4 AFFECTED ENVIRONMENT

4.1 REGIONAL PLANNING AREAS ON THE OCS

The three Outer Continental Shelf (OCS) regions analyzed for potential alternative energy development in this programmatic Environmental Impact Statement (EIS) are the Atlantic, Gulf of Mexico (GOM), and Pacific regions as shown in Figure 4.1-1 (alternative energy developments in the Alaska and Hawaii regions are not considered at this time). The Atlantic region extends from Maine southward through the Straits of Florida; the Gulf of Mexico region includes the area off the western coast of Florida through Texas; and the Pacific region extends from the southern coast of California northward to the border of Washington State with Canada. The extent of Federal (U.S. Department of the Interior [USDOI]/Minerals Management Service [MMS]) jurisdiction of the OCS is defined under principals of international law, such that jurisdiction extends from the seaward extent of State jurisdiction out about 200 nautical miles (mi) (230 mi; 370 kilometers [km]) into the ocean (there are exceptions to this for instances where the OCS width is greater than 200 nautical mi). State jurisdiction generally extends from the shore out to 3 nautical mi (3.5 mi; 5.6 km), except for Texas and the Gulf Coast of Florida, where State jurisdiction extends to 9 nautical mi (10.4 mi; 16.7 km).

Regional MMS offices[1] conduct oil and gas leasing on the OCS in regional planning areas, and they also permit and inspect oil and gas facilities to ensure operational safety and protection of the marine, coastal, and human environment. The MMS is also responsible for other minerals management offshore, which currently involves the use of sand and gravel for coastal restoration projects.

The Atlantic region is subdivided into four planning areas, which include the North Atlantic (from Maine south to include the New Jersey coast), the Mid-Atlantic (from Delaware south to include the coast of North Carolina), the South Atlantic (from the coast of South Carolina south to approximately Cape Canaveral, Florida), and the Straits of Florida (extending from around the southern tip of Florida about 200 km [125 mi] into the GOM). The MMS GOM regional office conducts all leasing and resource management activities for the Atlantic region. Currently, there are no active oil and gas leases on the Atlantic region OCS (USDOI/MMS 2006a). Historically there have been 433 leased blocks, with more than half of these in the Mid-Atlantic planning area. Between 1996 and 2006, there were 16 coastal restoration projects in the Atlantic region, providing about 15 million cubic meters (m^3) (20 million cubic yards [yd^3]) of OCS sand for beach restoration.

The GOM region is divided into three planning areas, including the Western GOM (includes the coast of Texas), the central GOM (includes the coasts of Louisiana, Mississippi, and Alabama), and the Eastern GOM (includes the western coast of Florida). There are about 42 million acres (17 million hectares [ha]) in the GOM region under oil and gas leases. This part

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1 The MMS has three regional offices: Gulf of Mexico Offshore Region, Pacific Offshore Region, and the Alaska Offshore Region. The resources in the Atlantic region are managed by the Gulf of Mexico Offshore Regional office.

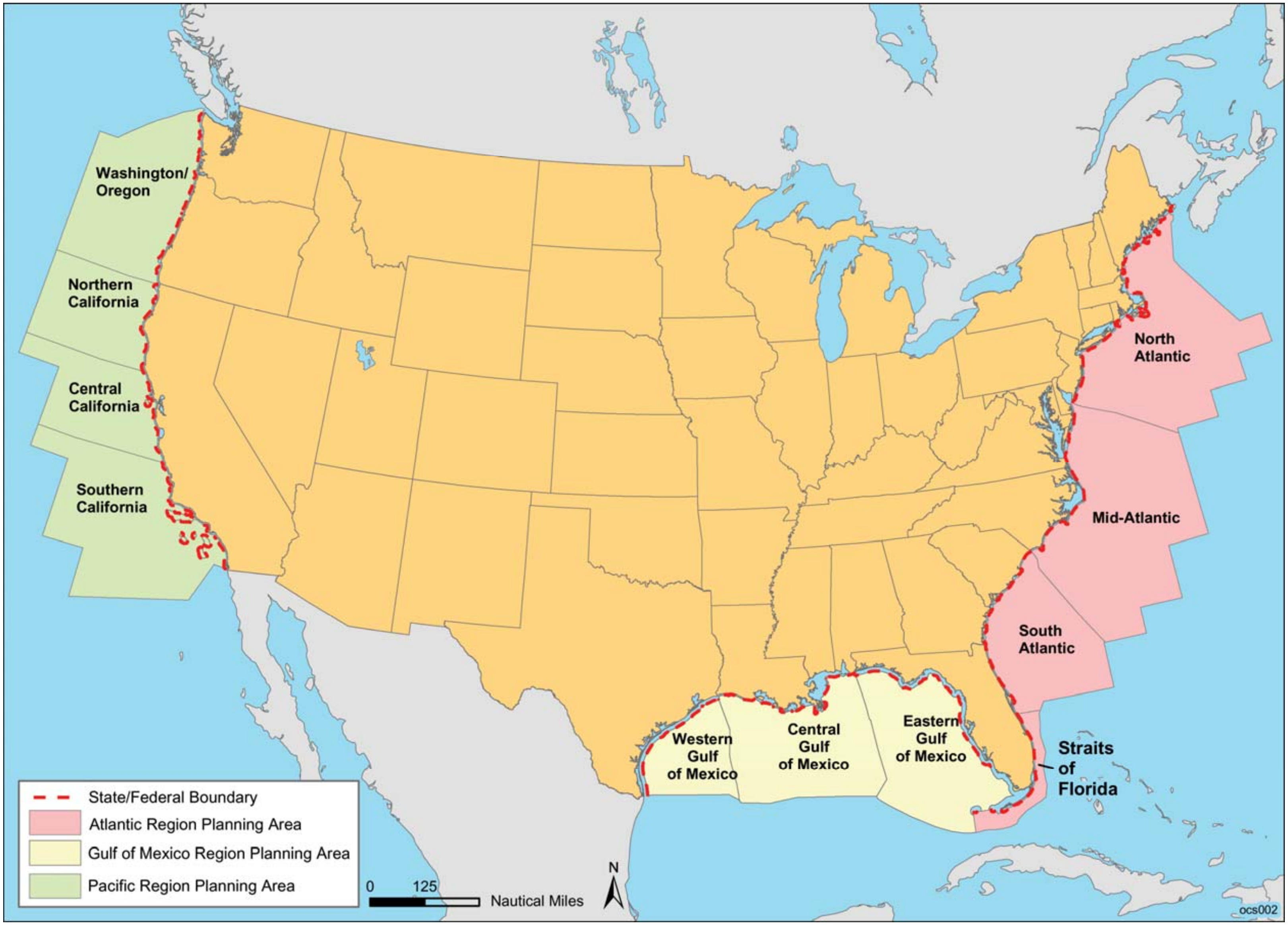

FIGURE 4.1-1 The Atlantic, Gulf of Mexico, and Pacific Regional Planning Areas on the Outer Continental Shelf

of the U.S. OCS is a major energy production area, generating 23% of total U.S. natural gas production and 30% of total U.S. oil production (USDOI/MMS 2006b). GOM production from January through June 2006 averaged about 1 million barrels/day (bpd) for oil and 6.9 billion cubic feet/day (bcf/d) for gas (USDOI/MMS 2006b). There are currently about 4,000 producing platforms on the GOM OCS; about half of these are considered major platforms and about one quarter are manned by personnel. It is estimated that there are more than 55,000 petroleum-related jobs in the GOM. Recent discoveries have mainly been in deep water (i.e., greater than 300 meters [m] [1,000 feet (ft)]). Due to administrative deferrals and congressional moratoria, relatively fewer leases (146) exist in the Eastern GOM than in the other two planning areas.

Many studies are underway on the use of OCS sand and gravel for beach restoration in the GOM, especially since the 2005 hurricane season, which caused extensive beach erosion. The Louisiana Coastal Area Ecosystem Restoration Study estimates that about 46 million m^3 (60 million yd^3) of OCS sand from Trinity Shoal, Ship Shoal, and other sites will be needed for barrier island and shoreline restoration (USDOI/MMS 2006b).

The Pacific region is divided into four planning areas: the South, Central, and Northern California areas and the Washington/Oregon planning area. The leased area in this region encompasses about 162,000 ha (400,000 acres), in which 79 leases are active (USDOI/MMS 2006c). There have been approximately 1,300 oil and gas wells drilled. Platform depths range from 29 m (95 ft) to 366 m (1,200 ft). Although no shoreline restoration projects have occurred in the Pacific region, the MMS has funded many studies of the potential environmental impact of sand and gravel dredging in all of the planning areas.

The affected environments along the Atlantic, Gulf of Mexico, and Pacific regions are described in Sections 4.2, 4.3, and 4.4, respectively. As indicated above, the OCS extends from about 3 nautical mi (3.5 statute mi; 5.6 km) off the coast (9 nautical mi [10 mi; 17 km] from the Texas coastline and the Gulf Coast of Florida) to about 200 nautical mi (230 mi; 370 km) into the ocean. For some resource areas, such as transportation, electromagnetic fields, coastal habitats, socioeconomic resources, land use, visual resources, and tourism and recreation, the affected environment would include part of the area covered by the State waters between the OCS and the coastline and some areas on land. The MMS expects that the applications to be received over the next 5 to 7 years for the development of alternative energy on the OCS will be in water depths of 100 m (330 ft) or less for wind and wave technologies and 500 m for marine current technologies. As a result, for most of the resource areas, the affected environment from these applications would not extend all the way to 200 nautical mi (230 mi; 370 km) into the ocean and, in fact, would cover only part of the OCS. In the following sections, these variations in the extent of the affected environment are discussed under individual resources as appropriate. The potential impacts from the expected alternative energy and alternate use program activities over the same period are described in Chapters 5, 6, and 7.

4.2 ATLANTIC REGION

4.2.1 Geology

4.2.1.1 General Description and Physiography

4.2.1.1.1 North to Mid-Atlantic Region. The North to Mid-Atlantic region is situated on a broad shelf with a width generally greater than 120 km (75 mi) (Figure 4.2.1-1). The 100-m (330-ft) water-depth contour generally coincides with the extent of the shelf in this area. The shelf is overlain by a mantle of sand, ranging in thickness from 20 m (65 ft) on the Mid-Atlantic portion of the shelf to 40 m (130 ft) on the North Atlantic portion. Linear sand ridges are also characteristic of the continental shelf in this region. Georges Bank, a broad and shallow platform on the shelf (with an area of about 67,000 km^2 [26,000 mi^2]), lies to the southeast of the Gulf of Maine. The Georges Shoals is a shallow area on the bank, with a depth of less than 20 m (65 ft). Georges Bank is separated from the rest of the shelf by two shallow channels: the Northeast Channel to the northeast, providing entrance to the Gulf of Maine, and the Great South Channel to the southwest, separating the bank from Nantucket Shoals. The eastern and southern sides of Georges Bank, at depths of 140 to 160 m (460 to 525 ft) along the shelf edge, are incised by several submarine canyons, gullies, and ravines. The New England Seamount chain lies to the east of Georges Bank (Scholle and Wenkam 1982; Shor and McClennen 1988).

The continental slope here is highly dissected by deep canyons and valleys. Submarine canyons in the North Atlantic region include (from northeast to southwest): Corsair, Lydonia, Oceanographer, Hudson, Wilmington, Baltimore, Washington, Norfolk, Pamlico, and Hatteras. Sediments on the slope are highly variable, but consist mainly of sandy silts on the upper slope and silts and clays on the lower slope (McGregor 1983).

The geological distinction between the North and Mid-Atlantic areas is based on the presence of two deep sedimentary basins that underlie the continental margin: the Georges Bank Basin to the north and the Baltimore Canyon Trough to the south (Figure 4.2.1-2). The elongate, northeast-trending basins are characterized by extensional tectonic features (horst and graben) related to the rifting between North America and Africa during the Triassic (about 200 million years ago). Both basins thicken seaward and have no physiographic expression. Georges Bank Basin is a collection of smaller basins with a thickness of greater than 10 km (6.2 mi); it merges with the Scotian Basin beneath the Canadian Shelf to the north. The Baltimore Canyon Trough is the deepest basin along the U.S. Atlantic margin, with a thickness of up to 18 km (11 mi) (McGregor 1983; Mattick and Hennessy 1980; Schlee and Klitgord 1988; Grow et al. 1988).

4.2.1.1.2 South Atlantic Region. Because of the position of the Gulf Stream, the continental shelf in the South Atlantic region has two distinct bathymetric areas: the Florida-Hatteras Shelf, a shallow, flat inner shelf where water depths are less than 100 m (330 ft); and

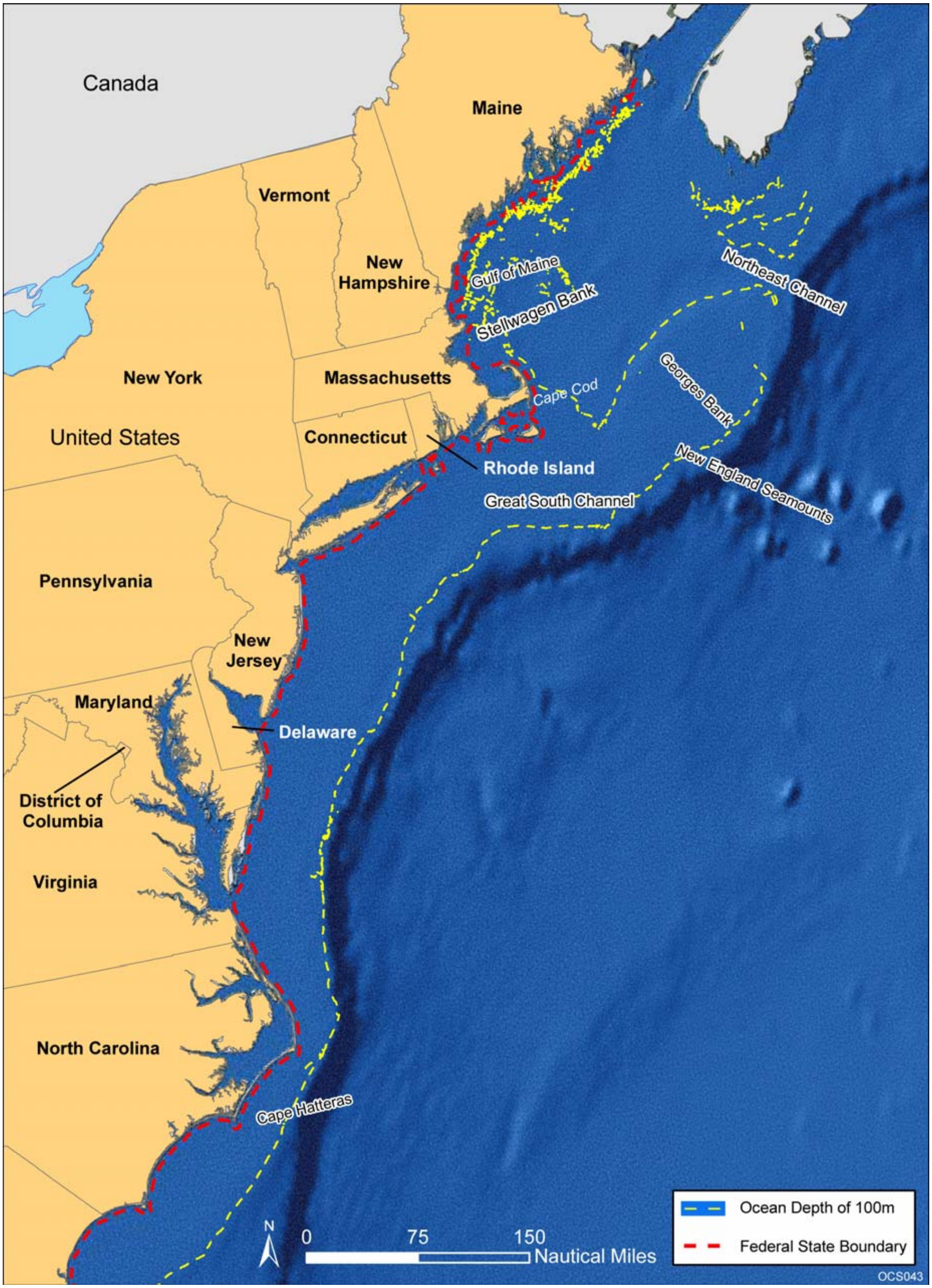

FIGURE 4.2.1-1 Physiographic Features along the North Atlantic Coast

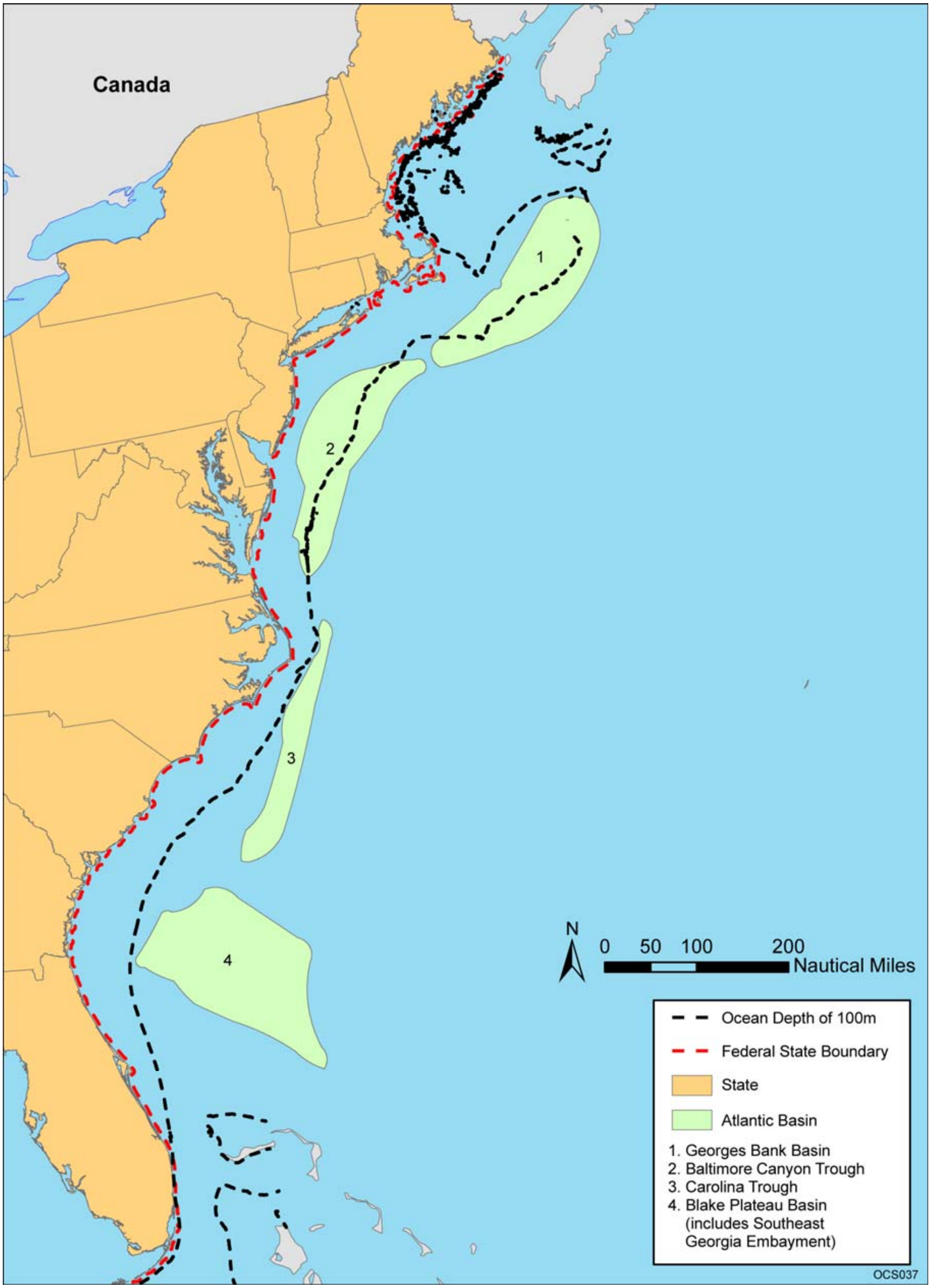

FIGURE 4.2.1-2 Major Basins on the Outer Continental Shelf within the Atlantic Region (Source: Folger 1988)

the Blake Plateau, an intermediate depth outer shelf where water depths range from 350 to 1,000 m (1,150 to 3,280 ft) (Figure 4.2.1-3). Connecting these two plains is a gently dipping slope, called the Florida-Hatteras Slope (Popenoe 1981; Shor and McClennen 1988).

The main physiographic features of the South Atlantic region (based on Popenoe 1981; Popenoe et al. 1982; Popenoe 1984; Silva and Booth 1986; Dillon and Popenoe 1988; Shor and McClennen 1988) are:

- ***Florida-Hatteras Shelf.*** The Florida-Hatteras Shelf is the shallow shelf off the South and Southeast Atlantic Coast. Its width ranges from 1 to 130 km (0.6 to 81 mi). The shelf is composed of Late Jurassic carbonate sediments and reefs of the Florida Platform (off the northern Florida coast) and the Carolina Platform (off the North Carolina coast). Over the platforms, terrigenous (land-derived) clastic sediments of Tertiary age form a thick wedge that has prograded out to and is truncated by the Gulf Stream. The Southeast Georgia Embayment is a deep sedimentary basin that lies below the shelf and has no physiographic expression. The basin extends from the coast between the Carolina and Florida Platforms and opens seaward beneath the Blake Plateau Basin. Sediment thicknesses in the embayment can be as high as 3.4 km (2.1 mi). The surface of the shelf is almost completely covered by a thin layer of sand, generally less than 5 m (15 ft) thick. In places where the sand cover is absent, the substrate is harder, consisting of exposures of cemented sand that can range from smooth outcrops to rough bottoms with relief up to 15 m (50 ft). Other physiographic features in this region include the Little and Great Bahama Banks (on the Florida Platform between Cape Canaveral and Miami). The Helena Banks fault has a surface trace of at least 30 km (19 mi) on the shelf.

- ***Florida-Hatteras Slope.*** The Florida-Hatteras Slope forms a gentle, transitional drop from the shallow shelf edge of about 60 m (200 ft) onto the Blake Plateau and the Straits of Florida to the south. The depth of the Blake Plateau is 600 to 800 m (1,970 to 2,630 ft) at the base of the slope. Reefs, sometimes referred to as shelf-edge ridges, occur near the top of the slope. The upper slope is smooth and largely devoid of submarine canyons.

- ***Blake Plateau.*** The Blake Plateau lies beneath and east of the Gulf Stream along the east side on the inner shelf (except in southern Florida). Because the Gulf Stream precludes deposition (instead transporting sediment along its current), sediment accumulation on the Blake Plateau has not kept pace with its rate of subsidence. The sediments of this plain are generally older than Paleocene, with only a thin section of later Tertiary sediments (mainly pelagic muds from biological sources). The western and northern portions of the plateau have a series of deep elongate and flat-bottomed erosional depressions caused by scouring by the Gulf Stream and other currents. The Blake Plateau is underlain by two deep sedimentary basins: the Carolina Trough and the

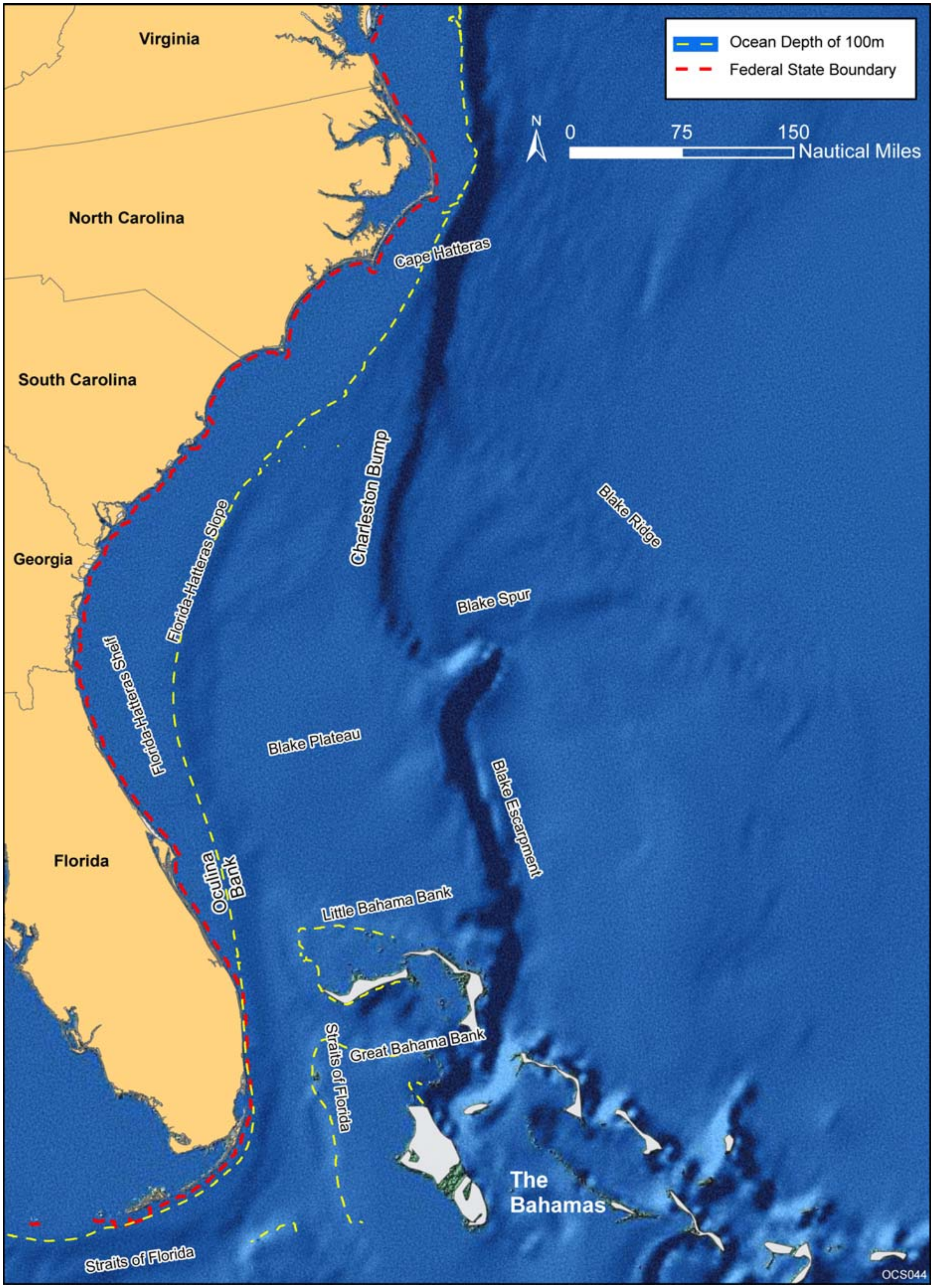

FIGURE 4.2.1-3 Physiographic Features along the South Atlantic Coast

Blake Plateau Basin. The Carolina Trough underlies the continental slope and upper rise to the east of North and South Carolina; the Blake Plateau Basin underlies the southern portion of the Blake Plateau to the east of Georgia and northern Florida. These basins have sediment accumulations of up to 13 km (8 mi), but have no physiographic expression. Salt diapirism is a distinct feature of the Carolina Trough. Deepwater corals have been recovered from the plateau and have likely existed there since the Late Pleistocene.

4.2.1.1.3 Straits of Florida

The Straits of Florida is a 180-km (110-mi) long passage that connects the Gulf of Mexico and the Atlantic Ocean along the southern edge of the Florida Keys, a series of limestone islands extending 225 km (140 mi) southwest of Florida (Figure 4.2.1-3). The continental shelf is narrow along this stretch of the Atlantic Coast; the 100-m (330-ft) water-depth contour is located within the width of the shelf, extending no more than 40 km (25 mi) offshore. The seafloor drops off sharply along the shelf edge in this area.

The physiography of the straits is influenced by the presence of carbonate sediments and reefs and by the Florida Current, part of the Gulf Stream that flows eastward out of the Gulf of Mexico into the Atlantic Ocean (Shor and McClennen 1988; McPherson and Halley 1996). The Jordon Knoll, located within the straits, is composed of remnants of an ancient reef system (Antoine 1972).

4.2.1.2 Coastal Features and Processes

The U.S. Atlantic Coast region is a low-lying area composed of a variety of coastal features, including mainland shores, delta plains, estuaries and bays, lagoons, barrier islands and capes, and tidal inlets. In the glaciated coasts of the north (from the United States-Canada border to New York City), the shorelines are deeply indented and bordered by numerous rocky islands. Glacial erosion has created embayments with straight sides and deep water. Portions of the coast are uplifted due to rebound; glacial features (moraines, drumlins, and outwash deposits) are common (Morton and Miller 2005; USACE 2002).

The central and south coastal region is characterized by continuous barrier islands and capes (spits) interrupted by inlets and large embayments with drowned dendritic river valleys (e.g., Delaware Bay and Chesapeake Bay). Extensive wetlands and marshes occur in areas where sediment and marsh vegetation have partially filled the lagoons behind barrier islands (Morton and Miller 2005; USACE 2002).

In the southeastern coastal region, barrier islands change in composition from quartz sand to carbonate sand because the shelf is mainly carbonate (coral reef). The Florida Keys are remnants of coral reefs that developed during the last interglacial period when sea level was higher. Live reefs currently grow to the east and south of the keys (Morton and Miller 2005; USACE 2002).

The Atlantic Coast is a mesotidal, mixed-energy region.[2] Its shoreline is constantly changing as a result of wind-driven waves and tidal currents that cause sediment transport. Although drift directions vary locally and seasonally, the predominant megascale drift direction (i.e., longshore current) is from north to south along north-south trending coastlines. Drift directions vary locally based on the locations of barrier islands and inlets. Seasonal storms, offshore bathymetry, and wave refraction patterns also have a great effect on local drift directions (Morton and Miller 2005; USACE 1992, 1995).

The primary sources of the sand that maintains the beaches and barriers along the Atlantic Coast are eroding beaches (upcurrent) and sand shoals on the inner continental shelf. With a few exceptions (e.g., Altamaha and Savannah Rivers in Georgia), rivers discharging to the Atlantic do not contribute significantly to the littoral system either because of river diversion and dam construction, which has reduced their flow and sediment supply, or because they empty into estuaries and deposit their sediment loads far inland from the shoreline (Morton and Miller 2005).

4.2.1.3 Geologic History

In the Late Triassic (about 200 million years ago), the Atlantic basin was closed, its future margins contained within a rift zone of shallow lacustrine and subaerial rift basins periodically flooded by the ancient Tethys Sea (which separated North and South Pangaea). During this time, marine transgression deposited evaporites as far south as today's Cape Hatteras; clastic sands, silts, and shales were also deposited as surrounding rift mountains were eroded. As rifting began between the North American and African Plates, the basin (graben) opened and a long, narrow seaway was formed. Because this seaway was cut off from the Tethys, the basin remained shallow and evaporites were deposited in local shallow basins (forming the early Carolina Trough). By the Middle Jurassic (about 170 million years ago) the ocean basin was wider and about 3 to 3.5 km (1.9 to 2.2 mi) deep. Carbonate reefs and banks formed on the North American continent margin. The ocean basin continued to widen into the Late Jurassic, a period of increased sediment accumulation and subsidence (Tucholke and McCoy 1986).

The Early Cretaceous (about 133 million years ago) was a period of low sea level. Gently sloping sediment prisms developed along the North American continent margin by deposition of terrigenous and shallow water clastic debris spilling over the continental shelf into the adjacent deep basins (e.g., the Baltimore Canyon Trough). Calcareous pelagic sediments were also deposited at this time. Turbidity currents (turbid underwater avalanches) were common and likely account for the rapid deposition and burial of carbon-rich sediments in these basins. In the Middle Cretaceous (about 118 million years ago), the Mid-Atlantic Ridge axis extended

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2 "Mesotidal" is a tidal category that refers to the tide range of a particular shoreline; the tidal range for the Atlantic is between 1 and 3.5 m (3 and 11.5 ft). "Mixed energy" is an energy-based shoreline classification taking into account the relative influence of the tidal range and mean wave height (USACE 1995). "Mixed energy" applies to the entire Atlantic Coast; shorelines to the south tend to be storm-dominated (i.e., characterized by episodic high wave energy), while shorelines to the north tend to be tide-dominated.

northward and eastward and seawater from the north entered the rift zone and connected the North and South Atlantic Oceans. The Late Cretaceous (84 to 69 million years ago) was a period of continued spreading, and extensive deposition and deepening of the sedimentary basins along the continental margin. The New England Seamounts were formed by this time (Tucholke and McCoy 1986).

The ocean basin continued to enlarge during the Early Tertiary (Middle Eocene, about 49 million years ago). Pelagic shales and turbidites rich in calcareous and biosiliceous debris were deposited over large areas. This was followed by a period (Early Oligocene, about 35.5 million years ago) of strong abyssal circulation. Water passing from the Arctic Ocean into the North Atlantic created a flow that caused extensive erosion along the margins of basins in the Atlantic. Thick sequences of sediments were eroded, cutting down to Lower Cretaceous levels in the southeastern part of the continent. Mass movement of sediments along the margin was common during this time. In the Late Tertiary (Late Miocene, about 9.5 million years ago), calcareous lithofacies became more widespread (Tucholke and McCoy 1986).

During low sea level cycles associated with glacial epochs of the Pleistocene (less than one million years ago), glaciers in the north scoured the continental shelf and deposited debris on the continental margin (Tucholke and McCoy 1986).

4.2.1.4 Mineral Resources

There have been no oil and gas leases off the Atlantic Coast since November 17, 2000 (USDOI/MMS 2006d). However, the MMS estimates that undiscovered oil and gas resources could be as high as 3.8 billion barrels (bbl) of oil and 1.1 trillion m^3 (37 trillion cubic feet [tcf]) of natural gas (USDOI/MMS 2006e). The 2000 Outer Continental Shelf Assessment identified potential reserves in the Georges Bank Basin, the Baltimore Canyon Trough, the Carolina Trough, and the Southeast Georgia Embayment (USDOI/MMS 2001). These occur in progradational clastic sediments within delta and fan complexes (Lower Cretaceous to Upper Jurassic) on the inner shelf and within reef complexes and associated carbonate talus (Middle to Upper Jurassic) on the inner shelf edge. Source rocks tend to be shales and platform carbonates. Trapping structures are typically anticlines, normal faults, and sediment pinchouts against diapirs.

The Atlantic OCS is also rich in hard mineral resources. Reserves include an estimated 2 trillion cubic m^3 (70 tcf) of sand and gravel on the inner shelf, and between 9 million and 91 million metric tons (10 million and 100 million tons) of manganese nodules and pavements (providing manganese, nickel, cobalt, and copper) on the Blake Plateau (Popenoe 1984; Duane and Stubblefield 1988; Riggs and Manheim 1988). Riggs and Manheim (1988) report that Atlantic coastal plain deposits in the southeast (mainly Florida and North Carolina) accounted for 87% of the U.S. production of phosphate in 1980; the reserve potential for the southeast Atlantic is extremely large. Phosphorite (phosphate ore) is also present further offshore in the pavements of the Blake Plateau (Popenoe 1984; Riggs and Manheim 1988). Other significant resources include placer deposits rich in titanium, rare earths, zirconium, aluminosilicates, and precious metals (gold, silver, and platinum), in unconsolidated shoreline sediments and

Pleistocene fluvial channels on the inner shelf; clay deposits (e.g., kaolin); high-grade calcium carbonate sands, diatomites, evaporates, and peats (U.S. Commission on Ocean Policy 2004; Riggs and Manheim 1988).

4.2.1.5 Geologic Hazards

Geologic hazards that may affect offshore operations off the U.S. Atlantic Coast are mainly associated with the scouring action of ocean currents, and seafloor instability caused by irregular topography, sedimentary processes, and strong ocean currents. Potential geohazards include:

- ***Scouring action of ocean currents.*** Vigorous tidal circulation and storm waves have an important effect on the transport of sediments on the surface of the continental shelf (e.g., at Georges Bank) (Folger 1988). Episodic sediment movement caused by ocean currents and waves can undermine foundation structures and lead to failure. The powerful currents of the Gulf Stream and other ocean currents sweep the surface of the Blake Plateau, creating numerous scour depressions and channels that contribute to its uneven topography (Popenoe 1981). The energy of currents and waves also poses a hazard risk to submarine cables and moorings.

- ***Slope failures.*** Unconsolidated surficial sediments are water saturated and susceptible to liquefaction and mass movement (slumping, mudslides, or gravity flows), which can be triggered by earthquakes, wave and tidal currents, storm surges, faulting, sediment loading, dissociation of hydrates, dewatering processes, or human activity. Although slumping on the Florida-Hatteras Slope is rare, major rotational slumps associated with salt diapirs have been observed (Popenoe 1981; Popenoe et al. 1982). McGregor (1983), Slater (1981), and Embley and Jacobi (1986) have noted widespread mass movement on the continental slope in the North Atlantic, especially within canyon areas. These factors present potential hazards to foundation structures, submarine cables, and moorings.

- ***Faulting.*** Seismic studies by Popenoe et al. (1982) have shown active faults to be present on both the Florida-Hatteras Shelf (e.g., Helena Banks fault) and along the edge of the Blake Plateau in the South Atlantic OCS. These faults may also provide conduits through which deep gases may rise to surficial sediments. Oil seeps and gas vents may indicate near-surface faulting.

- ***Tsunamis.*** Submarine earthquakes along faults with large vertical displacement anywhere in the Atlantic may create a tsunami. More locally, submarine landslides also have the potential to create tsunamis. Driscoll et al. (2000) have investigated an area off the coast of southern Virginia and North Carolina that may be in the early stages of large-scale slope failure, putting these coastlines and the lower Chesapeake Bay at risk. Collapse of volcanic islands in the east Atlantic (e.g., the Canary Islands) could also trigger a tsunami that could have significant, if not catastrophic, impacts on the U.S. Atlantic Coast (Terradaily 2004).

- ***Fluid and gas expulsion.*** Gaseous sediments may be present as a result of decomposing organic matter (biogenic) or gas rising along fault planes from a deeper reservoir into surficial sediments (thermogenic). Gaseous sediments tend to have a lower shear strength and less load-bearing capacity than nongaseous sediments and may prove to be an unstable substrate for foundation structures. Fluids and gases containing sulfur, hydrogen sulfide, and/or carbon dioxide are also toxic and corrosive.

- ***Variable bottom types.*** Bottom types range from lithified hard bottoms or hardpans to extremely soft fluid mud bottoms. These substrates vary in density and can affect the mooring and anchoring of structures.

- ***Irregular topography.*** Topography of the continental slope (and to a lesser extent, the continental shelf) is very irregular. Various features, including reef mounds, salt diapers, submarine channels and canyons, scour depressions, escarpments, and karst features associated with carbonates are found throughout the Atlantic OCS. These features are highly variable in load-bearing capacity over short vertical and horizontal distances and may present potential hazards to the emplacement of foundation structures, submarine cables, and moorings. Sediments across irregular topography vary in thickness. Steep slopes and scarps increase the risk of sediment failure.

At water depths of 100 m (300 ft) or less, the most likely geologic hazards to be encountered are scouring, irregular topography, variable bottom types, faulting, and the effects of tsunamis, if they were to occur anywhere in the Atlantic. Mass movement could also be of concern in shelf areas of thick sediment accumulation along steep slopes and scarps.

4.2.2 Meteorology and Air Quality

4.2.2.1 Meteorology

The climate of the offshore Atlantic Ocean and adjacent land areas is influenced by the temperatures of the surface waters and water currents as well as the winds blowing across the waters. Because of the ocean's great capacity for retaining heat, maritime climates are moderate and free of extreme seasonal variations. The oceans are the major source of the atmospheric moisture that is obtained through evaporation. Climatic zones vary with latitude; the warmest climatic zones stretch across the Atlantic north of the equator and the coldest zones are in the high latitudes, with the areas covered by sea ice. Ocean currents contribute to climatic control by transporting warm and cold waters between regions. Adjacent land areas are affected by the winds that are cooled or warmed when blowing over these currents, while such winds also transport moisture to adjacent land areas.

On the northern coastal areas off the Atlantic Ocean, the most frequent wind directions measured by National Data Buoy Center buoys are from the southwest or south-southwest, but wind directions are relatively uniformly distributed (NOAA 2006a). The average wind speeds are between 5.6 and 7.3 meters per second (m/s) (12.4 to 16.2 miles per hour [mph]). Wind speeds are typically lowest in July at 4.0–5.4 m/s (9.0–12.1 mph) and highest in January at 7.0–9.0 m/s (15.7–20.0 mph). Off the mid-Atlantic Coast, wind patterns are quite similar to those off the northern coast. The prevailing winds are from south to southwest with average wind speeds between 5.9 and 7.2 m/s (13.2 to 16.0 mph). Off the south Atlantic Coast, the prevailing wind direction is from south to southwest in the northern part (South Carolina and Georgia) and from southeast to east-southeast in the southern part (Florida). Average wind speeds range from 5.4 to 6.4 m/s (12.1 to 14.4 mph) and exhibit smaller monthly variations than along the mid- and north Atlantic Coasts.

The Atlantic Coast OCS regions are situated between about 25–45°N latitude, and thus variations in annual average temperatures are relatively large, ranging from 8.2–15.3°C (46.8–59.5°F) in the north Atlantic Coast to 20.7–24.1°C (69.3–75.4°F) in the south Atlantic Coast (NOAA 2006a). In the colder months, there is more variability in temperature, especially along the northern coast. In January and February ambient temperatures range from −2.0°C (28.4°F) along the northern coast to 12.9°C (55.2°F) along the southern coast. During the warm months, there is little diurnal, daily, or spatial variation in temperature. In August, average temperatures in the OCS regions range from 24.0°C (75.2°F) along the northern coast to 28.1°C (82.6°F) along the southern coast. Air temperatures over the southern coast and offshore Atlantic Ocean exhibit smaller daily and seasonal variations due to the moderating effects of large bodies of water.

In the south Atlantic coastal areas, precipitation is frequent and abundant throughout the year, but tends to peak in the summer months. In the north Atlantic coastal areas, precipitation is also frequent and abundant but uniformly distributed around the year (Bair 1992). Mean annual rainfall along the coastal areas ranges from about 106.5 cm (41.91 in.) in Block Island, Rhode Island, to 146.2 cm (57.55 in.) in Miami, Florida. Rainfall in the warmer months is usually associated with convective cloud systems that produce showers and thunderstorms. Winter rains are associated with the passage of frontal systems through the area. Precipitation also falls in the form of snow in the north Atlantic coastal areas, but only a trace of snow falls in the south Atlantic coastal areas. Highest snowfall among coastal areas occurs in Portland, Maine, with a maximum monthly average of 158.5 cm (62.4 in.).

At various locations in the Atlantic Coast OCS regions, fog occurs occasionally in cooler months as a result of warm, moist Gulf air blowing over cool land or water surfaces. Poorest visibility conditions occur from November through April. During periods of air stagnation, industrial pollution and agricultural burning also can impact visibility.

Atmospheric stability and mixing height provide a measure of the amount of vertical mixing of pollutants. Over water, the atmosphere tends to be neutral to slightly unstable since there is usually a positive heat and moisture flux. Over land, the atmospheric stability is more variable, being unstable during the daytime, especially in the summer months due to rapid surface heating, and stable at night, especially under clear conditions in the cooler season. The mixing height over water typically ranges between 500 to 1,000 m (1,640 to 3,281 ft) with a slight diurnal variation (Holzworth 1972). Mixing height over land can be 1,500 m (4,921 ft) or greater during the afternoon in the summertime and near zero during clear, calm conditions at night in the wintertime.

Hurricanes develop in the southern part of the Atlantic Ocean. The hurricane season in the Atlantic Ocean runs from June to November, with a peak around September 10. On average, 10.1 named storms—tropical disturbances that reach tropical storm intensity—occur each season, with an average of 5.9 becoming hurricanes and 2.5 becoming major hurricanes (Category 3 or higher). Most storms form in warm waters several hundred miles north of the equator. Once a tropical system is formed, it usually travels west and slightly north while strengthening. Many storms curve to the northeast near the Florida peninsula. The Atlantic basin averages about 10 storms of tropical storm strength or greater per year; about half reach hurricane level (NOAA 2005). Storms weaken as they encounter cooler water, land, or vertical wind shear, sometimes transitioning into an extratropical storm, mostly affecting the northern Atlantic coastal area.

4.2.2.2 Air Quality

The Clean Air Act (CAA) of 1970 established the National Ambient Air Quality Standards (NAAQS) for six pollutants, known as "criteria" pollutants—sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$),[3] and lead (Pb) (40 CFR 50). Collectively, the criteria pollutants are indicative of the quality of the ambient air. Table 4.2.2-1 presents the current primary and secondary NAAQS for the six criteria pollutants. The primary standards are referred to as "health effects standards." These standards are set at levels to protect the health of the most susceptible individuals in the population: the very young, the very old, and those with respiratory problems. The U.S. Environmental Protection Agency (USEPA) has designated secondary standards to protect public welfare. These are referred to as "quality of life standards." All of the standards are expressed as concentration in air and duration of exposure. Many standards address both short- and long-term exposures. Any individual State may adopt a more stringent set of standards. For example, the State of Florida has ambient standards for SO_2 that are somewhat more stringent than the NAAQS.

