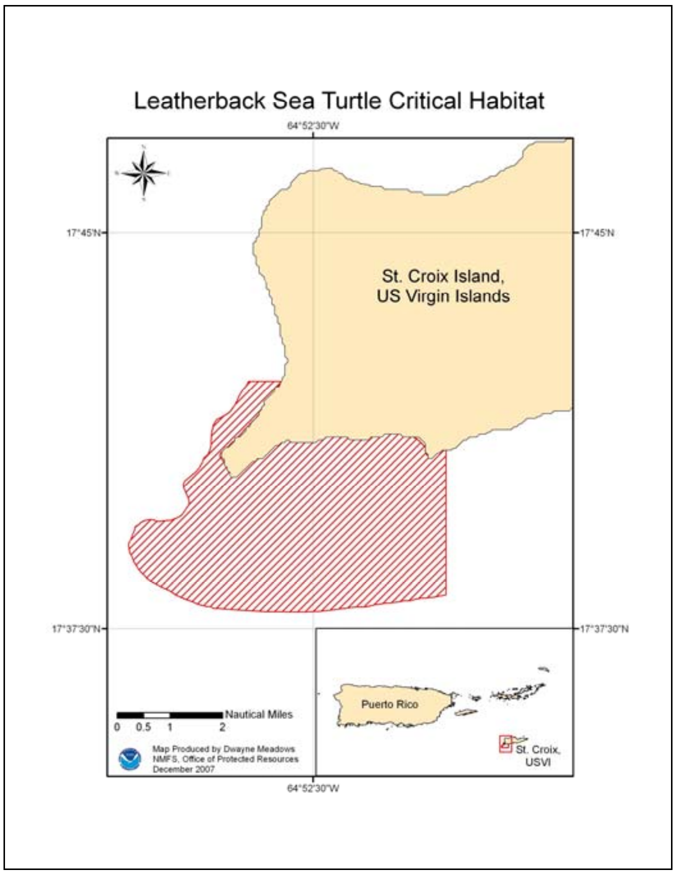

Figure 1. Leatherback critical habitat, St. Croix, U.S. Virgin Islands, designated in 1979.

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.

PART 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 require 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 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* and public comment is solicited. The CHRT will be reconvened to review relevant comments received on the agency's proposal and any additional information requiring consideration for the final critical habitat designation. The final rule identifying any revision to the critical habitat designation also will be published in the *Federal Register*.

PART 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.

PART 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).

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). In a single year, a leatherback may swim more than 10,000 kilometers (Eckert, 2006; Eckert *et al*., 2006). Leatherbacks nesting in Central America and Mexico migrate thousands of miles into tropical and temperate waters of the South Pacific (Eckert and Sarti, 1997). After nesting, females from Jamursba-Medi, Indonesia, make long-distance migrations across the equator either to the eastern North Pacific, westward to the Sulawasi and Sulu and South China Seas, or northward to the Sea of Japan (Benson *et al*., 2007a). One turtle tagged after nesting in July at Jamursba-Medi arrived in waters off Oregon in August (Benson *et al*., 2007a) coincident with seasonal maxima aggregations of jellyfish (Shenker, 1984; Suchman and Brodeur, 2005). Other studies similarly indicate that leatherbacks arrive 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). Largely pelagic, leatherbacks forage widely in temperate waters and exploit convergence zones and upwelling areas in the open ocean along continental margins and in archipelagic waters (Morreale *et al*., 1994; Eckert, 1998; 1999).

PART V: PHYSICAL OR BIOLOGICAL FEATURES ESSENTIAL FOR CONSERVATION

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 sea turtle 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. 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). 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; 2008). 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). 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) and in Oregon and Washington waters (Bowlby, 1994).

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).

In light of the aforementioned information the CHRT identified two PCEs essential for the conservation of leatherbacks in marine waters of the U.S. West Coast:

1. Occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora, Aurelia, Phacellophora*, and *Cyanea*) of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development
2. Migratory pathway conditions to allow for safe and timely passage and access to/from/within high use foraging areas

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 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.

When considering this potential PCE, the CHRT considered 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 (in review) 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 raised in any proposed rule to revise leatherback critical habitat and public comment and information sought on the issues.