When the pollutant levels in an area have caused repeated violations of a particular standard, the area is classified as "nonattainment" for that pollutant. The USEPA has established classification designations based on regional monitored levels of ambient air quality in accordance with the CAA Amendments of 1990. These designations impose Federal regulations on pollutant emissions and a time period in which the area must again attain the standard,

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[3] PM_{10} and $PM_{2.5}$ are particulate matter with aerodynamic diameters of ≤ 10 μm and ≤ 2.5 μm, respectively.

TABLE 4.2.2-1 National Ambient Air Quality Standards (NAAQS) and Maximum Allowable Increments for Prevention of Significant Deterioration (PSD)

		NAAQS[b]			PSD Increments[d] ($\mu g/m^3$)	
Pollutant[a]	Averaging Time	Standard Value		Standard Type[c]	Class I	Class II
SO_2	3 hours (h)	0.5 ppm	(1,300 $\mu g/m^3$)	S	25	512
	24 h	0.14 ppm	(365 $\mu g/m^3$)	P	5	91
	Annual	0.030 ppm	(80 $\mu g/m^3$)	P	2	20
NO_2	Annual	0.053 ppm	(100 $\mu g/m^3$)	P, S	2.5	25
CO	1 h	35 ppm	(40 mg/m^3)	P	–[e]	–
	8 h	9 ppm	(10 mg/m^3)	P	–	–
O_3	1 h	0.12 ppm[f]	(235 $\mu g/m^3$)	P, S	–	–
	8 h	0.08 ppm	(157 $\mu g/m^3$)	P, S	–	–
PM_{10}	24 h	150 $\mu g/m^3$		P, S	8	30
	Annual	–[g]		P, S	4	17
$PM_{2.5}$	24 h	35 $\mu g/m^3$[g]		P, S	–	–
	Annual	15.0 $\mu g/m^3$		P, S	–	–
Pb	Calendar quarter	1.5 $\mu g/m^3$		P, S	–	–

[a] CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter ≤ 2.5 µm; PM_{10} = particulate matter ≤ 10 µm; and SO_2 = sulfur dioxide.

[b] Refer to 40 CFR Part 50 for detailed information on attainment determination and reference method for monitoring (refer to http://www.gpoaccess.gov/cfr/index.html and http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-8477.pdf).

[c] P = Primary standards, which set limits to protect public health; S = Secondary standards, which set limits to protect welfare and quality of life.

[d] Class I areas are specifically designated federally owned areas (e.g., national parks) in which degradation of air quality is severely restricted under the Clean Air Act; Class II areas have somewhat less stringent allowable impacts.

[e] — means no standard exists.

[f] The USEPA's revised O_3 standards replaced the 1-h standard. However, 1-h standard will continue to apply to areas not attaining it for an interim period to ensure an effective transition to the new 8-h standard.

[g] Effective December 17, 2006, USEPA revoked the annual PM_{10} standard of the current 50 $\mu g/m^3$ and revised the 24-hour $PM_{2.5}$ standard from the original level of 65 $\mu g/m^3$ to 35 $\mu g/m^3$ (refer to http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-8477.pdf).

Sources: 40 CFR 50; 40 CFR 52.21.

depending on the severity of the regional air quality problem. The attainment status for the Federal OCS waters is unclassified because there is no provision for any classification in the CAA for waters outside the boundaries of State waters. Only areas within State boundaries are classified as either attainment, nonattainment, or unclassifiable. However, as will be discussed in greater detail later, air quality in adjacent onshore areas may be affected by releases of air pollutants from OCS sources. For the purpose of applying equitable controls on those sources, potentially affected onshore areas are formally designated as Corresponding Onshore Areas (COAs), and the NAAQS attainment status of those COAs is applied to the OCS area under consideration for the purpose of determining appropriate controls on air pollution sources in that OCS area.

In general, air quality in the coastal counties of the lower-mid and south Atlantic coastal regions is better than the national standards. Currently, all of the coastal counties[4] in North and South Carolina, Georgia, and Florida are in attainment for all criteria pollutants (USEPA 2006a).[5] None of the coastal counties along the Atlantic Coast are subject to the 1-hour ozone standard, and all counties meet the NAAQS for SO_2, NO_2, and Pb. However, some coastal counties in mid-Atlantic and northeastern States are not in attainment for ozone and/or $PM_{2.5}$. Only New York County in New York State is not in attainment for PM_{10}. In particular, coastal counties in Connecticut, New Jersey, and New York are in nonattainment for both ozone and $PM_{2.5}$. Ozone is a regional air pollutant issue. Emission controls are needed for local and regional sources to reduce ambient ozone levels. Prevailing southwest to west winds carry air pollution from the Ohio River Valley, where major NO_x emission sources (e.g., power plants) are located, and from mid-Atlantic metropolitan areas, to the northeast, contributing to high-ozone episodes.

Coastal counties from Virginia to Maine are classified as moderate or marginal nonattainment areas for ozone. For the 2001–2005 period, the fourth-highest 8-hour average ozone concentrations in the region ranged from 0.101 to 0.116 parts per million (ppm), with the highest occurring in Ocean County, New Jersey (USEPA 2006b). For PM_{10}, New York County in New York State was classified as a moderate nonattainment area. However, 99th-percentile 24-hour and annual average[6] PM_{10} concentrations were 67 $\mu g/m^3$ in 2002 and 30 $\mu g/m^3$ in 2001, respectively, for this county, which is well under the respective NAAQS of 150 and 50 $\mu g/m^3$. Nonattainment areas for $PM_{2.5}$ are limited to coastal counties in Connecticut, New Jersey, and New York. The highest annual-average concentration in 2001–2005 was 19.5 $\mu g/m^3$ in Hudson, New Jersey, in 2001.

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4 Many factors, especially topography, influence the extent to which an air mass over the OCS will migrate inland. The landward penetration of the sea breeze reaches 15 to 50 km (9 to 30 mi) in the temperate zones (http://www.pilotfriend.com/av_weather/meteo/prv_wnd.htm). Topographic features notwithstanding, onshore areas within 50 km (31 mi) of the coastline are considered in these analyses.

5 Because nonattainment status is not static, please refer to the USEPA's Greenbook for the most up-to-date nonattainment status (http://www.epa.gov/air/oaqps/greenbk/).

6 Effective December 17, 2006, USEPA revoked the annual PM_{10} standard of the current 50 $\mu g/m^3$ (refer to http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-8477.pdf).

Class I Areas are defined in Sections 101(b)(1), 169A(a)(2), and 301(a) of the CAA as amended [42 USC 7401(b), 7410, 7491(a)(2), and 7601(a)]. Class I areas are federally owned properties for which air quality-related values are highly prized and for which no diminution of air quality, including visibility, can be tolerated. Class I Areas are under the stewardship of four Federal agencies: USDOI's Bureau of Land Management (BLM), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), and Department of Agriculture's (USDA's) Forest Service (USFS). USEPA has promulgated a list of 156 Federal Class I Areas as mandated by Subpart D of 40 CFR 81.400 et seq. Class I Areas are protected by stringent air quality standards that allow for very little deterioration of ambient air quality. The Prevention of Significant Deterioration (PSD) regulations (40 CFR 52.21 et seq.), which are designed to protect ambient air quality, apply to major new sources and major modifications to existing sources located in an attainment or unclassified area. PSD regulations limit the maximum allowable incremental increases in ambient concentrations above established baseline levels of SO_2, NO_2, and PM_{10}, as shown in Table 4.2.2-1. Incremental increases in PSD Class I areas are severely limited, while greater incremental increases are allowed in Class II areas.

A number of these Class I areas are located on or near the coastlines adjacent to the Atlantic Ocean OCS region and, therefore, air quality in these areas could be influenced by activities taking place within the OCS area. These lands are under the stewardship of three Federal agencies, including the USDOI's NPS and USFWS and the USDA's USFS. A map of the Mandatory Class I Federal Areas potentially affected by OCS activities and their corresponding 100-km and 200-km buffers along the Atlantic Coast is shown in Figure 4.2.2-1 with information on each of these Class I Federal Areas presented in Table 4.2.2-2. In general, air quality analysis must be made in coordination with the Federal Land Manager if a proposed Federal action is within 100 km of a Class I area (see: http://www.epa.gov/fedrgstr/EPA-AIR/1996/July/Day-23/pr-23531.html). However, large emission sources located beyond 200 km of a Class I Federal Area can also trigger PSD Class I requirements if a significant impact on the region is suspected.

4.2.2.3 Regulatory Controls on OCS Activities That Affect Air Quality

An array of Federal and State authorities controls OCS activities that have the potential to affect air quality. Section 328 of the Clean Air Act Amendments of 1990 (CAAA 1990) directs that rules establishing air pollution control requirements for OCS sources be promulgated, ensuring attainment and maintenance of Federal and State ambient air quality standards in COAs and equitable treatment of onshore and OCS sources. Under Section 328, authority for control of air emissions from OCS sources was divided between USEPA and USDOI/MMS. USEPA has authority over all OCS sources except those located in the Gulf of Mexico west of 87.5°W longitude (at approximately the Florida-Alabama border), and the MMS has authority over facilities located in the Gulf of Mexico west of 87.5°W longitude. Prior to the promulgation of Section 328 of CAAA 1990, USDOI/MMS had jurisdiction over all of the OCS under the Outer

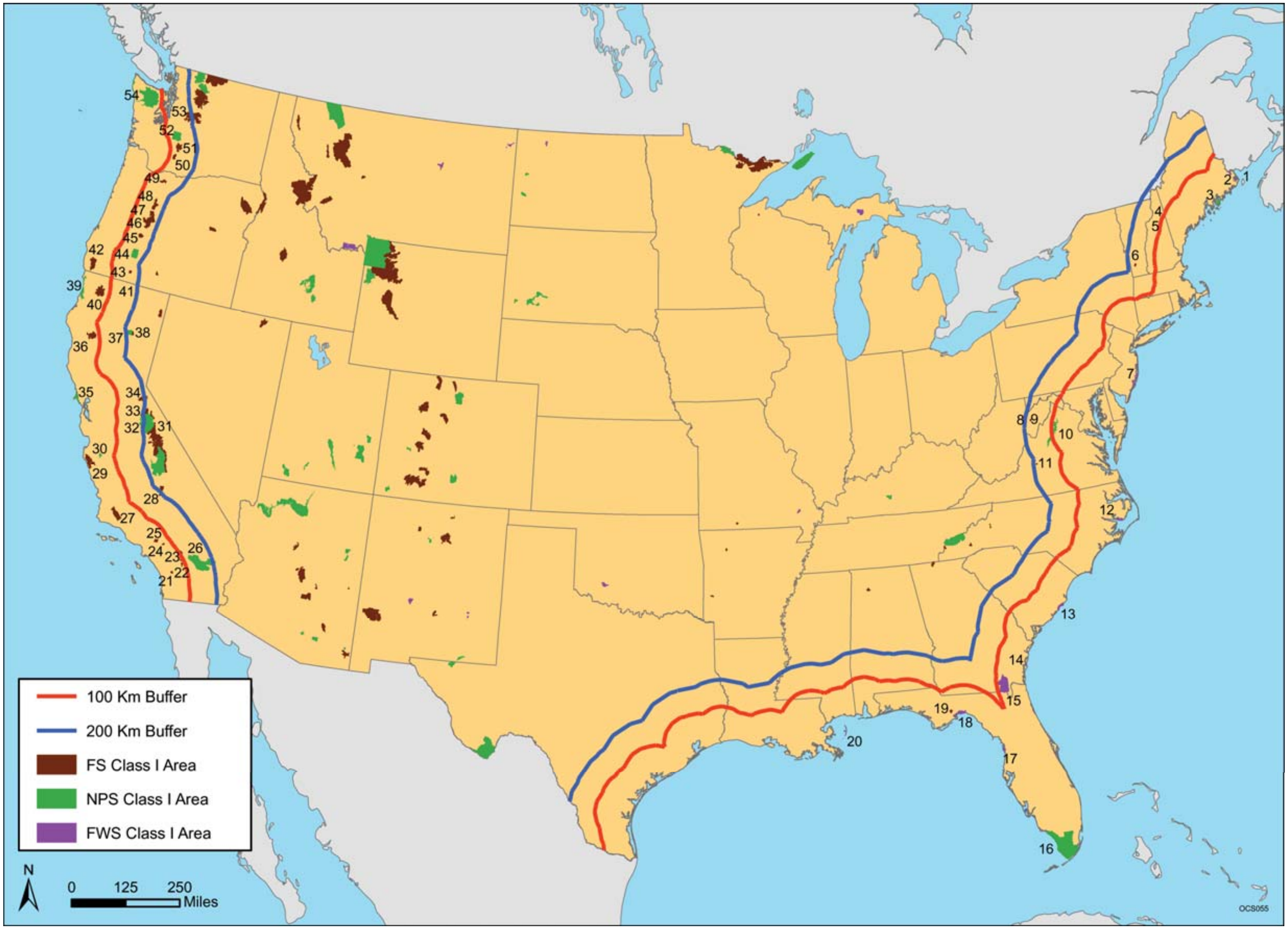

FIGURE 4.2.2-1 Mandatory Class I Federal Areas within 100-km and 200-km Buffers from the Atlantic, Pacific, and Gulf Coastlines (see Table 4.2.2-2 for key to Federal Class I Areas)

TABLE 4.2.2-2 Mandatory Class I Federal Areas Adjacent to the Atlantic, Gulf, and Pacific Coasts (See Figure 4.2.2-1)

No.	State	Area Name[a]	Federal Land Manager[b]	Area (acres)	Offshore Region
1	New Brunswick, Canada	Roosevelt Campobello International Park	NPS	2,721	North Atlantic
2	Maine	Moosehorn WA	USFWS	7,501	North Atlantic
3	Maine	Acadia NP	NPS	37,503	North Atlantic
4	New Hampshire	Great Gulf WA	USFS	5,502	North Atlantic
5	New Hampshire	Presidential Range-Dry River WA	USFS	20,000	North Atlantic
6	Vermont	Lye Brook WA	USFS	12,430	North Atlantic
7	New Jersey	Brigantine WA	USFWS	6,603	North Atlantic
8	West Virginia	Dolly Sods WA	USFS	10,215	Mid Atlantic
9	West Virginia	Otter Creek WA	USFS	20,000	Mid Atlantic
10	Virginia	Shenandoah NP	NPS	190,535	Mid Atlantic
11	Virginia	James River Face WA	USFS	8,703	Mid Atlantic
12	North Carolina	Swanquarter WA	USFWS	9,000	Mid Atlantic
13	South Carolina	Cape Romain WA	USFWS	28,000	South Atlantic
14	Georgia	Wolf Island WA	USFWS	5,126	South Atlantic
15	Georgia	Okefenokee WA	USFWS	343,850	South Atlantic
16	Florida	Everglades NP	NPS	1,397,429	South Atlantic
17	Florida	Chassahowitzka WA	USFWS	23,360	Eastern Gulf of Mexico
18	Florida	St. Marks WA	USFWS	17,745	Eastern Gulf of Mexico
19	Florida	Bradwell Bay WA	USFS	24,602	Eastern Gulf of Mexico
20	Louisiana	Breton WA	USFWS	5,000	Central Gulf of Mexico
21	California	Agua Tibia WA	USFS	15,934	Southern California
22	California	San Jacinto WA	USFS	20,564	Southern California
23	California	San Gorgonio WA	USFS	34,644	Southern California
24	California	Cucamonga WA	USFS	9,022	Southern California
25	California	San Gabriel WA	USFS	36,137	Southern California
26	California	Joshua Tree WA	NPS	429,690	Southern California
27	California	San Rafael WA	USFS	142,722	Southern California
28	California	Dome Land WA	USFS	62,206	Southern California
29	California	Ventana WA	USFS	95,152	Central California
30	California	Pinnacles WA	NPS	12,952	Central California
31	California	Yosemite NP	NPS	759,172	Central California
32	California	Emigrant WA	USFS	104,311	Central California
33	California	Mokelumne WA	USFS	50,400	Central California
34	California	Desolation WA	USFS	63,469	Central California
35	California	Point Reyes WA	NPS	25,370	Central California
36	California	Yolla-Bolly-Middle-Eel WA	USFS	109,091	Northern California
37	California	Lassen Volcanic NP	NPS	105,800	Northern California
38	California	Thousand Lakes WA	USFS	15,695	Northern California
39	California	Redwood NP	NPS	27,792	Northern California
40	California	Marble Mountain WA	USFS	213,743	Northern California
41	California	Lava Beds WA	NPS	28,640	Northern California
42	Oregon	Kalmiopsis WA	USFS	76,900	Washington/Oregon
43	Oregon	Mountain Lakes WA	USFS	23,071	Washington/Oregon

TABLE 4.2.2-2 (Cont.)

No.	State	Area Name[a]	Federal Land Manager[b]	Area (acres)	Offshore Region
44	Oregon	Crater Lake NP	NPS	160,290	Washington/Oregon
45	Oregon	Diamond Peak WA	USFS	36,637	Washington/Oregon
46	Oregon	Three Sisters WA	USFS	199,902	Washington/Oregon
47	Oregon	Mount Washington WA	USFS	46,116	Washington/Oregon
48	Oregon	Mount Jefferson WA	USFS	100,208	Washington/Oregon
49	Oregon	Mount Hood WA	USFS	14,160	Washington/Oregon
50	Washington	Mount Adams WA	USFS	32,356	Washington/Oregon
51	Washington	Goat Rocks WA	USFS	82,680	Washington/Oregon
52	Washington	Mount Rainier NP	NPS	235,239	Washington/Oregon
53	Washington	Alpine Lakes WA	USFS	303,508	Washington/Oregon
54	Washington	Olympic NP	NPS	892,578	Washington/Oregon

[a] NP = National Park; WA = Wilderness Area.

[b] USFS = U.S. Forest Service; USFWS = U.S. Fish and Wildlife Service; NPS = National Park Service.

Source: 40 CFR 81.400 et seq.

Continental Shelf Lands Act (OCSLA).[7] USEPA promulgated rules pursuant to its Section 328 authority on September 4, 1992. Those rules were codified as 40 CFR Part 55. Under authority of OCSLA, the MMS has promulgated regulations in 30 CFR 250 for oil, gas, and sulfur operations. The MMS is developing separate regulations under its CAAA 1990 authority to address OCS alternative energy sources.

Under the USEPA rules, for all OCS sources located within 25 mi of States' seaward boundaries, the requirements are the same as the requirements that would be applicable if the source were located in the COA.[8] In States affected by this rule, State boundaries extend 3 mi from the coastline, except off the coast of the Florida Panhandle, where that State's boundary extends three leagues (approximately 9 mi) from the coastline. Sources located beyond 25 mi of States' boundaries are subject to Federal requirements for Prevention of Significant Deterioration (PSD) (40 CFR Part 52). New Source Performance Standards (NSPS) (40 CFR Part 60) and National Emissions Standards for Hazardous Air Pollutants Standards (NESHAPS) (40 CFR Part 61) also apply under Section 328 to the extent that their application would be

7 Section 328 of the Clean Air Act does not in any way affect MMS's authority to grant licenses for activities anywhere on the OCS as established by the OCSLA. Section 328 grants of authority extend only to the control OCS sources that have the potential to impact air quality by release of air pollutants into the atmosphere.

8 The concept of a Corresponding Onshore Area (COA) is a unique and critical aspect of the Section 328 authority and of USEPA's OCS regulations. Differential heating of land and water surfaces causes daily exchanges of air masses between offshore areas and COAs. Thus, air pollutants emitted from OCS facilities can impact the air quality of nearby onshore areas. Circumstantial factors influence the geographic boundaries of a COA and thus COAs must be formally designated with respect to each OCS facility under consideration.

necessary to ensure that COAs can attain or maintain compliance with NAAQS. For OCS sources within 25 mi of the seaward boundary of a State or air pollution control district (APCD) for which authority has been delegated for implementation of CAA requirements, analogous State permit requirements and other controls would be applied as necessary to ensure successful State Implementation Plan (SIP) execution.

The USEPA rules also establish procedures for USEPA to delegate implementation and enforcement of its OCS requirements to State and local agencies for all activities occurring on the OCS within 25 mi of the States' seaward boundaries. Beyond 25 mi from these boundaries, delegation of authority is not possible, and OCS rules will be implemented and enforced solely by USEPA. The new regulations also establish procedures to allow the USEPA administrator to exempt any OCS source from a control technology requirement if it is technically infeasible or poses an unreasonable threat to health or safety.

Section 328 of the Clean Air Act also establishes a unique treatment for vessels associated with OCS facilities. With respect to calculations of the facility's Potential to Emit (PTE),[9] emissions from vessels that are servicing or associated with the operations of OCS facilities must be counted as direct emissions from the OCS source when those vessels are at the source or en route to or from the source when within 25 mi of the source.[10] USEPA rules at 40 CFR 55 replicate this treatment of vessels with respect to PTE calculations.

Finally, some activities associated with OCS sources may require compliance with the General Conformity Rule (also known as the Air Conformity Rule or Air Conformity) and the Transportation Conformity Rule. Section 176 of CAAA 1990 requires that Federal actions conform to applicable SIPs developed by States and approved by USEPA for the purpose of attaining or maintaining compliance with NAAQS. Federal actions include any action engaged in by the Federal Government, or any activity that a department, agency, or instrumentality of the Federal Government supports by providing financial assistance, licenses, permits, or approvals in any way. To conform to a SIP, the Federal action must not: cause or contribute to new violations of NAAQS, interfere with any provision of an approved SIP, increase the frequency or severity of existing violations of NAAQS, or delay timely attainment or interim emission reductions. Two types of conformity considerations, applicability and determination, are required. The General Conformity Rule applies to all Federal actions occurring in a NAAQS nonattainment or

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9 A facility's PTE determines the applicability of various permits. For facilities within any of the 28 standard industrial classifications (SICs) specified in PSD regulations [See 40 CFR 52.21(b)(1)(I)(a)], PSD requirements apply when the facility's PTE exceeds 100 tons per year (tpy) for any of the six NAAQS pollutants. For facilities in any other SIC, PSD permit requirements apply when the PTE exceeds 250 tpy. Likewise, a facility's PTE determines its status as a Major or Minor facility under the Title V Permit program and thus its eligibility for a Title V permit.

10 Discussion of regulatory construction in 40 CFR 55 suggests that USEPA's interpretation of Section 328 would include a consideration of the air quality impacts of vessels associated with only the operation of the OCS facility, and not its construction or decommissioning. Permits issued to date under 40 CFR 55 are consistent with this interpretation. However, it is within the discretionary authority of regulators to require that permits be secured for a facility's construction phase, including PSD permits, when projections indicate that PSD emission limits would be exceeded.

maintenance area. (In the case of OCS sources, the nonattainment or maintenance area would be the designated COA.)[11]

The applicability analysis requires Federal agencies to identify, analyze, and quantify emission impacts of an action where the total direct and indirect emissions for criteria pollutants in a nonattainment or maintenance area exceed rates (known as *de minimus* rates), specified in 40 CFR 93.153(b)(1) and (2). Actions are subject to the General Conformity rule if the emissions are deemed to be regionally significant, even when the total direct and indirect emissions are less than the *de minimus* rates. This calculation must include estimates of impacts from transportation of materials, equipment, and personnel, and must extend to construction and decommissioning phases as well as the operational phase of the action.

Once the applicability of the General Conformity Rule is established, a Conformity Determination must be performed. Various methods are available to demonstrate that the Federal action conforms to the SIP, including: verification that the air quality impacts of the action are already provided for in the SIP (state emissions budget); verification that the expected air quality impacts of the Federal action are offset by reductions of similar pollutant emissions from another facility within the same nonattainment or maintenance area (offset emissions); performance of modeling to calculate new estimated concentrations of criteria pollutants within the nonattainment area that result from the Federal action (air quality modeling); a determination by the State that the emissions from the Federal action and from all other actions within the area will not exceed the State Emission Budget (determination); or commitment by the State to revise the SIP in such a way as to achieve an emission reduction equivalent to the estimated contributions of the Federal action (state commitment).

The Transportation Conformity Rule was also directed by Section 176 of the CAAA 1990 and serves a function analogous to the General Conformity Rule, focusing specifically on the impact that emissions from transportation activities associated with construction and operation of the federally authorized facility would have on the ability of a SIP to attain or maintain compliance with NAAQS. Together with the Intermodal Surface Transportation Sufficiency Act, the CAAA 1990 requires that transportation planning and air quality planning be linked and that effective transportation control measures be incorporated in SIPs. Transportation Conformity rules appear in 40 CFR part 51, but are largely duplicated in 40 CFR Part 93, General Conformity, to emphasize that Transportation Conformity determinations and analyses are intended to be integrated with General Conformity considerations and further that both are intended to be integrated with NEPA decision making.

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11 Because the OCS facility itself would be subject to Federal or State permits, the General Conformity Rule would not apply to the functions occurring on the OCS (including vessels traveling to or from the OCS within 25 mi of the OCS). All other activities associated with the OCS (e.g., onshore activities) would be potentially subject to the General Conformity Rule.

4.2.3 Physical Oceanography

Physical oceanography is the scientific study of ocean physics, including ocean movements as well as the study of many other physical processes in the ocean. Physical oceanographic topics of interest for this EIS include:

- Ocean currents, or "circulations," and how the currents in the ocean respond to various forcing mechanisms, such as the wind,
- Waves (i.e., oscillatory movements in water, where its particles move in a vertical plane, up and down), and
- Tides (i.e., periodic variation in the surface level of the oceans and of bays, gulfs, inlets, and estuaries, caused by gravitational attraction of the moon and sun).

Tidal movements are neither affected by nor affect the ocean currents and waves on the OCS. As discussed in Section 1.2, the energy potential from tidal movements is restricted to coastal State waters and is not evaluated in this programmatic EIS. As a result, the tides are not discussed further.

Major currents along the eastern coast of North America include the Florida Current, the Gulf Stream, and the Labrador Current. The Florida Current and the Gulf Stream are part of the Gulf Stream System. The Florida Current is often considered to be the beginning of the Gulf Stream System; it is that section of the Gulf Stream that stretches from the Florida Straits north to Cape Hatteras, North Carolina. The Florida Straits lie between Cuba and the Florida Keys. The Straits mark the area where the Florida Current flows eastward out of the Gulf of Mexico.

The Florida Current is a strong ocean current that transports water at a rate of about 30 million m^3/s (1,060 million ft^3/s) through the Florida Straits. Transport in the Florida Current increases to the northeast and reaches about 85 million m^3/s (3,000 million ft^3/s) near Cape Hatteras (Pickard and Emery 1990). Its surface velocity sometimes exceeds 2.5 m/s (8.2 ft/s) (von Arx et al. 1974). It has a mean surface velocity of about 1.8 m/s (5.9 ft/s) (Tomczak and Godfrey 2003). In the Florida Straits, the current is largest within about 200 m (656 ft) of the surface. The velocity of the current decreases with depth. At depths greater than about 1,000 m (3,280 ft), the velocity is about 10 cm/s (0.3 ft/s) (Tomczak and Godfrey 2003).

The Florida Current starts about 8 km (5.0 mi) offshore in the southern part of Florida, close to Miami, and sustains relatively large speeds over significant distances in relatively unchanging patterns (USDOI/MMS 2006f). The width of the Florida Current is approximately 80 km (50 mi) at 27°N, and 120 km (74.5 mi) at 29°N; it slowly increases to a width of 145 km (90 mi) for the Gulf Stream at 73°W. The Florida Current generally tracks the 183 m (600 ft) water-depth curve along the East Coast of the United States until it reaches the Cape Hatteras area off North Carolina, where it begins its northeastward flow across the Atlantic Ocean (Pickard and Emery 1990). Within the Florida Straits between Miami and Bimini, the Florida Current is fairly steady, with fluctuations in speed of about 20% (von Arx et al. 1974).

Along its flow path, the Florida Current meanders and sheds eddies to the north and south. Meanders have wavelengths between 170 and 340 km (106 to 210 mi), periods ranging from 5 to 12 days, and propagation speeds that range from 28 to 36 km/d (17 to 22 mi/d) (Johns and Schott 1987). The amplitudes of the meanders increase outside of the constraint of the Florida Straits. Meanders and the eddies they generate serve as the principal forms of mesoscale variability along the path of the Florida Current within the Mid-Atlantic Bight (an area that extends between Cape Canaveral, Florida, and Cape Hatteras, North Carolina).

The Florida Current receives its water from two main sources, the Loop Current in the Gulf of Mexico (see Section 4.3.3) and the Antilles Current. The Antilles Current flows northward in the Atlantic Ocean past the northern and eastern coast of Cuba. It joins with the Florida Current past the outer Bahamas. The Loop Current is the more significant of these sources and can be considered an upstream extension of the Gulf Stream System. The Florida Current is subject to both seasonal and interannual variability.

The Florida Current becomes the Gulf Stream in the vicinity of Cape Hatteras, North Carolina, where the Florida Current ceases to follow the continental shelf (Pickard and Emery 1990). The Gulf Stream is a powerful, warm, and swift Atlantic Ocean current that is the western boundary current of the North Atlantic Subtropical Gyre (i.e., clockwise circulation pattern produced by the earth's rotation). After passing Cape Hatteras, the Gulf Stream flows northeast toward Europe.

The Gulf Stream is a western-intensified current that is largely driven by wind stress. Western intensification is the intensification of the western arm of an ocean current, particularly a large gyre in an ocean basin, due to the Coriolis effect (an effect produced by the earth's rotation), the variation of Coriolis force with latitude, and vorticity. Because of this effect, currents on the western boundary of a basin (such as the Gulf Stream) are stronger than those on the eastern boundary (such as the California Current, on the eastern side of the Pacific Ocean).

After passing Cape Hatteras, the Gulf Stream has a flow rate of 80 million m^3/s (2.8 billion ft^3/s). Typically, the Gulf Stream is 80 to 150 km (50 to 93 mi) wide and 800 to 1,200 m (2,600 to 4,000 ft) deep. The velocity of the current is fastest near the surface, with a maximum speed of about 2.5 m/s (8 ft/s) (Pickard and Emery 1990; Tomczak and Godfrey 2003).

North of Cape Hatteras, the Gulf Stream is separated from the coast by a narrow southern extension of the Labrador Current. The Labrador Current is a southward-flowing component of the North Atlantic Subpolar Gyre. The Labrador Current flows southward from Baffin Bay along the coast of Labrador and turns east after intersecting with the Gulf Stream north of the Outer Banks of North Carolina. The Outer Banks consists of a string of beaches and narrow barrier islands that is more than 160 km (100 mi) long. The Labrador Current transports cold waters into the warmer Gulf Stream ring and meander region (Tomczak and Godfrey 2003). The average volumetric flow for the current has been estimated to be 34 million m^3/s (1.2 billion ft^3/s). Speeds for the Labrador Current are about 0.2 m/s (0.7 ft/s) at the surface. The Labrador Current is strongest in February when on average it carries 6 million m^3/s (212 million ft^3/s) more water than in August. It is also more variable in winter (Tomczak and Godfrey 2003).

Waves are oscillatory movements in water, where its particles move up and down in a vertical plane. The difference in elevation between a wave's crest (i.e., uppermost elevation) and trough (i.e., wave's lowest elevation) is the wave's height. The mechanism of the origin of sea waves is not precisely known, but it is generally attributed to friction on the water surface caused by winds. The heights of sea waves depend on the wind speed, the duration of wind from a particular direction, and the fetch or the expanse of water surface over which the wind blows. In areas where the water is deep, the winds are fast and blow over a long period of time, and the bottom does not interfere with the undulatory movement of water, the formation of waves is high. A wind speed of 160 km/h (100 mph), blowing for about 50 h, over a fetch of 1,600 km (1,000 mi) has produced waves 15 m (49 ft) high. In high seas, a wave height of 1.5 to 4.5 m (5 to 15 ft) is common, and it can increase to 12 to 15 m (39 to 49 ft) during strong storms (NCERT 2006). Such wave heights are possible for any of the regions discussed in this EIS. Variations in height will occur depending on location, season, and atmospheric conditions.

4.2.4 Water Quality

In this programmatic EIS, the discussion of water quality considers natural and human-induced physical, chemical, and biological properties of the OCS and adjacent coastal waters. Although near-coastal and estuarine waters are not specifically in-scope for this EIS, they contribute to and affect the water quality on the OCS. Therefore, the water quality discussion includes some information on those areas, too. Further subdivision into regions is necessary because of the large geographic range of each of the regions.

Within the Atlantic region, the overall length of the coastline is approximately 3,300 km (2,000 mi). The Atlantic Coast covers several major biogeographic provinces. The biogeographic province boundaries are not the same as the MMS regional boundaries shown in Figure 4.1-1. They are mentioned here and in Sections 4.3.4 and 4.4.4 because of their general scientific validity. The description of the following provinces comes from the U.S. Geological Survey (USGS 2006). The Acadian province covers the upper New England Coast and part of the Canadian coast. Cape Cod represents the boundary between the Acadian and Virginian provinces. It has a large tidal range and is strongly influenced by the Labrador Current. The Virginian province covers the mid-Atlantic region, and extends to Cape Hatteras, North Carolina. The Labrador Current occasionally extends down to Cape Hatteras. The tidal range is moderate. The Carolinian province extends from North Carolina to about Cape Canaveral, Florida. It contains extensive marshes and well-developed barrier islands. Waters are turbid and productive. The Gulf Stream is the primary influence. The tidal range is small to moderate. The West Indian province extends south from Cape Canaveral and includes the rest of Florida's Atlantic Coast. The tidal range is small.

In its review of water quality along the Atlantic Coast, the USEPA combines the Acadian and Virginian provinces with the Northeast Coast and combines the Carolinian and West Indian provinces with the Southeast Coast (USEPA 2004a). These terms are used in the rest of this section.

Immediately along the Northeast coastline, water quality is influenced by large nearby populations, large expanses of agricultural land, and a network of wetlands, estuaries, and bays that serve vital commercial and ecological functions. Water quality is controlled primarily by the anthropogenic inputs of land runoff, land point source discharges, and atmospheric deposition. With increasing distance from shore, oceanic circulation patterns play an increasingly larger role in dispersing and diluting anthropogenic contaminants and determining water quality.

4.2.4.1 Coastal Waters

The U.S. Environmental Protection Agency (USEPA) has coordinated two major efforts to characterize the condition of the nation’s coastal areas. The results of these studies are contained in two reports. The first report, the National Coastal Condition Report, summarized coastal conditions with data collected from 1990–1996 (USEPA 2001). The second report, the National Coastal Condition Report II, contained data from 1997–2000 (USEPA 2004a). The reports assign a ranking of good, fair, or poor for five different indices, including water quality. In both reports, the water quality condition for the Northeast coast was rated as poor to borderline poor.

Estuaries are the transitional zones along the coastline where ocean saltwater mixes with freshwater from the land. There are two prominent estuaries in the mid-Atlantic region, the Chesapeake and Delaware Bays. The Chesapeake Bay is the largest estuary in the United States, with a total estuary surface area of about 11,500 km^2 (4,500 mi^2), and the Delaware Bay includes about 2,000 km^2 (800 mi^2) of estuary area (USEPA 1998). Most estuaries along the Atlantic Coast have tidal ranges from 2 to 4 m (6.5 to 13 ft), allowing them a moderate tidal flushing efficiency (USDOI/MMS 1992). However, the Chesapeake Bay has a much lower tidal range of about 0.75 m (2.5 ft) near its mouth and about 0.6 m (2 ft) at the head of the Bay. Because of the large size of the Chesapeake Bay, its conditions heavily influence the statistical summaries of the conditions of mid-Atlantic waters (USEPA 2001).

The overall condition of Northeast Coast estuaries is poor. Twenty-seven percent of estuarine area is impaired for aquatic life (poor condition), 31% is impaired for human use, and an additional 49% is threatened for aquatic life use (USEPA 2004a).

The condition of Northeast Coast estuaries as measured by the water quality index is fair to poor (USEPA 2004a). The water quality index was based on five water quality parameters: water clarity, and concentrations of dissolved oxygen, dissolved inorganic nitrogen, dissolved inorganic phosphorus, and chlorophyll *a*.

Generally, the relatively open rocky coasts, cold salty waters, and the high tidal ranges of the Acadian Province favor well-mixed conditions that minimize accumulation of nutrients or organic matter, which would lead to the undesirable effects associated with water quality degradation. In contrast, the unglaciated parts of the Virginian Province have extensive watersheds that funnel nutrients, sediment, and organic material into secluded, poorly flushed estuaries that are much more susceptible to eutrophication. The pattern of eutrophication also closely reflects the distribution of population density (USEPA 2004a).

Hypoxia, the condition of having low dissolved oxygen concentration in the water, is caused by excessive nutrients and other oxygen-demanding contaminants. Hypoxia often forms when the water column becomes vertically stratified, and mixing between oxygenated surface waters and bottom waters cannot occur. Within the Atlantic study area, hypoxia is not a widespread phenomenon. However, it does occur most notably during the summer in the deeper waters of the Chesapeake Bay (Hagy et al. 2004).

The combination of decreased dissolved oxygen concentrations and elevated chlorophyll *a* concentrations facilitates the high eutrophic conditions (prolonged phytoplankton blooms) observed in the estuary areas of the mid-Atlantic. Nearly half of all the estuary area within the mid-Atlantic regularly exhibits high levels of eutrophication, and almost all of the estuary area shows some symptoms of eutrophication (USEPA 2001).

The estuarine resources of the Southeast Coast are diverse and extensive, covering an estimated 13,000 km^2 (4,500 mi^2) (USEPA 2004a). The overall condition of Southeast Coast estuaries is fair to good. Neither environmental stressors (e.g., dissolved oxygen, contaminants) nor the required conditions for aquatic life showed signs of serious ecological impairment during the monitoring period. Forty percent of the estuarine area fully supports human and aquatic life uses, 37% is threatened for human and aquatic life use, and 23% is impaired for these uses (USEPA 2004a).

Monitoring by coastal States in 2000 showed that less than 5% of the area of Southeast Coast estuaries and coastal areas is in poor condition, based on bottom dissolved oxygen concentrations, sediment toxicity, and sediment chemical contamination (USEPA 2004a).

4.2.4.2 Marine Waters

Noncoastal water quality in the marine areas of the Atlantic region is generally good, as the region generally exhibits low water column stratification, low nutrient concentrations (both nitrogen and phosphorus concentrations), low chlorophyll populations, and good water quality measurements (USEPA 1998). There are, however, some major local variations, due primarily to the influence of tidal plumes leaving estuaries (USDOI/MMS 1992). Because the vast majority of pollutants and threats to marine waters originate on land, there are far fewer identified major threats to marine water quality that are identified as actually originating from activities in the waters.

Some sections of the Atlantic have heavy shipping traffic. They may experience localized impacts from ships.

No oil and gas exploration or production occurs along the Atlantic Coast. In previous studies, petroleum-derived hydrocarbons in water, biota, and bottom sediments were sampled in the mid-Atlantic and found to be low or below detectable levels. On the North and mid-Atlantic slope and rise, sediment samples indicated that hydrocarbons found were mainly biogenically and pyrogenically derived, the latter originating from the burning of fossil fuels. No evidence of petroleum contamination in sediments from the south Atlantic slope and rise was found (USDOI/MMS 1992).

Trace metals include elements that are generally present in minute amounts in the sediment and water column. With the exception of dump sites, trace metal concentrations near shore and offshore rarely approach toxicity limits defined by the USEPA.

Elevated lead concentrations have been detected, decreasing with depth in the sediment column, suggesting an anthropogenic source (USDOI/MMS 1992).

Concentrations of suspended matter (turbidity) are typically low in mid-Atlantic marine waters, though they increase naturally during storm events and vary locally between surface and bottom waters, different seasons, and in different areas due to differing sources and grain sizes. Detailed studies of total suspended matter concentrations in surface waters of the mid-Atlantic have shown general concentrations of less than 1 milligram/liter (mg/L) throughout the region (Louis Berger Group, Inc., 1999).

4.2.5 Acoustic Environment

Portions of three OCS regions are included within the scope of this programmatic EIS. The majority of the factors affecting the acoustic environments for all three are largely the same. Consequently, the discussion that follows is intended to be applied to those portions of all three OCS regions that are within the scope of this study. The closing paragraph contains information unique to the Atlantic OCS. Subsequent sections describing the acoustic environments of the Gulf of Mexico and Pacific regions will refer back to this section for basic information and will provide only information on unique aspects of the acoustic environments of those OCS regions.

Sound is a physical phenomenon and a form of energy that can be described and measured and represented with precise mathematical expressions. Noise, on the other hand, is not a physical process, but rather an implicit social value, defined generally as any unwanted sound.[12] Recognition of sound is based on the receptor's objective and reproducible response to sound's primary physical attributes: intensity (perceived by a receptor as loudness), frequency (perceived as pitch), frequency distribution and variation over time, and duration (continuous, sporadic [rhythmic], or impulse). Perception of sound, however, is subjective and circumstantial. Sounds that are soothing to some are annoying to others, and sounds barely noticed and generally ignored in one circumstance may be considered highly objectionable in another.

Beyond subjective effects, however, sound at higher intensities or power levels can have physical consequences. Rogers et al. (2006) define the range of impacts on individuals as falling into three categories as sound pressure levels increase: subjective effects (e.g., annoyance, nuisance, dissatisfaction), interferences with activities (e.g., speech, sleep, and learning), and

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12 It is particularly relevant to consider "noise" in the context of OCS activities since the word derives from the Latin *nausea* or "seasickness."

physiological effects (e.g., anxiety, tinnitus, or hearing loss). Additional discussions on physiological consequence of sound exposures are provided below.

4.2.5.1 Sound Fundamentals

The following discussions provide only a brief overview of the principles of sound. Those interested in a more in-depth treatment of the science of sound in an ocean environment are referred to the Discovery of Sounds in the Sea website maintained by the University of Rhode Island's Office of Marine Programs (OMP).[13] Sound is typically described by its magnitude (otherwise referred to as amplitude), intensity, and frequency and the changes in those values over time (e.g., sudden impulse vs. continuous vs. repetitive). The physical phenomenon of sound can be generated by numerous mechanisms, but always involves the vibration of a body that results in a rapid change in pressure (high and low pressure fluctuations) or waves in the medium surrounding that body.

Sound waves are characterized by parameters such as amplitude, intensity, frequency, and velocity. The amount of energy contained in a sound pressure wave is referred to as its amplitude, while the amount of energy passing through a unit area per unit time is the sound wave's intensity. The units of sound intensity are watts per square meter (energy per unit of time per unit of area). Amplitude and intensity are directly and linearly related. Higher amplitude sounds are perceived to be louder. Sound pressures are usually represented in Pascals (Pa). Humans respond to sound pressures as small as 0.00002 Pa.[14] Sound pressures above 20 Pa can cause irreversible damage to auditory systems and other adverse physiological effects.

The frequency of a sound represents the rate at which the source produces sound waves (a complete cycle of high and low pressure waves) or the rate at which the sound-producing body completes one vibration cycle. Standards of pitch are most often used to describe and differentiate between musical notes: middle "C" has a pitch of 262 hertz (Hz), while "A" above middle "C" has a pitch of 440 Hz.[15] Pitch and amplitude are also related in most individuals, especially at lower frequencies such that a loud, low-frequency tone will be perceived as having lower pitch than the same tone produced at a lower amplitude. Sounds are produced throughout a wide range of frequencies, including frequencies beyond a human's audible range.[16]

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13 Discovery of Sounds in the Sea: available at: http://www.dosits.org/science/intro.htm.

14 By convention, a sound pressure of 0.00002 Pa (or 20 μPa) represents the lower limit of human hearing, or 0 decibels of sound. A Pascal is equal to one Newton of force distributed over one square meter.

15 "Frequency" and "pitch" are often used interchangeably by the general public. In fact, they are fundamentally different. Frequency is a precisely measured quantity representative of a specific sound. Pitch, however, is imprecise and represents an individual sound receptor's "perception" of variation in frequency between two sounds.

16 The human auditory range is unique to each individual but generally ranges between 16 to 20 Hz to around 20 kHz, or about 10 octaves, with each octave change representing a doubling of the frequency from lower band limit to higher band limit sound. The threshold of hearing is dependent on frequency, with most individuals demonstrating less sensitivity to lower frequencies (i.e., sounds of lower frequencies must have higher amplitudes to be recognized).

The speed of sound is not affected by its intensity, amplitude, or frequency, but rather is dependent wholly on the characteristics of the medium through which it is passing, with sound traveling generally faster as the density of the medium increases. Speeds in air are mostly influenced by the air's temperature, and negligibly by the air's relative humidity and pressure, averaging about 340 m/s (1,115 ft/s) at 15ºC (59ºF). Sound speeds in air increase as air temperature increases. The speed of sound in liquids is similarly influenced primarily by the liquid's density and temperature. Thus, the speed of sound in 0ºC (32°F) water is 1,402 m/s (4,600 ft/s) and 1,482 m/s (4,862 ft/s) in 20ºC (68°F) water. The speed of sound in seawater at 25ºC (77°F) is 1,533 m/s (5,030 ft/s). The speed of sound in solids is a more complex matter, with longitudinal and transverse waves traveling at different speeds depending on the density of the material as well as its geometry and molecular structure. Speed is generally insensitive to the material's temperature. The speeds of sound in various materials include: diamond, 12,000 m/s (39,372 ft/s); Pyrex glass, 5,640 m/s (18,505 ft/s); iron, 5,130 m/s (16,832 ft/s); aluminum, 5,100 m/s (16,733 ft/s); and rubber, 1,600 m/s (5,250 ft/s).[17]

Similar to other physical stimuli such as the brightness of light, the mathematical relationship between sound stimulus and sound perception by a receptor is logarithmic. This logarithmic relationship between magnitude and perception is the basis for the decibel (dB) scale used to express sound intensity.[18] The decibel scale measures relative sound intensities rather than absolute intensities; specifically, it measures the ratio of a given intensity (of sound) to the threshold sound intensity of human hearing (by definition, 0 dB).[19] For most individuals, a sound wave pressure of 20 microPascals (μPa) represents the hearing threshold.[20] As sound stimuli increase geometrically (i.e., multiplied by a fixed factor), the corresponding perception changes arithmetically (i.e., additive by constant amounts). Thus, a tenfold increase in sound stimulus over the threshold of hearing is assigned a value of 10 dB but is perceived as a doubling of loudness; a hundredfold increase to 20 dB is perceived as a sound that is four times louder, and so forth. Each 10-dB rise represents a tenfold increase in sound energy.

Although sound is a physical phenomenon that can be represented by mathematical expressions and measured with precision, human perception of sound pressure levels (SPLs) is the result of physiological responses as well as subjective factors, each influenced or emphasized by both circumstance and past experiences. Rogers et al. (2006) provide the following convenient scale against which to anticipate a receptor's responses to changes in SPLs:[21]

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17 Data from the Georgia State University Hyperphysics website (accessed August 9, 2006): http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html.

18 The decibel scale, symbol dB, is named after Alexander Graham Bell, who conducted pioneering work in the science of sound energy.

19 Sound intensity is often considered synonymous with loudness. However, where sound intensity is an objective value that is the result of the application of a precise mathematical equation, sound loudness is a reflection of individual hearing sensitivities and perceptions.

20 This is taken to be the threshold of hearing for average young and healthy individuals with no auditory impairment. The normal ear is most sensitive at frequencies between 3,000 and 6,000 Hz.

21 All values represent a human receptor's interaction with sound waves propagating in air.

- Except under laboratory conditions, a change in sound level of 1 dB cannot be perceived.
- Doubling the energy of a sound source corresponds to a 3-dB increase in sound pressure level (SPL).
- Outside the laboratory, a 3-dB change in sound level is considered barely discernable.
- A change in sound level of 5 dB will typically result in a noticeable community response.
- A 6-dB increase is equivalent to moving half the distance toward a sound source.
- A 10-dB increase is subjectively heard as an approximate doubling in loudness.
- The threshold of pain is an SPL of 140 dB.[22]

A closely related value to the SPL is the sound power level, expressed as PWL or L_W. Whereas the SPL is the response to a sound wave's pressure by a single receptor at a specified distance and direction from the sound source, the sound power level represents the total sound power emanating from the source in all directions. However, because each individual receptor experiences only a fraction of the sound's power, the impact of a sound source on that receptor is more properly represented by the sound pressure level at the receptor's distance from the sound source, and not the total energy contained in the sound source.[23] As will be discussed in Section 4.2.5.2, sound propagation in various other media is more complex. In water, for example, sound propagation is initially spherical, but the shape of the propagating wave changes in response to numerous circumstantial factors.

Another common method of understanding sound pressure levels is to provide comparisons to commonly experienced sounds. A USEPA report published in 1974 as the basis for noise control regulations at both the Federal and State levels provided information on the sound levels of common activities. Those data, also appearing in a condensed version of the USEPA report published in 1978, are displayed in Figure 4.2.5-1.

SPLs are measured with sound level meters. Rather than capture the entire frequency range of sounds, sound level meters used to measure environmental or occupational exposures to

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22 The value given for the onset of pain represents the average response by a typical human being in good health.

23 Importantly, since as a practical matter, it is virtually impossible for a receptor to be impacted by the entire amount of energy contained in a sound wave that is propagating in many directions simultaneously, and since environmental receptors respond to sound pressure, the sound pressure level is a more reliable value against which to measure the sound's impact on those receptors.

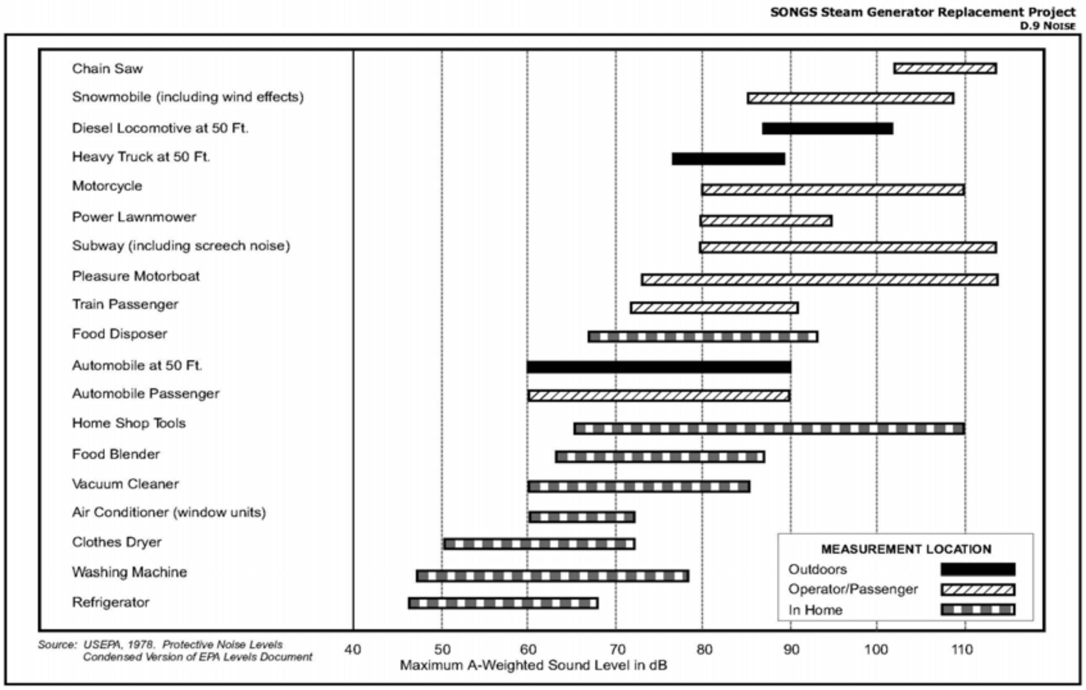

FIGURE 4.2.5-1 Sound Pressure Levels (dB) of Common Sources (Note: All data reflect sound propagation in air and imply a human receptor.) (Source: Protective Noise Levels, Condensed Version of the USEPA Levels Document [USEPA 1978])

sound typically contain filters that reduce the meter's sensitivity to frequencies of little to no relevance to the receptor. Thus, a meter that filters very low and very high frequency sounds acts as a general approximation of the human ear's response to sounds of medium intensity. Such meters are referred to as A-weighted measurement devices, and sound pressure levels measured by such instruments will be represented by units of dB(A). Other sound meters can also be used to measure loud high- and middle-frequency sound (B-weighted), very loud low-frequency sound (C-weighted), very loud sounds associated with aircraft (D-weighted), and infrasound (<20 Hz), or low-frequency sound (including frequencies below the lower limit of human auditory response) (10 to 200 Hz) (G-weighted). Infrasound propagates farther than sound of higher frequencies. Sounds of such frequencies are typically perceived not only as sound, but as tactile sensations such as vibration.

Of particular relevance to the evaluation of energy development facilities located on the OCS are the responses of marine animals to sound. Numerous studies have documented observed responses of marine animals to sound, and individual researchers have attempted to organize observed responses into general categories such as recognition, disturbance (i.e., triggering avoidance behavior), onset of pain, or SPLs that cause temporary damage (i.e., a temporary increase or shift in hearing thresholds) or permanent damage to auditory functions. It has been widely demonstrated that marine animal response to sound is very species-specific, and that circumstantial factors such as ambient ocean noise levels can affect the animal's sensitivity to sound impulses. However, there is no consensus among researchers that would allow for the establishment of reproducible threshold SPLs that would always result in a specific response. See Section 5.2.8.2 for additional discussion regarding marine animal responses to sound.

4.2.5.2 Sound Propagation

Understanding the impact of sound on a receptor requires a basic understanding of how sound propagates from its source. Sound propagation follows the inverse square law: the intensity of a sound wave decreases inversely with the square of the distance between the source and the receptor. Thus, doubling the distance between a receptor and a sound source results in a reduction of the intensity of the sound to one fourth its initial value; tripling the distance results in one ninth the original intensity, etc.

Sound propagates through gases and liquids primarily as longitudinal waves, causing displacements of the molecules comprising the gas or liquid in directions generally parallel to the direction of the sound wave. Sound propagates through solids as both longitudinal and transverse (or shear) waves, causing displacements of the medium in directions perpendicular to the direction of the sound wave. While the concept of a longitudinal or transverse sound wave traveling from its source to a receptor is relatively simple, sound propagation in real world conditions is more complex because of the simultaneous presence of numerous sound waves of different frequencies and other phenomena such as reflections of sound waves and the subsequent constructive and destructive interferences between reflected and incident waves. Interferences between two waves with different frequencies result in the production of "beats." Depending on whether the interferences between these waves are constructive (where their amplitudes are additive) or destructive (where their amplitudes cancel each other), the sound perceived by the receptor is alternately loud and soft, with the rate at which such amplitude changes occur generally reflecting the difference between the frequencies of the two interacting waves. In fact, perception of interfering sound waves is complex, and in some frequency ranges, the receptor "hears" neither of the frequencies of the interacting waves but rather a third frequency known as a "subjective tone" or "difference tone." Such "beating" is considered annoying by some individuals.

As noted earlier, in the simplest scenario of sound propagating from a point source without obstruction or reflection, the sound wave takes on the shape of an expanding sphere. As spherical propagation continues, the sound energy is distributed over an ever-larger surface area. For example, a sound wave that occupies one square meter at a one-meter distance from the source has been distributed over an area of 10,000 m^2 (107,640 ft^2) at a distance of 100 m (328 ft). As expected, sound intensity drops for receptors at the surface of the sphere at increasing distance from the point source. In spherical propagation, sound pressure levels drop an average of 6 dB for every doubling of distance from the source (Rogers et al. 2006).

Under real world circumstances, a sound wave from a source resting on or above a perfectly or nearly flat surface would propagate in a hemispherical shape, with the surface acting as a plane of sound reflection or absorption. Sound propagating from sources located on or above the water's surface on the OCS will have such propagation geometries and could be expected to lose 6 dB for every doubling of distance from its source; however, the sound level would be 3 dB higher at a given distance than it would be in spherical spreading. Rough water conditions could be seen as approximating rough ground terrain and might, therefore, be expected to contribute an additional reduction in sound pressure.

Sound propagates with different geometries under water, especially in relatively shallow near-shore environments. The surface of the water and the ocean floor are effective boundaries to sound propagation, acting either as sound reflective or absorptive surfaces. Consequently, sound originating underwater as a point source will initially propagate spherically over some distance until the sound pressure wave reaches these boundary layers; thereafter, the sound will propagate cylindrically. The area of the cylinder over which the sound energy is uniformly distributed is directly proportional to the distance from the source. (The area of a cylinder = height * π * radius.) Consequently, a doubling of the distance from the source means that the area of the cylinder is doubled and the sound intensity is halved. Thus, underwater, sound intensity diminishes at a rate of 3 dB per doubling of distance from the source. Cylindrical propagation geometries, together with the greater density of water relative to air, allow sound originating in shallow water to travel much longer distances than the same-intensity sound originating in air. Vertical thermal gradients in the water as well as wave and current actions can also be expected to constrain or distort sound propagation geometries.

Another unique phenomenon of sound propagation in the ocean results from the existence of what is known as the <u>SO</u>und <u>F</u>ixing <u>A</u>nd <u>R</u>anging (SOFAR) Layer or SOFAR Channel. The temperature, pressure, and salinity of ocean water, as well as latitude, have all been shown to influence sound propagation through the existence of such sound channels, allowing sound to travel great distances with minimal attenuation (reduction) of intensity. In general, the greatest influence on the speed of sound propagation in shallower depths is the water's temperature. At greater depths, the speed is influenced primarily by the water's pressure. The speed of sound propagation generally decreases with decreasing temperatures, but increases with depth and the resulting increase in water pressure. Not only the speed, but also the geometry of the sound wave is affected, always bending in the direction of minimal sound propagation speed. Thus, as a sound wave encounters a thermocline (i.e., a region of rapid change in temperature and pressure with depth), it is initially bent downward in response to decreasing temperature, but then upward in response to increasing pressure. These recurring responses to water temperature and pressure result in the sound pressure wave taking on a sinusoidal shape, a configuration that represents minimal energy loss, thus maximizing the distance the sound pressure wave can travel in this sound "channel." Figure 4.2.5-2 provides a graphical representation of the SOFAR phenomena.

The depth at which the SOFAR Layer exists also varies with water salinity and latitude, existing at depths of 600 to 1,200 m (1,968 to 3,937 ft) at middle latitudes, at somewhat deeper depths in the subtropical latitudes, and very near the surface at northern latitudes. When the SOFAR layer coincides with the depths at which marine mammals and fish with acoustic sensitivities normally exist, impacts can result from sound sources that are significant distances away, even as far away as entire ocean basins.

Even as the SOFAR Layer provides for trapping and enhanced propagation of anthropogenic sounds, it has an analogous influence on sounds made by fish and marine mammals. It is believed that marine mammals that annually migrate great distances, such as the

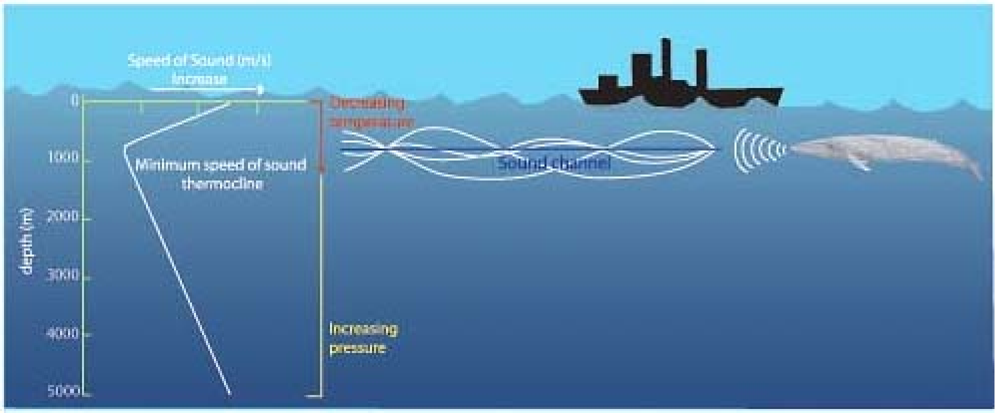

FIGURE 4.2.5-2 Graphical Representation of the Impacts of Water Temperature and Pressure on Sound Wave Propagation in the SOFAR Layer (Source: NOAA 2007a)

humpback whale, utilize the SOFAR Layer for orientation and long-distance communications. (More information about the SOFAR Layer can be found at websites maintained by the NOAA [http://oceanexplorer.noaa.gov/explorations/sound01/background/acoustics/media/sofar.html] and Woods Hole Oceanographic Institution [http://www.whoi.edu/oceanus/viewArticle.do?id=2492]).

4.2.5.3 Ambient Ocean Noise

Ambient noise above and below the water's surface contributes to the natural noise profile of ocean environments.[24] However, because sound propagation in water is different from propagation in air, reference standards for characterizing sound intensities reaching a receptor are different for the two media. Consequently, decibel levels for sound in air cannot be directly compared with decibel levels for sound in water. The text box on the next page provides additional detail on the fundamental differences between air and water sound propagation and decibel scales.

Various activities and processes, both natural and anthropogenic, combine to form the sound profile within the ocean, generally referred to as ambient ocean noise. Except for sounds generated by some marine animals using active acoustics, most ambient noise is broadband (composed of a spectrum of numerous frequencies without a differentiating pitch). Virtually the entire frequency spectrum is represented by ambient noise sources. Earthquakes and explosions produce noise signals from 1 Hz to 100 Hz; biologics can produce signals ranging from less than 10 Hz to well over 100,000 Hz; Sea State can produce signals from 100 to more than

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[24] Whereas "noise" is defined by humans as unwanted sound, the following discussion demonstrates that some marine animals rely on ambient noise (sounds), including sounds that they themselves generate, for their survival.

10,000 Hz[25]; and commercial shipping and industrial activities have signals between 10 and 10,000 Hz. At any given location, ambient noise can be quite variable with season and often follows a diurnal cycle. According to the Office of Marine Programs (OMP 2006) of the University of Rhode Island, distant shipping is the primary source of ambient noise in the 20-to-500-Hz range. Spray and bubbles associated with breaking waves are the major contributions to ambient noise in the 500-to-100,000-Hz range. At frequencies greater than 100,000 Hz, "thermal noise" caused by the random motion of water molecules is the primary source. Ambient noise sources, especially noise from wave and tidal action, can cause coastal environments to have particularly high ambient noise levels.

Understanding the Difference between Air and Water Decibel Scales

As discussed earlier in Section 4.2.5.1, the speed at which sound propagates is generally directly proportional to the density of the medium through which the sound pressure wave is passing; the more dense the medium, the faster the propagation. Because of the differences in density of air and water, sound pressure levels (decibel values) in air and water are not directly comparable. Where the decibel scale in air is established relative to a reference of 20 μPa (the threshold of human hearing), the reference value for the decibel scale in water is 1 μPa. Consequently, decibel values of sound intensity in water must be corrected for both differences in the reference values selected for the two scales, as well as for the differences in the speeds of sound and the densities between air and water. Subtracting approximately 61.5 dB for sound pressure levels in seawater provides roughly equivalent sound pressure levels for the identical sound source propagating in air. Decibel values in water are typically given the notation "dB re 1 μPA-m" to clearly indicate that the measurement was made against the underwater reference value at a distance of 1 m (3 ft) from the source.

Other factors such as water depth can affect ambient noise levels. Because waves "break" in the shallow waters of near-shore environments, the contributions from these noise sources predominate in such locations. In general, ambient noise levels tend to be greatest in relatively shallow near-shore environments and appear to be directly related to wind speeds and indirectly related to sea state (Willie and Geyer 1984; Worley and Walker 1982). The seafloor also plays a role in either reflecting or absorbing sound, with that role becoming more influential in shallow waters (Urick 1983).

There have been many independent measurements of ambient ocean noise. The first major collation of these independently developed data was performed by G.M. Wenz in 1962 (Wenz 1962). Wenz compiled decades of empirical data on ambient ocean noise from both natural and anthropogenic sources, across the frequency spectrum of 1 Hz to 100 kHz, into a graphical representation of sound intensity versus frequency that is widely known as the Wenz Curves (Figure 4.2.5-3).

In their ambient noise-measuring research taking place off the Canadian Atlantic continental shelf, Zakarauskas et al. (1990) also confirmed that because of relatively poor sound

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25 Sea State is a measure of the intensity of the ocean's movement and is characterized by such parameters as wind speed, wave height, wave periodicity, and wave length. Sea States vary from "0," which represents calm conditions, to "9," which is characterized by wind speeds of more than 70 knots and wave heights as high as 100 ft.

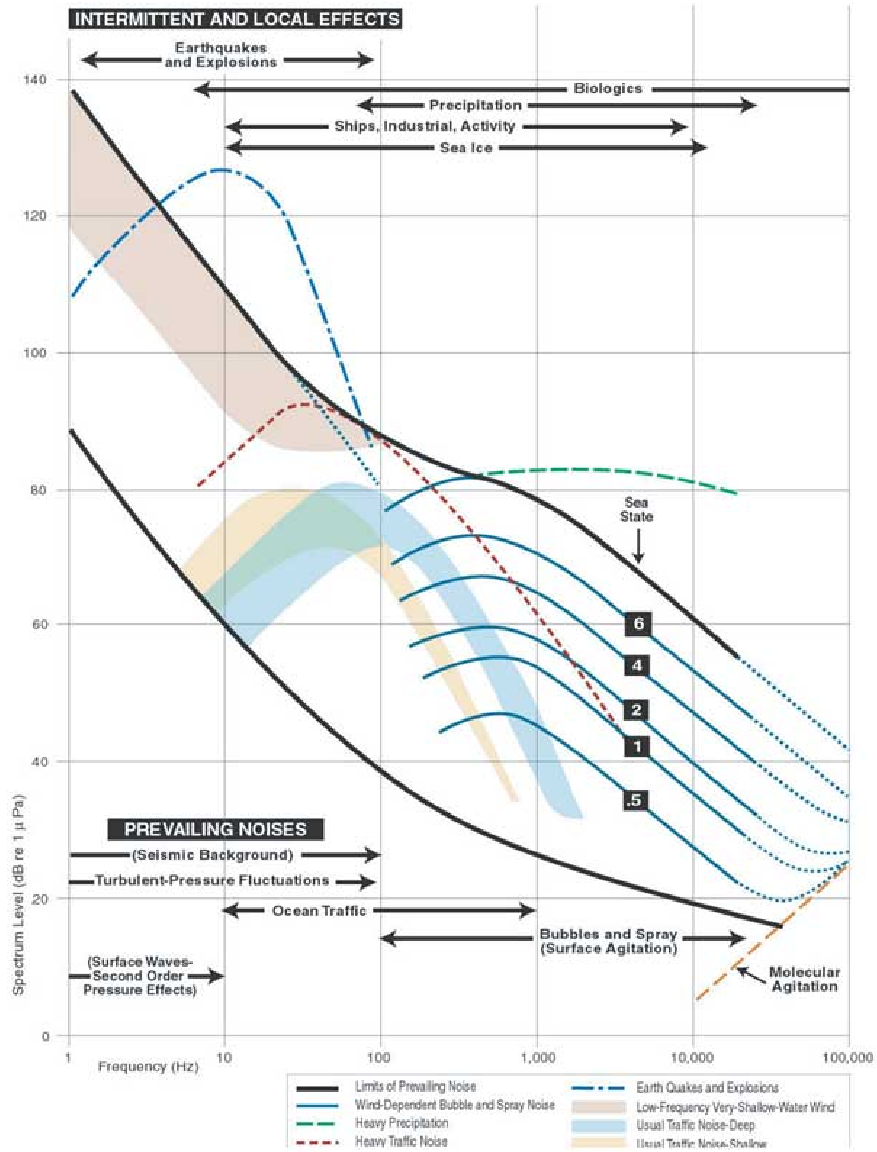

FIGURE 4.2.5-3 Wenz Curves of Natural and Anthropogenic Ocean Noise Sources. (Reprinted with permission from Wenz, Gordon M., *Journal of the Acoustical Society of America*, 34(12), pp. 1936–1956, 1962.)

transmission in shallow waters, noise from ship traffic in the near vicinity is the predominant contributor to ambient noise levels; noise from more distant shipping provides a lesser contribution. Further, seasonal variation in ambient noise was also established, with the highest ambient noise levels occurring over the period December through March; summer ambient noise levels were found to be an average of 3 dB lower than winter levels. The probable explanation for this is the bending of the sound wave downward as it interacts with the thermocline, thereby allowing the ocean bottom to absorb a greater degree of sound over a relatively short distance of sound wave propagation.

While many sources represent relatively continuous contributions to ambient noise in the ocean, intermittent sources can also represent major contributions: lightning strikes, sea ice cracking and underwater volcanoes, earthquakes, and hydrothermal eruptions. The impacts of these intermittent events can be substantial. For example, lightning striking the surface of the water can have sound power levels of as much as 260 dB (underwater) at 1-m distances, and heavy rain can add as much as 35 dB over a broad frequency range (OMP 2006). Marine life, especially marine mammals such as whales and dolphins and some fish and marine invertebrates, can also contribute sounds over a broad frequency range, using sound to navigate, communicate, mate, and feed.[26] Marine animals apply either passive acoustics (receive and interpreting sounds only) or active acoustics (sending, receiving, and interpreting reflected sounds [e.g., echolocation practiced by dolphins]). OMP notes that marine mammals can contribute as much as 20 to 25 underwater dB to ambient levels at certain times of the year (OMP 2006).

Anthropogenic activities also contribute to ambient ocean noise. Ship traffic is a leading contributor. In the open water, ship traffic can influence ambient background noise at distances up to 4,000 km (2,485 mi); however, the effects of ship traffic sounds in shallow coastal waters are much less far reaching, most likely because a large portion of the sound's intensity is absorbed by soft, nonreflective, unconsolidated materials (sands and mud) on the seafloor. Most vessel-related sound involves low frequencies (<500 Hz). Aircraft flying over water can also contribute to ambient ocean noise. Motors, propellers, or rotors provide the major contributions, but aerodynamic turbulence can also contribute. In general, helicopters produce higher-intensity sounds than fixed-wing aircraft.[27] As with most manmade noise sources, most of the sounds involve low frequencies. It has been further established that the angle of incidence of a sound wave propagating from an aircraft must enter the water at an angle of incidence of 13º from the vertical or less for the wave to continue propagating under the water's surface. At greater angles of incidence, the water surface acts as an effective reflective surface for the sound wave and very little penetration of the wave below the water occurs (Urick 1972).

As noted above, noise from shipping and other boating (e.g., commercial or recreational fishing and military training exercises) contributes the majority of manmade sound, all broadband in character with frequencies mostly below 500 Hz. Other reliable characteristics of vessel noise include the following:

- Larger vessels generate sound of greater intensity than their smaller counterparts.

- Fully loaded vessels underway or vessels pushing or towing a load are operating in their noisiest configurations.

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26 The OMP website provides a link to audio sound tracks of various marine animals: http://omp.gso.uri.edu/work1/gallery/intro.htm.

27 The sound intensity of a Bell Model 212 helicopter has been estimated at 149 to 151 dB re 1 μPa-m (Richardson et al. 1995).

- Propellers represent the greatest noise source; broadband noise signals from larger, slower-turning propellers are biased toward lower frequencies.
- Larger vessels with deeper drafts have propellers further below the surface of the water, allowing sound to travel greater distances, especially when the vessel is in the open ocean's "sound channel."
- Propellers experiencing cavitations (air entrainment) produce the most intense sound waves over the broadest of frequency spectra (Ross 1976).
- Propeller cavitations account for as much as 83% of the total propeller sound signal (Southall 2005).
- While propellers and the engines driving them are the major contributors, virtually every mechanical noise source on the vessel can communicate sound waves to the water through the vessel's hull, irrespective of whether it is associated with the ship's propulsion system.
- Frictional noise of water interacting with a vessel's hull and hulls breaking waves are also substantial noise contributors.
- Supply vessels (e.g., small- to medium-sized vessels that provide manpower, supplies, and equipment transport to offshore oil and gas rigs) and many berthing tugs are equipped with bow thrusters for maneuverability; such thrusters may create a harmonic tone with fundamental frequencies greater than 1,000 Hz and may contribute as much as 11 additional dB of noise over the conventional propellers on these vessels (U.S. Department of the Navy 2005).
- Fishing vessels harvesting groundfish, shrimp, scallops, or lobster may produce noise signals apart from those associated with vessel propulsion and on-board machinery; noise from trawler nets or dredging activities is also produced.

Richardson et al. (1995) have compiled noise signatures for common vessels (Table 4.2.5-1).

Other manmade sources of underwater sound include dredging (especially prevalent in harbors and straits), near-shore construction activities, oil, gas and mineral explorations and extractions,[28] mineral exploration, geophysical surveys (especially routine hydrographic surveys in shipping lanes and harbors to ensure safe navigation), and sonar surveys (for both scientific and military purposes). Dredging and construction activities are common occurrences in near-shore environments, especially harbors that can contribute substantial amounts of sound when they are operational.

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28 Oil and gas activities are limited at this time to the Gulf Coast study area.

TABLE 4.2.5-1 Noise Signatures of Common Vessels

Vessel Type	Sound Intensity (dB re 1 uPa-m)	Predominating Tone (Hz)
Tug pulling a barge @ 18 km/h (9.7 knots)	171	None
Small crew boat w/outboard engine	156	630
Small inflatable boat w/25-hp outboard engine	152	6,300
12-m-long fishing boat underway @ 1.8 km/h (7 knots)	151	250–1,000
Fishing trawler	158	100
Freighter	172	41
Large vessels (tankers, bulk carriers, containerships)	169–181	None
Very large containership	181–198	None
Supertankers	185–190	7
Supertankers	160	20–60

Source: Richardson et al. (1995).

Characteristics of dredging-related sounds are dependent on the particular type of equipment used, with sound intensities ranging from 150 to 180 dB re 1 μPa-m and frequencies ranging from 10 to 1,000 Hz (Greene 1985, 1987). A detailed study of dredging in Cook Inlet, Alaska, in August 2001 established the repetitive (rather than continuous) nature of dredging-related sounds (Dickerson et al. 2001). Researchers established a repeating pattern of sounds resulting from sequential steps of the dredging cycle, including: the variable sound of the derrick swinging the bucket over the side of the dredging vessel and the bucket hitting the surface of the water (at different speeds); the short, intense sound of the bucket hitting the bottom; a grinding sound as the bucket is closed, capturing the bottom material; a sharp sound as the bucket jaws close against each other; winch noise as the bucket is raised and breaks the surface of the water; and the sound of the recovered material being dumped onto the deck of the dredging barge or other vessel, also variable based on material, the composition of the deck, and the presence or absence of other dredged material already on the deck. These six distinct sound events repeat over intervals that vary, but are typically 1-minute (min) periods. Sound pressure levels underwater for these six sound events ranged from a high of 124.01 dB re 20 μPa-m for the bucket hitting the bottom (the most intense of the six sound events) to lows for dredged material being dumped onto previously dredged material on the deck of the barge, bucket loading, and bucket raising (82.47, 40.38, and 33.65 dB re 20 μPa-m).

Near-shore construction activities, including activities in shallow waters such as construction and maintenance of piers and docks, contribute broadband sounds, including peak impulse sounds when pile driving is involved. Construction can also sometimes involve the use of explosives. Detonation of explosives results initially in a shock wave that converts to a conventional sound wave as it propagates from the source. This broadband source can have intensities as high as 294 dB re 1 μPa-m from very large explosive charges (Richardson et al. 1995).

Oil and gas drilling activities also have unique sound signatures, with drilling ships having somewhat more intense sound signatures than fixed leg platforms or semisubmersible drilling platforms.[29] Gales (1982) reports broadband drilling-related sound levels from fixed leg drilling platforms ranging from 119 to 127 dB re 1 μPa-m in frequencies ranging from 4.5 to 38 Hz. By comparison, drilling ships can produce broadband sound levels as high as 174 dB re 1 μPa-m. Both fixed and semisubmersible drill rigs also produce other sounds associated with visits from crew boats, helicopters, and supply ships, some of which may or may not have direct parallels with drilling ships.

Marine seismic surveys can produce substantial amounts of high-intensity, low-frequency sound. Air guns are used to direct a "shot" of compressed air toward the ocean bottom.[30] Reflections of the sound wave are monitored and interpreted as differences in densities of the geologic formations that are reflecting the sound wave. Sound intensities from typical surveys involving multiple shots can be as high as 248–255 dB re 1 μPa-m (peak to peak) (Barger and Hamblen 1980; Johnston and Cain 1981). More meaningful for biological exposure considerations is to represent the sound intensity for this brief pulse to a root mean square (rms) or average intensity level over the entire period of the sound impulse. To do so results in intensity levels that average about 10 dB less than the peak level, and 16 dB less than the peak-to-peak value (McCauley et al. 2000). Sound waves from air guns that propagate horizontally can be detected in shallow waters (<50 m [164 ft]) to distances of 50 to 75 km [31 to 47 mi] and in deeper waters to distances exceeding 100 km [62 mi] (Richardson et al. 1995). Although the total energy released from a typical air gun array can be substantial, there are three principal mitigating factors to the scale of their potential adverse impacts: 1) the sound is emitted over a relatively short duration; 2) the sound propagation is directional, with the majority of the energy propagating into the seafloor; and 3) air gun arrays act more as a distributed source rather than a point source, consequently ensuring that at no point in the near field will sound intensities be as large as the nominal energy of the air gun array.[31]

Sonar signals are unique among anthropogenic noise sources because they consist of broadband high-frequency sound (rather than the more typical low-frequency sound). Sonar signals vary widely; most oceangoing vessels employ sonar of relatively low intensity for depth

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29 Semisubmersible drilling rigs "float" on the water surface by means of flotation hulls. Although they have no foundation installed in the seafloor, they are anchored.

30 Explosive charges were formerly used to produce "shots"; however, the technology has evolved to the almost exclusive use of air guns, which is expected to be the case for all future seismic surveys conducted within the study area.

31 Seismic surveys, including those using air guns, are not expected to be employed to support development of alternative energy sources in the OCS. Instead, survey techniques of much lower intensity will be sufficient to collect the data necessary to support design and installation decisions for structures with foundations on the seafloor or cables or other components buried beneath the seafloor.

finding. Military sonar signals can be many orders of magnitude more powerful.[32] Bathymetric surveys, the marine equivalent of a topographic survey, are one type of sonar survey that is routinely conducted in near-shore environments, especially to maintain accurate chartings of the seafloor in shipping lanes. In the current state of technology, bathymetry is performed using multibeam echo sounders (MBES) in what is known as swath technology as replacements of the vertically oriented single-beam echo sounders (SBES). In addition to providing a more complete data set over more of the ocean floor than is included within the survey vessel's footprint, MBES surveys are completed much more quickly, thereby contributing to ambient ocean noise for a smaller fraction of time. Swath bathymetry emits sounds impulses in the 100,000 to 200,000 Hz range with pulse durations of 2.0 milliseconds (ms) or less.[33]

Trends in ambient ocean noise in the past few decades show an increase of approximately 10 dB or more over the period 1950 to 1975 (Hildebrand 2004). Although ambient ocean noise levels are highly variable with time and location, and natural sources continue to be major contributors to ambient noise, anthropogenic sources are making increased contributions. Comparisons of historical U.S. Navy acoustic array data over the period 1964–1966 with data recorded at the same location along the west coast of North America over the period 2003–2004 suggest a low-frequency (30–50 Hz) noise increase of 10 to 12 dB. This represents an increase of 2.5 to 3 dB per decade. The increases observed at higher frequency levels were markedly lower, however, leading the researchers to speculate that the observed increase in low-frequency sound was due primarily to an increase in shipping, noting that the number of vessels on the ocean doubled over the period 1965 to 2003 and the gross tonnage quadrupled (requiring a proportional increase in average vessel horsepower (McDonald et al. 2006).

4.2.5.4 Effects of Sound Exposure

Exposure to sound can cause both subjective and objective responses in receptors, including physiological effects. Such effects can be auditory in nature (e.g., partial or total hearing loss) or nonauditory. Although there is still a great deal of uncertainty regarding the cause/effect relationships of sound exposures, sound clearly acts as a nonspecific general stressor. Because sound often acts in conjunction with other general stressors (e.g., in a workplace environment), it is difficult to differentiate the effects of sound. Nevertheless, certain

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32 Two active sonar technologies are currently in use. The more prevalent and older technology utilizes mid-frequency sound that can travel tens of kilometers and overlaps the hearing frequency range of some marine mammals. Low-Frequency Active Sonars (LFASs) utilize sounds of much lower frequencies that can travel thousands of kilometers. LFAS technology is currently deployed on only a very small number of ships, including U.S. Navy ships. However, to date, the Navy's use of LFAS has been confined to remote regions of the western Pacific.

33 The latest iteration of bathymetric technology eliminates conventional sound echo technology and instead utilizes laser light energy. The U.S. Army Corps of Engineers had developed and successfully implemented an Airborne Lidar Bathymetry (ALB) program known as Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS). SHOALS was particularly suited for bathymetric surveys of very shallow waters. The SHOALS program was retired in 2003 and reincarnated as the Compact Hydrographic Airborne Rapid Total Survey (CHARTS) operated by the Navy's Naval Oceanographic Office. See https://www.navo.navy.mil/nipr_2006/airhydro.html for more details.

nonauditory effects have been linked to sound exposure. The Canadian Center for Occupational Health and Safety (CCOHS 2006) summarizes some of these physiological responses as: cardiovascular function changes (hypertension, changes in heart rate or blood vessel constriction), respiratory changes (changes in respiratory rhythm), synesthesia,[34] and involuntary muscle response (tension). Researchers have also identified psychological effects ranging from annoyance to sleep disruptions, reading development problems in children, stress, and a general overall impact mental health.

Effects of sound exposure are frequency dependent. Infrasound exposure results in unique effects. At magnitudes of 90 dB and below, there is no documented adverse psychological or physiological adverse effect. However, at magnitudes of 115 dB, infrasound exposure can result in fatigue, apathy, abdominal symptoms, and hypertension in some humans. The threshold of pain for infrasound exposures is generally considered to be 120 dB, while magnitudes of 120 to 130 dB and above can result in physiological damage after 24-h exposures (Rogers et al. 2006).

4.2.5.5 Acoustic Receptors of Relevance to OCS Energy Technologies

Sound sources can be defined for all phases of the life cycles of all of the alternative energy sources within the scope of this programmatic EIS. Given the positions, orientations, and designs of these technological devices, it can be expected that the respective sounds associated with the operation of each will propagate both above and below the water. However, since the propagation of sound waves follows the inverse square law, it is unlikely, given the proposed locations of these technologies, that the intensities of sound pressure waves reaching the nearest probable human receptor on the shore or present in the nearest onshore facilities will be of any consequence. Individuals performing periodic maintenance on any of the technologies, as well as individuals engaged in recreational or commercial boating and fishing, have the potential of exposure to sound waves of greater intensities; however, these individuals will be at such closer distances for what are expected to be limited durations of time.

The same arguments regarding the relative positions of sound source and receptors cannot be made for marine life. Research has established that sound also acts as a stressor to marine animals. Observed effects include changes in responsiveness to other stimuli, masking, temporary threshold suppression, and injury, as well as the general effects on communication, echolocation, spawning, and shoaling behavior.

4.2.5.6 Regulatory Controls

Regulations addressing sound, or more precisely, what society defines as noise, exist for noise sources that originate or propagate on or above the ground surface. Federal noise standards have been established under the auspices of the Noise Control Act of 1972 for a variety of land-

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[34] Synesthesia, a neurological condition affecting as much as 4% of the population, is when stimulation of one of the sensory organs causes a response in another.

based transportation-related equipment and activities such as interstate rail carriers and motor carriers engaged in interstate commerce (see 40 CFR 201 and 202, respectively). Standards have also been established for low-noise-emission products (see 40 CFR 203), construction equipment (see 40 CFR 204), and for the control of traffic-related noise (see 40 CFR 205 and the Department of Transportation's Federal Highway Administration [FHWA] regulations promulgated in 23 CFR 772). In 1979, standards for product noise labeling were promulgated (see 40 CFR 211). The Noise Control Act, as well as subsequent Federal legislation (the Quiet Communities Act of 1978, 42 USC 2901-4918) delegate the authority to regulate noise to State and local governments. Although there has been no formal noise control program functional at the Federal level since 1981, Federal noise standards have served as the basis for State and local regulations and ordinances addressing noise. Such State and local controls initially focused on construction or industrial noise, but have evolved to also include noise control strategies in building codes to protect occupants from both exterior noise and noise generated within the structure. State and local regulations are typically enforced at the municipal or county level under broadly written nuisance statutes.

In addition to technical standards, USEPA has also published numerous guidance manuals for conducting community noise surveys, establishing acceptable levels of noise control at the community level, and enforcing those noise limits. For example, a day-night maximum average sound level (represented as L_{dn} or DNL) of 55 dBA has been established as sufficient to protect the public from the effects of broadband environmental noise in quiet settings and residential neighborhoods (USEPA 1974). USEPA guidelines also recommend that the equivalent sound level, L_{eq} (a sound level maintained continuously over a 24-hour period), be limited to 70 dBA or less over a 40-year (yr) period to protect the general population against hearing loss from nonimpulsive noise.

In addition to the USEPA, other Federal agencies have issued circumstantially specific noise standards. The Federal Aviation Administration, in conjunction with the Federal Interagency Committee on Urban Noise, has issued land-use compatibility guidelines indicating that a yearly L_{dn} of less than 65 dBA is compatible with residential land uses and that, if a community determines it is necessary, levels up to 75 dBA may be compatible with residential uses and transient lodgings if such structures also incorporate noise-reduction construction technologies (see 14 CFR Part 150, Appendix A.). Finally, regulations governing the amount of noise to which workers can be exposed in the workplace are promulgated and enforced by the Occupational Safety and Health Administration (OSHA) (see 29 CFR 1910 Occupational Safety and Health Standards, Subpart G, Occupational Noise Exposure).

Several counties in California in the 1980s and 1990s passed ordinances regulating noise levels from wind energy conversion systems. The provisions of these ordinances are summarized in a report from the Working Group on Wind Turbine Noise (ETSU 1996, Appendix B), a nongovernmental European panel. While these ordinances apply to land-based wind projects, they are further summarized below to provide a context for what might be expected in the way of local noise ordinances for offshore projects.

Noise limits in the ordinances are generally applied at the exterior of the nearest resident or sensitive receptor, such as a school or hospital, within a minimum distance, typically less than

1 mi. Limits on broadband noise in the various ordinances range from 45 dBA to 65 dBA, with levels around 50 dBA being the most frequently cited. Separate limits on low-frequency noise, which range up to 75 dB, are included in many of the ordinances. A number of penalties, usually 5 dBA, are applied to these basic values to reduce impacts from annoyances such as evening operations, steady pure tones, or repetitive impulse sounds.

Noise standards specific for wind facilities have been promulgated in the United Kingdom, patterned after a report published in 1996 by The Working Group on Noise from Wind Farms of the Department of Trade and Industry's Energy Technology Support Unit (ETSU 1996). Noise limits are established relative to background levels (rather than as absolute values) over the range of wind speeds over which the wind facility is expected to be operational.[35]

None of the controls or standards discussed above specifically address noise in waterborne or underwater environments (although noise ordinances applicable to certain pieces of construction equipment can conceivably be enforced against such equipment operating in offshore locations). Nevertheless, Federal and State agencies that control activities in offshore areas that have the potential for producing or propagating sounds in underwater environments under their respective jurisdiction can establish effective noise controls as stipulations to leases or permits required to be secured for such activities.

4.2.5.7 Atlantic Region Acoustic Environment

In the Atlantic OCS region, all of the natural and manmade sounds discussed above are possible, with their relative contributions to ambient ocean noise levels being proportional to the intensity, frequency of occurrence, and duration of each of the sound sources. In some portions of the region, certain sound sources will be the predominant contributors to ambient noise; for example, vessel-related noise in shipping lanes, whale vocalizations or dolphin and porpoise echolocation clicks in areas occupied by those animals, or noise produced by shrimp in certain near-shore areas of Florida.

There is no oil and gas exploration or production currently ongoing within the Atlantic region.[36] Instead, primary anthropogenic sound sources contributing to ambient ocean noise include commercial shipping and commercial and recreational fishing. Data from the U.S. Department of Transportation's Maritime Administration and the American Association of Port Authorities representative of commercial shipping activities at ports on the Atlantic Seaboard are displayed in Tables 4.2.17-1 and 4.2.17-2, respectively.

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35 To optimize operational efficiency and to prevent undue wear or damage to components, wind turbines are designed to operate only within a specified range of wind speeds, typically from a low or "cut in" speed of 2 m/s (4.5 mph) to a "cut out" speed of 12 m/s (26.8 mph).

36 Ten exploratory wells were drilled in Georges Bank from 1976 to 1982. None of the wells displayed economic viability for oil or gas, and no further drilling has occurred in the Atlantic Planning Area since 1982 (Edson et al. 2000). Additional oil and gas lease sales were proposed in 1985 and 1988, none of which materialized into commercial production (USDOI/MMS 1985; USDOI/MMS 1988).

Vessel and other noises related to commercial and recreational fishing activities occur throughout the Atlantic Coast; however, the majority of commercial fishing activity is concentrated in areas off the coasts of New England, the Mid-Atlantic States, and the Atlantic Coast of Florida. Major species include oyster, clam, crab, scallop, summer and winter flounder, lobster, scup, porgy, bluefish, Atlantic mackerel, squid, menhaden, butterfish, swordfish, tilefish, and striped bass. Data on commercial fishing activities are compiled by the National Marine Fisheries Service (NMFS) and are discussed in the Fisheries Section (Section 4.2.23). Although the NMFS data are not sufficient to calculate absolute noise levels caused by commercial fishing vessel traffic in the ambient ocean environment, the data on total weights of fish harvested and delivered to ports provide some implications on the relative levels of fishing vessel traffic, and thus the relative contributions to ambient ocean noise that can be expected from commercial fishing activities in those areas.

Mineral mining on the OCS also contributes to the ambient ocean noise in the Atlantic. Materials are typically removed by dredging and, in most instances, are used for nourishment and/or restoration of beaches in adjacent onshore areas or protection of military training areas or critical infrastructure. Between 1995 and 2006, more than 18 million m^3 (23 million yd^3) of sand was mined in 17 coastal projects, providing for the restoration of more than 145 km (90 mi) of coastline.[37] Demand for OCS sands and gravels is expected to increase in future years.

4.2.6 Hazardous Materials and Waste Management

As used in this programmatic EIS, the term “hazardous materials” refers to nonwaste substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare or the environment if they are improperly managed or released into the environment. This definition is general in nature and is not intended to suggest that the requirements of any particular law or set of regulations apply to a particular material. Such materials may be transported to and from, stored at, and/or used at alternative energy and alternate use project sites approved on the OCS.