Geographical Area Occupied by the Species and Specific Areas Within the 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). The CHRT reviewed a variety of data sources to identify specific areas within and adjacent to the petitioned area that contain one or more PCE requiring special management considerations or protection. Information reviewed included: turtle distribution data from nearshore aerial surveys (Peterson *et al*., 2006; Benson *et al*., 2006; 2007b; 2008; 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; 2007c;

2008; 2009; 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; 2008); bathymetry (Benson *et al*., 2006; 2008); 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 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 (Figure 3) and summarize the data used to determine that each area is occupied by leatherback.

Area 1: Nearshore area from Point Arena to Point Sur California and offshore to the 200 meter isobath. Leatherback presence is based on aerial surveys, shipboard sightings, and telemetry studies. This area is a principal California foraging area (Benson *et al*. 2007b) with high densities of primary prey species, brown sea nettle (*C. fuscescens*), occurring here seasonally from April to November (Graham 1994).

Area 2: Nearshore area from Cape Flattery, Washington, to Umpqua River (Winchester Bay), Oregon and offshore to the 2000 meter isobath. 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 Heceta Bank, Oregon. The greatest densities of a primary prey species, brown sea nettle (*C. fuscescens*), occur north of Cape Blanco, Oregon and in shallow inner shelf waters (Suchman and Brodeur 2005).

Area 3: Nearshore area from Umpqua River (Winchester Bay), Oregon, to Point Arena, California, shoreward of the 2000 meter isobath. Leatherback presence is based on aerial survey data. This area includes major upwelling centers between Cape Blanco, Oregon and Cape Mendocino, California and is characterized by cold sea surface temperatures (<13^{o} C), and great densities of the prey species—moon jellyfish (*A. labiata*). Although leatherback use is limited, this area could experience greater use during warm water episodes such as an El Niño event.

Area 4: Offshore area west and adjacent to Area 2 (see above). Includes waters west of the 2000 meter isobath from N47.651/W126.229 southwest to N43.750/W128.834. Leatherback presence is based on aerial surveys. This area is used primarily as a region of passage to/from areas 2 and 5 (see below) although prey species are present and it is also used as secondary foraging area.

Area 5: Offshore area south and adjacent to Area 4 and west and adjacent to the northern portion of Area 3 (see above). This area includes all waters in the U.S. EEZ deeper than the 2000 meter isobath south of Area 4 and north of a line consistent with the California/Oregon border. Leatherback presence is based on aerial surveys, telemetry studies, and fishery interaction data. This area includes prey species within primary offshore foraging habitat and passage to areas 2 & 4 (see above).

Area 6: Offshore area south and adjacent to Area 5 and west and adjacent to the southern portion of Area 3 (see above) off shore to a line connecting N42.000/W129.000 and N38.95/W126.382. Leatherback presence is based on aerial surveys, telemetry studies, and fishery interactions. This area includes prey species within secondary foraging habitat west of Cape Mendocino and passage between Area 5 (see above) and Area 7 (see below).

Area 7: Nearshore area from Point Arena, California, to Point Vicente, California, exclusive of area 1 (see above) and offshore to a line connecting N38.955/W126.382 and N33.741/W121.893. This area includes waters surrounding the northern Santa Barbara Channel Islands (San Miguel, Santa Rosa, Santa Cruz, and Anacapa Islands). Leatherback presence is based on based on aerial surveys, telemetry studies, and fishery interactions. This area includes prey species within secondary foraging areas characterized by ocean frontal zones west of the continental shelf that are occupied by aggregations of moon jellyfish (*A. labiata*) and lower densities of brown sea nettles (*C. fuscescens*). The frontal zones are created by a series of quasi-permanent, retentive eddies or meanders, associated with offshore-flowing squirts and jets anchored at coastal promontories between Point Reyes and Point Sur, which create linkages between nearshore waters of area 1 and offshore waters of the California Current. Telemetry data indicate that this area is commonly utilized by leatherbacks, particularly when jellyfish availability in area 1 is poor. This area also provides passage to/from foraging habitat in areas 1, 5, and 6 (see above), often through the northern Santa Barbara Channel Islands during the spring and early summer months.