Table 4.2.6-1 lists examples of hazardous materials associated with alternative energy projects likely to be proposed on the OCS within the next 5 to 7 years. A brief description of the uses of such materials is also provided. While not all of the hazardous materials listed would be used at every alternative energy project site, each site is likely to use several.

Solid wastes classified as either hazardous or nonhazardous under the Resource Conservation and Recovery Act (RCRA) may be generated by technology testing, site characterization, construction, operation, and decommissioning activities associated with alternative energy project sites likely to be proposed on the OCS within the next 5 to 7 years. Table 4.2.6-2 lists examples of such wastes. While not all of the wastes listed would be generated at every alternative energy project site, each site is likely to generate several.

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[37] More details on the MMS Marine Mineral Program can be obtained from the MMS website: http://www.mms.gov/sandandgravel/.

TABLE 4.2.6-1 Hazardous Materials Likely to Be Used at Alternative Energy Project Sites

Hazardous Material[a]	Possible Use on the OCS	Estimated Amount to Be Stored on the OCS
Fuels (e.g., gasoline, diesel fuel) and lubricants (e.g., oils, grease)	Fueling of equipment, emergency generators, and transport vessels. Lubrication of gears and other moving parts in equipment and machines	7,570 L (2,000 gal)
Propane	Fueling of space heating in enclosures	1,900 to 4,000 L (500 to 1,000 gal)
Hydraulic fluids (e.g., mineral oil; organophosphate ester; polyalphaolefin)	Transferring pressure from one point to another in machine and equipment systems, such as braking and transmission systems, hydraulic rams pumps, and motors	Delivered as needed
Coolant/antifreeze	Protection against freezing in turbines and emergency diesel generators	Less than 76 L (20 gal)
Cleaning solvents	Cleaning and degreasing of equipment and tools	Delivered as needed
Paints/coatings (e.g., copper-based)	Antifouling and protection against climatic conditions	Delivered as needed
Dielectric fluids (e.g., synthetic oil, mineral oil consisting of saturated hydrocarbons such as paraffins and naphthenes)	Transformer insulation and cooling	150,000 L (40,000 gal) (on the electric service platform)
Explosives	Constructing foundations	Delivered as needed

[a] For the purpose of this programmatic EIS, the term "hazardous material" is defined as a nonwaste substance that, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare or to the environment, if it is improperly managed or released. This definition is general in nature and is not intended to suggest that the requirements of any particular law or set of regulations apply to a particular material.

Source: Elcock (2006).

TABLE 4.2.6-2 Wastes Likely to Be Generated at Alternative Energy Project Sites

Type of Waste	Activity Generating the Waste	Quantity and Likely Method of Management
	Nonhazardous Wastes	
General refuse (e.g., food, food wrappings, plastics, paper and other nonrecyclable trash)	Routine crew activities during testing, site monitoring, construction, operation, and decommissioning activities	• About 114 L (30 gal) per day per person of domestic wastes • Amount of industrial debris would vary depending on stage of project and would be substantial at decommissioning • Collect and return to shore for management at an appropriately permitted facility
Sanitary waste	Routine crew activities during testing, site monitoring, construction, operation, and decommissioning activities	• About 76 L (20 gal) per day per person • Collect and return to shore for management at an appropriately permitted facility; OR • Treat and discharge to the ocean in accordance with a National Pollutant Discharge Elimination System (NPDES) permit
Recyclable and reusable materials (e.g., metals, waste oil and grease, antifreeze, unused paints, solvents, reusable equipment)	Construction, routine maintenance, and decommissioning activities	• Amounts will vary depending on the stage of the project and would be substantial at decommissioning • Collect and return to shore for appropriate reuse or recycling
Drilling fluid (bentonite)	Accidental leaks during transmission cable hookup	• Small amount • Collect and return to shore for management at an appropriately permitted facility
Dielectric fluids (non-polychlorinated biphenyl [non-PCB])	Transformer maintenance and decommissioning	• Amounts will vary depending on the stage of the project and would be substantial at decommissioning • Collect and return to shore for management at an appropriately permitted facility
Nonhazardous spent solvents	Routine maintenance of equipment during construction, operation, and decommissioning activities	• Amounts will vary depending on the stage of the project • Collect and return to shore for recycling or disposal at an appropriately permitted facility
	Hazardous/Universal Wastes[a]	
Spent batteries containing hazardous metal (e.g., Ni-Cd batteries), spent fluorescent bulbs	Routine maintenance of equipment during testing, site monitoring, construction, operation, and decommissioning activities	• Small amount • Collect in closed containers • Return to shore for recycling or disposal at an appropriately permitted facility

TABLE 4.2.6-2 (Cont.)

Type of Waste	Activity Generating the Waste	Quantity and Likely Method of Management
Spent lead-acid batteries	Routine maintenance of equipment during construction, operation, and decommissioning activities	• Small amount • Collect in closed containers • Return to shore for recycling or disposal at an appropriately permitted facility
Spent solvents that meet a hazardous waste listing description or exhibit a characteristic of hazardous waste, as defined in 40 CFR 261, subpart C	Routine maintenance of equipment during construction, operation, and decommissioning activities	• Amounts will vary depending on the stage of the project, but are expected to be very small because, to the extent possible, only nonhazardous solvents will be used • Collect in closed containers • Return to shore for appropriate treatment and disposal as hazardous waste

[a] *Universal Waste* means any hazardous waste that is managed under the universal waste requirements of 40 CFR Part 273, which cover certain hazardous waste batteries (such as nickel-cadmium batteries), certain pesticides, certain mercury-containing equipment (such as thermostats), and certain lamps (including fluorescent, high intensity discharge, neon, mercury vapor, high pressure sodium, and metal halide lamps).

Hazardous Waste means a material that is defined in 40 CFR 261.2 as a “solid waste” (pursuant to the Resource Conservation and Recovery Act [RCRA]) and that also meets the RCRA definition of “hazardous waste” in 40 CFR 261.3.

The following subsections provide an overview of hazardous materials and waste management in the OCS Atlantic region.

4.2.6.1 Hazardous Materials Management

When transported on the OCS, hazardous materials are subject to the requirements for classification, documentation, packaging, labeling, and handling established under the Hazardous Materials Transportation Act (HMTA). If they are bound for or came from international waters, they are also subject to similar requirements under the International Maritime Dangerous Goods Code. These requirements are implemented by the U.S. Coast Guard (USCG). During 2004, cargo shipped on the ocean within the Atlantic region included a total of approximately 196 billion kilograms (kg) (432 billion pounds [lb]) of petroleum products and chemical products, not including crude oil and fertilizers (USACE 2004a). Gasoline, lubricants, diesel fuel, and solvents are examples of hazardous materials associated with alternative energy projects that are among the cargos classified as petroleum products. Paints, explosives, dielectric fluids, and hydraulic fluids are examples of hazardous materials associated with alternative energy projects that are among the cargos classified as chemical products.

Section 311(b) of the Clean Water Act and Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), require that a national contingency plan be established for identifying and responding to releases of hazardous substances (as defined in CERCLA §101) and oil. Releases of oil and hazardous substances exceeding reportable quantities, which have been set forth in 40 CFR Part 302, must be reported to the National Response Center, which is staffed by the USCG. National Response Center watch standers enter telephonic reports of pollution incidents into the Incident Reporting Information System and immediately relay each report to the predesignated Federal On-Scene Coordinator (FOSC). The USCG also provides emergency response support to the FOSCs. FOSCs are Federal officials predesignated by USEPA for inland areas and by the USCG for coastal and major navigable waterways.

4.2.6.2 Waste Management

In 1972, Congress enacted the Marine Protection, Research, and Sanctuaries Act (MPRSA) to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. The MPRSA, also known as the Ocean Dumping Act, implements the requirements of the London Convention, which is the international treaty governing ocean dumping. Under the MPRSA, the USEPA is charged with developing ocean dumping criteria to be used in evaluating permit applications, is responsible for designating recommended sites for ocean dumping, and is the permitting authority for all materials except dredged material. The USACE is the permitting authority for dredged material. However, when issuing a permit, the USACE must obtain USEPA's concurrence, use USEPA-developed dumping criteria, and use USEPA-designated ocean dump sites to the maximum extent feasible. Virtually all material ocean-dumped in the United States today is dredged material (USEPA 2006c).

There are 36 final dredged material disposal sites designated on the Atlantic OCS (40 CFR 228.15). Other materials that were ocean-disposed on the OCS during calendar year 2004 were vessels (3 sites). Additionally, 4 naval vessels were sunk for military target practice on the OCS during calendar year 2004 (USEPA 2004b). Ocean disposal sites are not currently authorized for disposal of the waste types that may be generated by alternative energy projects likely to be proposed within the next 5 to 7 years.

Certain materials, such as chemical warfare agents, high-level radioactive waste, medical waste, sewage sludge, and industrial waste, may not be dumped in the ocean. Before 1972, however, accepted practices for disposal of chemical weapons by the U.S. military included ocean dumping, because it was thought that the vastness of ocean waters would absorb any chemical agents that leaked. The first recorded instance of ocean disposal of chemical weapons was in 1918 at an unknown location in the Atlantic Ocean between the United States and England. The last recorded instance occurred in 1970, approximately 402 km (250 mi) off the coast of Florida (Bearden 2006). The Department of Defense first publicly acknowledged ocean disposal of chemical weapons by the U.S. military in the late 1960s, but little information about specific disposal locations was provided. In 2001, the Army published more information on this topic than had previously been released. Even so, the Army's records included exact coordinates for only a few disposal sites. The locations of most disposal sites were indicated by using general references to the sites being offshore from specified States or cities, and sometimes the approximate distance from shore was provided. Eleven sites appear to be in the vicinity of the Atlantic region (U.S. Army 2001). Figures 4.2.17-1 and 4.2.17-2 show the approximate locations of known dump sites. Chemical agents disposed of in the vicinity of the Atlantic region include arsenic trichloride, lewsite, mustard gas, nerve gas, and white phosphorus.

Another source of wastes placed into the oceans is oceangoing vessels, including military craft (U.S. Navy and Coast Guard), commercial business craft (freighters, tugboats, fishing vessels, ferries, and passenger ships), commercial recreational craft (cruise ships and fishing/sightseeing charters), research vessels, and personal craft (fishing boats, house boats, yachts, and other pleasure craft). The extent to which these vessels are present in the Atlantic region is discussed in Section 4.2.17.

Wastes that may be generated by these vessels include gray water, bilge water, blackwater (sewage), ballast water, antifouling paints (and their leachate), hazardous materials, and municipal and commercial garbage and other wastes. Large cruise ships and military vessels generate wastes in volumes comparable to those of small cities. For example, a single large passenger vessel is capable of producing more than 379,000 liters (L) (100,000 gallons [gal]) of wastewater per day. Such ships also generate significant volumes of other waste materials that are released to the ocean, disposed of onshore, and/or incinerated (CEPA 2003).

The discharge of wastes on the OCS by oceangoing vessels is governed by a set of international treaties, known collectively as the MARPOL convention, as well as by U.S. Federal and State laws. For example, the USCG limits the oil content of discharges to the oceans from nonmilitary ships to no more than 15 parts per million, and oil pollution control equipment, called an oil water separator, is required to achieve this limit (see 33 CFR 155). Also, the USCG controls generation, handling, storage, and disposal of solid waste (e.g., garbage) on vessels in the oceans (33 CFR 151). These regulations specify minimum distances for the disposal of the principal types of garbage. Section 312 of the Clean Water Act (CWA) requires the use of marine sanitation devices (MSDs), on-board equipment for treating and discharging or storing sewage, on all commercial and recreational vessels that are equipped with installed toilets. There are three types of MSDs. For Type I MSDs (vessels equal to or less than 65 ft), the effluent produced must have a fecal coliform bacteria count no greater than 1,000/100 mL and no visible floating solids. For Type II MSDs (vessels greater than 65 ft), the effluent produced must have a fecal coliform bacteria count no greater than 200/100 mL and suspended solids no greater than 150 mL/L. Type III MSDs are designed to prevent the overboard discharge of treated or untreated sewage. They are commonly called holding tanks because the sewage flushed from the marine head is deposited into a tank containing deodorizers and other chemicals. The contents of the holding tank are stored until they can be properly disposed of at a shore-side pumpout facility. Section 312 does not apply to: vessels with portable toilets or any other on-board portable sewage reception system; gray water from bath or kitchen sinks; or vessels beyond the 3 nautical mi limit of U.S. territorial waters.

Section 312 also allows the USEPA or States to establish no-discharge zones in which the discharge of sewage from all vessels into specified waters is prohibited. There are three objectives for this designation. Under CWA Section 312 (f)(3), a State may designate portions of its waters as no-discharge zones if the State determines that the protection and enhancement of the quality of the waters require greater environmental protection than current Federal standards allow. In this instance, the USEPA is required to determine if there are adequate pumpout facilities available. Additionally, a State may make a written application to the Administrator, under CWA Sections 312(f)(4)(A) or 312(f)(4)(B), for the issuance of a regulation completely prohibiting discharges from a vessel of any sewage, whether treated or not, into specified waters that have environmental importance or waters that serve as drinking water intakes, respectively. The application requirements may vary depending on whether it is an application under CWA Sections 312 (f)(3), 312 (f)(4)(A), or 312 (f)(4)(B). Currently, the following States in the Atlantic region have designated all or certain segments of their surface waters as no-discharge zones: Rhode Island, Connecticut, Florida, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, South Carolina, and Virginia.

The States partially bounded by coastal waters adjacent to the OCS Atlantic region contain many public and commercial municipal solid waste and sanitary landfills, as well as several waste-to-energy combustion facilities capable of accepting general refuse. A number of public and commercial industrial waste landfills that would be capable of accepting nonhazardous industrial wastes not suitable for disposal in sanitary or municipal solid waste landfills are also operating in these States. Four States contain active commercial hazardous waste landfill facilities (USEPA 2006d).

4.2.7 Electromagnetic Fields

Electric power is carried from the generator on the OCS to land via submarine power cables that are either direct current (DC) or alternating current (AC). The advantages of DC cables are that they lose less energy per length than AC cables and require only one or two conductors, whereas AC cables requires three. However, a DC system might affect navigational systems through magnetic disturbance.

The affected environment includes both the levels of current exposure to electromagnetic fields (EMFs) in general and the number of existing submarine electrical power cables. A large set of submarine cables used for communications is similarly installed but generates negligible EMFs.

EMFs are generated by the electricity moving in these cables. The fields vary in time as the current and voltage changes so that the frequency of the EMF is the same as the current (e.g., 60 Hz for standard AC current) and static fields from DC cables. The electrical fields are highly attenuated by the metal shielding around the cables. The magnetic fields, however, penetrate most materials, but their strength decreases with increasing distance from the cable. The earth's magnetic field on average is slightly larger than half a Gauss (or 500 milliGauss [mG]). Typical house wiring and appliances contribute a 60-Hz magnetic field that can be up to about 3 mG. The static fields from DC cables are not a health concern. The time-varying EMF (mainly the magnetic fields) associated with AC cables can be of concern.

4.2.7.1 Current State of EMF Science and Research

For more than 20 years, research has been conducted in the United States and around the world to examine whether the use of electricity and the associated exposure to electric and magnetic fields poses a health risk. In 1992, the U.S. Congress authorized the Electric and Magnetic Fields Research and Public Information Dissemination Program (EMF-RAPID) in the Energy Policy Act (PL 102-486). The National Institute of Environmental Health Sciences (NIEHS), National Institutes of Health (NIH), and the Department of Energy (USDOE) were designated to direct and manage a program of research and analysis aimed at providing scientific evidence to clarify the potential for health risks from exposure to EMF (NIEHS 1999).

Over the course of this program, the USDOE and NIEHS managed more than 100 cellular and animal studies, exposure assessment studies, and engineering studies. No additional epidemiology studies were conducted; however, analysis of studies already conducted were an important part of the assessments (NIEHS 2002). In 1998, the NIEHS completed the review of a comprehensive body of scientific research on the potential health effects of EMF. NIEHS organized several technical symposia and a Working Group meeting to review EMF research. The Working Group was made up of scientists representing a wide range of disciplines including engineering, epidemiology, cellular biology, medicine, toxicology, statistics, and pathology to review and evaluate the RAPID program research and other research.

In June 1999, the NIEHS submitted the report, *NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields* (i.e., extremely low frequency-electromagnetic fields [ELF-EMF]) to Congress. In part, the report concluded the following:

> *The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for heath effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults… In contrast, the mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies although some sporadic findings of biological effects have been reported. No indication of increased leukemia in animals has been observed…. Virtually all of the laboratory evidence in animals and humans and most of the mechanistic work done in cells fail to support a causal relationship between ELF-EMF at environmental levels and changes in biological function or disease status. The lack of consistent, positive findings in animal or mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but it cannot completely discount the epidemiological findings.*

The NIEHS concludes that ELF-EMF exposure cannot be recognized as entirely safe because of weak epidemiological evidence that exposure may pose a leukemia hazard. However, because virtually everyone in the United States uses electricity, and, therefore, is routinely exposed to ELF-EMF, passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulatory community on ways in which to reduce exposure. NIEHS also suggested that the power industry continue the current practice of siting power lines to reduce exposure and encourage technologies that lower exposures from neighborhood distribution lines, provided that they do not increase other risks such as those from fire or accidental electrocution. The NIEHS does not believe that other cancers or noncancer outcomes provide sufficient evidence of a risk to currently warrant concern (NIEHS 1999).

4.2.7.2 Human Health Impacts Associated with EMF

The potential for power line electric and magnetic fields to cause adverse health impacts in humans has been reviewed by many scientific groups. Hazard is assessed by a standard scientific approach that considers data from epidemiologic, laboratory, and biophysical studies. A number of epidemiologic studies have reported a small degree of association between measures of EMF and several diseases (e.g., childhood leukemia). Other studies have failed to find an association. A causal basis for the EMF associations is not supported by laboratory and biophysical evidence, and the actual basis remains unexplained. Nonetheless, in 2002, the International Agency for Research on Cancer (IARC 2002) designated EMF as a class 2B carcinogen (“possibly carcinogenic”), based on “consistent statistical associations of high-level residential magnetic fields with a doubling of the risk of childhood leukemia.” Also, in 2002, the California Department of Health Services (CADHS 2002) issued a report concluding that “EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig’s disease, and miscarriage.”

Extensive investigations of animals exposed at much higher levels of magnetic fields (up to 50,000 mG) have not demonstrated adverse health effects (Boorman et al. 2000). The elevated levels of EMF exposure in occupational settings likewise do not show a consistent pattern of increased risk (Sahl et al. 2002). Laboratory studies of cells and tissues do not support the hypothesis that EMF exposure at ambient levels is a significant risk factor for human disease (NIEHS 1999). The failure to observe biological effects from EMF exposure may be due to the fact that, mechanistically, effects of EMF on biology are very weak (Valberg et al. 1997). Cells and organs function properly in spite of many sources of intrinsic chemical “noise” (e.g., stochastic, temperature, concentration, mechanical, and electrical noise), which exceed the effects caused by EMF by a large factor (Weaver et al. 2000).

In summary, a large number of blue-ribbon panels and public health review groups have examined the issue of the public’s exposure to power line EMF. The overall conclusion of these groups is that available data do not establish a cause and effect relationship between exposure to typical environmental levels of EMF and elevated risk of disease. EMF impacts on humans are expected to be negligible from alternative energy source operation on the OCS because of the lack of a definitive causal relationship, the short potential exposure time frame (i.e., maintenance operations), and relatively large distance of separation including shielding (i.e., buried cable and water cover for most operations).

4.2.7.3 Ecological Health and Exposure Impacts Associated with EMF

Both terrestrial (e.g., birds and honeybees) and marine animals (e.g., finfish, eels, sharks, and sea turtles) likely use the earth's DC magnetic field for orientation, navigation, and migration (Kirschvink et al. 2001). The mechanism underlying this magnetic sense is primarily limited to slowly varying fields and is not expected to respond to rapidly varying (e.g., 60 Hz) AC fields. Aside from orientation and navigation, other potential effects of low-frequency electric and magnetic fields on ecological systems have been investigated (National Research Council 1997), and there is no consistent evidence to establish an adverse-effect level. In fact, the RAPID research program mentioned above was carried out on laboratory animals, and the lack of consistent findings for EMF effects in those species also supports this conclusion.

Weak electric fields can be detected by certain fish (rays, sharks) for use in orientation and prey location. For example, sharks are capable of responding to extremely weak, slowly changing electric fields in seawater. The shark's electric sense organ (ampullae of Lorenzini) is complex, containing a large number (~10,000) of receptor cells, in which small interactions are integrated to generate a change that stands out against noise (Adair et al. 1998).

Currently, submarine power cables are used to supply power to offshore oil platforms, islands (such as the Nantucket Cable, which became operational in 2006), and to effect large power transmissions across a body of water. There are at least 5 major AC submarine cables in Europe with voltages ranging from 90 to 380 kilovolts (kV). About two thirds of the 18 major DC lines worldwide operate in Europe. The United States has one, the Cross Sound Cable bringing power from Connecticut to New York. This cable is about 40 km (25 mi) long and can transmit up to 330 megawatts (MW) at 150 kV with more than 1,000 amps of current. It was constructed in 2002 and has been operating since August 2003.

4.2.8 Marine Mammals

Approximately 39 species of marine mammals occur in Atlantic OCS waters from Florida to Maine. Some species are widespread and have been reported from all Atlantic OCS waters, while other species are generally restricted to smaller areas of the Atlantic OCS. In addition, many of these species are composed of distinct stocks that exhibit distinct distributions within overall population distributions and may be locally abundant in some OCS waters but absent from other areas of the Atlantic OCS (Waring et al. 2007). The Atlantic Coast's marine mammals are represented by members of the taxonomic orders Cetacea, Pinnipedia, and Sirenia. The order Cetacea includes the mysticetes (the baleen whales) and the odontocetes (the toothed whales, including the sperm whale, dolphins, and porpoises). Occurrence of cetacean species is generally widespread in Northwest Atlantic waters; many of the large whales and populations of smaller toothed whales undergo seasonal migrations along the U.S. Atlantic coast. The order Sirenia is represented by the West Indian manatee, which occurs mainly in the South Atlantic, but individual animals have been documented as far north as New England. The order Pinnipedia includes four species of seal, which are mainly found in the North Atlantic.

4.2.8.1 Threatened or Endangered Species

Seven species of marine mammals that occur in Atlantic waters of the United States are listed as endangered under the Endangered Species Act of 1973 (ESA). These include five species of baleen whales (North Atlantic right, blue, fin, sei, and humpback whales), one toothed whale (the sperm whale), and the West Indian manatee. All cetaceans are protected under the Marine Mammal Protection Act (MMPA), and some species (or stocks) may be designated as depleted under the MMPA. Species designated as depleted are afforded additional conservation efforts under the MMPA. A species or stock may be listed as depleted if it is determined to be below an optimum sustainable population size or if it is listed as endangered or threatened under the ESA.

4.2.8.1.1 Cetaceans—Mysticetes. The species of endangered mysticetes reported from the western Atlantic along the U.S. coast are the North Atlantic right whale, blue whale, fin whale, sei whale, and humpback whale.

The western stock of the North Atlantic right whale (*Eubalaena glacialis*) is the most endangered whale occurring along the Atlantic Coast. It inhabits primarily temperate and subpolar waters, and feeds exclusively on plankton (ACS 2004a). This species ranges from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding, nursery, and mating grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Six major congregation areas have been identified for the western stock of the North Atlantic right whale (coastal Florida and Georgia, Great South Channel, Cape Cod and Massachusetts Bays, Georges Bank/Gulf of Maine, Bay of Fundy, and Scotian Shelf) (Waring et al. 2007). The location of a large percentage of the North Atlantic right whale population during the winter months remains unknown (Waring et al. 2007). Occasional winter sightings have also been reported from coastal waters offshore New Jersey south to North Carolina. Abundance for the western stock of the North Atlantic right whale is estimated to be about 300 individuals (Waring et al. 2007). It is unclear whether its abundance is remaining stable, undergoing a slight growth, or currently in decline. Three areas have been designated under the Endangered Species Act of 1973 as critical habitat for the North Atlantic population. These areas include coastal Florida and Georgia (Sebastian Inlet, Florida, to the Altamaha River, Georgia), Great South Channel (east of Cape Cod), and portions of Cape Cod Bay, Massachusetts (50 CFR Part 226, Docket No. 930363-4145; I.D. 012793B).

The blue whale (*Balaenoptera musculus*) is the largest of all marine mammals. Blue whales may be found in all oceans of the world, but sightings in the Atlantic OCS waters have been sporadic. This species migrates to tropical-to-temperate waters during winter months to mate and give birth to calves. The blue whale feeds almost exclusively on krill and can feed throughout its range (ACS 2004b). This species is most frequently sighted in the Gulf of St. Lawrence, from where more than 300 individuals have been catalogued (Waring et al. 2007).

This species is considered an occasional visitor to Atlantic waters of the United States. Little is known about the population size of blue whales in the North Atlantic, but it may number only in the low hundreds (Waring et al. 2007). No critical habitat has been designated for the blue whale.

The fin whale (*Balaenoptera physalus*) is an oceanic species that occurs worldwide, although it seems to prefer temperate and polar waters to tropical seas (ACS 2004c). It is the second largest baleen whale and the most abundant of the ESA-listed large whale species in Mid- and North Atlantic OCS waters (Waring et al. 2007). Fin whales feed on concentrations of krill, fish, and copepods (ACS 2004c). While most often encountered alone, groups of 3 to 7 individuals are common, and larger congregations may occur in some areas at times. During the winter, they appear to move farther offshore and may be found from Cape Cod to Florida (Blaylock 1985). There is evidence that fin whales calve in the mid-Atlantic region. Calving is thought to take place during approximately 4 months from October to January in latitudes of the U.S. mid-Atlantic region; however, it is unknown where calving, mating, and wintering for most of the population occur (Waring et al. 2007). The Atlantic waters off New England represent a major feeding ground for this whale. While there are currently insufficient data to estimate population size and trends (Waring et al. 2007), the present populations are thought to be about 40,000 whales in the northern hemisphere and 20,000 individuals in the southern hemisphere (ACS 2004c).

The sei whale (*Balaenoptera borealis*) is an oceanic species that occurs from tropic to polar regions; in Atlantic waters of the United States, it is more often observed at more northern latitudes (ACS 2004d; NatureServe 2006; Waring et al. 2007). Sightings of sei whales in U.S. waters occur mostly in the spring and are infrequent (Waring et al. 2007). Sei whales feed on concentrations of plankton, fish, and squid (ACS 2004d). Sei whales show a seasonal movement pattern, between southern wintering grounds and northern feeding grounds (NatureServe 2006). Current worldwide population estimates for the sei whale are 51,000, with the western Atlantic population numbering in the few thousands (NatureServe 2006).

The humpback whale (*Megaptera novaeangliae*) occurs in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical banks where they breed and calve (ACS 2004e). During the summer, humpback whales congregate on feeding grounds located in the Gulf of Maine, the Great South Channel, Georges Bank, and Stellwagen Bank (NatureServe 2006; Waring et al. 2007). Humpback whales may be observed migrating north and south offshore of the Atlantic States during mid-to-late spring and mid-to-late fall, respectively. Humpbacks are rarely observed inshore north of North Carolina, but from Cape Hatteras south to Florida, inshore sightings occur more frequently. Humpback whales feed on concentrations of krill and fish (Whale Center 2005; ACS 2004e). The overall North Atlantic population is estimated at 8,000 individuals (Whale Center 2005). Current data suggest that the North Atlantic Gulf of Maine humpback whale stock is increasing (Waring et al. 2007).

4.2.8.1.2 Cetaceans—Odontocetes. The sperm whale (*Physeter macrocephalus*) is found worldwide in deep waters between approximately 60° N and 60° S latitudes (ACS 2004f; Waring et al. 2007). Sperm whales occur year-round offshore the Atlantic Coast. Sperm whales generally inhabit oceanic waters, but sometimes occur around islands or in shallow shelf waters. Highest densities often occur at steep drop-offs such as at the edge of the continental shelf (NatureServe 2006). Sperm whales prey on squid, sharks, skates, and fish (ACS 2004f).

While the sperm whale is migratory, its patterns are not as predictable or well understood as those of most baleen whales. In winter, the North Atlantic stock of sperm whales is concentrated east and northeast of Cape Hatteras (Waring et al. 2007). In spring, the center of distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central portion of the Mid-Atlantic Bight and the southern portion of Georges Bank. In summer, the distribution is similar but also includes the areas east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest levels, and there remains a continental shelf edge occurrence in the Mid-Atlantic Bight. Currently, there is no good estimate for the total number of sperm whales worldwide. The total global population of sperm whales has been estimated at around 360,000 individuals (ACS 2004f), with the North Atlantic sperm population estimated at 4,029 (Waring et al. 2007). No critical habitat has been designated for this species.

4.2.8.1.3 Sirenians. The West Indian manatee (*Trichechus manatus*) is the only sirenian occurring in U.S. waters. Manatees are herbivores and feed opportunistically on a wide variety of submerged, floating, and emergent vegetation (USFWS 1993; NatureServe 2006). Manatees primarily use open coastal (shallow nearshore) areas and estuaries, and they are also found far up in freshwater tributaries. Shallow seagrass beds with access to deep channels are their preferred feeding areas. Coastal and riverine habitats (near the mouths of coastal rivers) and sloughs are used for feeding, resting, mating, and calving.

Population size along the southeastern Atlantic Coast, and throughout this species' range, has not been adequately described. However, minimum estimates suggest that there may be fewer than 2,600 manatees left in the United States (NatureServe 2006). The majority of the West Indian manatee population along the Atlantic Coast is located in eastern Florida and southern Georgia. Not restricted to freshwater habitat, individuals of this species make seasonal migrations up the Atlantic Coast. The northernmost area occupied seasonally on a regular basis is coastal North Carolina (USFWS 2001; NatureServe 2006), although individuals have been observed as far north as New England. With the onset of cooler seasonal temperatures, manatees return to warmer waters.

4.2.8.2 Nonendangered Species

4.2.8.2.1 Cetaceans. The Atlantic OCS waters support a diverse nonendangered and nonthreatened cetacean fauna. Approximately 28 species have been reported from Atlantic OCS waters (Table 4.2.8-1). The toothed whales and dolphins (the odontocetes) account for most of the species observed within Atlantic OCS waters; the smallest of these toothed whales is the harbor porpoise (*Phocoena phocoena*), and the second largest (next to the sperm whale) is the

TABLE 4.2.8-1 Marine Mammals in the South Atlantic, Mid-Atlantic, and North Atlantic OCS Waters[a]

		General Occurrence[c]			Typical Habitat		
Species	Status[b]	South Atlantic[d]	Mid-Atlantic[e]	North Atlantic[f]	Coastal	Shelf	Slope/ Deep
Order Cetacea							
Suborder Mysticeti (baleen whales)							
Family Balaenidae							
North Atlantic right whale (*Eubalaena glacialis*)	E/D	UC[g]	O	UC	X	X	X
Family Balaenopteridae							
Blue whale (*Balaenoptera musculus*)	E/D	A	A	O		X	X
Bryde's whale (*Balaenoptera edeni*)		O	O	EX		X	X
Fin whale (*Balaenoptera physalus*)	E/D	O	UC	UC	X	X	X
Humpback whale (*Megaptera novaeangliae*)	E/D	UC	UC	UC	X	X	X
Minke whale (*Balaenoptera acutorostrata*)		O	O	UC	X	X	X
Sei whale (*Balaenoptera borealis*)	E/D	A	O	UC		X	X
Suborder Odontoceti (toothed whales and dolphins)							
Dwarf sperm whale (*Kogia sima*)		O	O	UC			X
Pygmy sperm whale (*Kogia breviceps*)		UC	UC	O			X
Sperm whale (*Physeter macrocephalus*)	E/D	UC	UC	UC			X
Family Ziphiidae							
Blainville's beaked whale (*Mesoplodon densirostris*)		O	O	O			X
Cuvier's beaked whale (*Ziphius cavirostris*)		O	O	O			X
Gervais' beaked whale (*Mesoplodon europaeus*)		O	O	O			X
True's beaked whale (*Mesoplodon mirus*)		O	O	O			X
Sowerby's beaked whale (*Mesoplodon bidens*)		EX	O	UC			X

TABLE 4.2.8-1 (Cont.)

		General Occurrence[c]			Typical Habitat		
Species	Status[b]	South Atlantic[d]	Mid-Atlantic[e]	North Atlantic[f]	Coastal	Shelf	Slope/ Deep
Family Delphinidae							
Short-beaked common dolphin (*Delphinus delphis*)		O	C	C		X	X
Pantropical spotted dolphin (*Stenella attenuata*)		C	O	O			X
Bottlenose dolphin (*Tursiops truncatus*)	D	C	C	C	X	X	X
Clymene dolphin (*Stenella clymene*)		UC	O	A			X
False killer whale (*Pseudorca crassidens*)		UC	O	A			X
Fraser's dolphin (*Lagenodelphis hosei*)		EX	A	A			X
White-sided dolphin (*Lagenorhynchus acutus*)		A	EX	C		X	X
White-beaked dolphin (*Lagenorhynchus albirostris*)		A	A	O		X	
Killer whale (*Orcinus orca*)		O	O	O		X	X
Melon-headed whale (*Peponocephala electra*)		A	O	A			X
Atlantic spotted dolphin (*Stenella frontalis*)		C	C	C			X
Pygmy killer whale (*Feresa attenuata*)		EX	EX	EX			X
Short-finned pilot whale (*Globicephala macrorhynchus*)		C	C	O		X	X
Long-finned pilot whale (*Globicephala melas*)		A	UC	C		X	X
Risso's dolphin (*Grampus griseus*)		O	C	C			X
Rough-toothed dolphin (*Steno bredanensis*)		EX	EX	A			X
Spinner dolphin (*Stenella longirostris*)		O	O	A			X
Striped dolphin (*Stenella coeruleoalba*)		C	C	C			X
Harbor porpoise (*Phocoena phocoena*)		A	O	C	X	X	
Order Sirenia							
Family Trichechidae							
West Indian manatee (*Trichechus manatus*)	E	UC	O	O	X		

TABLE 4.2.8-1 (Cont.)

Species	Status[b]	General Occurrence[c] South Atlantic[d]	Mid-Atlantic[e]	North Atlantic[f]	Typical Habitat Coastal	Shelf	Slope/Deep
Order Carnivora							
Suborder Fissipeda							
Family Phocidae							
Harbor seal (*Phoca vitulina*)		A	UC	C	X	X	
Gray seal (*Halichoerus grypus*)		A	O	C	X	X	
Harp seal (*Pagophilus groenlandicus*)		A	EX	EX	X	X	
Hooded seal (*Cystophora cristata*)		EX	EX	EX		X	X

[a] Source: Waring et al. (2007).

[b] E = Endangered under the Endangered Species Act; D = Depleted under the Marine Mammal Protection Act.

[c] The indicated occurrence does not reflect the distribution and occurrence of individual stocks of marine mammals within localized geographic areas, but rather the broad distribution of the species within the larger categories of OCS waters.

[d] South Atlantic includes OCS waters from central Florida to the South Carolina-North Carolina border.

[e] Mid-Atlantic includes OCS waters from the South Carolina-North Carolina border to the Delaware-New Jersey border.

[f] North Atlantic includes OCS waters from the Delaware-New Jersey border to the Maine border with Canada.

[g] A = Absent – not recorded from the area; C = Common – regularly observed throughout the year; EX = Extralimital – known only on the basis of a few records that probably resulted from unusual wanderings of animals into the region; O = Occasional – relatively few observations throughout the year, but some species may be more frequently observed in some locations or during certain times (e.g., during migration); UC = Uncommon – infrequently observed throughout the year, but some species may be more common in some locations or during certain times of the year (e.g., during migration or when on summer calving grounds or wintering grounds).

killer whale (*Orcinus orca*). There are only two nonendangered mysticetes, the minke whale (*Balaenoptera acutorostrata*) and Bryde's whale (*B. edeni*) (Table 4.2.8-1).

While the winter distribution and migration of many small odontocetes are not well known; the distribution and seasonal movements of the various nonendangered and nonthreatened cetaceans are assumed to be similar to those described for the endangered whales (Cetacean and Turtle Assessment Program 1982; Waring et al. 2007). Feeding, breeding, and calving activities are thought to occur to some degree in at least some portions of Atlantic OCS waters. A limited migration or season distribution occurs for most species with animals moving north in the spring and summer and returning south in the fall and winter. Many species are present in the mid-Atlantic waters throughout the year; however, some species that inhabit mid-Atlantic waters in late autumn to early spring move into North Atlantic waters in summer.

There are two broadly distinct communities of nonendangered and nonthreatened cetaceans. One occurs well offshore and is generally associated with the shelf edge, canyons, other pronounced seafloor features, and areas of ocean current convergence. This offshore community possesses the greatest species diversity and includes such species as Risso's dolphin (*Grampus grieseus*), striped and spotted dolphins (*Stenella* spp.), false and pygmy killer whales (*Pseudorca crassidans* and *Feresa attenuata*), pilot whales (*Globicephala* spp.), and various species of beaked whales (*Mesoplodon* spp.). The other community occurs inshore of the shelf slope break and occupies nearshore and coastal habitats including estuaries, harbors, and river mouths. This community includes species such as the bottlenose dolphin (*Tursiops truncatus*) and harbor porpoise (*Phocoena phocoena*).

There are several morphologically and genetically distinct bottlenose dolphin types present in coastal and offshore waters of the western North Atlantic. In offshore waters, bottlenose dolphins are from the western North Atlantic offshore stock and occur along the outer continental shelf and continental slope from Florida to Maine (Waring et al. 2007). In coastal waters, there are a minimum of five stocks of bottlenose dolphins (western North Atlantic Coastal morphotype stocks), which are distributed in coastal and estuarine waters along the Atlantic coast from south of Long Island to the Florida peninsula. These stocks are designated as depleted under the MMPA.

4.2.8.2.2 Pinnipeds. Four species of seals have been reported from Mid- and North Atlantic waters: harbor seal (*Phoca vitulina*), gray seal (*Halichoerus grypus*), harp sea (*Pagophilus groenlandicus*), and hooded seal (*Cystophora cristata*) (Table 4.2.8-1). None have been reported from Southern Atlantic waters. The hooded seal usually occurs in New England waters between January and May, and in summer and autumn off the southeast U.S. Coast (Waring et al. 2007). While the harp seal typically inhabits waters of the North Atlantic and Arctic Oceans, the numbers of sightings and strandings have recently been increasing off the east coast from Maine to New Jersey. These extralimital sightings, which usually occur between January and May, may represent a southward shift in the winter distribution of this species (Waring et al. 2007). The gray seal occurs from New England to Labrador, with a year round breeding population present on outer Cape Cod (Waring et al. 2007). The harbor seal is found in all nearshore waters of the Atlantic Ocean above about 30°N; it is a year-round resident in Maine and a seasonal inhabitant from southern New England to New Jersey, and scattered sightings have been reported as far south as Florida (Waring et al. 2007). All four species feed on fish and large invertebrates (NatureServe 2006).

4.2.9 Marine and Coastal Birds

The Atlantic Coast of North America provides a wide variety of habitats that are used by a diverse bird fauna, while the offshore waters support a variety of marine birds (National Geographic Society 1999). Marine birds or seabirds are generally considered to include species that spend the majority of their life at sea, coming ashore mainly to breed or to avoid severe environmental conditions. Included in this group are pelagic birds (e.g., petrels and shearwaters); diving birds (e.g., cormorants and pelicans); and gulls, terns, and skimmers. Pelagic species tend to concentrate in nutrient-rich upwelling areas to feed. For example, the waters off Cape Hatteras, North Carolina, along the western edge of the Gulf Stream are known to be an important feeding area for several species.

The Atlantic Coast also supports a great diversity of coastal birds that forage and nest in coastal habitats such as beaches, wetlands, marshes, and ridges. These include shorebirds such as sandpipers and plovers, wading birds such as herons and egrets, and numerous passerines (National Geographic Society 1999).

As might be expected, habitat types vary widely from the Florida Keys to the Maine coastline. Major habitat types include: (1) beach front, including high energy beaches, sandy deltas, rock and gravel shorelines, and high beach/dune; (2) intertidal mudflats lacking vegetation; (3) vegetated intertidal marshes; (4) managed freshwater and brackish impoundments; (5) inland habitats, including forested wetlands and managed uplands; and (6) mangrove and pine forests (Clark and Niles 2000; Hunter et al. 2000).

4.2.9.1 Threatened and Endangered Species

Several species of federally endangered or threatened species of birds occur in Atlantic OCS waters during at least part of the year. These species include the endangered Eskimo curlew, Everglade snail kite, wood stork, Bachman's warbler, and the northeastern U.S. population of the roseate tern (Table 4.2.9-1). Species listed as threatened include the Florida scrub jay, piping plover, and the roseate tern from other than northeastern U.S. coastal areas. There is currently only one bird species, the red knot, identified from the Atlantic Coast States as a candidate for listing as threatened or endangered under the Endangered Species Act (USFWS 2006a). Coastal habitats used by these species may include offshore areas, coastal beaches, and intertidal wetlands and marshes wetlands. Table 4.2.9-1 also identifies the waters and coastal States in which federally listed species might be encountered, as well as a brief description of the habitats used by these species.

4.2.9.2 Nonendangered Species

The Atlantic Coast of the United States and associated OCS waters support a large diversity of birds, including waterfowl, pelagic seabirds, shorebirds, wading birds, songbirds (such as finches, warblers, thrushes, blackbirds, and wrens), and raptors (National Geographic Society 1999). Coastal habitats provide nesting and foraging habitats for seasonal and year-round residents, as well as large types and numbers of birds that annually migrate along the coast. Some birds, such as shorebirds, are generally restricted to coastline margins except when migrating. Coastal and adjacent inland wetlands may serve as important habitats for overwintering, and as temporary feeding and resting habitats for migrating birds. The South

TABLE 4.2.9-1 Federally Endangered and Threatened Birds That May Occur in the Coastal and Marine Areas of the Atlantic

Species	Federal Status[a]	Atlantic OCS Waters	State	General Ecology
Eskimo curlew (*Numenius borealis*)	E	Straits of Florida South Atlantic Mid-Atlantic North Atlantic	FL, GA, SC, NC, VA, MD, DE, NJ, NY, RI, CT, NH, MA, ME	A migrant shorebird that historically nested in the Arctic wetlands and wintered in South America. May be extinct.
Florida scrub jay (*Aphelocoma coerulescens*)	T	Straits of Florida South Atlantic	FL	Restricted mostly to scrub ridges of central peninsular Florida, with scattered occurrences on Atlantic coastal ridges.
Everglade snail kite (*Rostrhamus sociabilis plumbeus*)	E	Straits of Florida	FL	Historically inhabited freshwater marshes of peninsular Florida that support adequate populations of apple snails.
Piping plover (*Charadrius melodius*)	T	Straits of Florida South Atlantic Mid-Atlantic North Atlantic	FL, GA, SC, NC, VA, MD, DE, NJ, NY, RI, CT, NH, MA, ME	Shorebird that inhabits coastal sandy beaches and mudflats. Has recently shown a 141% increase in population because of beach closures, twine barriers, and other buffers established between nest beaches and human activities.
Wood stork *(Mycteria americana*)	E	Straits of Florida South Atlantic	FL, GA, SC	Large, wading bird inhabiting freshwater and brackish wetlands; typically nests in cypress and mangrove swamps.
Roseate tern except NE U.S. (*Sterna dougallii dougallii)*	T	Straits of Florida	FL	Caribbean breeds from Florida through the West Indies to islands of Central and northern South America. Strictly a coastal species usually observed foraging in nearshore surf. This species is pelagic. Open sandy beaches isolated from human activity are optimal nesting habitat for the roseate tern.
Roseate tern NE U.S. (*Sterna dougallii dougallii*)	E	Mid-Atlantic North Atlantic	SC, NC, VA, NJ, NY, RI, MA, ME	Breeds in colonies almost exclusively on small offshore islands, rarely on large islands. The northeastern colonies are on rocky offshore islands, barrier beaches, or salt marsh islands. Most colonies are close to shallow water fishing sites with sandy bottoms, bars, or shoals.

TABLE 4.2.9-1 (Cont.)

Species	Federal Status	Atlantic OCS Waters	State	General Ecology
Bachman's warbler (*Vermivora bachmanii*)	E	South Atlantic	SC	Historically found in low, wet forested areas; South Carolina coast represents the most important historical nesting area. May be extinct.

[a] E = endangered; T = threatened.

Sources: USFWS (2006a); AP (2007).

Atlantic and Straits of Florida areas support many overwintering species, which may remain within specific areas throughout the season and utilize the same areas year after year. Coastal habitats in the North Atlantic are considered critical to the survival of hemispheric populations of some shorebirds, such as red knots, piping plovers, and whimbrels (Clark and Niles 2000), and they also provide important breeding areas for a variety of marine species such as terns and gulls.

4.2.9.3 Use of Atlantic Coast Habitats by Migratory Birds

The Atlantic Coast plays an important role in the ecology of many bird species. The Atlantic Flyway (Figure 4.2.9-1) is a major route for migratory birds traveling along the Atlantic Coast between northern habitats in New England, Canada, and the Arctic, and southern habitats in subtropical and tropical areas of North, Central, and South America. For example, about 50 different kinds of landbirds that breed in New England follow the coast southward to Florida and beyond to Central and South America (Lincoln et al. 1998). During the spring and fall migrations, the beaches, bays, marshes, wetlands, and coastal forests of the Atlantic Coast provide important resting and foraging habitats for migratory birds. These migratory birds and their parts (including nests, eggs, and feathers) are protected under the Migratory Bird Treaty Act of 1918.

Many species migrate from summer breeding habitats in the northern habitats in the United States and Canada (as far north as the Arctic) to overwinter on the central and southern U.S. coastlines. For example, the Brant goose (*Branta bernicla*) winters on the Atlantic Coast, chiefly at Barnegat Bay, New Jersey, but depending upon the severity of the season and the food available, many winter south to North Carolina. Their breeding grounds are in the Canadian arctic archipelago and on the coasts of Greenland (Lincoln et al. 1998).

The Atlantic Coast also receives overwintering birds from several of the inland migration paths. For example, canvasback (*Aythya valisineria*), redhead (*Aythya americana*), and lesser scaup (*Aythya affinis*) coming from breeding grounds on the great northern plains of central Canada migrate to the Atlantic Coast in the vicinity of Delaware and Chesapeake Bays. Many of

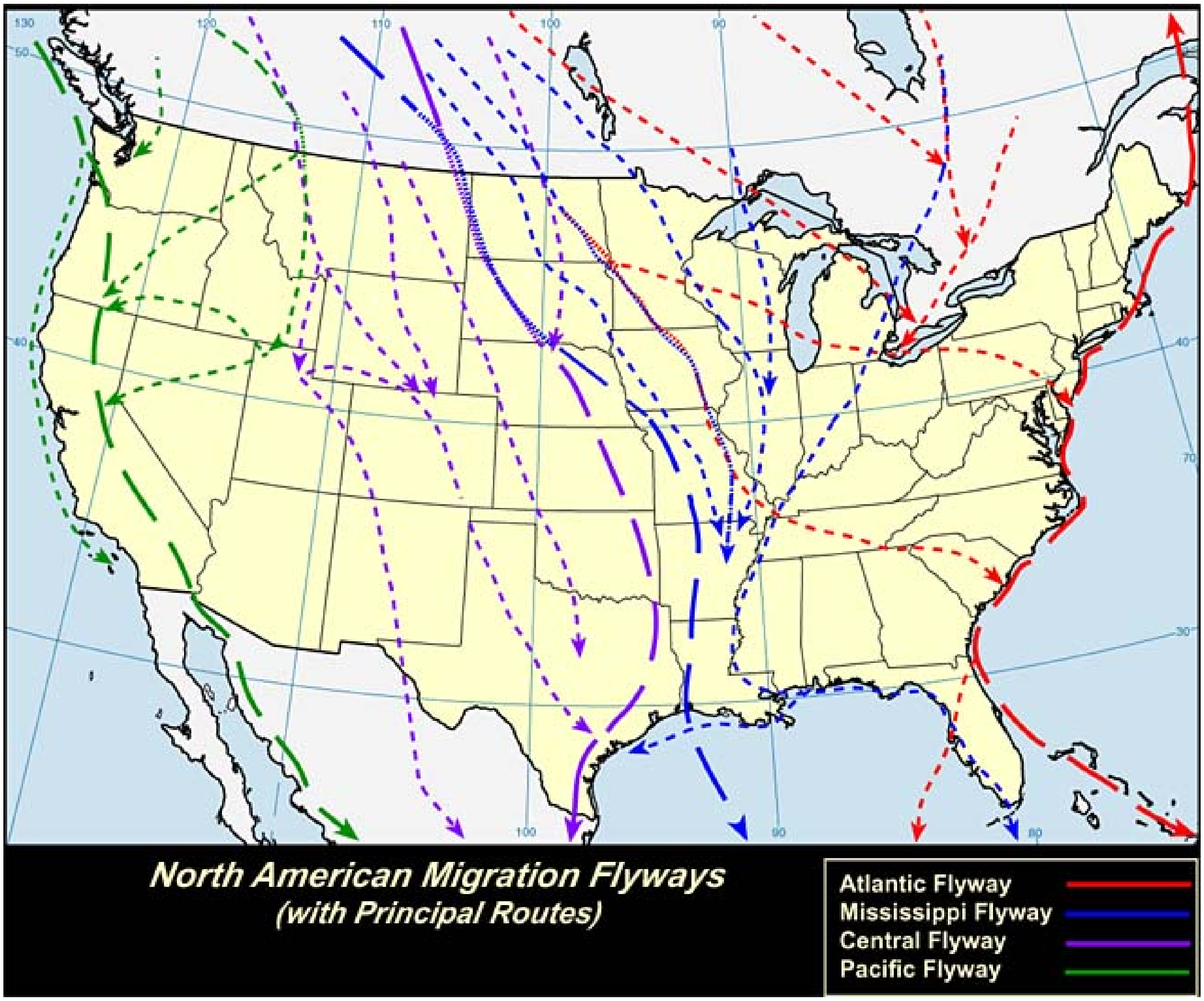

FIGURE 4.2.9-1 Major North American Migration Flyways Showing General Locations of Principal Routes (used with permission of birdnature.com)

the black duck (*Anas rabripes*), mallard (*Anas platyrhynchos*), and blue-winged teal (*Anas discors*) that have gathered on feeding grounds in southern Ontario during the fall leave these areas and proceed to the Atlantic Coast south of New Jersey (Lincoln et al. 1998).

4.2.10 Terrestrial Biota

Ecoregions delineate areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources present in the area (Omernik 1987); they are based on unique combinations of geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. A number of individuals and organizations have characterized North America on the basis of ecoregions (e.g., Omernik 1987; CEC 1997; Bailey 1995). The following discussion of terrestrial biota along the coastlines of the Atlantic OCS waters is based on the Level III ecoregion classification of Omernik (1987) as refined through collaborations among USEPA regional offices, State resource management agencies, and other Federal agencies (USEPA 2004c).

The Atlantic Coast of the United States supports a great diversity of terrestrial biota. This diversity is a function of the combinations of geology, topography, and climate that occur along the coast from the Florida Keys to the Canadian border in Maine and the ecoregions that encompass these areas. The eastern Atlantic Coast falls into six ecoregions (Figure 4.2.10-1), each with a relatively unique ecosystem and biota. Descriptions of these ecoregions are presented in Table 4.2.10-1.

Each of these ecoregions support a vast variety of plant and animal species, some of which inhabit or visit coastal habitats. Included among these species of terrestrial biota are numerous species that have been listed as threatened or endangered under the Endangered Species Act of 1973, species being considered for listing under the Act, as well as many species listed by individual States. The numbers of threatened, endangered, or candidate species listed under the Endangered Species Act are presented in Table 4.2.10-2. These listed species include plants, invertebrates, amphibians, reptiles, birds, and mammals. While many of these species occur inland, well away from coastal areas, some inhabit or visit coastal habitats adjacent to the Atlantic OCS waters. For example, the seabeach amaranth (*Amaranthus pumilus*) is an annual flowering plant found on the dunes of Atlantic Ocean beaches from South Carolina to Massachusetts.

4.2.11 Fish Resources and Essential Fish Habitat

Marine habitats of the Atlantic Coast range from coastal marshes to the deep-sea abyssal plain and support varied and abundant fish and invertebrate populations, including threatened and endangered species, nonlisted species, and species important to commercial and recreational fisheries.

Several State and Federal Agencies are involved in the management of fish resources in the Atlantic. The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) manages commercial and recreational fisheries within Federal waters under the Magnuson-Stevens Fishery Conservation and Management Act (FCMA) and designates Essential Fish Habitat (EFH) to conserve Atlantic fishery resources in the Exclusive Economic Zone (EEZ) that ranges between 3 and 200 mi offshore. In the Atlantic Ocean, the fisheries in waters of the EEZ offshore from the States of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and part of North Carolina are managed by the Northeast Region of NMFS, while fisheries off the coasts of the remaining portions of North Carolina, South Carolina, Georgia, and Florida are managed by the Southeast Region of the NMFS. Fishery management plans for fishery resources within the Federal waters of the EEZ are typically developed by the New England, Mid-Atlantic, or South Atlantic Fishery Management Councils, as appropriate; the Atlantic States Marine Fisheries Commission's Interstate Fisheries Management Program develops fishery management plans for marine, estuarine, and anadromous fisheries in State

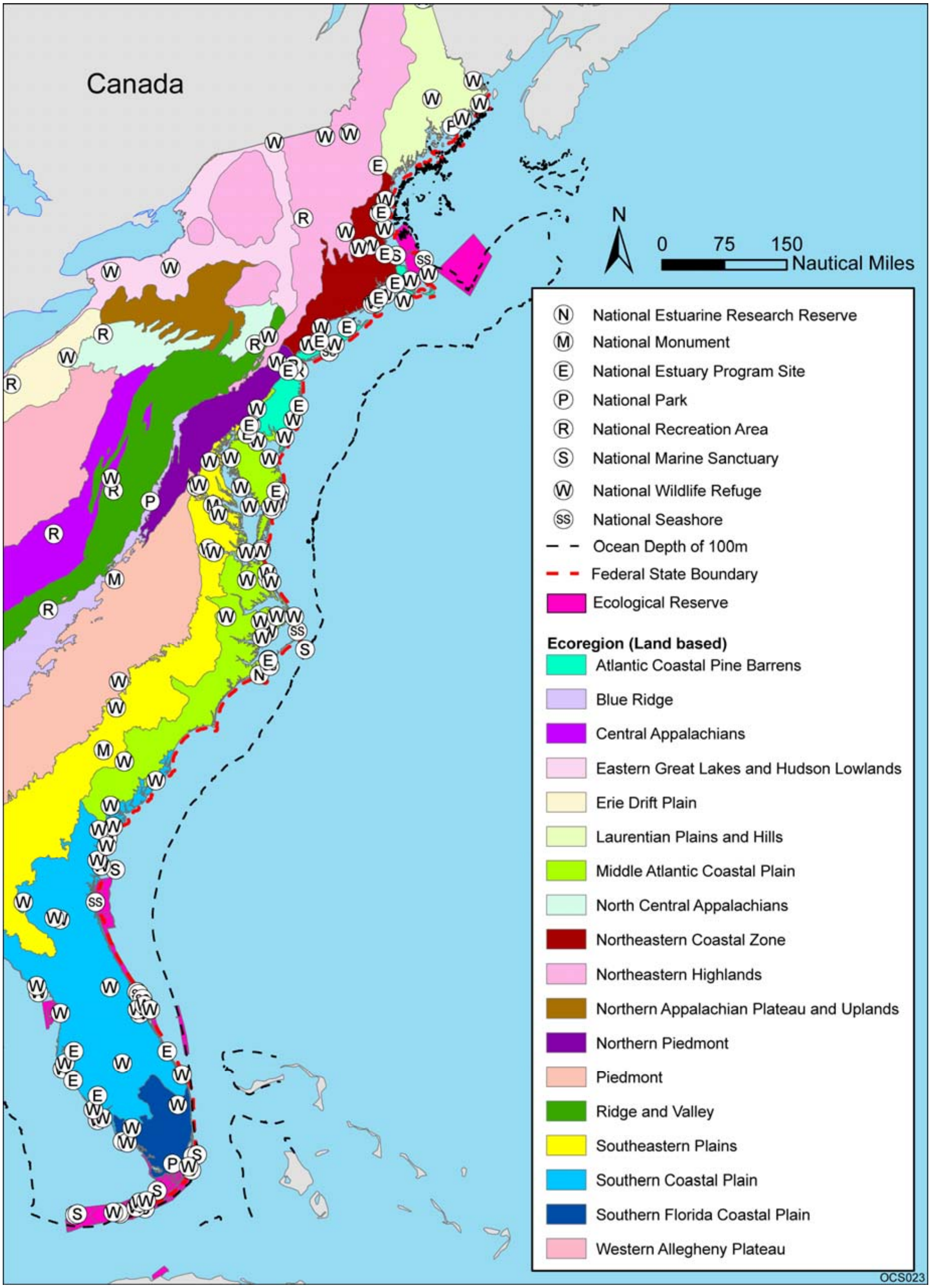

FIGURE 4.2.10-1 Ecological Resources in the Atlantic Region

TABLE 4.2.10-1 Ecoregions and Terrestrial Ecological Setting of the OCS Atlantic Coast

Ecoregion	Atlantic OCS Waters (State)	Description
Southern Coastal Plain	Straits of Florida, South Atlantic (FL, GA, SC)	The Southern Coastal Plain consists mostly of flat, with barrier islands, beaches, coastal lagoons, marshes, and swampy lowlands along the coast. Land cover of the region is mostly slash and loblolly pine with oak-gum-cypress forest in some areas.
Southern Florida Coastal Plain	Straits of Florida (FL)	This ecoregion encompasses the southern end of Florida peninsula and the Florida Keys. This frost-free region is characterized by flat plains with wet soils, marshland, and swamp land cover with everglades and palmetto prairie vegetation types.
Middle Atlantic Coastal Plain	South Atlantic, Mid-Atlantic (SC, NC, VA, MD, DE, NJ)	This ecoregion consists of low elevation flat plains, with many swamps, marshes, and estuaries. Forest cover in the region is mostly loblolly and some shortleaf pine, with patches of oak, gum, and cypress near major streams. Its low terraces, marshes, dunes, barrier islands, and beaches are underlain by unconsolidated sediments.
Atlantic Coastal Pine Barrens	North Atlantic (NJ, NY, MA)	This ecoregion is distinguished from the Middle Atlantic Coastal Ecoregion to the south by its coarser-grained soils, cooler climate, and oak-pine potential natural vegetation. The climate is milder than the Northeastern Coastal Ecoregion to the north, which contains Appalachian Oak forests and some Northern hardwood forests. The physiography of this ecoregion is not as flat as that of the Middle Atlantic Coastal Plain, but it is not as irregular as that of the Northeastern Coastal Zone.

TABLE 4.2.10-1 (Cont.)

Ecoregion	Atlantic OCS Waters (State)	Description
Northeastern Coastal Zone	North Atlantic (CT, RI, MA, NY, ME)	This ecoregion contains relatively nutrient-poor soils and concentrations of continental glacial lakes, some of which are sensitive to acidification; however, this ecoregion contains considerably less surface irregularity and much greater concentrations of human population. Land use now mainly consists of forests and residential development.
Laurentian Plains and Hills	North Atlantic (ME)	This mostly forested ecoregion has dense concentrations of continental glacial lakes. Vegetation here is mostly spruce-fir with some patches of maple, beech, and birch.

Source: USEPA (2004c).

TABLE 4.2.10-2 Numbers of Terrestrial (Nonmarine) Endangered, Threatened, and Candidate Species Listed under the Endangered Species Act of 1973[a]

State	Endangered Species	Threatened Species	Candidate Species
South Carolina	23	11	1
North Carolina	40	14	5
Virginia	43	15	5
Maryland	14	9	0
Delaware	8	7	2
New Jersey	10	10	2
New York	12	14	4
Rhode Island	6	5	1
Massachusetts	12	7	1
Connecticut	8	6	1
New Hampshire	6	5	1
Maine	1	5	1

[a] Numbers of species, per category, cannot be summed, as many listed species occur in multiple States.

Source: USFWS (2006b).

waters. NMFS is directly responsible for development of the fishery management plan for Atlantic tunas, swordfishes, and sharks and the fishery management plan for Atlantic billfishes (Table 4.2.11-1). The NMFS and the U.S. Fish and Wildlife Service (USFWS) share responsibility for threatened and endangered anadromous fish species in the Atlantic (i.e., the Maine distinct population segment of Atlantic salmon). State fish and wildlife agencies assist in the management of fish species in State waters. Additional protection and management of marine habitats are offered by national parks, refuges, marine sanctuaries, and estuaries.

4.2.11.1 Threatened or Endangered Fish Species

Three fish species that are currently federally listed as endangered occur along the Atlantic Coast: shortnose sturgeon, smalltooth sawfish, and Atlantic salmon. Another species, the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), is currently being considered for listing as threatened or endangered (72 FR 15865–15866, 2007).

4.2.11.1.1 Shortnose Sturgeon (*Acipenser brevirostrum*). The shortnose sturgeon, federally listed as an endangered species, is an anadromous fish that spawns in the coastal rivers along the east coast of North America from the St. John River in Canada to the St. Johns River in Florida. In the northern portion of the range, it is found in the Chesapeake Bay system; Delaware River; the Hudson River; the Connecticut River; the lower Merrimack River; and Kennebec River to the St. John River in New Brunswick, Canada. The shortnose sturgeon prefers the nearshore marine, estuarine, and riverine habitats associated with large river systems, and migrates periodically into faster-moving freshwater areas to spawn. Shortnose sturgeon individuals do not appear to make long-distance offshore migrations.

4.2.11.1.2 Smalltooth Sawfish (*Pristis pectinata*). The smalltooth sawfish is one of two species of sawfish that inhabit U.S. waters. Little is known about the life history of these animals, but they may live up to 25 to 30 years and commonly reach 18 ft (5.5 m) or more in length. Smalltooth sawfish are usually found over muddy and sandy bottoms in sheltered bays, on nearshore shallow banks, and in estuaries or river mouths.

Smalltooth sawfish have been reported in the Pacific and Atlantic Oceans, and Gulf of Mexico; however, the U.S. population is found only in the Atlantic Ocean and Gulf of Mexico and it is this distinct population segment (DPS) that is federally listed as endangered (*Federal Register* 2003 [68 FR 15674]). Historically, the U.S. population was common throughout the Gulf of Mexico from Texas to Florida, and along the east coast from Florida to Cape Hatteras. However, the current range of this species has contracted to peninsular Florida, and, although no accurate estimates of abundance are available, smalltooth sawfish are now relatively common only in the Everglades region at the southern tip of the State. The decline in smalltooth sawfish abundance has been largely attributed to their capture as bycatch in various fisheries (especially in gill nets), loss and limited availability of appropriate habitat (especially for juveniles), and to the species' low population growth rate.

TABLE 4.2.11-1 Current and Proposed Fishery Management Plans in the Atlantic, Gulf, and Pacific Regions[a]

Fishery Management Plan	Responsible Fishery Management Council(s)	Responsible NMFS Office
Atlantic Sea Scallops	NEFMC	NMFS Northeast Regional Office
Northeast Multispecies Fishery	NEFMC	NMFS Northeast Regional Office
Atlantic Salmon Fishery	NEFMC	NMFS Northeast Regional Office
Monkfish Fishery	NEFMC	NMFS Northeast Regional Office
Atlantic Herring Fishery	NEFMC	NMFS Northeast Regional Office
Atlantic Deep Sea Red Crab	NEFMC	NMFS Northeast Regional Office
Skates	NEFMC	NMFS Northeast Regional Office
Atlantic Surf Clam and Ocean Quahog Fisheries	MAFMC	NMFS Northeast Regional Office
Atlantic Mackerel, Squid, and Butterfish Fisheries	MAFMC	NMFS Northeast Regional Office
Summer Flounder, Scup, and Black Sea Bass Fisheries	MAFMC	NMFS Northeast Regional Office
Atlantic Bluefish	MAFMC	NMFS Northeast Regional Office
Spiny Dogfish	MAFMC and NEFMC	NMFS Northeast Regional Office
Tilefish	MAFMC	NMFS Northeast Regional Office
Snapper-Grouper Fishery of the South Atlantic Region	SAFMC	NMFS Southeast Regional Office
Atlantic Coast Red Drum	SAFMC	NMFS Southeast Regional Office
Shrimp Fishery of the South Atlantic Region	SAFMC	NMFS Southeast Regional Office
Coral, Coral Reefs, and Live/Hard Bottom Habitats of the South Atlantic Region	SAFMC	NMFS Southeast Regional Office
Golden Crab Fishery of the South Atlantic Region	SAFMC	NMFS Southeast Regional Office
Dolphin and Wahoo	SAFMC, GMFMC, and CFMC	NMFS Southeast Regional Office
Pelagic Sargassum Habitat of South Atlantic Region	SAFMC	NMFS Southeast Regional Office
Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic	GMFMC and SAFMC	NMFS Southeast Regional Office
Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic	GMFMC and SAFMC	NMFS Southeast Regional Office
Coral and Coral Reefs of the Gulf of Mexico	GMFMC	NMFS Southeast Regional Office
Red Drum Fishery of the Gulf of Mexico	GMFMC	NMFS Southeast Regional Office
Stone Crab Fishery of the Gulf of Mexico	GMFMC	NMFS Southeast Regional Office
Shrimp Fishery of the Gulf of Mexico	GMFMC	NMFS Southeast Regional Office
Reef Fish Resources of the Gulf of Mexico	GMFMC	NMFS Southeast Regional Office

TABLE 4.2.11-1 (Cont.)

Fishery Management Plan	Responsible Fishery Management Council(s)	Responsible NMFS Office
West Coast Salmon	PFMC	NMFS Northwest Regional Office
Coastal Pelagic Species	PFMC	NMFS Southwest Regional Office
Pacific Coast Groundfish	PFMC	NMFS Northwest Regional Office
U.S. West Coast Fisheries for Highly Migratory Species	PFMC	NMFS Southwest Regional Office
Atlantic Tunas, Swordfish, and Sharks	NA[c]	NMFS Highly Migratory Species Management Division
Atlantic Billfishes	NA[c]	NMFS Highly Migratory Species Management Division

[a] CFMC = Caribbean Fishery Management Council; GMFMC = Gulf of Mexico Fishery Management Council; MAFMC = Mid-Atlantic Fishery Management Council; NEFMC = New England Fishery Management Council; NMFS = National Marine Fisheries Service; PFMC = Pacific Fishery Management Council; SAFMC = South Atlantic Fishery Management Council.

[b] Fishery management plans developed by State Marine Fisheries Commissions are not included.

[c] Authority to manage these highly migratory species in U.S waters of the Atlantic Ocean has been delegated directly to NMFS instead of the Fishery Management Councils.

Source: NMFS (2006a).

4.2.11.1.3 Atlantic Salmon (*Salmo salar*). The Gulf of Maine DPS of the Atlantic salmon that spawns within eight coastal watersheds within Maine is federally listed as endangered (65 FR 69459), while other Atlantic salmon populations in Maine waters are considered species of concern. The listing of this population segment was based on a species status review that concluded that Atlantic salmon in the Gulf of Maine DPS exhibit a critically low abundance of spawning fish, poor marine survival, and are confronted with the increased presence of numerous threats.

Atlantic salmon are anadromous and have a relatively complex life history that extends from spawning and juvenile rearing in freshwater rivers to extensive feeding migrations in the open ocean. In the United States, adult Atlantic salmon ascend the rivers of New England to spawn during the spring to fall seasons. Juvenile salmon feed and grow in the rivers from one to three years before migrating to the ocean. Atlantic salmon of U.S. origin are highly migratory, undertaking long marine migrations between the mouths of U.S. rivers and the northwest Atlantic Ocean where they are widely distributed over much of the region south of Greenland. Most Atlantic salmon of U.S. origin spend two winters in the ocean before returning to freshwater to spawn, although this can range from one to four years for some individuals.

4.2.11.2 Other Fish Species

A wide variety of fish species inhabit waters of the Atlantic region, with variation in the numbers and types of species present changing from northern to southern latitudes to reflect differences in habitat conditions such as topography, temperature gradients, locations of major oceanic currents, and the availability of appropriate food sources. Fish assemblages in State and Federal waters along the Atlantic Coast, generally categorized according to life habits or preferred habitat associations, are described below.

4.2.11.2.1 Diadromous Fishes. Diadromy is a general category describing fish that spend portions of their life cycles in freshwater and portions in saltwater. This group can be further subdivided into anadromous and catadromous fish. Anadromous fishes spend most of their adult lives at sea, but migrate from the ocean to spawn in freshwater rivers or in the brackish upper reaches of estuaries. Catadromous fishes spend most of their adult lives in freshwater, but migrate to the marine environment to spawn; the resulting young catadromous fish then move to the riverine environment to mature. In the Atlantic Ocean, anadromous fish include various species of sturgeons (family Acipenseridae), herrings and shad (family Clupeidae), temperate basses (family Moronidae), smelts (family Osmeridae), lampreys (family Petromyzontidae), and trout and salmon (family Salmonidae). The American eel (*Anguilla rostrata*) is the only catadromous species that occurs along the Atlantic Coast.

4.2.11.2.2 Pelagic Fishes. Fish that spend most of their lives swimming in the water column, rather than occurring on or near the bottom, are known as pelagic species. Some coastal pelagic species in the Atlantic region, including important schooling forage fish such as menhaden (*Brevoortia tyrannus*) and predatory species such as red drum (*Sciaenops ocellatus*), are found primarily in shallower waters. Many coastal pelagic species rely on coastal wetlands, seagrass habitats, and estuaries to provide habitat for specific life stages and many of these species migrate north and south along the Atlantic Coast during some periods of the year.

Some pelagic species are distributed from the shore to the continental shelf edge. A number of these species are schooling fish that are sought by both recreational and commercial fisheries. Included in this assemblage are smaller forage species, such as Atlantic herring (*Clupea harengus*), and larger predatory fishes, including bluefish (*Pomatomus saltatrix*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), cobia (*Rachycentron canadum*), and dolphin (*Coryphaena hippurus*). These fish share the common characteristics of rapid growth, high feeding rates, and high reproductive capacity. Many of these species mature at an early age and spawn over protracted periods of time. In general, these fish use the highly productive coastal waters within the Atlantic region during the summer months and migrate to deeper and/or more distant waters during the rest of the year. There are a number of fishery management plans in place for regulating and managing pelagic fisheries in the Atlantic region, including plans for Atlantic salmon, Atlantic herring, bluefish, dolphin, and wahoo (*Acanthocybium solandri*). Typically gears, such as trawls, longlines, and purse seines are employed by commercial fisheries to target pelagic fish species.

In addition there are a variety of deepwater pelagic fishes, including lanternfish (family Myctophidae), anglerfish (several families in the Order Lophiiformes), rattails (family Macrouridae), and hakes (family Merluciidae). These species, which generally occur at the outer reaches of the continental shelf or beyond, are rarely observed near the surface.

4.2.11.2.3 Demersal Fishes. Demersal fish (groundfish) are those fish that spend at least the adult portion of their life cycle in association with the ocean bottom. Many of these species are considered to be high-value fish and are sought by both commercial and recreational anglers. Demersal fish are often found in mixed species aggregations that differ depending upon the specific area and time of year. Some examples of common demersal fish within these aggregations include flounders (family Pleronectidae), hakes and cods (family Gadidae), and sea basses and groupers (family Serranidae). Many demersal fish species have pelagic eggs or larvae that are sometimes carried long distances by oceanic surface currents.

In the mid- and southern portions of the Atlantic region, groundfish assemblages that occur in association with hard-bottom substrates including rock outcroppings, wrecks, coral growths, sponges, and other bottom anomalies can often generally be categorized as belonging to the snapper-grouper complex. They typically include various species of snappers (family Lutjanidae) or groupers, in addition to other species. In northern portions of the Atlantic region, Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and pollock (*Pollachius virens*) are commonly associated with such habitats.

In commercial fisheries, demersal fish are usually taken by using trawling gear, although a great number are also caught with other gear such as gill nets, traps, and longlines. Fisheries for demersal fishes in the Atlantic region are managed by multispecies groundfish fishery management plans as well as a number of single-species management plans (Table 4.2.11-1).

4.2.11.2.4 Highly Migratory Fishes. Highly migratory fishes include those species often thought of as "big game" or "blue water" species. Fish within this assemblage often migrate from southern portions of the South Atlantic to as far north as the Gulf of Maine. Examples of these wide-ranging pelagic species include Atlantic swordfish (*Xiphias gladius*), sailfish (*Istiophorus platypterus*), blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), Atlantic bluefin tuna (*Thunnus thynnus*), albacore (*Thunnus alalunga*), blackfin tuna (*Thunnus atlanticus*), and yellowfin tuna (*Thunnus albacares*). Other than some tuna species (family *Scombridae*), which exhibit schooling behavior, individuals of many of the highly migratory species may occur either singly or in pairs. These fish species feed on fish or invertebrates such as flying fish (family Exocoetidae), mackerel (family Scombridae), or squid.

A wide variety of highly migratory pelagic shark species also occur in waters of the Atlantic region. Many of these are also sought by commercial and recreational anglers. Examples of such sharks include blue shark (*Prionace glauca*), thresher shark (*Alopias vulpinus*), oceanic whitetip shark (*Carcharhinus longimanus*), porbeagle (*Lamna nasus*), shortfin mako (*Isurus oxyrinchus*), and longfin mako (*Isurus paucus*). There is concern for the declining populations of sharks, since they are slow-growing and long-lived species with slow reproductive rates.

Although many of these shark species are managed under a fisheries management plan (Table 4.2.11-1), there is often a lack of data needed to adequately identify reproductive capacity and rates in order to establish appropriate harvest rates.

Fisheries for Atlantic Ocean highly migratory species are managed under two fisheries management plans: one for Atlantic tunas, swordfishes, and sharks and a second for Atlantic billfishes (Table 4.2.11-1).

4.2.11.3 Essential Fish Habitat

The FCMA requires fishery management councils to: (1) describe and identify EFH in their respective regions, (2) specify actions to conserve and enhance that EFH, and (3) minimize the adverse effects of fishing on EFH. The Act requires Federal agencies to consult on activities that may adversely affect EFH designated in fishery management plans.

Marine fish and invertebrates depend on healthy habitats to survive and reproduce. Throughout their lives, these organisms use many types of habitats including seagrass, salt marsh, coral reefs, rocky intertidal areas, and hard/live bottom areas, among others. Various activities on land and in the water may threaten to alter, damage, or destroy these habitats, thereby affecting the fishery resources that utilize them. The NMFS, regional Fishery Management Councils, interstate Marine Fisheries Commissions, and other Federal and State agencies work together to address these threats by identifying EFH for each federally managed fish and invertebrate species and developing conservation measures to protect and enhance these habitats. Species in the Atlantic region for which EFH descriptions have been completed are presented in Table 4.2.11-2.

In addition to designating EFH, the NMFS requires fishery management councils to identify habitat areas of particular concern (HAPCs) within fishery management plans. HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. Councils may designate a specific habitat area as an HAPC based on: (1) importance of the ecological function provided by the habitat; (2) extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; or (4) rarity of the habitat type. While the HAPC designation does not confer additional protection for or restrictions on an area, it can help prioritize conservation efforts. Healthy populations of fish require not only the relatively limited habitats identified as HAPCs, but also other areas that provide suitable habitat functions. Thus, protection of designated HAPCs alone may not suffice in supporting the larger numbers of fish needed to maintain sustainable fisheries and a healthy ecosystem. Many specific HAPCs have been identified for fishes in the Atlantic Region. Some examples include The Point, The Ten Fathom Ledge, and Big Rock off North Carolina; The Charleston Bump off South Carolina (see Section 4.2.14.1); the Oculina Bank Habitat Area of Particular Concern off Florida (see Section 4.2.14.1); manganese outcroppings on the Blake Plateau; and Council-designated Artificial Reef Special Management Zones.

TABLE 4.2.11-2 Species for Which Essential Fish Habitat Has Been Designated in the Atlantic Region

New England Species	
American plaice	Pollock
Atlantic cod	Red hake
Atlantic halibut	Redfish
Atlantic herring	Rosette skate
Atlantic salmon	Silver hake
Atlantic sea scallops	Smooth skate
Barndoor skate	Thorny skate
Clearnose skate	White hake
Deep-sea red crab	Whiting
Haddock	Windowpane flounder
Little skate	Winter flounder
Monkfish	Winter skate
Ocean pout	Witch flounder
Offshore hake	Yellowtail flounder
Mid-Atlantic Species	
Atlantic mackerel	Ocean quahog
Black sea bass	Scup
Bluefish	Spiny dogfish
Butterfish	Summer flounder
Tilefish	*Illex* squid
Surfclam	*Loligo* squid
Monkfish	
South Atlantic Species	
Almaco jack	Mutton snapper
Atlantic spadefish	Nassau grouper
Banded rudderfish	Ocean triggerfish
Bank sea bass	Pink shrimp
Black grouper	Queen snapper
Black margate	Queen triggerfish
Black sea bass	Red drum
Black snapper	Red grouper
Blackfin snapper	Red hind
Blue striped grunt	Red porgy
Bluefish	Red snapper
Blueline tilefish	Rock hind
Brown shrimp	Rock sea bass
Cero	Rock shrimp
Cobia	Sailfish
Coney	Saucereye porgy
Cubera snapper	Scamp
Dog snapper	Schoolmaster
Dolphinfish	Scup
French grunt	Sheepshead
Gag grouper	Silk snapper
Golden crab	Snowy grouper

TABLE 4.2.11-2 (Cont.)

Golden tilefish	Spanish mackerel
Goliath grouper	Speckled hind
Gray snapper	Spiny lobster
Gray triggerfish	Tiger grouper
Graysby	Tomtate
Greater amberjack	Vermilion snapper
Hogfish	Wahoo
Jolthead porgy	Warsaw grouper
King mackerel	Weakfish
Knobbed porgy	White grunt
Lane snapper	White shrimp
Lesser amberjack	Whitebone porgy
Little tunny	Wreckfish
Mahogany snapper	Yellowmouth grouper
Margate	Yellowtail snapper
Misty grouper	
Highly Migratory Species and Billfish	
Albacore tuna	Longfin mako
Atlantic angel shark	Porbeagle
Atlantic bigeye tuna	Sand tiger shark
Atlantic bluefin tuna	Sandbar shark
Atlantic sharpnose	Scalloped hammerhead
Atlantic skipjack	Shortfin mako
Atlantic swordfish	Silky shark
Atlantic yellowfin tuna	Thresher shark
Basking shark	Tiger shark
Blue marlin	White marlin
Blue shark	White shark
Dusky shark	

4.2.12 Sea Turtles

Five species of sea turtles (green, hawksbill, Kemp's ridley, leatherback, and loggerhead) occur along the U.S. Coast and offshore waters of the Atlantic, and all are listed as threatened or endangered under the Endangered Species Act of 1973 (Table 4.2.12-1). These species use coastal and oceanic waters for foraging, while some species nest on sandy coastal beaches. The loggerhead is the most widely seen sea turtle species on the Atlantic Coast, followed by the leatherback and then the Kemp's ridley. Green turtles prefer the warmer waters of the South Atlantic and are uncommon further north. The hawksbill is considered to be an accidental visitor to Mid- and South Atlantic coastal habitat area waters (NOAA 2006c).

The life history of sea turtles includes four developmental stages: egg (embryo), hatchling, juvenile, and adult. Habitat utilization and migrations of sea turtles vary depending upon these specific developmental stages and result in differential distributions (Ackerman 1997; Musick and Limpus 1997). Sea turtle eggs are deposited in nests excavated on sandy beaches.

TABLE 4.2.12-1 Sea Turtles of the U.S. Atlantic Coast

Species	Status[a]	Typical Adult Habitat	Juvenile/ Hatchlings Potentially Present?	Nesting
Family Cheloniidae				
Loggerhead turtle (*Caretta caretta*)	T	Estuarine, coastal, and shelf waters	Yes	Nesting occurs from Virginia south through Florida; main U.S. nesting beaches are in southeast Florida; southeastern U.S. coastline supports 35–40% of known worldwide nesting, and about 80% of all U.S. nesting occurs in six Florida counties
Green turtle (*Chelonia mydas*)	T, E[b]	Shallow coastal waters, seagrass beds	Yes	Small numbers of turtles nest in Georgia and the Carolinas, and several hundred nests reported annually on east coast of Florida
Hawksbill turtle (*Eretmochely imbricata*)	E	Coral reefs, hard-bottom areas in coastal waters; adults not often sighted in northern Gulf	Yes	Nesting in continental United States is limited to southeastern Florida and Florida Keys
Kemp's ridley turtle (*Lepidochelys kempi*)	E	Shallow coastal waters, seagrass beds	Yes	Nests mainly at Rancho Nuevo, Mexico; scattered nesting reported from Texas, Florida, and South Carolina
Family Dermochelyidae				
Leatherback turtle (*Dermochelys coriacea*)	E	Slope, shelf, and coastal waters; considered the most "pelagic" of the sea turtles	Yes	Nest sites from Georgia to U.S. Virgin Islands; nearest major nesting concentrations are in Caribbean and southeast Florida

[a] Status: E = endangered species; T = threatened species (under the Endangered Species Act of 1973).

[b] Green sea turtles are listed as threatened except for Florida, where breeding populations are listed as endangered.

Source: USFWS (2006b).

Upon hatching, the young turtles move immediately from the nests to the sea. Most species are passively carried into areas of current convergence or to mats of floating sargassum.

After a period of years, most juvenile turtles (defined as those that can actively swim but have not attained sexual maturity) actively move to nearshore developmental habitats within tropical and temperate zones, and in some temperate zones also make seasonal migrations to foraging habitats at higher latitudes in summer months. The bays, estuaries, and nearshore coastal waters of the U.S. east coast provide important developmental habitat for juvenile and subadult sea turtles.

When approaching sexual maturity, juvenile turtles move into adult foraging habitats. Once maturity is reached, most sea turtles move to permanent feeding grounds or through a series of feeding areas. Near the onset of nesting season, adult turtles move between foraging habitats and nesting beaches. Mating may occur directly off the nesting beaches or at more remote locations well away from the nesting beach, depending on the species and population. During the nesting season, females become resident in the vicinity of the nesting beaches and may be more vulnerable to impacts within these near coastal waters and on nesting beaches.

There are no designated critical habitats in Atlantic OCS waters for any of the five sea turtle species.

The green turtle (*Chelonia mydas*) is globally distributed; it occurs in the Atlantic OCS waters from Florida to Massachusetts (NMFS and USFWS 1991a; NOAA 2006c). While primarily a tropical species, in the summer, green turtles have been found in estuarine waters as far north as Long Island Sound and Massachusetts (NMFS and USFWS 1991b; NOAA 2006c). Green turtle habitat includes broad expanses of shallow, sandy flats covered with seagrasses, or areas where seaweed can be found. Scattered rocks, bars, and coral heads are used as nighttime sleeping sites. Juvenile and subadult green turtles are carnivorous, feeding on animals such as jellyfish, but adult green turtles are unique in being herbivores that feed on algae and seagrasses (NMFS and USFWS 1991b; NOAA 2006c). Important feeding areas along the Atlantic Coast of Florida include the Indian River Lagoon and the Florida Keys (NOAA 2006c). Most green turtles nest in the Caribbean but several hundred nests are recorded on the east coast of Florida each year (NMFS and USFWS 1991b; NOAA 2006c). Small numbers of green turtles also nest annually in Georgia, South Carolina, and North Carolina (USFWS 2005a). The breeding populations off Florida and the Pacific Coast of Mexico are listed as endangered, while all others are threatened.

The endangered hawksbill sea turtle (*Eretmochelys imbricata*) is found in coastal reefs, estuaries, bays, and lagoons of tropical and subtropical regions of the Atlantic, Pacific, and Indian Oceans (NMFS and USFWS 1993; USFWS 2005b). In the continental United States, this species has been reported from along the eastern seaboard as far north as Massachusetts (Shoop and Kenney 1992), but is most often seen in waters near the Florida Keys and on reefs off Palm Beach County, Florida (NMFS and USFWS 1993). Hawksbills are most common in Puerto Rico and its associated islands and in the U.S. Virgin Islands.

Coral reefs are widely recognized as the residential foraging habitat of juvenile, subadult, and adult hawksbills due to their primary diet of sponges (NOAA 2006c). Hawksbills are also found around rocky outcrops and high energy shoals, which are also optimum sites for sponge growth. Hawksbills are also known to inhabit mangrove-fringed bays and estuaries. They are seldom seen in waters deeper than 20 m (65 ft) (USFWS 2005b). Small isolated beaches, often on offshore islands, are favored as nest sites. Because hawksbills are small and agile, they can exploit nesting areas that may be inaccessible for other species of sea turtle. Within the continental United States, hawksbill nesting is largely restricted to the southeastern coast of Florida and the Florida Keys (NMFS and USFWS 1993); about 15,000 females are estimated to nest each year throughout the world (USFWS 2005b).

The endangered Kemp's ridley sea turtle (*Lepidochelys kempi*) is the smallest and most endangered of the sea turtles (USFWS 2005c). Adults are found primarily in the Gulf of Mexico on the continental shelf, but juvenile and subadult sea turtles are observed in coastal waters, especially in areas of seagrass habitat, from Texas to Maine, and in northern summer feeding areas such as the Chesapeake Bay and coastal waters of Virginia and New Jersey (Keinath et al. 1996; Lutcavage and Musick 1985; NMFS and USFWS 1992a).

The major habitat for Kemp's ridley sea turtle is the nearshore and inshore waters, including salt marshes of the northern Gulf of Mexico (USFWS 2005c). Although scattered nesting has been reported in Texas, Florida, and South Carolina, as well as in Colombia (Ernst et al. 1994), the major nesting area for this species is near Rancho Nuevo, along the northeastern coast of Mexico (Tamaulipas) (NMFS and USFWS 1992a; USFWS 2005c).

The endangered leatherback sea turtle (*Dermochelys coriacea*) is the largest, deepest diving, and most migratory and wide ranging of all sea turtles, undertaking extensive migrations from the tropics to boreal waters; it is also the largest living turtle in the world (USFWS 2005d; NOAA 2006c). The leatherback turtle's range in the Atlantic extends from Cape Sable, Nova Scotia, south to Puerto Rico and the U.S. Virgin Islands (NMFS and USFWS 1992b). While leatherbacks venture into some of the deepest and coldest regions of the ocean, they also inhabit relatively shallow coastal waters along the eastern seaboard of the Atlantic. During the summer, leatherbacks are found along the U.S. east coast from the Gulf of Maine south to the middle of Florida.

The leatherback is known to travel thousands of kilometers from its nesting beaches; tagged individuals have been tracked from summer feeding areas in Canadian waters to nesting beaches along the northeast coast of South America (NOAA 2006c). Nesting occurs from February to July, with nest sites along Atlantic coast from Georgia to the U.S. Virgin Islands (NMFS and USFWS 1992b). Nesting populations of leatherbacks are difficult to determine because females frequently change beaches.

The loggerhead sea turtle (*Caretta caretta*) is the most common species of sea turtle in the Atlantic (USFWS 2005e), and it is classified as threatened throughout its range under the Endangered Species Act of 1973. Loggerheads inhabit continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters, where they forage on benthic invertebrates. In the Atlantic, the loggerhead's range extends from Newfoundland to as far south as Argentina. Loggerheads forage along the inshore and coastal waters of the Gulf of Mexico, the Florida Keys, and north along the eastern seaboard as far as New England (NMFS and USFWS 1991c). Important feeding areas along the Atlantic coast include Chesapeake Bay, where thousands of subadult loggerhead turtles forage during the summer months (Keinath et al. 1987).

Loggerhead turtles mate offshore between late March and early June, and eggs are laid throughout the summer. During the nesting season, adult females remain in shallow areas near their nesting beaches. Loggerheads in the United States nest from Virginia to Texas (USFWS 2005e). Total estimated nesting in the United States is approximately 68,000–90,000 nests/year, and one of only two known loggerhead nesting beaches with more than 10,000 females nesting per year occurs in Florida. The primary Atlantic nesting sites are along the east coast of Florida, with additional sites in Georgia, the Carolinas, and occasionally Virginia. Overall, the southeastern United States supports 35 to 40% of the known worldwide nesting of this species (NMFS and USFWS 1991c). Approximately 80% of all United States nesting occurs in six Florida counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward counties) (NOAA 2006c).

4.2.13 Coastal Habitats

Habitats along the Atlantic Coast include unvegetated or sparsely vegetated intertidal shorelines (such as beaches), wetlands, and adjacent upland areas. The Atlantic Coast shoreline is constantly changing as a result of wind-driven waves and tidal currents that cause sediment transport (see Section 4.2.1.2). Energy forces along shorelines to the north tend to be tide-dominated, while those to the south tend to be storm-dominated. Although drift directions vary locally and seasonally, the predominant drift direction (i.e., longshore current) is from north to south along north-south trending coastlines. The primary sources of sand that maintain the beaches and barriers are eroding beaches (upcurrent) and sand shoals on the inner continental shelf.

A wide variety of shoreline types is found along the coast, including rocky shores, sand and gravel beaches, and mudflats. Rocky shorelines are more common along the northern Atlantic coastline. The coast of Maine is primarily characterized by a rugged rocky shoreline, with ledge outcrops and massive boulders, and has numerous long narrow inlets, coastal islands, and bays (CEM 1972). This portion of the Atlantic Coast has a high tidal range, resulting in an abundance of intertidal communities (Beccasio et al. 1980). Although small areas of sand beach are also present, sand beaches become common south of Portland. Irish moss (*Chondrus crispus*) and rockweed (primarily *Fucus* spp.) are common macroalgae found on rocky intertidal shorelines of the north Atlantic (RIGM 1974). Mussels are often abundant in this habitat, while soft-shell clams (*Mya arenaria*) commonly occur on intertidal mudflats, sandflats, and gravel beaches. American oysters (*Crassostrea virginica*) are found in shallow rocky, sandy, or muddy areas below the tide line and can form aggregations known as oyster bars that provide substrate and refuge for many other intertidal species. In somewhat deeper nearshore areas, ocean quahog (*Arctica islandica*) and sea scallops (*Placopecten magellanicus*) occur in areas with sandy substrates. Along the New Hampshire and Massachusetts coast, pocket sand beaches occur among rock ledges, with long, narrow barrier sand beaches, in front of salt meadow and tidal marsh, predominant in some areas. Beaches are high-energy habitats of coarse sand, gravel, and cobble north of Cape Ann, Massachusetts, with fine sand to the south. Small sheltered beaches between rocky headlands are the predominant shoreline type for Massachusetts, Rhode Island, Connecticut, and Long Island Sound.