Area 8: Extreme offshore area west and adjacent to areas 6 and 7 from the California/Oregon border then south, including areas closer to the coast, along the U.S. EEZ to the U.S./Mexico border. This area includes waters surrounding the southern Santa Barbara Channel Islands (San Nicholas, Santa Barbara, Catalina, and San Clemente Islands). Leatherback presence is based on based on aerial surveys, telemetry studies, and fishery interactions. This area includes prey species within tertiary foraging habitat characterized by warm, low salinity offshore waters and passage to/from foraging habitat in areas 1, 5, 6, and 7 (see above).

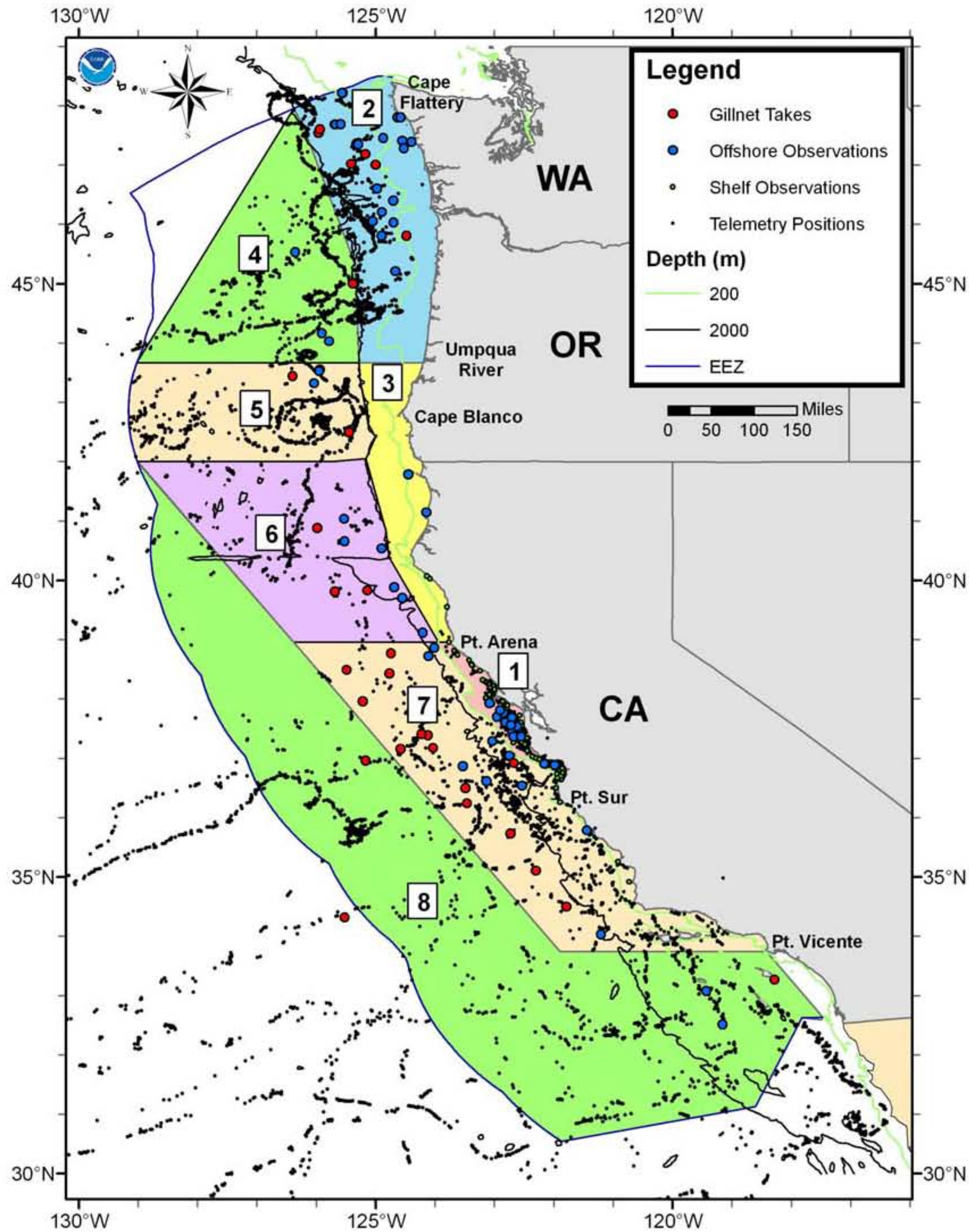

Figure 3. Specific Areas Reviewed for Possible Designation as ESA Critical Habitat for the Leatherback Turtle