The Atlantic Coastal Plain is a flat stretch of land that borders the Atlantic Ocean for approximately 3,541 km (2,200 mi) from Cape Cod, through the southeast United States. Much of the coastline along Cape Cod and from Long Island to southern Florida consists of sand beach-dune and/or barrier beach areas. Mudflats exist along the shores of many of the bays and sounds, with the most extensive ones found along the shores of Delaware and Chesapeake Bays and along the coast of Georgia. In the vicinity of urban areas, there are localized sections of dense shoreline development. Barrier islands occur along the Atlantic Coast from New Jersey to south Florida. Low sand beaches occur along the Florida coast, with very extensive barrier islands in some areas (Beccasio et al. 1980).

The majority of the Atlantic shoreline has been altered to some degree, and most coastal habitats have been impacted by human activities. Most of this alteration has been from development, beach replenishment, or shore protection activities such as jetties. Relatively undisturbed areas include Assateague Island, Cape Lookout National Seashore, and Cape Hatteras National Seashore.

Barrier islands, spits, and many beaches are elongated, narrow landforms composed of sand and other unconsolidated sediments that have been transported to their present locations by rivers, waves, currents, storm surges, and winds. Barrier islands tend to be narrow and sparsely vegetated, exhibiting a low profile with numerous washover channels. Elevations on the barrier islands typically range from sea level to about 8 m (25 ft), although individual dunes may be higher (Johnson et al. 1974). Coastal landforms are transitory in nature and are constantly being modified by the same forces that led to their original deposition.

Barrier islands, sand spits, and beaches are particularly important for providing protection from storms, high tides, and wave action for the lagoons, sounds, wetlands, and low ground often located landward. By separating coastal waters from the open ocean, these landforms contribute to the total area and diversity of estuarine habitat. Natural dune areas found landward of sand beaches often support a dune grass or shrub community. The ecologically fragile dune grass or shrub communities are important for maintaining beach and dune stability and are particularly intolerant of pollution or beach development. Mudflats and swamps occur in areas of low wave energy. These areas tend to act as sediment sinks, trapping nutrients that support a variety of plants species and can also trap pollutants.

The seaward side of barrier islands typically consists of sand beaches and dune ridges. The beaches and dunes of the mainland and barrier islands are exposed to strong, salt-laden winds, constantly shifting sands, low substrate moisture, and intense summer heat. Subsequently, upper beaches and overwash flats are less than 1% vegetated (NPS undated). Dynamic disturbance regimes largely limit vegetation to pioneering, salt-tolerant, succulent annuals. Searocket (*Cakile edentula*) is usually most numerous and characteristic. Other scattered associates include Carolina saltwort (*Salsola caroliniana*), sea-purslane (*Sesuvium maritimum*), sea-beach knotweed (*Polygonum glaucum*), sea-blites (*Suaeda* spp.), and sea-beach orach (*Atriplex arenaria*) to the north and beach hogwort (*Croton punctatus*), beach sandspur (*Cenchrus tribuloides*), salt wort (*Salsola kali*), and beach-spurge (*Euphorbia polygonifolia*) to the south (Johnson et al. 1974; Department of Conservation and Recreation undated). Extensive construction of high, artificial dunes along the Atlantic Coast has reduced the extent of these habitats by increasing oceanside beach erosion and eliminating the disturbance regime that creates and maintains overwash flats.

At higher dune elevations, the dominant plant species are saltmeadow cordgrass (*Spartina patens*), American beachgrass (*Ammophila breviligulata*), sea oats (*Uniola paniculata*), bitter seabeach grass (*Panicum amarum*), beach panic grass (*Panicum amarum*), and seaside little bluestem (*Schizachyrium littorale*). On steep dunes facing the ocean, American beachgrass forms narrow, monospecific stands by growing additional stems when buried, thus helping to bind the substrate and reduce erosion. Other species produce only low, temporary dunes because they lack a sufficient lateral root system, have excessive water requirements, or lack the ability to stay above the sand (Johnson et al. 1974). The dominant species on more gentle back slopes and terraces, however, are generally sea oats and/or bitter seabeach grass, with a slightly more diverse assemblage of low-cover species. A series of smaller secondary dunes spread inward from the primary dune and are typically colonized by beach panic grass or seaside little bluestem.

In the sheltered zone behind the dunes where freshwater is more available, vegetation density is greater and is predominantly composed of somewhat stunted individuals of less-salt-tolerant shrubs. Common species in these areas include wax myrtle (*Myrica cerifera*) and northern bayberry (*Myrica pensylvanica*), blackberry (*Rubus argutus*), groundselbush (*Baccharis halimifolia*), and poison ivy (*Toxicodendron radicans*) to the north (NPS undated), and live oak (*Quercus virginiana*), red bay (*Persea borbonia*), wax myrtle, cabbage palm (*Sabal palmetto*), saw palmetto (*Serenoa repens*), and groundselbush to the south (Johnson et al. 1974).

Deciduous, coniferous, and broadleaf evergreen woodlands occur on back dunes protected from regular salt spray. Similar communities occur along the Atlantic Coast south of New Jersey. These habitats are commonly located on convex, rapidly drained dunes and less frequently on dry sand flats. Floristic composition of communities in this group varies considerably with geography. The dominant species include coast live oak (*Quercus virginiana*), bluejack oak (*Quercus incana*), sassafras (*Sassafras albidum*), and loblolly pine (*Pinus taeda*). Trees may be widely spaced with large areas of exposed sand. Evergreen and mixed coastal forests of sheltered, oceanside, and bayside dunes and sand flats that are generally protected from salt spray have low species diversity with loblolly pine as the dominant species or co-dominant with oaks (*Quercus* spp.), hickories (*Carya* spp.), and black cherry (*Prunus serotina*). All community types in these woodland and forest groups are considered globally rare because of restricted ranges, narrow habitat requirements, and threats from coastal development (Department of Conservation and Recreation undated).

Wetlands occur in intertidal and shallow subtidal areas along the Atlantic Coast from Maine to southern Florida. The majority of the wetland and estuarine systems bordering the

Atlantic have been moderately to severely modified. Coastal wetlands along the Atlantic are located predominantly south of New York because these coastal areas have not been glaciated. Wetland habitats occupy only narrow bands along the shore in some areas, but in other areas cover vast expanses of the coastline. Extensive estuarine areas are associated with the major rivers along the Maine coast and small areas of mudflats and marshes, however, wetlands become common south of Portland (CEM 1972; Beccasio et al. 1980). Extensive tidal marshes and large areas of salt meadows behind long barrier beaches characterize portions of the New Hampshire and Massachusetts coast. The large number of small rivers, streams, inlets, and bays create a variety of estuarine and wetland habitats. In the mid-Atlantic region, marshes are larger than those of the northern coast, and extensive areas of wetlands are associated with Narragansett, Raritan, Delaware, and Chesapeake Bays and many smaller estuarine systems from Massachusetts to North Carolina. The States with the most extensive coastal wetland habitats are North Carolina, Virginia, and New Jersey. The coastline of South Carolina and Georgia includes a high degree of freshwater input and some of the most expansive tidal marshes in the world protected by numerous irregularly shaped islands (Beccasio et al. 1980). Long barrier islands protect an extensive series of high-salinity shallow lagoons, with limited freshwater inflow, along much of the Florida coast. Tidal salt marsh and seagrass beds occur on the lagoon margins in the north, with mangrove swamp prominent to the south (Beccasio et al. 1980). The seagrass beds are composed of turtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*). Mangrove swamp, including red, black, and white mangroves, with interspersed coastal marshes, comprises the shoreline community of south Florida.

Wetland habitats along the Atlantic Coast consist of fresh, brackish, and salt marshes; mudflats; and nontidal wet grasslands, shrub swamps, and swamp forests. Wetland vegetation helps to stabilize them by preventing the erosion of sediments and by absorbing the energy of storms. Seagrass beds occur offshore in shallow water, in southern Florida or north of North Carolina, while marshes occur in intertidal zones. Forested wetlands are found inshore, away from direct tidal influence, and form extensive areas of bottomland hardwoods in some areas. Pocosins and Carolina Bays are nonalluvial forested wetlands unique to the south Atlantic Coast. Freshwater ponds are common near the coastline along many portions of the Atlantic Coast.

Estuaries, which are shallow, semi-enclosed areas where stream or river inflows mix with marine waters, include a range of intertidal and subtidal habitats from fresh to brackish and saline. Coastal wetlands and estuaries are highly productive, yet fragile, environments that support a great diversity of fish and wildlife species. Many species of invertebrates, reptiles, amphibians, birds, and mammals are common residents of coastal wetlands.

Major estuaries in the mid-Atlantic region are Narragansett, Raritan, Delaware, and Chesapeake Bays and Currituck, Albemarle, and Pamlico Sounds. Many smaller estuarine systems also occur along the coast, such as the estuaries of Georgia, which connect with the sea through the sounds that separate the barrier islands. Currituck, Albemarle, and Pamlico Sounds, which together constitute the largest estuarine system along the entire Atlantic Coast, make up a large portion of these estuaries. A unique feature of these sounds is that they are partially enclosed and protected by a chain of fringing islands, the Outer Banks, about 32–48 km (20–30 mi) from the mainland. The dominant submerged aquatic vegetation found in these estuaries consists of eelgrass (*Zostera marina*) and widgeongrass (*Ruppia maritima*). Most of the other estuaries are more open to the ocean since there are no barrier islands. Dominant submerged aquatic vegetation in most of the southern estuaries consists of eelgrass, widgeongrass, and shoalgrass (*Halodule wrightii*). Beds of submerged aquatic vegetation provide shelter and spawning areas for aquatic animals. Bay scallops (*Argopecten irradians*) are found in eelgrass beds of the north Atlantic, especially in areas with muddy sand and up to 18 m (60 ft) deep.

Salt marshes are intertidal wetlands that occur on the margins of estuaries, protected bays, and the landward side of barrier islands. Extensive stands of salt marsh with deep tidal channels are found south of Cape Lookout, North Carolina, through South Carolina and Georgia. Almost three-quarters of the salt marsh acreage along the Atlantic is found in these three States.

Many factors contribute to the determination of plant composition of coastal marshes. Salinity and inundation depth and fluctuation are most important, and vegetation zones related to these factors are commonly evident. Other factors are the substrate type, acidity, available nutrients, and fire, among others. Species diversity is greatest in shallow, freshwater marshes. In salt marshes, a few species often develop pure stands. The dominant salt marsh vegetation along much of the Atlantic Coast includes smooth cordgrass (*Spartina alterniflora*), big cordgrass (*Spartina cynosuroides*), black needlerush (*Juncus roemerianus*), saltgrass (*Distichlis spicata*) and giant cutgrass (*Zizaniopsis miliacea*) (Department of Conservation and Recreation undated; Johnson et al. 1974).

Freshwater marshes occur primarily near the mouths of larger mainland streams in the uppermost portion of the estuarine zone, where the inflow of saltwater from tidal influence is diluted by a much larger volume of freshwater from upstream. Pulses of higher salinity may occur during spring tides or periods of unusually low river discharge (Department of Conservation and Recreation, undated). Shallow freshwater marshes contain a variety of species including cattails (*Typha* spp.), several bulrushes (*Scirpus* spp.), smartweeds (*Polygonum* spp.), arrowhead (*Sagittaria* spp.), arrow-arum (*Peltandra virginica*), and others (Department of Conservation and Recreation undated; Johnson et al. 1974). The deeper freshwater marshes are more extensive, occupying large areas along the Georgia coast. In many areas, this marsh type is composed almost exclusively of giant cutgrass. Stands of sawgrass (*Cladium jamaicense*) occur intermittently. Around the deeper margins of the marsh, stands of cattail are common and wild rice (*Zizania aquatica*) occurs in sporadic stands. In the deeper creeks and potholes, submersed and floating-leaved plants are dominant. Species diversity and vegetation stature vary with salinity, duration of inundation, and disturbance; the most diverse marshes occupy more elevated surfaces in strictly freshwater regimes. Mud flats that are fully exposed only at low tide support nearly monospecific stands of spatterdock (*Nuphar advena*), although submerged aquatic species may also be present.

Tidal freshwater marshes provide the principal habitat for rare plants and are important breeding habitats for a number of birds (Department of Conservation and Recreation undated). Chronic sea-level rise is advancing the salinity gradient upstream in rivers on the Atlantic Coast, leading to shifts in vegetation composition and the conversion of some tidal freshwater marshes into oligohaline marshes. Tidal freshwater marshes are also threatened by invasive plants, such as marsh dewflower (*Murdannia keisak*) in Virginia.

Under brackish conditions, big cordgrass is the most characteristic and abundant species and often forms extensive, tall stands, particularly along edges of the main tidal channels (Department of Conservation and Recreation undated). Associates include a mix of species characteristic of freshwater marshes, and species more tolerant of higher salinities. Diversity generally decreases as salinity increases, but some communities of mixed composition, particularly those of low stature, may support more species than many tidal freshwater marshes.

Maritime dune systems frequently contain seasonal wet grasslands, which are densely vegetated by one or more species of grasses (e.g., saltmeadow cordgrass [*Spartina patens*]); rushes (*Juncus* spp.); or sedges (e.g., *Cyperus odoratus*, *Fimbristylis caroliniana*, or *Schoenoplectus pungens*) (Department of Conservation and Recreation undated). Encompassing swales and low hollows between secondary dune habitats are characterized by perched water tables and shallow, seasonal, or temporary flooding. The swales are predominantly influenced by freshwater from rainstorms, but some may be periodically flooded by saltwater from ocean storm surges.

Nontidal shrub swamps occur in sheltered, maritime dune hollows where surface water is present throughout most of the year. Both groundwater and surface water are typically fresh, although saltwater may pool in these areas after episodic storm surges during events such as hurricanes. Species composition of these communities varies. Southern areas characteristically contain southern bayberry (*Myrica cerifera*), inkberry (*Ilex glabra*), and highbush blueberry (*Vaccinium* spp.). Inkberry and highbush blueberry are less common in the north.

Seasonally flooded, or less frequently saturated, maritime wetland hardwood and pine forests occur in large, protected, interdune swales or along sluggish streams just inland from estuarine zones. These habitats are level flats characterized by hummock-and-hollow microtopography and sizeable areas of seasonally standing water. Loblolly pine is the usual dominant overstory tree in the pine forest, sometimes with hardwood associates. The dominant overstory trees in the hardwood forests include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), blackgum (*Nyssa sylvatica*), black willow (*Salix nigra*), sweetbay (*Magnolia virginiana*), bald cypress (*Taxodium distichum*), and Atlantic white cedar (*Chamaecyparis thyoides*). Shrubs are diverse in these forests.

Bald cypress tupelo swamps are deeply flooded (up to 1 m [3 ft]) for part of the year, and most retain at least some standing water throughout the growing season. The composition of the tree overstory varies from mixed stands of bald cypress, water tupelo (*Nyssa aquatica*), and swamp tupelo (*Nyssa biflora*) to nearly pure stands of one of these species.

Most of the wetlands and estuaries along the U.S. Atlantic Coast have been altered in some way. These areas have been subjected to drainage and filling as well as collecting much of the pollution that is introduced into the rivers of the Atlantic States. Vegetated wetlands became converted to open water or were drained for development (Frayer et al. 1983). In addition, invasive species, including plants (such as common reed [*Phragmites australis*]) and animals (such as nutria [*Myocastor coypus*]), have degraded wetland habitat quality. The abundance of submerged aquatic vegetation in upper Chesapeake Bay has significantly declined, likely a result of reduced photosynthesis due to an excess of planktonic and attached algae resulting from eutrophication and increased turbidity from sediments suspended in the water column (Kemp et al. 1983).

4.2.14 Seafloor Habitats

The Atlantic region includes the area from the Canadian border to the Dry Tortugas. Within this region are a number of biological provinces, shaped in part by differences in water temperature and recognized by their characteristic fauna. A major biogeographic boundary for marine organisms on the continental shelf occurs at Cape Hatteras where the Gulf Stream turns eastward, separating the temperate and tropical provinces (Cerame-Vivas and Gray 1966). A sharp faunal break is less obvious on the slope, although this area does appear to be a region of considerable faunal change (Blake et al. 1987).

The mid-Atlantic shelf is relatively flat, but there is a ridge-and-swale (hill-and-valley) topography that may be a result of present oceanographic conditions or remnant barrier beaches. The shelf typically is composed of a thin (1- to 20-m [3- to 65-ft]) surficial layer of poorly sorted shell and medium-to-coarse grained sand that overlays clay sediments. In general, the surficial sediments grade from medium-grained sands inshore to finer sediments at the shelf break (Wigley and Theroux 1981).

A sand-shell mixture is characteristic of the OCS, while sediments along the slope generally are fine-grained (silty sand to clay). Wigley and Theroux (1981) found that faunal composition and abundance strongly correlated with this sediment gradient and recognized four faunal assemblages: bays and sounds, continental shelf, continental slope, and continental rise. Coarse-grained sediments generally supported the largest quantities of animals, including many sessile forms. Fine-grained sediments usually contained a depauperate fauna, and attached organisms were uncommon.

Soft sediments on the OCS are dynamic habitats, not just mixtures of different grain-sized mineral particles. Seafloor sediments contain varying amounts of organic matter depending on grain size and oceanographic conditions. Thousands of invertebrates, along with bacteria and protozoa, per square meter live in—or on—the sediments of the ocean bottom. Amphipod and polychaete tubes can cover and cement the sediment surface over hundreds of square kilometers at certain locations during certain times. These emergent tubes can provide habitat for other important macroinvertebrates, as well as fish. Physical mixing of surficial sediments by these invertebrates, together with microbial activity, recycle nutrients into the overlying water column where they become accessible to algae and plants. There are also many important biogeochemical processes within the sediments, which form a mosaic of structure and function. The fauna associated with the sediments account for a major portion of the biomass in the ocean and constitute an integral part of the marine food web that supports exploitable fish species.

4.2.14.1 Topographic Features

Important topographic features along the Atlantic Coast include various fishing banks and ledges, coral reefs, seamounts, and submarine canyons. Because development activities for alternative energies on the OCS are unlikely to occur in depths such as those occupied by seamounts or submarine canyons, such features are not discussed.

Georges Bank is an elevated region of the seafloor in the northern Atlantic region that covers an area of approximately 29,000 km^2 (11,972 mi^2). This bank is located approximately 100 km (62 mi) offshore between the Gulf of Maine and the open Atlantic Ocean (Figure 4.2.1-1). Depths on the bank range from several meters to less than 100 m (328 ft). These depths are more than 100 m (328 ft) shallower than surrounding seafloor areas in the Gulf of Maine.

The particular combination of oceanic currents and topography causes nutrient-rich waters to be transported into the shallow areas where photosynthesis can take place, thereby resulting in an area that is especially productive for marine organisms. In addition, there are a variety of substrate types ranging from sand to gravel to hard-bottom habitats that increase the diversity of species that occur on the bank. The location of Georges Bank (relatively close to shore) allows relatively easy access to these productive areas by commercial fisheries, which harvest commercially valuable fish and invertebrate species such as cod, haddock, herring, and sea scallops.

Despite Georges Bank’s high productivity, commercially important fish stocks were showing signs of decline by the early 1990s. Overfishing and the degradation of habitat due to the repeated use of bottom-fishing gears such as trawls and scallop dredges are among the likely causes for the reductions in fish populations. To allow for recovery of fish stocks, approximately 25% of Georges Bank was closed to bottom fishing in 1994. Some populations of fish and invertebrates appear to be recovering.

Jeffreys Ledge and the Stellwagen Bank (Figure 4.2.1-1) are smaller topographic features in the Gulf of Maine off the Coast of Massachusetts that also provide unique areas because of their depth, substrate, and productivity. These areas fall within the Gerry E. Studds Stellwagen Bank National Marine Sanctuary and are currently under consideration for designation as habitat areas of particular concern by the New England Fishery Council. These areas support both pelagic and demersal fish species such as bluefin tuna, herring, cod, and flounder. A wide variety of invertebrates, ranging from sponges to lobsters and scallops, are also abundant. Because of their high productivity, these areas also provide feeding grounds for more than a dozen cetacean species and many species of seabirds.

The Charleston Bump Closed Area is a portion in the U.S. Exclusive Economic Zone stretching from southern North Carolina to southern Georgia (Figure 4.2.1-3). This area includes a topographic irregularity, located southeast of Charleston, South Carolina, known as the Charleston Bump that rises abruptly from 700 to 300 m (2,300 to 980 ft) in depth over a distance of about 20 km (12 mi). The Charleston Bump includes areas of nearly vertical rocky scarps up to 90 m (300 ft) high, with outcrops and overhangs. Other complex bottom features, such as coral mounds and flat hard-bottom areas, are also present. The topography of the Charleston Bump deflects the Gulf Stream offshore, causing eddies, gyres, and upwelling that concentrate plankton, fishes, and other organisms and leads to localized increases in overall productivity. Areas containing the highest relief are the only documented spawning locations for wreckfish (*Polyprion americanus*). This species is fished intensively within the relatively small area of high relief.

The *Oculina* Bank, located near the continental shelf edge off the coast of eastern central Florida, is a 90-mi strip of deepwater coral reefs that is named for the presence of banks, thickets, and rubble zones of a stony coral that occurs there (*Oculina varicose*) (South Atlantic Fishery Management Council 2005) (Figure 4.2.1-3). Depths of the Oculina Bank range from about 55 to 122 m (180 to 400 ft). The substrate is mostly sandy, silty, and muddy sediments with limestone ridges and pinnacles. The pinnacles vary in size and shape but can rapidly rise as much as 18 m (60 ft) or more from the seabed. When colonized by Oculina coral, the habitat complexity and amount of surface area associated with the pinnacles is greatly increased. Human-caused and natural events can produce significant quantities of Oculina rubble, which can be a major component of the sediment and can accumulate in piles more than 1 m (3 ft) in depth. A wide variety of fish and invertebrates are attracted to the relief and cover provided by the pinnacles, coral outcrops, and rubble piles. The entire Oculina Banks, covering and area of approximately 775 km^2 (300 mi^2), has been set aside as a Habitat Area of Particular Concern by the South Atlantic Fishery Management Council (2005). This designation protects the area from mobile fishing gear and from other potentially damaging mechanical impacts. In addition, the lower portion of the Habitat Area of Particular Concern, called the Experimental Oculina Research Reserve, was closed to bottom fishing in 1994 for a period of 10 years to allow scientific studies on the recovery of fish populations and grouper spawning aggregations. The reserve closure period was renewed in 2004 for an additional 10 years.

Because of the location close to the shelf edge as well as the Gulf Stream, the conditions of the Oculina Bank are very dynamic. Typically, the Gulf Stream meanders inshore during the warmer summer months, bringing with it warm (e.g., 85°F) surface waters and a swift, northward-moving current. Surface disturbances and upwellings produced by the deflection of currents off the limestone pinnacles during periods of strong currents may help transfer and distribute nutrients flowing in colder, slower-moving, bottom currents to the warmer, faster-moving, surface currents. This has implications for the dispersal and settlement of fish and invertebrate larvae within the area and affects the distribution and behavior of adults of some fish species.

Extensive shallow coral reef formations occur along the Atlantic Coast of Florida, extending to the southern tip of Key West. Reefs in Florida receive the greatest number of tourists and visitors of any U.S. jurisdiction and consequently sustain substantial human impacts, particularly along the southeastern coast and in the Florida Keys (Turgeon et al. 2002). In general, documented species fluctuations, decreases in coral coverage, and disease indicate that reef health is declining in southeastern Florida and the Keys (Turgeon et al. 2002). These coral reefs support numerous fish and invertebrate species that are ecologically and economically important.

4.2.14.2 Benthic Communities

Numerically dominant taxonomic groups in shallow habitats of the Atlantic region include Bivalvia, Crustacea, Annelida, Echinoidea, Sipunculidae, Echiura, and Holothuroidea. In terms of biomass, the leading groups include Crustacea, Bivalvia, Annelida, Echinoidea, Ophiuridea, Holothuroidea, and the bathyal assemblages. Wigley and Theroux (1981) found that, in general, the density of benthic organisms within the Mid-Atlantic Bight decreased markedly from north to south and from shallow to deep water (4–3,080 m [13–10,102 ft]).

The benthic communities of the OCS shelf, break, and slope areas of the Atlantic region are diverse. Sediments from nearshore areas consist primarily of medium sands. Ridge and swale topography are important features of this area and affect the distribution of sediments, their chemical constituents, and benthic organisms. Dynamic coarse sediments support active species such as the polychaetes *Goniadella* spp. and *Lumbrinerides* spp., which are adapted for recovery from physical disturbances and are dependent on interstitial resources. More stable, fine sediments within swale areas support large burrowers and surface tube dwellers that utilize surface and subsurface deposits for food. Dominant species include the polychaetes *Notomastus latericuns* and *Typosyllis tegula*, the bivalve *Cyclocardia borealis*, and peracaridea (amphipod crustaceans) such as *Ampelisca agassizi*.

In the region of the shelf break, sediments become finer, both in terms of sand-sized particles and increased silt and clay content. The dominant species described by Boesch et al. (1977) included the polychaete *Onuphis pallidula*, the bivalve *Thyasira flezuosa*, the ostracods *Harbansus bowenae* and *H. dayi*, the amphipod *Ampelisca agassizi*, and the ophiuroid *Amphiplus maculentus*.

Large epibenthic populations of crustaceans and near-surface dwelling crustaceans are important food items for demersal fish (McEachran et al. 1976). On the continental slope, certain invertebrate groups are numerically important, including polychaetes, peracarid crustaceans (amphipods, isopods, etc.), bivalve molluscs and often sipunculids in the infauna (Sanders et al. 1965), and echinoderms (sea cucumbers, brittle stars, and sea urchins), polychaetes, and coelenterates (sea anemones) in the epifauna (Rowe and Menzies 1969). Which group is found to be dominant, either in abundance or biomass, depends largely on the depth sampled and the type of sampling gear used. Commercially important species include bivalves (e.g., surf clams, ocean quahogs) and crustaceans (e.g., lobster and red crab).

4.2.14.3 Live Bottoms

Patches of “live bottoms” (i.e., hardground areas colonized by species typical of tropical environments such as sea fans, sea whips, hydroids, anemones, sponges, corals, and their associated fish fauna) are evident on the shelf south of Cape Hatteras (Kirby-Smith et al. 1985). Live-bottom habitats, although sporadically distributed, are areas of high productivity and are usually found in water depths of between approximately 20 and 55 m (66 and 180 ft). Species composition for line-bottom areas vary depending on latitude, water depth, and associated factors such as underlying substrate type, light availability, and temperature. In shallower water, live-bottom areas are usually more dynamic because water currents can transport the surficial sand layer and cover existing communities or expose new hard bottoms for colonization. Deeper live-bottom areas tend to be more stable. As a consequence, the complexity and average vertical relief of live-bottom areas typically increase in the seaward direction.

Live-bottom communities in different geographical areas support different coral assemblages. Near the Florida Keys, live-bottom habitat is essentially composed of underdeveloped coral reefs nearshore and seaward of more developed reef tracts. Northward, off southeastern Florida, live-bottom communities include most types of corals, although most hermatypic (i.e., reef-building hard coral) species are approaching their northern limit due to temperature and water clarity needs. Coral communities from Florida north to North Carolina are dominated by ahermatypic species, such as sea fans and sea whips, although some hermatypic species do still occur.

4.2.15 Areas of Special Concern

Executive Order 13158 on Marine Protected Areas (MPAs) was signed on May 26, 2000, and directs the USDOC and USDOI, in consultation with other Departments, to strengthen and enhance the nation's system of MPAs. Through existing authorities, current sites will be augmented, and new sites will be established or recommended, as appropriate. A Federal Advisory Committee was established to provide guidance on the framework for the national system, stewardship of MPAs, and coordination of interested parties. The National Marine Protected Areas Center, administered by NOAA, provides coordination for the Committee, manages the website (www.mpa.gov), and provides technical assistance and training. At present, over 120 MPAs have been identified for the Atlantic region (Table 4.2.15-1). In addition, there are a number of coastal and aquatic reserves located along the Atlantic Coast that are managed by State agencies or nongovernmental organizations. Figure 4.2.10-1 shows the locations of offshore Federal and State ecological reserves, including marine sanctuaries, wildlife refuges, and other protected areas such as critical habitats.

National marine sanctuaries, national parks, national wildlife refuges, national estuarine research reserves, and estuaries within the national estuary program of the Atlantic region are discussed in the following sections.

4.2.15.1 Marine Sanctuaries

Four national marine sanctuaries have been established in the Atlantic region: Florida Keys National Marine Sanctuary, Gray's Reef National Marine Sanctuary, Gerry E. Studds/Stellwagen Bank National Marine Sanctuary, and the Monitor National Marine Sanctuary (Table 4.2.15-1).

The Florida Keys National Marine Sanctuary, designated in November 1990, was established to allow management and protection of the marine ecosystems around the Florida Keys. This marine sanctuary spans the southern tip of Florida and has portions in both the

TABLE 4.2.15-1 Marine Protected Areas in the Atlantic Region[a]

Site Name	State	Managing Agency (Office/Bureau)[b]	Type of Site[c]
Timucuan Ecological & Historic Preserve	FL	USDOI (NPS)	E&HP
Oculina Bank Habitat Area of Particular Concern	FL	NOAA (NMFS)	FFHCZ
Charleston Bump Closed Area	NC	NOAA (NMFS)	FFHCZ
East Florida Coast Closed Area	GA	NOAA (NMFS)	FFMZ
Closed Area I	MA	NOAA (NMFS)	FFMZ
Closed Area II	MA	NOAA (NMFS)	FFMZ
Nantucket Lightship Closed Area	MA	NOAA (NMFS)	FFMZ
Western Gulf of Maine Closure Area	MA	NOAA (NMFS)	FFMZ
Carl N. Shuster, Jr. Horseshoe Crab Reserve	MD	NOAA (NMFS)	FFMZ
Flynet Closure	NC	NOAA (NMFS)	FFMZ
Waters off New Jersey Closure	DE	NOAA (NMFS)	FMMPA
Great South Channel Restricted Gillnet Area	MA	NOAA (NMFS)	FMMPA
Great South Channel Restricted Lobster Area	MA	NOAA (NMFS)	FMMPA
Great South Channel Sliver Restricted Area	MA	NOAA (NMFS)	FMMPA
Massachusetts Bay Closure Area	MA	NOAA (NMFS)	FMMPA
Mid-Coast Closure Area	MA	NOAA (NMFS)	FMMPA
SAM East	MA	NOAA (NMFS)	FMMPA
Southern Mid-Atlantic Waters Closure Area	MD	NOAA (NMFS)	FMMPA
Cashes Ledge Closure Area	ME	NOAA (NMFS)	FMMPA
Northeast Closure Area	ME	NOAA (NMFS)	FMMPA
Northern Inshore State Lobster Waters Area	ME	NOAA (NMFS)	FMMPA
Northern Nearshore Lobster Waters Area	ME	NOAA (NMFS)	FMMPA
Stellwagen Bank/Jeffreys Ledge Restricted Area	ME	NOAA (NMFS)	FMMPA
Mid-Atlantic Coastal Waters Area	NC	NOAA (NMFS)	FMMPA
Mudhole Closure	NY	NOAA (NMFS)	FMMPA
Cape Cod South Closure Area	RI	NOAA (NMFS)	FMMPA
Cape Cod Bay Restricted Area	MA	NOAA (NMFS)	FMMPA
SAM West	MA	NOAA (NMFS)	FMMPA
Offshore Lobster Waters	NC	NOAA (NMFS)	FMMPA
Southern Nearshore Lobster Waters	NC	NOAA (NMFS)	FMMPA
Offshore Closure Area	MA	NOAA (NMFS)	FMPA
Delaware National Estuarine Research Reserve	DE	Delaware DNR and Environmental Control (Division of Soil and Water Conservation)	NERR
Guana Tolomato Matanzas National Estuarine Research Reserve	FL	Florida DEP (Office of Coastal and Aquatic Managed Areas)	NERR
Sapelo Island National Estuarine Research Reserve	GA	Georgia DNR (Wildlife Resources Division)	NERR
Waquoit Bay National Estuarine Research Reserve	MA	Massachusetts DEM (Forest and Parks)	NERR
Chesapeake Bay National Estuarine Research Reserve - Maryland	MD	Maryland DNR (Watershed Services Unit)	NERR
Wells National Estuarine Research Reserve	ME	Wells Reserve Management Authority (Wells Reserve Management Authority)	NERR
North Carolina National Estuarine Research Reserve	NC	North Carolina Department of Environment and Natural Resources (Division of Coastal Management)	NERR
Great Bay National Estuarine Research Reserve	NH	New Hampshire DFG (Division of Marine Fisheries)	NERR
Jacques Cousteau National Estuarine Research Reserve	NJ	Rutgers University of New Jersey (Institute of Marine and Coastal Sciences)	NERR
Hudson River National Estuarine Research Reserve	NY	New York DEC (Division of Marine Resources)	NERR

TABLE 4.2.15-1 (Cont.)

Site Name	State	Managing Agency (Office/Bureau)[b]	Type of Site[c]
Narragansett Bay National Estuarine Research Reserve	RI	Rhode Island Department of Environmental Management (Office of Sustainable Watersheds)	NERR
Ashepoo-Combahee-Edisto (ACE) Basin National Estuarine Research Reserve	SC	South Carolina DNR (Marine Resources Division)	NERR
North Inlet-Winyah Bay National Estuarine Research Reserve	SC	University of South Carolina (Belle W. Baruch Institute for Marine and Coastal Sciences)	NERR
Chesapeake Bay (VA) National Estuarine Research Reserve	VA	College of William and Mary (Virginia Institute of Marine Science)	NERR
Florida Keys National Marine Sanctuary	FL	NOAA (National Ocean Service)	NMS
Gray's Reef National Marine Sanctuary	GA	NOAA (National Ocean Service)	NMS
Gerry E. Studds/Stellwagen Bank National Marine Sanctuary	MA	NOAA (National Ocean Service)	NMS
Monitor National Marine Sanctuary	NC	NOAA (National Ocean Service)	NMS
Fort Sumter National Monument	SC	USDOI (NPS)	NM
Biscayne National Park	FL	USDOI (NPS)	NP
Everglades National Park	FL	USDOI (NPS)	NP
Acadia National Park	ME	USDOI (NPS)	NP
Gateway National Recreation Area	NY	USDOI (NPS)	NRA
Canaveral National Seashore	FL	USDOI (NPS)	NS
Cumberland Island National Seashore	GA	USDOI (NPS)	NS
Cape Cod National Seashore	MA	USDOI (NPS)	NS
Cape Hatteras National Seashore	NC	USDOI (NPS)	NS
Cape Lookout National Seashore	NC	USDOI (NPS)	NS
Fire Island National Seashore	NY	USDOI (NPS)	NS
Assateague Island National Seashore	VA	USDOI (NPS)	NS
Stewart B. McKinney National Wildlife Refuge	CT	USDOI (USFWS)	NWR
Bombay Hook National Wildlife Refuge	DE	USDOI (USFWS)	NWR
Prime Hook National Wildlife Refuge	DE	USDOI (USFWS)	NWR
Archie Carr National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Hobe Sound National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Merritt Island National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Pelican Island National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Blackbeard Island National Wildlife Refuge	GA	USDOI (USFWS)	NWR
Harris Neck National Wildlife Refuge	GA	USDOI (USFWS)	NWR
Pinckney Island National Wildlife Refuge	GA	USDOI (USFWS)	NWR
Wassaw National Wildlife Refuge	GA	USDOI (USFWS)	NWR
Wolf Island National Wildlife Refuge	GA	USDOI (USFWS)	NWR
Mashpee National Wildlife Refuge	MA	USDOI (USFWS)	NWR
Monomoy National Wildlife Refuge	MA	USDOI (USFWS)	NWR
Nantucket National Wildlife Refuge	MA	USDOI (USFWS)	NWR
Nomans Land Island National Wildlife Refuge	MA	USDOI (USFWS)	NWR
Parker River National Wildlife Refuge	MA	USDOI (USFWS)	NWR
Thacher Island National Wildlife Refuge	MA	USDOI (USFWS)	NWR
Blackwater National Wildlife Refuge	MD	USDOI (USFWS)	NWR
Eastern Neck National Wildlife Refuge	MD	USDOI (USFWS)	NWR
Martin National Wildlife Refuge	MD	USDOI (USFWS)	NWR
Susquehanna National Wildlife Refuge	MD	USDOI (USFWS)	NWR
Cross Island National Wildlife Refuge	ME	USDOI (USFWS)	NWR
Franklin Island National Wildlife Refuge	ME	USDOI (USFWS)	NWR

TABLE 4.2.15-1 (Cont.)

Site Name	State	Managing Agency (Office/Bureau)[b]	Type of Site[c]
Moosehorn National Wildlife Refuge	ME	USDOI (USFWS)	NWR
Petit Manan National Wildlife Refuge Complex	ME	USDOI (USFWS)	NWR
Pond Island National Wildlife Refuge	ME	USDOI (USFWS)	NWR
Rachel Carson National Wildlife Refuge	ME	USDOI (USFWS)	NWR
Seal Island National Wildlife Refuge	ME	USDOI (USFWS)	NWR
Alligator River National Wildlife Refuge	NC	USDOI (USFWS)	NWR
Cedar Island National Wildlife Refuge	NC	USDOI (USFWS)	NWR
Currituck National Wildlife Refuge	NC	USDOI (USFWS)	NWR
Pea Island National Wildlife Refuge	NC	USDOI (USFWS)	NWR
Swanquarter National Wildlife Refuge	NC	USDOI (USFWS)	NWR
Great Bay National Wildlife Refuge	NH	USDOI (USFWS)	NWR
Cape May National Wildlife Refuge	NJ	USDOI (USFWS)	NWR
Edwin B. Forsythe National Wildlife Refuge	NJ	USDOI (USFWS)	NWR
Supawna Meadows National Wildlife Refuge	NJ	USDOI (USFWS)	NWR
Amagansett National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Conscience Point National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Elizabeth A. Morton National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Lido Beach Wildlife Management Area	NY	USDOI (USFWS)	NWR
Oyster Bay National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Sayville National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Seatuck National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Target Rock National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Wertheim National Wildlife Refuge	NY	USDOI (USFWS)	NWR
Block Island National Wildlife Refuge	RI	USDOI (USFWS)	NWR
John H. Chafee National Wildlife Refuge	RI	USDOI (USFWS)	NWR
Ninigret National Wildlife Refuge	RI	USDOI (USFWS)	NWR
Sachuest Point National Wildlife Refuge	RI	USDOI (USFWS)	NWR
Trustom Pond National Wildlife Refuge	RI	USDOI (USFWS)	NWR
ACE Basin National Wildlife Refuge	SC	USDOI (USFWS)	NWR
Cape Romain National Wildlife Refuge	SC	USDOI (USFWS)	NWR
Tybee National Wildlife Refuge	SC	USDOI (USFWS)	NWR
Waccamaw National Wildlife Refuge	SC	USDOI (USFWS)	NWR
Back Bay National Wildlife Refuge	VA	USDOI (USFWS)	NWR
Chincoteague National Wildlife Refuge	VA	USDOI (USFWS)	NWR
Eastern Shore of Virginia National Wildlife Refuge	VA	USDOI (USFWS)	NWR
Fisherman Island National Wildlife Refuge	VA	USDOI (USFWS)	NWR
Mackay Island National Wildlife Refuge	VA	USDOI (USFWS)	NWR
Mason Neck National Wildlife Refuge	VA	USDOI (USFWS)	NWR
Plum Tree Island National Wildlife Refuge	VA	USDOI (USFWS)	NWR
Wallops Island National Wildlife Refuge	VA	USDOI (USFWS)	NWR

[a] Includes sites designated by the U.S. Department of the Interior and NOAA. Sites designated by State, Territory, and Commonwealth agencies are not included, but can be obtained from the lists on the Marine Protected Areas of the United States website at http://www3.mpa.gov/exploreinv/status.aspx.

[b] DNR = Department of Natural Resources; NMFS = National Marine and Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NPS = National Park Service; USDOI = U.S. Department of the Interior; USFWS = U.S. Fish and Wildlife Service.

[c] E&HP = Ecological and Historic Preserve; FFHCZ = Federal Fishery Habitat Conservation Zone; FFMZ = Federal Fishery Management Zone; FMMPA = Federal Marine Mammal Protected Area; NERR = National Estuarine Research Reserve; NM = National Monument; NMS = National Marine Sanctuary; NP = National Park; NRA = National Recreational Area; NS = National Seashore; NWR = National Wildlife Refuge.

Source: U.S. Department of Commerce and U.S. Department of the Interior (2006).

Atlantic and the Gulf regions. The boundaries of the sanctuary include various types of coral reef areas, seagrass beds, mangrove shorelines, and sand flats. The reefs and surrounding environments contain high-diversity biological communities that are easily impacted by the activities of humans. To better allow the protection and management of the sanctuary, special restriction zones have been established to protect sensitive habitat areas. These zones include wildlife management areas, ecological reserves, sanctuary preservation areas, existing management areas, and special-use areas.

Gray's Reef National Marine Sanctuary is located 17 nautical mi (20 mi; 32 km) east of Sapelo Island, Georgia, in waters 18 to 21 m (60 to 70 ft) deep. Gray's Reef, one of the largest nearshore limestone reefs in the southeastern United States, is a nearshore live-bottom reef that consists of limestone ledges up to 3 m (10 ft) in height. The area was recognized as an international Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1986 and has since been designated as a live-bottom Habitat Area of Particular Concern (HAPC) by the South Atlantic Fishery Management Council (SAFMC). Because of the diversity of marine life, Gray's Reef is also one of the most popular sportfishing and diving destinations along the coast of Georgia.

The site of the wreck of the Civil War vessel USS Monitor was the first national marine sanctuary, designated in January 1975. The sanctuary, located approximately 26 km (16 mi) southeast of Cape Hatteras, North Carolina, encompasses an area with a diameter of 1 nautical mi (1 mi; 2 km). The wreck of the Monitor is the only feature in the sanctuary. Commonly found at this pelagic, open ocean, and artificial reef site are species such as amberjack (*Seriola* spp.), black sea bass (*Centropristis striata*), sand tiger shark (*Carcharias taurus*), dolphin, sea anemones, corals, and sea urchins.

The Gerry E. Studds/Stellwagen Bank National Marine Sanctuary is located at the mouth of Massachusetts Bay between Cape Cod and Cape Ann. It is a 2,181-km^2 (842-mi^2) area that includes the five main habitat types found in the Gulf of Maine (mud, sand, gravel, boulder, and bedrock). Formed by the retreat of glaciers during the previous ice age, Stellwagen Bank rises rapidly from depths of around 183 m (600 ft) to depths of 18 m (60 ft). The position of Stellwagen Bank at the mouth of Massachusetts Bay forces an upwelling of nutrient-rich water from the Gulf of Maine over the bank, thereby resulting in high productivity and a multilayered food web. Stellwagen Bank National Marine Sanctuary is one of the most important whale feeding grounds in the world. In the past, fishermen in the sanctuary have recovered paleontological remains representing a period when portions of Stellwagen Bank were dry land. Numerous shipwrecks have been documented, and historical records indicate that several hundred vessels sank in the vicinity of the sanctuary.

4.2.15.2 National Park System

The National Park System ensures the protection of some of the country's finest natural, cultural, and recreational resources. The sites include National Parks, National Seashores, National Monuments, and National Recreation Areas. The sites found along the coast of the Atlantic region include three national parks (Acadia, Biscayne, and Everglades National Parks) and seven national seashore areas (Canaveral, Cumberland Island, Cape Cod, Cape Hatteras, Cape Lookout, Fire Island, and Assateague Island National Seashores). In addition, Gateway National Recreation Area is located in the vicinity of New York City, and Fort Sumter National Monument is located near Charleston, South Carolina.

Composed of all or part of several islands on the Maine coast, Acadia National Park encompasses more than 19,020 ha (47,000 acres) of mountains, woodlands, lakes, ponds, and ocean shoreline. The variety of available habitats support diverse ecological communities, including many plant and animal species of international, national, and State significance.

Biscayne National Park encompasses an area of 7,001 ha (173,000 acres) in southeastern Florida at the northern edge of the Florida Keys. Marine habitats compose approximately 95% of this area, and the mainland shoreline of Biscayne Bay contains the longest uninterrupted stretch of mangrove forest on Florida's east coast. Biscayne Bay itself is a broad, shallow body of water that is rich in marine life and that provides recreational opportunities, especially in its southern end, which is relatively pristine. The world's third-longest tract of coral reef habitat begins in Biscayne National Park. Overall, the park is home to more than 200 species of fish and a wide variety of marine plants and animals, and it contains some of the healthiest coral reefs in Florida.

The Everglades National Park spans the southern tip of the Florida peninsula and most of Florida Bay. The park contains both temperate and tropical plant communities, including sawgrass prairies, mangrove and cypress swamps, pinelands, and hardwood hammocks, in addition to marine and estuarine environments. The park is known for its rich bird life, particularly large wading birds, such as the roseate spoonbill (*Platalea ajaja*), wood stork (*Mycteria americana*), great blue heron (*Ardea herodias*), and a variety of egrets. Everglades National Park is the only subtropical preserve in North America and has been designated a World Heritage Site, an International Biosphere Reserve, and a Wetland of International Importance.

The national seashores of Cape Cod (Massachusetts), Assateague Island (Maryland), Cape Hatteras (North Carolina), and Cape Lookout (North Carolina) total more than 60,000 ha (148,262 acres) of beach and dune habitats. The dune areas found landward of the sandy beaches at these national seashore areas typically support dune grass or shrub communities that are sensitive to stress-inducing factors such as water pollution or beach development. Seabirds, shorebirds, and waterfowl are the primary wildlife species that use these beach/dune habitats.

Cumberland Island National Seashore is located in southeast Georgia, north of Jacksonville, Florida. Cumberland Island is 28 km (18 mi) long and totals 14,737 ha (36,415 acres), of which 6,819 ha (16,850 acres) are marsh, mudflats, and tidal creeks that support fish and shellfish communities and provide feeding grounds for a variety of birds. Cumberland Island's beaches provide nesting grounds for loggerhead sea turtles.

Canaveral National Seashore is approximately 23,472 ha (58,000 acres) of barrier island habitat located on the eastern central coast of Florida. This site includes ocean, beach, dune, hammock, lagoon, salt marsh, and pine flatland habitats. Indian River Lagoon and Mosquito Lagoon are highly diverse and productive estuaries that support commercial and recreational fisheries for finfish, clams, oysters, blue crabs, and shrimp. The island and its surrounding waters provide habitat for many threatened and endangered species including loggerhead, green and leatherback sea turtles, West Indian manatee, bald eagle (*Haliaeetus leucocephalus*), wood stork, peregrine falcon (*Falco peregrinus*), eastern indigo snake (*Drymarchon couperi*), and Florida scrub jay (*Aphelocoma coerulescens*).

4.2.15.3 National Wildlife Refuges

The National Wildlife Refuge System is a network of lands and waters managed specifically for wildlife. There are more than 60 national wildlife refuges located along the coastline or within coastal areas of the Atlantic States (Table 4.2.15-1). Most of these refuges were established to provide feeding, resting, and wintering areas for migratory birds such as waterfowl and shorebirds. Some of these refuges are of international importance, since they serve as stopover areas for neotropical migrants, which travel to various parts of Central and South America. Some are also important to threatened and endangered species such as the piping plover (*Charadrius melodus*), loggerhead and other sea turtles, bald eagle, West Indian manatee, brown pelican (*Pelecanus occidentalis*), and American alligator (*Alligator mississippiensis*).

4.2.15.4 National Estuarine Research Reserves

The National Estuarine Research Reserve System is a network of 26 areas created by the Coastal Zone Management Act of 1972, as amended, to provide a system of representative estuarine ecosystem areas suitable for long-term research, education, and stewardship. The NOAA and coastal State partners collaborate to set common priorities and to develop system-wide programs. A lead State agency or university manages each reserve, with input from local partners. One of the primary objectives for establishing this program was to provide research information for coastal managers and the fishing industry to help ensure the continued productivity of estuarine ecosystems. Fourteen estuarine research reserves, totaling nearly 147,943 ha (365,575 acres), have been established in the Atlantic States (Table 4.2.15-1).

4.2.15.5 National Estuary Program

In 1987, an amendment to the Clean Water Act, known as the Water Quality Act (P.L. 100-4), established the National Estuary Program. The purposes of the program are to identify nationally significant estuaries, to protect and improve their water quality, and to enhance their living resources. The program currently includes 28 sites. Under the administration of the USEPA, comprehensive plans are generated to protect and enhance environmental resources of estuaries designated to be of national importance. In the Atlantic States, the National Estuary Program includes 13 estuaries, with a total area of more than 242,000 km^2 (93,437 mi^2) (Table 4.2.15-2).

TABLE 4.2.15-2 Watersheds in the National Estuary Program

Estuary or Watershed	Region	State	Area (km^2)
Delaware Inland Bays	Atlantic	DE	804
Buzzards Bay	Atlantic	MA	1,939
Massachusetts Bays	Atlantic	MA	19,038
Maryland Coastal Bays	Atlantic	MD	1,035
Casco Bay	Atlantic	ME	2,965
Albemarle-Pamlico Sounds	Atlantic	NC	81,791
New Hampshire Estuaries	Atlantic	NH	2,789
Barnegat Bay	Atlantic	NJ	3,525
Delaware Estuary	Atlantic	DE, NJ, and PA	35,297
Peconic Bay	Atlantic	NY	1,187
Long Island Sound	Atlantic	NY and CT	45,050
New York-New Jersey Harbor (Harbor Estuary Program)	Atlantic	NY and NJ	42,128
Narragansett Bay	Atlantic	RI	4,674
Mobile Bay	Gulf	AL	115,467
Charlotte Harbor	Gulf	FL	12,653
Indian River Lagoon	Gulf	FL	3,575
Sarasota Bay	Gulf	FL	733
Tampa Bay	Gulf	FL	6,583
Barataria-Terrebonne Estuarine Complex	Gulf	LA	15,769
Coastal Bend Bays and Estuaries	Gulf	TX	65,987
Galveston Bay	Gulf	TX	63,306
Morro Bay	Pacific	CA	242
San Francisco Estuary	Pacific	CA	177,699
Santa Monica Bay	Pacific	CA	1,465
Tillamook Bay	Pacific	OR	1,451
Lower Columbia River Estuary	Pacific	OR and WA	614,771
Puget Sound	Pacific	WA	42,791

4.2.15.6 Chesapeake Bay Estuary

The Chesapeake Bay is North America's largest estuary, encompassing more than 165,759 km^2 (64,000 mi^2). It is also one of the most biologically diverse estuaries, supporting more than 3,600 species of plants, fish, and animals. The Chesapeake Bay is protected under its own federally mandated program, which is separate but related to the National Estuary Program. Accordingly, in 1983 and 1987, the States of Virginia, Maryland, and Pennsylvania; the District of Columbia; the Chesapeake Bay Commission; and the USEPA signed a historic agreement that established the Chesapeake Bay Program to protect and restore the Chesapeake Bay's ecosystem.

Chesapeake Bay provides habitat for nearly 300 species of fish, including many that support important commercial and recreational fisheries. While many of these fish species are only periodic residents, the Bay provides important habitats for reproduction, growth, and feeding for a large number of species. Some of the commercially and recreationally important fish species include striped bass, weakfish, red drum, flounder, and shad. In addition to important fish species, there are a number of invertebrate species that also support commercial and recreational fisheries, including blue crab and American oyster. The Chesapeake Bay is the largest producer of crabs in the country, estimated to provide more than 30% of the nation's catch; commercial harvests in a good year can yield close to 45 million kg (100 million lb) of crab.

Nearly 1 million waterfowl use the Chesapeake Bay in the winter months, and thousands more use it during migration seasons. The bay also provides important habitat for a variety of other resident and migratory birds, including the osprey, bald eagle, six colonially nesting waders (such as the great blue heron and snowy egret), and dozens of shorebird species.

4.2.16 Military Use Areas

Military Use Areas, established in numerous areas off all U.S. coastlines, are required by the U.S. Air Force, Navy, Marine Corps, and Special Operations Forces to conduct various testing and training missions. Military activities can be quite varied but normally consist of various air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and antisubmarine training, and air force exercises. (See Figures 4.2.16-1 and 4.2.16-2 for depictions of military areas in the Atlantic region.)

The U.S. Army Corps of Engineers (USACE) has established surface danger zones and restricted areas in many areas adjacent to U.S. coastlines. Danger zones are defined as water areas used for a variety of hazardous operations. The danger zones may be closed to the public on a fulltime or intermittent basis. A restricted area is a defined water area for the purpose of prohibiting or limiting public access. Restricted areas generally provide security for Government property and/or protection to the public from the risks of damage or injury arising from the Government's use of that area. The regulations pertaining to the identification and use of these areas are found at 33 CFR Part 334.

Units of the U.S. Department of Defense (USDOD) and the National Aeronautics and Space Administration (NASA) make use of surface danger zones and restricted areas within coastal waters and offshore for rocket launching, weapons testing, and a variety of training and readiness operations. Of particular interest is NASA's Kennedy Space Center on the eastern coast of Florida, where NASA-manned space launches occur. Military operating areas (OPAREAs) define where the U.S. Navy conducts surface and subsurface training and operations. The Navy conducts various training activities at sea such as sinking exercises of surface targets and mine warfare exercises. The Navy also conducts shakedown cruises for newly built ships, and for ships completing overhaul or extensive repairs in shipyards located along the coasts. Most importantly, Navy Fleet and Marine Corps amphibious training occurs nearly every day all along the east coast (OPAREAS, Warning Areas, and Restricted Areas from the Virginia Capes to Jacksonville). The level of activity varies from unit-level training to full-scale Carrier/Expeditionary Strike Group operations and certification. Aircraft operated by all USDOD units train within special use airspace overlying the coast and offshore.

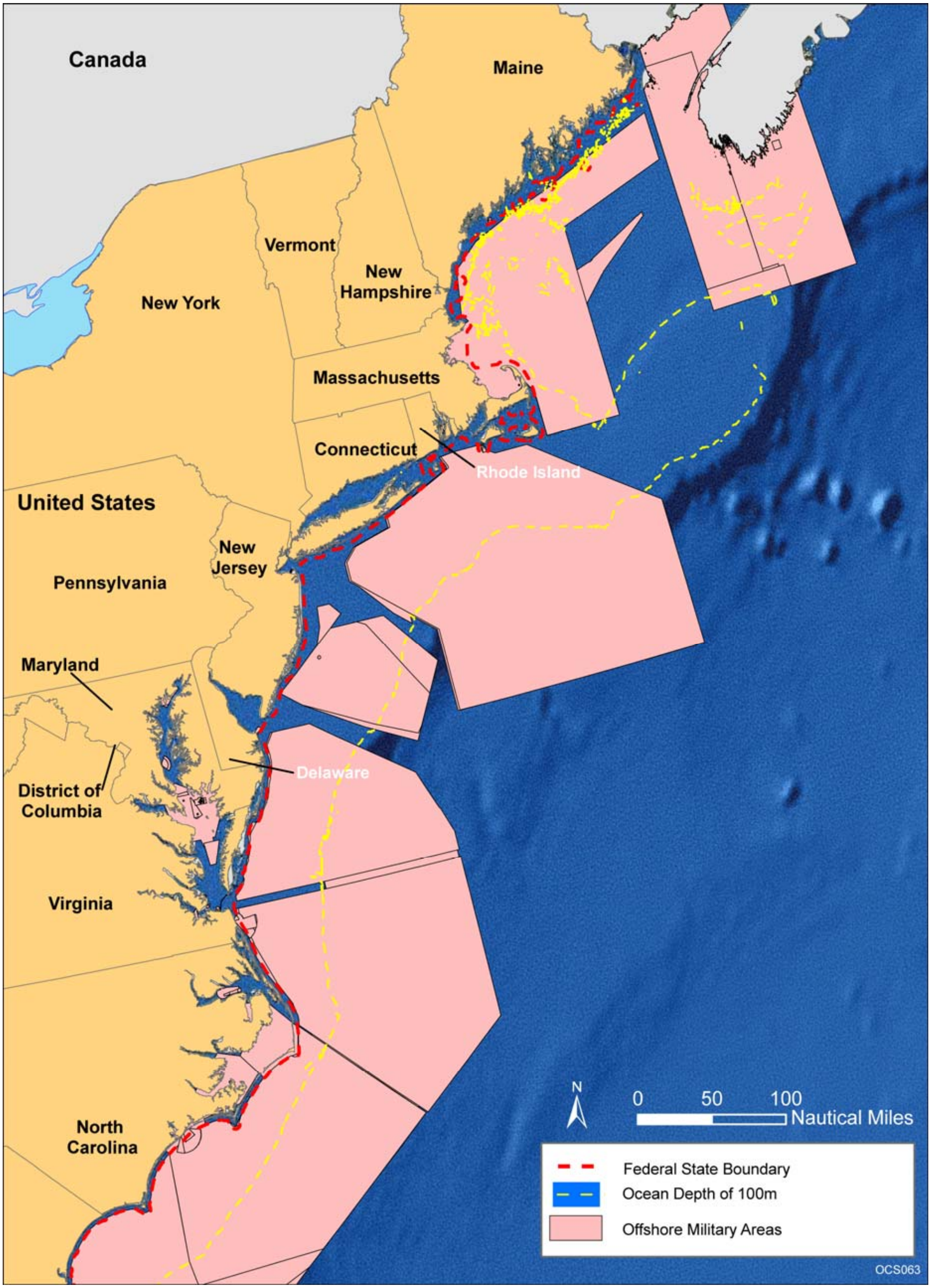

FIGURE 4.2.16-1 North Atlantic Military Areas (Source: NOAA 2006h; Parisi 2007)

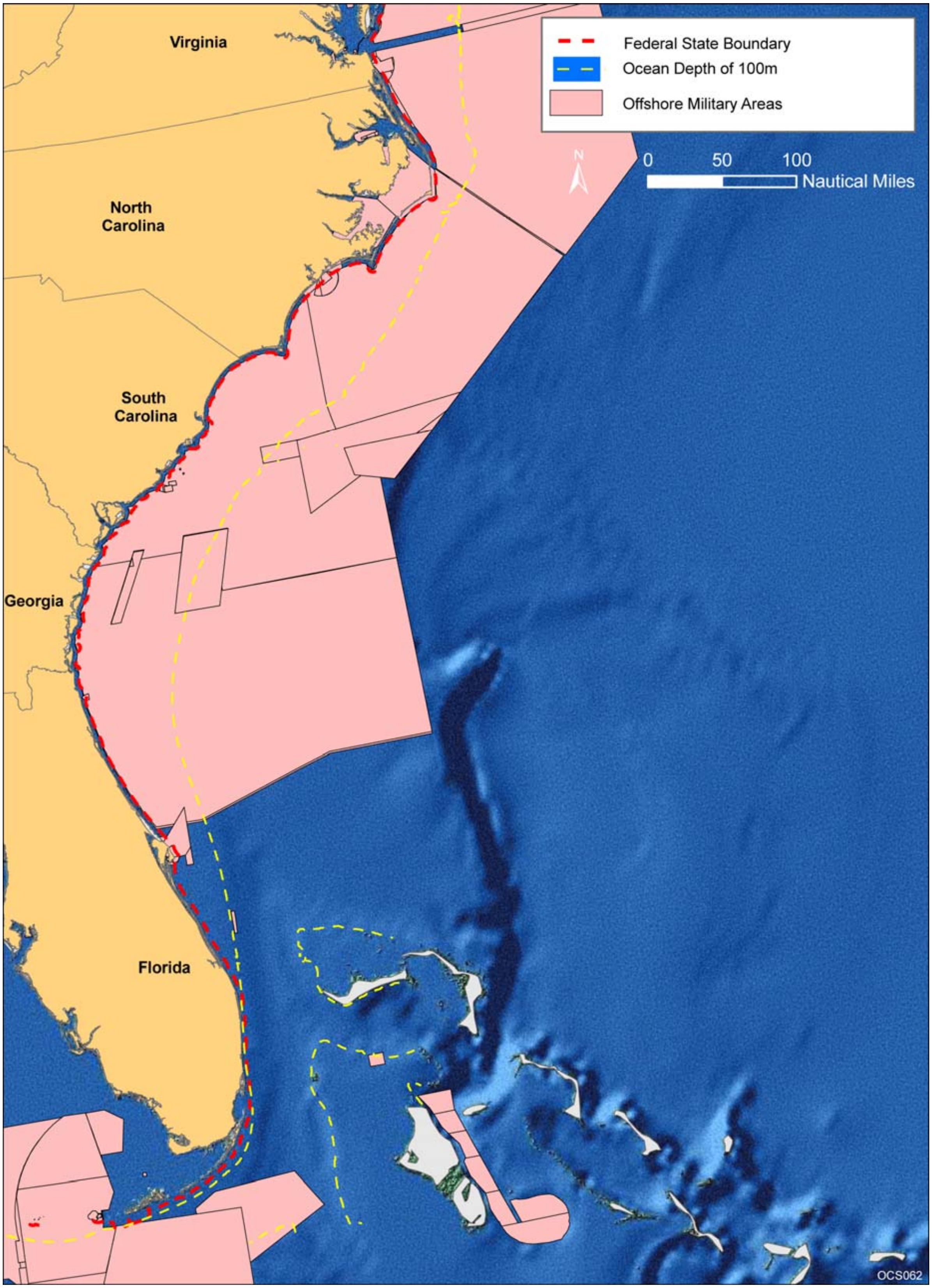

FIGURE 4.2.16-2 South Atlantic Military Areas (Source: NOAA 2006h; Parisi 2007)

There are also military training routes, military operating areas, restricted airspace, and warning areas designated by the Federal Aviation Administration. Warning areas are the most as relevant to the alternative energy program because they are largely located offshore, extending from 3 nautical mi (3.5 mi; 5.6 km) outward from the coast over international waters and in international airspace. These areas are designated as airspace for military activities, but because they occur over international waters, there are no restrictions on nonmilitary aircraft. The purpose of designating such areas is to warn nonparticipating pilots of the potential danger. When in use for military exercises, the controlling agency notifies civil, general, and other military aviation organizations through notice-to-airmen and notice-to-mariner advisories, which specify the current and scheduled status of the area and warn other aircraft (U.S. Department of the Navy 2004). Warning areas and military operating areas are generally used for air-to-air training operations. Aircraft operations conducted in warning areas primarily involve air-to-air combat training, such as air combat maneuvers and air intercepts, and are rarely conducted at altitudes below 1,524 m (5,000 ft) (U.S. Department of the Navy 2002).

There are numerous military and civilian radar systems that provide radar coverage along the U.S. coastline. As part of the National Defense Authorization Act of 2006, the USDOD was directed to prepare a study addressing the potential for impact of the construction of wind energy developments (including both onshore and offshore) on radar operations. This study was completed in September 2006 and submitted to Congress. In the report, USDOD found potential for conflict between installation of wind energy developments and the operation of various radar systems; it recommended that additional studies be undertaken to assess the conflict and possible mitigating measures. The Federal Aviation Administration has also issued "potential hazard" letters to proponents of wind energy development pending the review of the potential effect of these developments on radar system performance.

4.2.17 Transportation

All alternative energy project locations on the OCS would be accessible by air and boat for construction, operation, and decommissioning activities. This section discusses the existing transportation infrastructure that may be affected by and is available to support such activities in the Atlantic coastal region. Applicable areas include ocean port locations and capabilities as well as vessel operations and traffic. Any air support for facility construction, operation, and decommissioning is expected to consist primarily of helicopter transport of work crews and supplies from onshore locations to and from the offshore site location where the offshore site location is further from shore, or in some situations where support vessels remain in-place at the offshore site location (i.e., the support vessels do not take daily trips from port to the offshore location).

Offshore support for alternative energy facilities would rely on ocean port locations and capabilities. Ports provide an interface to land-based transportation systems such as highways and railroads where vessels may dock. Ports provide equipment and personnel to load and unload cargo and/or passenger vessels. Ports also provide areas for vessel maintenance (routine upkeep and repairs) and cargo storage.

Vessels using these ports may include military craft (U.S. Navy and U.S. Coast Guard [USCG]), commercial business craft (freighters, tug boats, fishing vessels, ferries, and cruise passenger ships), commercial recreational craft (cruise ships and fishing/sight-seeing charters), research vessels, and personal craft (fishing boats, house boats, yachts, and other pleasure craft). While many of these vessels generally remain within State waters (i.e., near shore), such as most ferries and personal craft, they influence the availability of port facilities and impact vessel traffic near ports in areas that might be considered for alternative offshore energy projects. Such projects would rely on nearby ports for support.

The locations of major commercial ocean ports on the Atlantic Coast are shown in Figures 4.2.17-1 and 4.2.17-2 along with designated lanes and precautionary areas for vessel traffic. Of these ports, the commercial freight ports handling larger vessels are listed in Table 4.2.17-1. For oceangoing vessels of 10 deadweight tons (DWT) or larger, the ports of New York and Philadelphia handled the most vessel calls in 2005, with 4,902 and 2,998 vessels, respectively (MARAD 2006a). Such detailed statistics are not available for smaller commercial vessels, but such traffic is expected to have a similar trend at these ports because of the available infrastructure such as cargo handling/storage capabilities and connecting roads and railroads, as well as the need to provide support craft (e.g., tugboats or lightering vessels) for the larger vessels. In addition, these larger vessels are more likely than smaller craft to travel into Federal waters (e.g., to international destinations). Another measure of vessel traffic and port size and capabilities is the annual volume of goods shipped and received. Table 4.2.17-2 lists the ports along the Atlantic Coast that were within the top 149 U.S. ports in 2004 for the amount of cargo handled.

Commercial fishing ports could also provide a base of support operations for OCS alternative energy facilities. For smaller commercial freight vessels, no detailed statistics of total vessel activity at fishing ports are available, but the total fish landings at a port can be used as a rough estimate of vessel activity. Fish landings and the correlation to vessel trips will vary somewhat depending on vessel size (i.e., the amount of fish a vessel can carry) and what percentage of that capacity was actually used on each trip. Table 4.2.23-2 presents the amount of fish landed in 2004 by State off the Atlantic Coast. Also given is the breakdown between the amount caught within State waters (0 to 5 km [0 to 3 mi] from shore) and within the Federal waters (5 to 321 km [3 to 200 mi] from shore). Overall, about half the fish landed off the Atlantic Coast were caught in Federal waters. Thus, fishing activity can be significant in certain OCS waters. Almost 30% of the total landings occurred in Virginia, but most of that State's landings (84%) were caught within Virginia State waters. Reedville, Virginia, led fishing ports with the most landings as shown in Table 4.2.23-5. Figures 4.2.17-1 and 4.2.17-2 show port locations and relative commercial freight and fishing vessel activity (Tables 4.2.17-1 and 4.2.23-5) for the Atlantic Coast. Larger ports also service and are departure points for cruise ships. Approximately 17 major cruise lines operate cruises with a U.S. port of call (MARAD 2006b). Table 4.2.17-3 lists the annual number of cruises departing Atlantic Coast ports from 2003 to 2005. The summer season is the busiest for the northern Atlantic ports. These cruise ships are larger oceangoing vessels, often with international ports of call, that frequent OCS waters.

Helicopters may be used for support operations at OCS alternative energy facilities, ferrying supplies and workers, similar in function to those used in the Gulf of Mexico region for

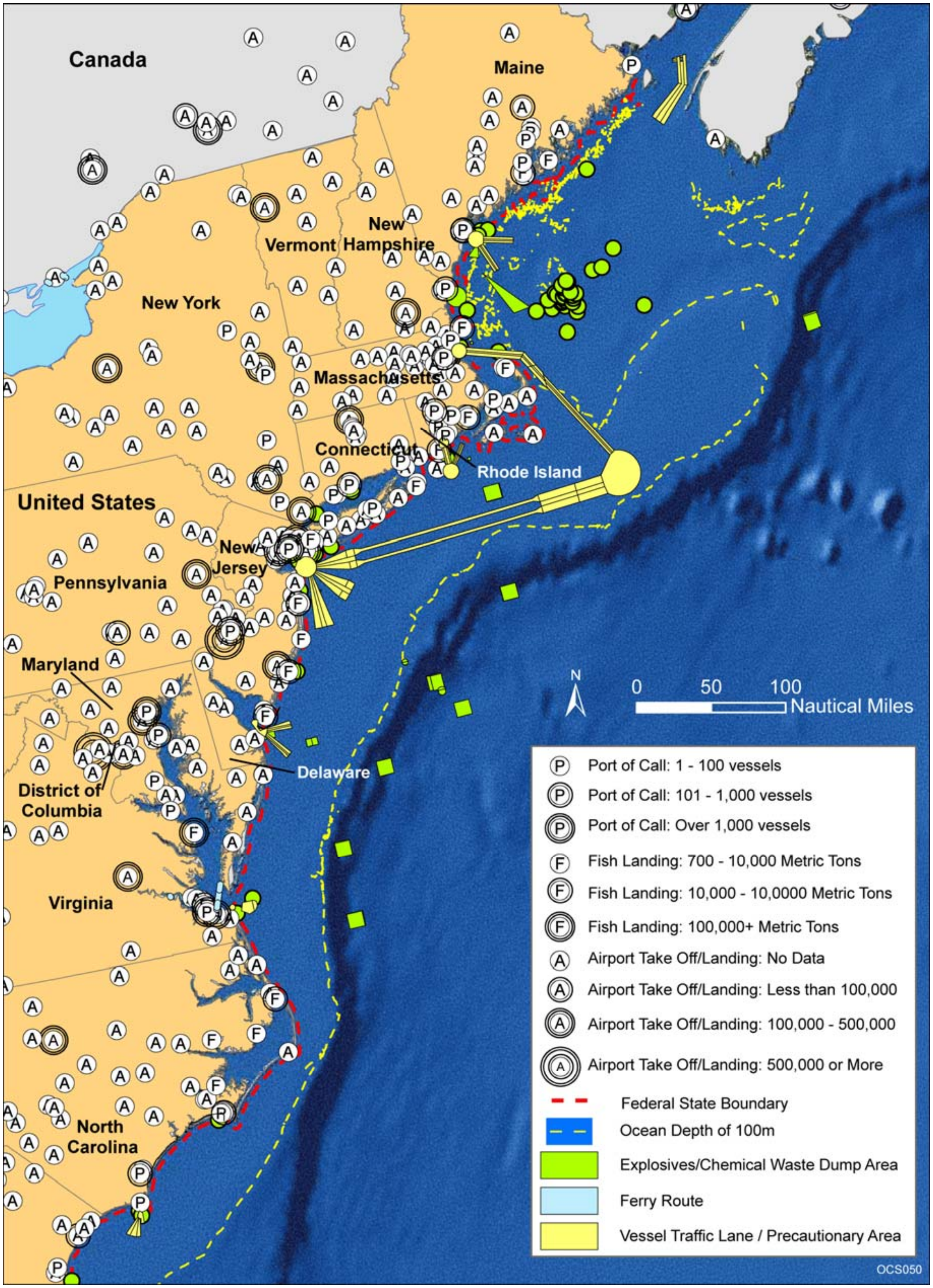

FIGURE 4.2.17-1 North Atlantic Offshore Dump Sites and Transportation Features (Source: NOAA 2006h and references in text)

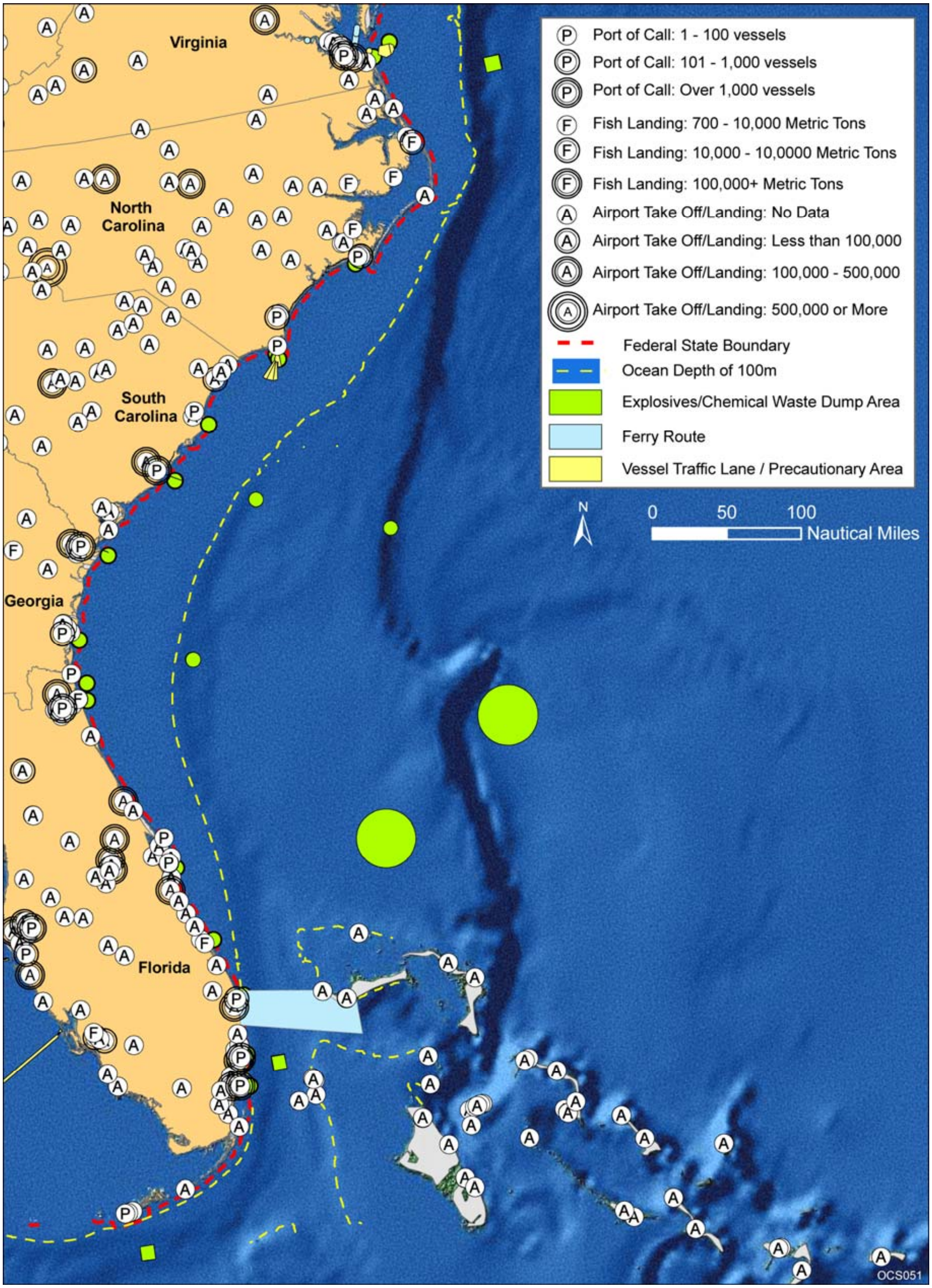

FIGURE 4.2.17-2 South Atlantic Offshore Dump Sites and Transportation Features (Source: NOAA 2006h and references in text)

TABLE 4.2.17-1 U.S. Atlantic Port Calls by Port and Commercial Vessel Type for 2005[a]

Port	State	All Types Calls	Tanker[b] Calls	Container Calls	Dry Bulk Calls	Ro-Ro[c] Calls	Gas Carrier Calls	Combination Calls	General Cargo Calls
New York	NY	4,902	1,380	2,370	348	573	13	66	152
Philadelphia	PA	2,998	1,534	390	435	189	35	10	405
Virginia Ports	VA	2,547	147	1,731	391	160	6	54	58
Savannah	GA	2,333	273	1,386	264	195	60	0	155
Charleston	SC	2,046	166	1,464	138	194	0	0	84
Baltimore	MD	1,825	165	376	408	717	4	18	137
Miami	FL	1,299	6	907	3	318	0	0	65
Jacksonville	FL	1,237	299	244	191	437	1	0	65
Port Everglades	FL	1,182	440	460	113	105	2	4	58
Wilmington	NC	600	267	96	108	30	0	0	99
Portland	ME	364	304	0	32	0	0	5	23
Boston	MA	332	114	149	22	8	32	5	2
Brunswick	GA	243	0	0	16	219	0	0	8
Providence	RI	193	97	0	85	1	6	1	3
New Haven	CT	185	91	1	62	2	0	9	20
Annapolis Anch.	MD	134	8	4	80	22	0	9	11
Portsmouth	NH	129	50	1	66	0	10	1	1
Palm Beach	FL	116	2	50	2	0	0	0	62
Bridgeport	CT	87	0	0	35	0	0	0	52
Davisville	RI	78	0	0	3	75	0	0	0
Cove Point	MD	74	1	0	0	0	73	0	0
Port Canaveral	FL	55	10	0	10	21	0	0	14
Piney Point	MD	50	45	0	0	0	1	4	0
Northville	NY	47	47	0	0	0	0	0	0
Morehead City	NC	36	10	1	15	0	0	0	10
New London	CT	32	1	0	12	0	0	0	19
Searsport	ME	19	17	0	1	0	0	0	1
Eastport	ME	13	2	0	7	0	0	0	4
Northport	NY	9	8	0	0	0	0	1	0
Georgetown	SC	6	1	0	2	1	0	0	2
Fernandina	FL	6	0	0	0	1	0	0	5
Brayton Point	RI	5	0	0	4	0	0	0	1

TABLE 4.2.17-1 (Cont.)

Port	State	All Types Calls	Tanker[b] Calls	Container Calls	Dry Bulk Calls	Ro-Ro[c] Calls	Gas Carrier Calls	Combination Calls	General Cargo Calls
Groton	CT	4	4	0	0	0	0	0	0
Stony Point	NY	2	0	0	2	0	0	0	0
Riverhead	NY	2	2	0	0	0	0	0	0
Kingston	NY	2	0	0	2	0	0	0	0
Bucksport	ME	2	2	0	0	0	0	0	0
Sandwich	MA	2	2	0	0	0	0	0	0
Salem	MA	2	0	0	2	0	0	0	0
Cape Canaveral	FL	2	0	0	0	1	0	0	1
Newport	RI	1	0	0	1	0	0	0	0
Jamestown	RI	1	0	0	0	0	0	0	1
Albany	NY	1	0	0	1	0	0	0	0
Southport	NC	1	1	0	0	0	0	0	0
Sandy Point	ME	1	1	0	0	0	0	0	0
Camden	ME	1	0	0	0	0	0	0	1
Fall River	MA	1	0	0	1	0	0	0	0

[a] For vessels of 10 dead weight tons (DWT) or larger.

[b] Includes product tanker and crude tanker.

[c] Includes vehicle carriers.

Source: MARAD (2006a).

TABLE 4.2.17-2 U.S. Atlantic Ports by Cargo Volume for 2004

U.S. Rank	Port / State	Metric Tons
3	New York/New Jersey	138,234,547
15	Hampton Roads, VA	43,949,844
17	Baltimore, MD	42,999,759
21	Philadelphia, PA	31,950,696
25	Paulsboro, NJ	27,656,120
27	Portland, ME	26,951,865
28	Savannah, GA	25,561,434
31	Boston, MA	23,402,392
32	Port Everglades, FL	22,588,741
34	Charleston, SC	22,443,036
36	Marcus Hook, PA	22,288,347
38	Jacksonville, FL	19,460,373
51	New Haven, CT	9,848,338
56	Miami, FL	8,849,203
57	Providence, RI	8,671,759
60	New Castle, DE	7,411,677
63	Wilmington, NC	7,156,150
68	Camden-Gloucester, NJ	6,521,981
74	Bridgeport, CT	5,144,853
78	Wilmington, DE	4,534,732
80	Portsmouth, NH	4,349,898
81	Port Canaveral, FL	4,200,136
84	Palm Beach, FL	3,761,736
94	Morehead City, NC	3,090,894
97	Fall River, MA	2,867,802
113	Port Jefferson, NY	2,176,253
117	Brunswick, GA	2,046,145
122	Searsport, ME	1,662,390
130	Chester, PA	1,421,971
134	Richmond, VA	1,313,868
140	Hempstead, NY	1,148,880
143	Stamford, CT	926,643
147	Hopewell, VA	895,233
148	Georgetown, SC	877,815

Source: AAPA (2006).

TABLE 4.2.17-3 U.S. Atlantic Coast Cruises by Departure Point

	Annual		
Departure Port	2003	2004	2005
Miami, FL	738	641	656
Fort Lauderdale, FL	593	637	618
Port Canaveral, FL	450	466	343
New York, NY	236	253	171
Jacksonville, FL	5	65	83
Cape Liberty (Bayonne, NJ)	–	–	59
Boston, MA	43	47	49
Philadelphia, PA	16	22	34
Baltimore, MD	31	55	32
Norfolk, VA	5	37	31
Charleston, SC	17	24	25
West Palm Beach, FL	4	0	2

Source: MARAD (2006b).

oil and gas operations support. Figures 4.2.17-1 and 4.2.17-2 show the locations of airports (BTS 2006; ACI-NA 2006) along the Atlantic Coast that could be used for maintaining helicopter operations.

4.2.18 Socioeconomic Resources

4.2.18.1 Regional Population, Employment, and Income

In 2004, there were 55.6 million persons living in the coastal counties in the Atlantic Region, which includes all of the eastern seaboard states (Table 4.2.18-1). Population in the region is projected to reach 56.0 million by 2007 and 56.5 million by the end of the OCS planning period in 2014. Regional population grew at an annual average rate of 1% over the period 1990 through 2004. Growth is expected to decline for the period 2004 through 2014, with a projected annual average rate of 0.2%. Within the region, the majority of the coastal population in the region is concentrated in New York (13.7 million in 2004) and Florida (10.2 million), with smaller populations in New Jersey (7.8 million), Massachusetts (4.8 million), and Virginia (4.7 million).

Employment in the Atlantic region stood at 32.2 million in 2004 and, on the basis of population growth rates, is expected to reach 32.5 million by 2007 and 32.7 million at the end of the planning period in 2014 (Table 4.2.18-1). Growth rates in employment in the region have been similar to those in population, with annual growth rates over the period 1990 through 2004 averaging 1.4%. At 2.2%, average annual growth in personal income in the Atlantic region over the period 1990 through 2004 slightly exceeded growth rates in both population and employment

TABLE 4.2.18-1 Socioeconomic Environment for the Coastal Economy in the Atlantic Region (millions, except where noted)[a]

	1990			2004			2007[b]			2014[b]		
State	Population	Employ-ment	Income ($b)[c]	Population	Employ-ment	Income ($b)	Population	Employ-ment	Income ($b)	Population	Employ-ment	Income ($b)
CT	2.0	1.2	84.3	2.2	1.3	109.4	2.2	1.3	109.9	2.2	1.3	110.3
DE	0.7	0.4	21.6	0.8	0.5	30.7	0.8	0.5	30.8	0.8	0.5	30.9
FL	7.5	3.0	226.5	10.2	5.7	338.8	10.3	5.8	340.4	10.5	5.9	341.6
GA	0.5	0.2	10.6	0.6	0.3	16.2	0.6	0.3	16.2	0.6	0.3	16.3
ME	0.9	0.5	24.1	1.0	0.6	31.8	1.0	0.6	32.0	1.0	0.6	32.1
MD	3.3	1.9	102.8	3.7	2.1	138.8	3.8	2.1	139.5	3.8	2.2	140.0
MA	4.5	2.9	164.2	4.8	3.2	224.0	4.8	3.2	225.1	4.9	3.2	225.9
NH	0.4	0.2	11.0	0.4	0.2	16.3	0.4	0.2	16.4	0.4	0.3	16.4
NJ	7.0	3.9	257.0	7.8	4.3	325.9	7.9	4.4	327.5	7.9	4.4	328.7
NY	12.5	6.9	474.5	13.7	7.6	597.4	13.7	7.6	600.2	13.8	7.6	602.4
NC	0.7	0.4	14.7	0.9	0.5	24.6	0.9	0.5	24.7	0.9	0.5	24.8
PA	2.7	1.4	79.6	2.6	1.4	95.2	2.6	1.4	95.6	2.7	1.4	96.0
RI	1.0	0.6	29.6	1.1	0.6	38.2	1.1	0.6	38.4	1.1	0.6	38.5
SC	0.8	0.5	19.7	1.1	0.6	31.6	1.1	0.6	31.8	1.1	0.6	31.9
VA	3.9	2.5	127.7	4.7	3.1	201.0	4.7	3.2	201.9	4.8	3.2	202.7
Total	48.2	26.4	1,648.0	55.6	32.2	2,219.8	56.0	32.5	2,230.4	56.5	32.7	2,238.4

[a] Coastal economy applies to counties wholly or partly within 50 mi of the coast in each state.

[b] Projections based on annual population growth for each state.

[c] $b = billions of dollars.

Sources: U.S. Bureau of the Census (2006a); USDOC (2006a,b).

(Table 4.2.18-1). Personal income in the region rose from $1.6 trillion in 1990 to $2.2 trillion in 2004 and, on the basis of population growth rates, is expected to grow slowly over the planning period 2007 through 2014. Per capita income in the region grew from $34,162 to $39,959 between 1990 and 2004.

Within the region, employment is concentrated in New York (7.6 million in 2004) and Florida (5.7 million), with smaller levels in New Jersey (4.3 million), Massachusetts (3.2 million), and Virginia (3.1 million). In 2004, there was wide variation in per capita incomes among the states with coastal counties in the region, ranging from $50,229 in Connecticut and $46,506 in Massachusetts, to less than $30,000 in Georgia, North Carolina, and South Carolina. The average for all coastal counties in the region was $40,154 in 2004.

The Atlantic region consists of a number of contrasting types of economic areas. There are a number of large metropolitan areas located in the region, including Boston, New York, Baltimore, Philadelphia, Washington, and Miami, and a large number of smaller urban and suburban areas located in each State. All of the metropolitan areas and many of the larger urban areas have highly complex economic structures, containing a wide range of industries, with wide and diverse labor markets and a comprehensive range of occupations. The Atlantic region also includes a number of urban areas that serve a smaller number of more specialized economic functions, including renewable and nonrenewable resource development, maritime shipping, power generation, recreation, tourism, and residential retirement. Outside of the urban areas, there are a large number of local and regional market areas serving resource extraction, agriculture, power generation, and transportation industries. These areas have simpler economic structures and contain smaller, less-diversified labor markets.

4.2.18.2 Sociocultural Systems

There is a variety of demographic, employment, income, land-use, and infrastructure patterns in the coastal communities of the Atlantic region, reflecting the heterogeneous sociocultural systems in these areas. This rich diversity is evident in a variety of cultural centers containing numerous cultural groups of African, European, Asian, Latin American, and Middle Eastern origins (U.S. Bureau of the Census 2006a).

The metropolitan areas of the Atlantic Coast are located off the open coast in estuaries and bays, each hosting extensive port facilities, with waterborne commerce an important aspect of their economies. Between the Atlantic coastal cities of Washington, Philadelphia, Baltimore, New York, and Boston are extensive suburban developments. The large metropolitan areas of the Atlantic region represent destinations of opportunity for many individuals, as evidenced by the diverse racial and cultural composition of the regions major cities. The coastline of much of New England, and between Virginia and northern Florida, is characterized by small communities that rely, variably, on agriculture and fishing, as well as recreation and tourism.

Many of these smaller communities maintain sociocultural environments that are less diverse, often supporting a small number or a single cultural group in the most important community economic activity.

4.2.18.3 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629), issued by President Clinton on February 11, 1994, formally requires Federal agencies to incorporate environmental justice as part of their missions. Specifically, it directs them to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations.

The analysis of potential environmental justice issues associated with offshore energy developments followed guidelines described in the Council on Environmental Quality's Environmental Justice Guidance under the National Environmental Policy Act (CEQ 1997). The analysis method has three parts. First, a description of the geographic distribution of low-income and minority populations in the affected area is undertaken, followed by an assessment of whether the impacts of construction and operation of the energy facilities would produce impacts that are high and adverse, and lastly, if impacts are high and adverse, a determination is made as to whether these impacts disproportionately impact low-income or minority populations.

Description of the geographic distribution of low-income and minority population groups was based on demographic data from the 2000 Census (U.S. Bureau of the Census 2006a). The following definitions of individuals were used to define low-income and minority populations:

- **Minority.** Beginning with the 2000 Census, where appropriate, the census form allows individuals to designate multiple population group categories to reflect their ethnic or racial origin. Persons are included in the minority category if they classify themselves as belonging to any of the following racial groups: Hispanic, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian, or Other Pacific Islander. In addition, persons who classify themselves as being of multiple racial origins may choose up to six racial groups as the basis of their racial origins. The minority population includes all persons, including those classifying themselves in multiple racial categories, except those who classify themselves as not of Hispanic origin and as White or Other Race.

  A minority population exists where the percentage of minority persons for any given geographic unit, a State, for example, is more than 20 percentage points higher than the percentage of minority persons for the reference geographic unit, the nation, for example. A minority population also exists in any geographic unit where the number of minority persons exceeds 50% of the total population.

- **Low-Income**. Individuals who fall below the poverty line are low-income. The poverty line takes into account family size and age of individuals in the family. In 1999, for example, the poverty line for a family of five with three children below the age of 18 was $19,882. For any given family below the poverty line, all family members are considered as being below the poverty line for the purposes of analysis.

A low-income population exists where the percentage of low-income persons for any given geographic unit, a State, for example, is more than 20 percentage points higher than the percentage of low-income persons for the reference geographic unit, the nation, for example. A low-income population also exists in any geographic unit where the number of low-income persons exceeds 50% of the total population.

Table 4.2.18-2 shows the minority and low-income composition of total population for the coastal counties (U.S. Bureau of the Census 2006b) in the Atlantic region based on 2000 Census data and CEQ Guidelines. Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals also identifying themselves as being part of one or more of the population groups listed in the table.

Table 4.2.18-2 shows that 35.3% of individuals in coastal counties of the Atlantic region identified themselves as minority, while 11.2% of individuals had an annual income in 2000 at or below the poverty line. For the coastal counties in the region as a whole, the percentage of individuals identifying themselves as minority was slightly less than in the reference group, the

TABLE 4.2.18-2 Minority and Low-Income Populations in the Atlantic Region (millions)

Total population	65.2
White, Non-Hispanic	42.2
Hispanic or Latino	7.9
Non-Hispanic or Latino minorities	15.1
One race	14.1
Black or African American	11.0
American Indian or Alaskan Native	0.2
Asian	2.6
Native Hawaiian or Other Pacific Islander	0.0
Some other race	0.2
Two or more races	1.1
Total minority	23.0
Low income	7.3
Percent minority	*35.3*
Percent low income	*11.2*

Source: U.S. Bureau of the Census (2006a).