PART VI: PHYSICAL OR BIOLOGICAL FEATURES WHICH MAY REQUIRE SPECIAL MANAGEMENT

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 PCEs, as impacts to the PCEs also impact the physical and biological features. 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 PCEs by altering prey abundance, prey contamination levels, and free passage between and within specific areas (Table 1). Some of these activities may also have the potential to impact PCEs 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 PCEs present, and activities that may affect the PCEs within each area such that special management considerations or protection may be required.

Specific Area	Est. Area (sq. mi)	PCE(s) Present	Activities
Area 1	4,700	Prey, Passage	Prey—point pollution, pesticides, oil spills, power plants, desalination plants, tidal wave/energy projects, aquaculture Passage—oil spills, tidal wave/energy projects, aquaculture
Area 2	21,800	Prey, Passage	Prey—point pollution, pesticides, oil spills Passage—oil spills
Area 3	11,600	Prey, Passage	Prey—point pollution, pesticides, oil spills, tidal wave/energy projects Passage—oil spills, tidal wave/energy projects
Area 4	30,000	Prey, Passage	Prey—oil spills Passage—oil spills
Area 5	24,500	Prey, Passage	Prey—oil spills Passage—oil spills

Specific Area	Est. Area (sq. mi)	PCE(s) Present	Activities
Area 6	34,200	Prey, Passage	Prey—oil spills Passage—oil spills
Area 7	46,100	Prey, Passage	Prey—point pollution, pesticides, oil spills, power plants, desalination plants, tidal wave/energy projects, LNG, aquaculture Passage—oil spills, tidal wave/energy projects, aquaculture
Area 8	117,000	Prey, Passage	Prey—oil spills, LNG, aquaculture Passage—oil spills, aquaculture

PART VII: AREA CONSERVATION VALUES

After reviewing the best available information, the CHRT determined that the eight specific areas varied in terms of potential conservation value to leatherback turtles. Specifically, the CHRT assessed how leatherbacks used each area, the frequency of that use, and the quality and quantity of PCEs within each area. The CHRT used professional judgment to assign a relative biological importance score of 1, 2, or 3 (3 representing the highest importance) to each area for each of our two identified PCEs. Scores were then summed and used to assign an overall conservation rating of “Very Low”, “Low”, “Medium”, or “High” for each specific area. Summed numeric equivalents for each conservation rating were: Very Low = 3 or less; Low = 4; Medium = 5; High = 6. Areas rated as “High” were deemed to have a high likelihood of promoting the conservation of leatherbacks; areas rated as “Medium” were deemed to have a moderate likelihood of promoting the conservation of the species; and areas rated as “Low” were deemed to have a low likelihood of promoting the conservation of the species; Areas rated as “Very Low” were deemed to have a very low likelihood of promoting the conservation of the species. The parameter scoring and final conservation ratings are summarized in Table 2.

Table 2. Summary of presence (Yes/No) of primary constituent elements and resultant conservation value ratings for specific areas occupied by leatherback turtles.

Specific Area	PCE Condition & Frequency 1 = Preferred prey rare or absent and passage conditions to/from /within high use foraging areas needed infrequently or inconsistently 2 = Preferred prey present but not consistently abundant or not well distributed and passage conditions to/from/within high use foraging areas are needed more frequently and consistently 3 = Preferred prey consistently abundant and well distributed and passage conditions to/from/within high use foraging areas needed frequently and consistently				Overall Conservation Rate
	PREY	**VALUE**	**PASSAGE**	**VALUE**	**TOTAL**
Area 1	Yes	3	Yes	3	High
Area 2	Yes	3	Yes	3	High
Area 3	Yes	2	Yes	1	Very Low
Area 4	Yes	2	Yes	3	Medium
Area 5	Yes	2	Yes	3	Medium
Area 6	Yes	1	Yes	3	Low
Area 7	Yes	2	Yes	3	Medium*
Area 8	Yes	1	Yes	3	Low

* The CHRT noted that Area 7 likely has more conservation value than areas 4 and 5.

PART 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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