Atlantic region as a whole (31.6%). Similarly, the percentage of individuals below the poverty line was slightly less than in the Atlantic region as a whole (11.2%). As the percentage of low-income and minority individuals in the Atlantic region does not exceed 50% of the total population, or is not more than 20 percentage points above the corresponding percentage for the United States as a whole, according to CEQ guidelines, there are no minority or low-income populations in the Atlantic region.

Within the Atlantic region, there is a diversity of population groups. Metropolitan and larger urban areas have a wide variety of ethnic and racial groups, reflecting heterogeneous sociocultural systems in these areas, with cultural centers containing population groups of African, European, Asian, and Latin American origins. Smaller urban centers and rural areas tend to be less diverse, with a smaller number of cultural and racial and ethnic groups present. There are also a number of tribes located on land along the coast within the region.

4.2.19 Cultural Resources

As defined in the ACHP regulations at 36 CFR 800.16, *historic property* means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria. As used in this analysis, the more general term, *cultural resources,* also includes those historic resources not yet determined eligible for the National Register.

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA; 16 USC 470(f)) requires that Federal agencies such as the MMS take into account the effect of an undertaking under their jurisdiction on significant cultural resources. A cultural resource is considered significant when it meets the eligibility criteria for listing on the National Register of Historic Places (36 CFR 60.4). The Section 106 process requires the identification of cultural resources within the area of potential effect of a Federal project, consideration of a project's impact on cultural resources, and the mitigation of adverse effects to significant cultural resources. The process also requires consultation with State Historic Preservation Officers, the Advisory Council on Historic Preservation, Native American tribes, and interested parties. In the case of oil, gas, and sulfur leases, the MMS has established regulations (e.g., 30 CFR 250.194) and issues guidance to lessees (e.g., Notice to Lessees [NTL] No. 2005-G07 and G10, NTL No. 2006-G07, NTL No. 2005-A03, NTL No. 2006-P03) to ensure compliance with Section 106 of the NHPA and its implementing regulations in 36 CFR Part 800. The NTLs provide guidance on the regulations regarding archaeological discoveries and the conduct of archaeological surveys and identify specific OCS lease blocks with a high potential for containing cultural resources on the basis of previous studies.

The MMS can only consider the effects on cultural resources of projects over which it has permitting authority (Sansonetti 1987). The MMS does not have the legal authority to manage cultural resources on the OCS outside of its lease areas (Solicitor 1980). The only impacts that the MMS can consider off of the OCS are the indirect visual impacts to historic properties on land. The MMS intends to develop additional guidance on the issue of indirect visual impacts through consultation with the Advisory Council on Historic Preservation and other interested parties. Once a project's footprint enters State waters, the project is no longer under MMS control but is subject to the requirements identified by the State.

The Atlantic region consists of approximately 3,300 km (2,000 mi) of coastline. The coastal zone is one of the most highly utilized areas by human populations and all manner of historic properties are likely to be found in present or former coastal areas. Onshore cultural resources are highly varied in coastal areas, from small, temporary use archaeological sites to substantial permanent settlements ranging in age from the earliest known occupation of the area, between 11,000 and 12,000 years ago, through the post-contact period (e.g., the last several hundred years). As an example, many early colonial sites along the Atlantic Coast are very important to our nation's history and would be considered significant historic properties eligible for the NRHP.

Offshore cultural resources include numerous shipwrecks dating from as early as the 16th century. Early Spanish exploration was occurring at that time in the south Atlantic (Florida Keys), and shipwrecks dating to this period are present in the area. Further north, early exploration and commercial shipping into the mid-Atlantic area (Virginia) occurred since the 17th century. Many commercial shipwrecks dating between 1630 and 1800 are clustered in the Chesapeake Bay vicinity. Similarly, shipwrecks from various time periods would also be encountered in the north-Atlantic area. The potential for finding shipwrecks increases in areas such as historic shipping routes, approaches to sea ports, reefs, straits, and shoals.

Literature searches can be completed for reported ship losses and known shipwrecks, but they offer only a partial understanding of the resources that may be present. For example, as part of one of the early OCS archaeological baseline studies, a literature search was conducted for the Atlantic OCS from the Bay of Fundy to Cape Hatteras by the Institute for Conservation Archaeology (1979). In a specific proposed lease sale area, 86 shipwrecks with known locations within the sale area were reported. The shipwrecks dated from 1689 to 1930. Numerous other shipwrecks were reported for the area, but the reports did not contain detailed locational information and could not be definitively tied to the lease sale. It can also be assumed that some percentage of the reporting is inaccurate, some of the locations were imprecisely recorded, some of the ships were badly broken up and widely dispersed during drift, and the additional ship losses, such as losses of smaller fishing boats, may not have been documented. These records also provide no information regarding the preservation potential of the shipwreck; the level of preservation can be determined only by visiting the site. Water depth, type of bottom, nature of adjacent coast, strength and direction of storm currents and waves, and size and type of the vessel are all factors that can contribute to the condition of the shipwreck and the spatial distribution of materials and artifacts associated with the shipwreck.

Offshore resources also include submerged prehistoric archaeological sites. Available data for the Atlantic OCS indicate that the position of paleoshorelines will vary greatly from north to south. This variability is primarily related to the relative distance from the late Wisconsin glacial ice mass. Approximately 10,000 years ago, the sea level in the northern area (north of 40° latitude) was about 36 m (118 ft) below the present sea level; south of this area, the elevation was about 23 m (75 ft) below present levels. For sea levels prior to 10,000 years ago, few data are available. Data that have been reported indicate sea levels of 70 m (230 ft) below present levels north of Cape Hatteras approximately 15,000 years ago (Dillon and Oldale 1978) and 53 m (174 ft) below present levels south of Cape Hatteras 16,500 years ago (SAI 1981). The available sea-level data can be extrapolated to approximate what the relative seal level would have been on the Atlantic OCS when the earliest human populations were known to exist in the region (around 12,000 years ago). North of Cape Hatteras, the bathymetric contour of interest is located between 50 and 56 m (164 and 184 ft) below present sea level, and for south of Cape Hatteras, the contour is located between 33 and 38 m (108 and 125 ft) below the present sea level. Submerged areas between the present shoreline and the approximate paleoshoreline would, therefore, have the potential to contain prehistoric sites.

Geographic features associated with onshore prehistoric archaeological sites in coastal areas include river channels and associated floodplains, terraces, levees and point bars, estuaries, barrier islands, and back barrier lagoons. These same types of features are present on the OCS, are submerged and often buried by estuarine and marine sediments, and have the same potential for being associated with prehistoric site locations. The MMS requires high-resolution remote sensing surveys prior to any bottom disturbing activities associated with oil, gas, and sulfur leasing. These surveys have been successful in identifying geographic features that are associated with prehistoric site locations. Of all the geographical features, relict river courses have been shown to have higher concentrations of sites in the United States (Delgado 1998). It is suspected that the intersection of major shelf river valleys and the paleoshoreline along the Atlantic Coast would be the areas of highest potential for well-preserved, significant early prehistoric archaeological sites to occur on the OCS. For example, the ancestral Susquehanna River Valley, the ancestral James River Valley, and the Virginia Beach Valley were all identified by Swift et al. (1972) as three major shelf river valleys in the mid-Atlantic planning area. According to Science Applications, Inc. (SAI 1981) in an evaluation of the potential for archaeological sites to occur offshore in the area between Cape Hatteras and Key West, the shelf off the coast of Georgia and South Carolina has the greatest potential for both containing evidence of human occupation by the presence of river channels and preserving that evidence by sedimentary deposition.

As with shipwrecks, site preservation of underwater prehistoric archaeological sites is subject to many factors. Low-energy environments with little current or sedimentary movement have the best preservation potential. These areas would include previous floodplains, bays, lagoons, river terraces, and subsiding deltas that are now buried by marine sediments. The preservation of organic materials (e.g., wood, seeds, fibers, skins, and possibly animal or human soft-tissue remains) is possible when buried under such conditions (Purdy 1988). Sites that are fully or partially exposed in near-shore or high-energy environments are likely to erode over time, displacing and/or destroying the artifacts and their primary context. Shell midden sites seem to be able to withstand higher energy environments (Delgado 1998).

4.2.20 Land Use and Existing Infrastructure

The Atlantic region encompasses approximately 3,300 km (2,000 mi) of coastline. Land uses along the Atlantic coastline, as is the case along the Pacific and Gulf Coasts, are highly diverse and, in many cases, have been well established over many years. Centers for manufacturing, transportation, communication, military operations, and urban development are found on the coast. The coastline also supports both low-density agricultural production and areas known for their scenic beauty and wildness. These latter areas frequently are important areas for escape for urban populations seeking natural environments, recreational pursuits, and solitude.

Offshore "land uses" are also well established. For example, the Atlantic Coast near New York City has many nearshore uses, including shipping lanes, telecommunication cables, municipal waste disposal areas, oil and gas production facilities, military operations areas, and marine protected areas are among the myriad of existing uses found in this near shore environment.

The coastline of the Atlantic region contains 9 of the 50 largest cities in the United States, 43% of the U.S. population, and 12 of the 50 largest U.S. ports. The northern portion of the region has robust transportation systems in place, including maritime ports of all sizes and an extensive highway and rail system. The southern portion of the region is less densely developed and has less transportation infrastructure. There has been no offshore development in this area, although there has been discussion of leasing both for oil and gas exploration and permitting for wind energy development.

Population along the Atlantic Coast is discussed in detail in Section 4.2.18, but population numbers are major drivers influencing all uses in coastal areas. In addition to major population centers located on or near the coasts, because of the abundance of their recreational and leisure resources, coastal areas are subject to major population inflows during peak vacation periods. In the next few decades, coastal areas will also see a growing proportion of older residents as an unprecedented number of Americans reach retirement age. This also has the potential to place more demands on coastal resources as there will be more time for people to enjoy the many coastal amenities (Culliton 1998).

Atlantic coastal States have authority over submerged lands out to 3 nautical mi (approximately 3.5 mi; 5.6 km). States have authority to manage ocean energy resources and structures within these coastal zones, but they do not have the right to regulate navigation, commerce, or foreign affairs, which is reserved for the Federal Government. Within this zone, States may permit alternative energy developments as well as other uses.

All of the States in the Atlantic region are participants in the Coastal Zone Management Program and have taken various approaches to managing their coastal lands (see the discussion of the Coastal Zone Management Act in Section 1.7). The coastal area of the States in this region is very diverse, ranging from the craggy shores of Maine to the beaches of southern Florida. Some of the most prominent geographical features of the planning unit are Capes Cod and Hatteras, Long Island, the Chesapeake Bay, and the beaches of the Carolinas and Florida.

Agriculture is an important activity in many of the Atlantic Coast States. There are numerous well known and important features along the coast that attract recreation users and that have important scenic and ecological values. Acadia National Park, Cape Cod, the Eastern Shore of Virginia and Maryland, the Outer Banks of North Carolina, and the beaches of South Carolina and Florida are among some of the notable examples. The sea side of the Eastern Shore of Virginia is considered a global treasure and has been designated by the United Nations as a “Man and the Biosphere Reserve.”

There are also important federally designated areas along the coasts including military areas, national parks, national wildlife refuges, and marine protected areas. Military areas are discussed in Section 4.2.16. Areas of special concern, including National Marine Sanctuaries, National Wildlife Refuges, and National Estuaries, are discussed in Section 4.2.15. The individual States also maintain important parks, recreation, and wildlife areas that support local/regional uses along the coastal zone.

4.2.21 Visual Resources

Description of the visual resources potentially affected by the proposed facilities involves establishing landscape types and scenic quality in the areas in which energy facilities would be located, followed by an assessment of the potential sensitivity to changes in the visual environment, including the likely number of viewers.

Visual resources in the Atlantic region can be broadly grouped into three main areas. The mid-Atlantic Coastal Plain extends from the Atlantic Ocean south of Long Island to the Virginia-North Carolina border, where the hilly Piedmont begins. Water is a dominant feature of the landscape, with forested wetlands, salt marshes, and barrier island and bay complexes distinctive features of the landscape. Upland forests on the remaining land are dominated by pinewoods on the outer Coastal Plain nearer the coast with hardwood forests on the inner Coastal Plain. The South Atlantic Coastal Plain covers northeastern Florida, the southern half of Georgia, and the eastern halves of South Carolina and North Carolina. The Atlantic Coast is lined with barrier islands that support sand dune and maritime forest habitats and are backed by marshland. Estuaries become more saline near the coast, and river valleys become increasingly wooded farther inland, supporting significant areas of bottomland hardwood forest.

The Atlantic Coast provides a rich diversity of visual resources. Small sheltered beaches between rocky headlands are common in Massachusetts, Rhode Island, Connecticut, and Long Island Sound. Much of the ocean frontage along Cape Cod and from Long Island to southern Florida consists of sandy beach-dune and/or barrier beach areas. In the vicinity of urban areas, there are localized sections of dense shoreline development. Coastal wetlands and a number of major estuaries, including the Narragansett, Raritan, Delaware, and Chesapeake Bays and Currituck, Albemarle, and Pamlico Sounds, support a great diversity of fish and wildlife. Waterfowl, shorebirds, wading birds, and raptors use coastal wetlands for breeding, feeding, migrating, and wintering, together with a variety of reptiles and mammalian species.

A large percentage of the U.S. population lives near the Atlantic Coast; consequently, beaches are heavily used for recreation, particularly near large urban areas. The number of potential viewers and the recreational nature of the activities they are engaged in makes viewsheds from beaches particularly sensitive to offshore visual impacts.

In addition, many residences are located at or very close to the shore; many people choose to live in these areas because of the ocean views or nearby ocean front. Seaside residents would likely have frequent and extended views of offshore energy developments, and many will have strong emotional attachments to the visible seascapes, especially if those seascapes are relatively free of development and visual clutter. Seaside residents would potentially be very sensitive to changes visible from the shore, and hence viewsheds from seaside residences are of particular concern for potential visual impacts.

4.2.22 Tourism and Recreation

The mid-Atlantic coastal region is a popular tourist and recreational destination that offers a diverse range of activities, featuring sandy beaches, barrier islands, inland water bodies, estuarine bays and sounds, river deltas, maritime forests, and marshland. Popular recreational activities include swimming, boating, fishing, sunbathing, waterfowl hunting, wildlife viewing and other nature studies, visits to historic and cultural sites, visits to amusement parks and other commercial destinations, nightlife and entertainment, shopping, gaming, and outdoor sports like golf. Specialized activities include surfing (board, kite, and wind), hang-gliding, kayaking, and scuba diving. Public lands are intermingled with developed areas throughout the region. National Parks and Seashores such as Cape Hatteras in North Carolina and Cumberland Island in Georgia occupy more than 168,300 ha (650 mi^2) along the Atlantic Ocean between New Jersey and Florida. The National Wildlife Refuges (NWRs) containing marine habitats occupy more than 414,400 ha (1,600 mi^2) of the mid-Atlantic coastal region. State and locally protected lands and military and research establishments occupy the remaining area.

Tourism and recreation are important activities for many communities on the Atlantic Coast. However, for the coastal States, these activities do not make a significant contribution to overall employment or wages (Table 4.2.22-1); less than 6% of total coastal county employment in 2004 was in the ocean-related sectors in which tourism and recreation expenditures occur.

4.2.23 Fisheries

4.2.23.1 Commercial Fisheries

In 2004, commercial fishery landings in the Atlantic region totaled approximately 743 million kg (1,638 million lb), with a value of over $1.3 billion (Table 4.2.23-1; NMFS 2005). Commercial landings in the Atlantic region during 2005 accounted for approximately 36% of the total value ($3.7 billion) of commercial fisheries in the United States for that year. The five Atlantic region States with the highest values of commercial fish landings

TABLE 4.2.22-1 Ocean-Related Tourism and Recreation (T&R) Economy, 2004

State	T&R Sector[a] Employment	Sector Share of Total Coastal County[b] Employment (%)	T&R Sector Wages ($ millions)
CT	36,612	2.3	682.7
DE	12,997	3.2	188.5
FL	262,643	3.7	4,668.9
GA	19,739	0.5	299.8
ME	30,603	5.2	470.5
MD	35,014	1.4	566.8
MA	54,062	1.7	1,095.8
NH	8,337	1.4	130.9
NJ	58,787	1.6	1,020.7
NY	227,974	2.8	5,596.8
NC	31,933	0.9	387.2
RI	23,416	5.0	394.1
SC	38,301	2.2	614.6
VA	46,827	1.4	669.1
Total	624,602	1.8	12,117.6

[a] T&R sectors are Amusement and Recreation Services, Boat Dealers, Eating and Drinking Places, Hotels and Lodging Places, Marinas, RV Parks and Campsites, Scenic Water Tours, Sporting Goods Retailers, Zoos, and Aquaria.

[b] Economic activity in counties wholly or partly within 50 mi of the coast in each State.

Source: NOAA (2006d).

in 2004 were: Massachusetts ($326.1 million), Maine ($315.8 million), Virginia ($160.3 million), New Jersey ($139.4 million), and North Carolina ($77.1 million) (Table 4.2.23-1).

Many commercial fish species are landed along the Atlantic Coast. The most important commercial fish species groups are oceanic pelagic (epipelagic) fishes, reef (hard bottom) fishes, coastal pelagic species, and estuarine-dependent species. Targeted epipelagic species include yellowfin tuna and swordfish; coastal pelagic species—king and Atlantic mackerel (*Scomber scombrus*); and reef/hard-bottom species—American lobster and vermillion snapper (*Rhomboplites anrorubeus*). The primary estuarine-dependent species are Atlantic menhaden, blue crab (*callinectes sapidus*), and penaeid shrimps (e.g., brown and white shrimp [*Penaeus* spp.]).

Each species or species group is caught by using various methods and gear types. Shrimp are taken by bottom trawling; Atlantic menhaden are caught in purse nets; yellowfin tuna are

TABLE 4.2.23-1 Total Landing Weights and Values for U.S. Commercial Fisheries in 2004

Regions and States	Weight (millions kg)	Weight (millions lb)	Value (thousands $)
Atlantic Region	**743**	**1,638**	**1,310,034**
Maine	95	208	315,766
New Hampshire	10	22	8,805
Massachusetts	153	337	326,067
Rhode Island	44	97	71,141
Connecticut	10	21	35,787
New York	15	34	46,381
New Jersey	84	186	139,427
Delaware	2	4	5,437
Pennsylvania	0.01	0.03	27
Maryland	22	50	49,185
Virginia	218	482	160,285
North Carolina	62	136	77,138
South Carolina	6	12	18,541
Georgia	3	6	11,320
Florida, East Coast	19	42	44,727
Gulf of Mexico Region	**669**	**1,476**	**667,315**
Florida, West Coast	38	83	145,861
Alabama	12	27	37,036
Mississippi	83	184	43,791
Louisiana	497	1,096	274,419
Texas	39	86	166,208
Pacific Region	**512**	**1,129**	**415,139**
Washington	206	455	175,081
Oregon	134	295	101,081
California	172	379	138,977
Total, United States[a]	**4,374**	**9,643**	**3,652,281**

[a] Total for the U.S. includes values for Alaska, Great Lakes States, and Utah, which are not itemized in the table.

Source: NMFS (2005).

caught on surface longlines; snapper are caught by hook and line; and pots and traps are used for blue crab and American lobster. Commercial fishing methods with the highest potential for conflicts with OCS operations are bottom trawling (potential for snagging on cables, pipelines, and debris) and surface longlining (potential for space-use conflicts with OCS construction and service vessels). Both fishing methods could have space-use conflict interactions if fixed OCS facilities were to be located in previously fished areas. Table 4.2.23-2 shows the portion of fishery landings that occurred in nearshore and offshore waters for each of the Atlantic Coast States. Deep-sea fisheries, such as swordfish longlining, and shallow-water nearshore fisheries,

TABLE 4.2.23-2 Atlantic Coast Fish Landings by Distance from Shore by State for 2004 (1,000 kg)

State	Distance from Shore (mi) 0–3	3–200	Total (mi)	% from OCS Waters
Maine	57,961	45,633	103,595	44.0
New Hampshire	7,083	2,934	10,017	29.3
Massachusetts	22,646	130,688	153,334	85.2
Rhode Island	5,648	44,219	49,867	88.7
Connecticut	3,483	4,768	8,251	57.8
New York	8,093	7,565	15,658	48.3
New Jersey	17,445	67,752	85,197	79.5
Delaware	1,900	45	1,945	2.3
Maryland	18,787	3,692	22,480	16.4
Virginia	183,342	35,112	218,454	16.1
North Carolina	49,210	31,624	80,834	39.1
South Carolina	4,382	1,260	5,642	22.3
Georgia	408	2,615	3,023	86.5
Florida (Atlantic Coast)	5,839	7,217	13,056	55.3
Total	**386,226**	**385,124**	**771,350**	**49.9**

Source: NMFS (2006b).

such as net fisheries for menhaden, are unlikely to occur within areas where OCS alternative energy development is most likely.

The landing values for the commercial species with the highest commercial values in the Atlantic region in 2004 (expressed as dollar value and percentage contribution) are shown in Table 4.2.23-2. In 2004, for the entire Atlantic Coast, American lobster, sea scallop, and blue crab had a combined worth of $775 million, which composed 56.2% of the total value of the commercial catch (Table 4.2.23-3).

In terms of pounds landed in 2004, Atlantic menhaden, a coastal pelagic species, contributed the highest proportion (28.3%) of the total landings in the Atlantic region (760.2 million kg [1,676 million lb]). Atlantic herring, Atlantic mackerel, blue crab, and American Lobster were also important; collectively; these four species represented about 30.2% of the total weight of reported landings (Table 4.2.23-4).

Fishery statistics for major U.S. ports in the Atlantic region are presented in Table 4.2.23-5. In terms of total landing weight, the top U.S. ports were Reedville, Virginia (181.7 million kg [400.1 million lb), New Bedford, Massachusetts (79.4 million kg [155.2 million lb]), and Gloucester, Massachusetts (51.4 million kg [133.3 million lb]). Ports with the highest total catch value were New Bedford, Massachusetts ($206.5 million), Hampton Roads Area, Virginia ($100.6 million), and Cape May-Wildwood, New Jersey ($68.1 million).

TABLE 4.2.23-3 Species with the Highest Total Commercial Value in the Atlantic Region

Species	Total Value ($)	% Total Value
American lobster	365,882,857	26.5
Sea scallop	321,373,824	23.3
Blue crab	87,672,143	6.4
Hard (quahog) clam	42,209,753	3.1
Goosefish	33,455,599	2.4
Atlantic surf clam	32,602,740	2.4
Summer flounder	28,778,563	2.1
White shrimp	27,741,522	2.0
Atlantic menhaden	27,525,226	2.0
Squids	25,033,179	1.8
Atlantic cod	21,690,704	1.6
Ocean quahog clam	20,682,180	1.5
Softshell clam	18,859,545	1.4
Haddock	18,525,710	1.3
Atlantic herring	14,942,314	1.1
Atlantic mackerel	13,105,622	1.0

Source: NMFS (2005).

TABLE 4.2.23-4 Species with the Highest Total Commercial Landing Weight in the Atlantic Region

Species	Total Weight Landed (kg)	Total Weight Landed (lb)	% Total Weight
Atlantic menhaden	215,163,503	474,356,804	28.3
Atlantic herring	85,432,644	188,347,723	11.2
Atlantic mackerel	55,000,309	121,255,560	7.2
Blue crab	49,406,896	108,924,130	6.5
American lobster	40,078,556	88,358,552	5.3
Sea scallop	29,326,130	64,653,388	3.9
Atlantic surf clam	26,620,530	58,688,529	3.5
Goosefish	21,177,267	46,688,126	2.8
Squids	19,566,476	43,136,920	2.6
Skates	16,020,960	35,320,356	2.1
Ocean quahog clam	15,536,034	34,251,270	2.0
Northern shortfin squid	15,209,356	33,531,066	2.0
Atlantic croaker	11,548,555	25,460,338	1.5
Silver hake	8,572,069	18,898,277	1.1
Haddock	8,239,971	18,166,122	1.1
Summer flounder	8,120,801	17,903,395	1.1
Atlantic cod	7,288,912	16,069,385	1.0
Yellowtail flounder	7,234,849	15,950,196	1.0

Source: NMFS (2005).

TABLE 4.2.23-5 Reported Total Landing Weights and Total Landing Values for Major Ports in the Atlantic Region in 2004

Rank among All U.S. Fishing Ports	Port	State	Total Landing Weight (millions kg)	Total Landing Value (millions $)
2	Reedville	VA	181.7	26.1
7	New Bedford	MA	79.4	206.5
10	Gloucester	MA	51.4	42.7
13	Cape May-Wildwood	NJ	44.2	68.1
19	Beaufort-Morehead City	NC	28.8	16.9
20	Portland	ME	26.3	24.2
24	Point Judith	RI	18.0	31.5
27	Hampton Roads Area	VA	15.6	100.6
28	Point Pleasant	NJ	15.1	19.2
29	Atlantic City	NJ	15.1	17.7
30	Wanchese-Stumpy Point	NC	14.2	20.6
32	Rockland	ME	14.0	2.7
51	Provincetown-Chatham	MA	6.2	14.1
55	Montauk	NY	5.5	13
59	Stonington	ME	4.7	7.5
61	Engelhard-Swanquarter	NC	4.1	7.8
62	Boston	MA	4.0	8.8
65	Long Beach-Barnegat	NJ	3.9	20.6
71	Mayport	FL	3.3	7.9
73	Oriental-Vandemere	NC	3.2	7.2
74	Hampton Bay-Shinnicock	NY	2.9	6.6
78	Cape Canaveral	FL	2.7	9.3
80	Belhaven-Washington	NC	2.4	3.7
81	Charleston-Mt. Pleasant	SC	2.4	8.5
86	Darien-Bellville	GA	1.5	5
90	Ft. Pierce-St. Lucie	FL	1.0	2.6

Source: NMFS (2005).

4.2.23.2 Recreational Fisheries

The primary source for marine recreational fisheries data in U.S. waters is the Marine Recreational Fisheries Statistics Survey conducted by the NMFS (NMFS 2005). This survey combines random telephone interviews and on-site intercept surveys of anglers to estimate recreational catch and effort for inland, State, and Federal waters. Information gathered includes all of the States along the Atlantic Coast.

Nearly 6.5 million people engaged in marine recreational fishing in the Atlantic region during 2004 (NMFS 2005). In the Atlantic Coastal States, recreational anglers took 48.2 million trips; the highest proportion of these trips occurred in east Florida (22%), followed by North Carolina (15%), New Jersey (14%), New York (9%), and Massachusetts (9%) (NMFS 2005).

The mode of fishing most common on the Atlantic Coast was the use of private or rental boats, which composed 43% of the approximately 48 million ocean fishing trips in the Atlantic region during 2004. The second most popular mode was fishing from shore, which composed approximately 34% of the total trips. Fifty-five percent of the recreational fishing trips occurred in inshore saltwater and brackish water bodies (e.g., bays, estuaries, and sounds). Thirty-seven percent of the trips occurred in the ocean within 5 km (3 mi) of the shore, and 8% of the trips occurred in the ocean at more than 5 km (3 mi) from shore (NMFS 2005).

In 2004, more than 6.4 million residents participated in marine recreational fishing. These anglers took more than 48 million trips and caught an estimated total of more than 229 million fish (NMFS 2005). The five most important fish species, based upon estimated total landing weight, caught by recreational fishers in the Atlantic Coastal States during 2005 were striped bass, bluefish, summer flounder, Atlantic croaker, and dolphin (Table 4.2.23-6). Of the estimated 64 million kg (141 million lb) of fish taken by the recreational anglers in the Atlantic region as a whole, these five types of fishes represented approximately 55% of the total weight of the catch. In terms of total numbers of fish caught, the five dominant recreational species in the Atlantic region were bluefish (11.7%), summer flounder (11.5%), black sea bass (7.1%), herrings (6.6%), and spot (6.3%) (Table 4.2.23-7).

TABLE 4.2.23-6 Total Recreational Fishery Landing Weights for the Top 20 Species in the Atlantic Region

Species	Total Weight (kg)	% of Catch
Striped bass	12,055,042	18.83
Bluefish	8,524,530	13.31
Summer flounder	5,064,887	7.91
Atlantic croaker	4,797,589	7.49
Dolphins	4,440,548	6.94
Atlantic cod	2,025,800	3.16
King mackerel	1,998,915	3.12
Spot	1,610,218	2.51
Kingfishes	1,245,533	1.95
Black sea bass	1,228,420	1.92
Scup	1,214,499	1.90
Tautog	1,111,148	1.74
Atlantic mackerel	1,056,274	1.65
Spotted seatrout	858,193	1.34
Sheepshead	789,677	1.23
Spanish mackerel	765,423	1.20
Weakfish	718,746	1.12
Red drum	696,930	1.09
White perch	511,732	0.80
Black drum	502,679	0.79

Source: NMFS (2005).

TABLE 4.2.23-7 Estimated Numbers for the Top Fish Species Caught by Recreational Anglers in the Atlantic Region during 2005

Species	Estimated Number Caught	% Total Number
Bluefish	11,362,274	11.7
Summer flounder	11,172,875	11.5
Black sea bass	6,880,715	7.1
Herrings	6,383,546	6.6
Spot	6,097,573	6.3
Striped bass	5,966,742	6.2
Kingfishes	4,707,934	4.9
Atlantic mackerel	2,846,592	2.9
Searobins	2,574,302	2.7
Atlantic cod	2,466,926	2.5
Atlantic croaker	2,306,126	2.4
Skates/rays	2,181,535	2.3
Dogfish sharks	1,898,613	2.3
Pinfishes	1,855,404	2.0
Spanish mackerel	1,702,117	1.9
Dolphins	1,491,264	1.8
Scup	1,409,731	1.5
Mullets	1,171,187	1.3

Source: NMFS (2005).

4.3 GULF OF MEXICO REGION

4.3.1 Geology

4.3.1.1 General Description and Physiography

The Gulf of Mexico is a roughly circular ocean basin with a surface area of 1.7 million km^2 (0.7 million mi^2) and a mean water depth of about 1,615 m (5,300 ft). The basin is almost completely surrounded by continental landmasses. Its shoreline runs 5,700 km (3,500 mi) from Cape Sable, Florida, to the tip of Mexico's Yucatan peninsula, with another 380 km (240 mi) of shoreline on the northwest tip of Cuba.

The continental shelf, which extends from the coastline to a water depth of about 200 m (660 ft), is the shallowest part of the Gulf. The 100-m (330-ft) water depth contour is located within the width of the shelf, extending offshore from less than 16 km (10 mi) near the Mississippi Delta to about 160 km (100 mi) off the Southern Florida Coast. The shelf itself extends about 280 km (175 mi) off the southern tip of Florida and the Yucatan Peninsula. Extending from the edge of the shelf to the abyssal plain is the continental slope, a steep area with diverse geomorphic features (canyons, troughs, and salt structures). The base of the slope in the Gulf occurs at a depth of about 2,800 km (9,190 ft). The Sigsbee Deep, located within the Sigsbee Abyssal Plain in the southwestern part of the basin, is the deepest region of the Gulf with a maximum depth ranging from 3,750 m (12,300 ft) to 4,330 m (14,200 ft). The Gulf basin contains a volume of 2,434,000 km^3 (6.43×10^{17} gal) of water (Shideler 1985; GulfBase 2006).

Antoine (1972) has divided the Gulf of Mexico into seven physiographic provinces, three of which are located just off the U.S. coast (Figure 4.3.1-1). The descriptions are based on Antoine (1972) with additional information from others (Salvador 1991; Shideler 1985; Bryant et al. 1989; GulfBase 2006).

- ***Northern Gulf of Mexico***. The northern portion of the Gulf extends from the Rio Grande River to Alabama, and from 320 km (200 mi) inland of today's shoreline to the Sigsbee Escarpment. It encompasses the Texas-Louisiana Shelf and the Mississippi-Alabama Shelf. The major geologic feature in this province is the Mississippi Fan, which extends from the Mississippi River Delta to the central abyssal plain. The Mississippi Canyon cuts the eastern side of the Texas-Louisiana Shelf to the southwest of the Mississippi River Delta. The canyon is thought to have formed from large-scale slumping along the shelf edge. The area is characterized by thick sediments and widespread salt deposits.

  Northeast Gulf of Mexico. This portion of the Gulf extends from just east of the Mississippi River Delta near Biloxi, Mississippi, to the eastern side of Apalachee Bay (west Florida) and encompasses the West Florida Shelf and Terrace (Figure 4.3.1-1). The shelf is characterized by soft terrigenous

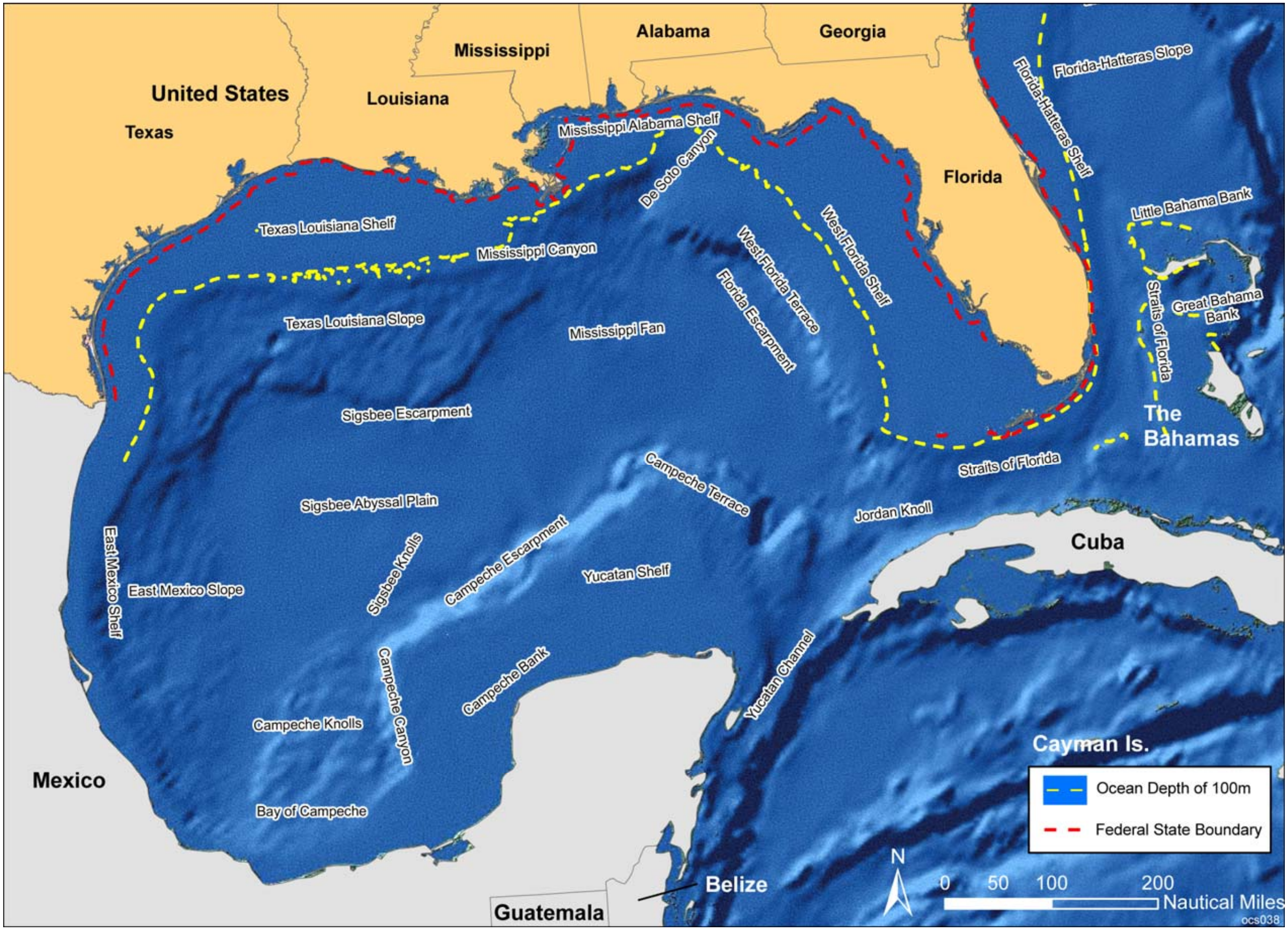

FIGURE 4.3.1-1 Physiographic Features in the Gulf of Mexico Region

sediments. Sediments are thick west of DeSoto Canyon; Mississippi River-derived sediments cover the western edge of the carbonate platform of the West Florida Shelf. The Florida Escarpment separates the West Florida Shelf from the deeper Gulf Basin and also forms the southeastern side of DeSoto Canyon.

- ***South Florida Continental Shelf and Slope***. This region is the submerged portion of the Florida peninsula. It extends along the west Florida coast from Apalachee Bay southward to the Straits of Florida and includes the Florida Keys and Dry Tortugas. Sediments become progressively more carbonate from north to south with thick accumulations in the Florida Basin. The basin may have been enclosed by a barrier reef system at one time. The Jordon Knoll, located within the Straits of Florida, is composed of remnants of the ancient reef system.

- ***Gulf of Mexico Basin***. The Gulf of Mexico Basin is located in the western part of the Gulf and is its deepest portion. Prominent features include the Sigsbee Abyssal Plain, the Sigsbee Deep, and the Mississippi Cone. The Sigsbee Abyssal Plain is the deep, flat portion of the Gulf bottom, just northwest of the Campeche Escarpment. It is 450 km (280 mi) long and 290 km (180 mi) wide and covers an area of more than 103,600 km^2 (40,000 mi^2). The plain is underlain by very thick sediments (up to 9 km [5.6 mi]); the only major topographical features in this region are the small salt diapirs that form the Sigsbee Knolls. The Mississippi Cone is the portion of the Mississippi River Delta that has accumulated at the base of the continental slope.

4.3.1.2 Coastal Features and Processes

The Gulf Coast region includes west Texas, Louisiana, Mississippi, Alabama, and Florida. It is a low-lying area composed of a variety of coastal features, including mainland shores, bays and lagoons, deltaic plains, chenier plains (mudflats), barrier islands and peninsulas, and tidal inlets. From Texas to western Louisiana, barrier islands (e.g., Padre Island) are the predominant coastal feature. The highest rates of land loss in the Gulf Coast region are occurring along beaches and barrier islands due to erosion resulting from episodic high wave energy. Morton et al. (2004) estimate that wetland losses make up 75% of the total land losses in Texas alone. Rates of land loss around bays via slumping and bluff retreat are also high (Morton et al. 2004; USACE 2002).

It is estimated that about 90% of the Louisiana Gulf shoreline is undergoing erosion; loss of interior wetlands is extensive due to a combination of subsidence (of the Mississippi River Delta plain), delta lobe abandonment, and wave-induced erosion. In the past, the channel switching that would cause wetlands loss in abandoned lobes would create new wetlands in coastal areas along new lobes; however, human intervention in the past few hundred years has disrupted this natural process by artificially reducing the Mississippi River's sediment supply to the delta and preventing it from flowing to the Atchafalaya Basin. Currently, there is a westward movement of sediments over the inner shelf supplied by the Atchafalaya River mouth (Morton et al. 2004; National Research Council 2006).

Along the western coast of Florida, barrier islands are also important features, extending from Cape Romano to as far north as Cedar Keys. The low-lying coast consists of numerous enclosed bays with mangrove islands and marshes. Rates of erosion along the western Florida shoreline are fairly low relative to other stretches of the Gulf Coast, generally due to low wave energy; however, the highest rates typically occur near tidal inlets (Morton et al. 2004; USACE 2002).

The Gulf Coast is a microtidal, storm-dominated region.[38] Its shoreline is constantly changing as a result of the action of wind-driven waves and currents that cause sediment transport (Morton el al. 2004). Although drift directions vary locally and seasonally, the predominant megascale drift direction (i.e., longshore current) is from north to south along the north-south trending coastlines of Florida and Texas and from east to west along the east-west trending coastlines of the northern Gulf Coast (USACE 1992; Morton et al. 2004).

The primary sources of the sand that maintains the beaches and barriers along the Gulf Coast are the eroding mainland shores and the continental shelf. Rivers discharging to the Gulf do not contribute significantly to the littoral system because they empty into estuaries and deposit their loads far inland from the shoreline. The construction of high levees along the Mississippi River has significantly reduced the frequency and volume of sediment deposition along the Mississippi Delta River plain, resulting in an acceleration of land loss in this area (Morton 2003; Morton et al. 2004).

4.3.1.3 Geologic History

The formation of the present Gulf of Mexico basin began as a result of rifting within the North American Plate during the Late Triassic (over 200 million years ago) just as the North American Plate was separating from the Africa-South America part of Pangaea. The rifting is thought to have continued through the early Late Jurassic, resulting in the development of complex systems of linear rift basins (grabens), which were initially filled with nonmarine “red bed” sediments and volcanics. They were later filled with extensive salt deposits as shallow, hypersaline seawater filled portions of the basins. As the graben systems widened and the Yucatan block moved southward from the North American Plate, the continental crust in the central part of the basin was stretched and thinned, forming a “transitional” crust. Once the transitional crust was thinned sufficiently, the emplacement of oceanic crust and seafloor spreading began. This period of seafloor spreading continued until the Late Jurassic. The newly formed oceanic crust cooled, contracted, and subsided (Salvador 1991; Shideler 1985).

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[38] “Microtidal” is a tidal category that refers to the tide range of a particular coastline; the tide range for the Gulf of Mexico is less than 0.5 m (1.6 ft). “Storm-dominated” is an energy-based shoreline classification that takes into account the relative influence of the tidal range and mean wave height. “Storm-dominated” indicates a condition that is dominated by episodic high wave energy (USACE 1995).

In the early Late Jurassic, terrigenous sediments brought in by rivers accumulated in alluvial fans and deltaic complexes and were redistributed by wind to form extensive dune fields within the basin. This was followed by a period of widespread and prolonged marine transgression as seawater entered the basin from the Pacific Ocean across central Mexico. The ancestral Gulf of Mexico was well developed by the end of this period. In the northeastern region of the Gulf, the encroaching sea reworked the fluvial, deltaic, and eolian sediments, redepositing them as a thin, shallow-water, marine sandstone unit. The extensive salt deposits known today were also deposited at this time (Salvador 1991).

Since the Late Jurassic, the Gulf basin has been tectonically stable. Subsidence, due mainly to sediment loading and salt deformation, continues throughout the basin and is most active in its central part and in the interior salt basins along its northern flank. During the remaining history of the Gulf basin, three stratigraphically distinct provinces took shape:

1. To the northeast, north, and northwest: a prograding sequence of clastic (and later, fine-grained) sediments brought in by streams draining the Ouachia and Appalachian mountains and the continental interior (and later, the Laramide orogeny) and widespread carbonate deposition;

2. To the west and southwest: isolated platforms along which great reef complexes developed and shallow-water carbonate and evaporite deposition occurred; and

3. To the east and southeast: stable platforms of Florida and the Yucatan composed of shallow-water carbonates and evaporites (Salvador 1991).

Salt flow under the northern region of the Gulf was most active in the Pliocene and Pleistocene (5.3 to less than 1 million years ago) and occurred in response to the sedimentary load caused by the prograding deltaic systems present at that time. Diapiric salt deformation is still active today in the outer shelf and northern slope (Salvador 1991).

The lower sea level at the end of the last glacial epoch (about 18,000 years ago) caused the coastal plain rivers to cut deep valleys across the continental shelf. As sea level rose to its current level, these valleys were inundated, forming the major bays, such as Galveston Bay (Texas), Mobile Bay (Alabama), and Pensacola Bay (Florida), that rim the Gulf of Mexico today. Only large rivers like the Mississippi River carried enough sediment to fill their valleys and build up deltas into the Gulf. Many of these deltas have been retreating in recent times due to decreased stream flow and sediment load. Sand from these eroding deltas has been a major source of barrier islands and beaches along the Gulf Coast (Morton et al. 2004).

The Mississippi River Delta is a prominent feature of today's Gulf Coast. Its early history was characterized by high rates of sediment accumulation, which built the delta plain seaward across the southern margin of the North American continent. Over the last 10,000 years, natural processes have caused periodic changes in the course of the lower Mississippi River, resulting in the building of new lobes adjacent to the new channel alignment and gradual land loss (predominantly wetlands) at the abandoned channel site. Currently, the Mississippi River Delta plain consists of six delta complexes or lobes, four of which are abandoned and two of which are active (modern and Atchafalaya) (Figure 4.3.1-2). The abandoned lobes make up most of Louisiana's coastal plain (National Research Council 2006).

4.3.1.4 Mineral Resources

Offshore operations in the Federal portion of the Gulf of Mexico represented 23% (just under 5 trillion cubic feet [tcf]) of the nation's natural gas production and about 30% (570 million bbl) of its oil production in 2002 (USDOI/MMS 2006g). As of 2003, there were an estimated 4,000 offshore platforms in the Gulf of Mexico (McCrary et al. 2003). Progradational sands have historically been the greatest producers of oil and gas; the MMS estimates that about 55% of the oil reserves and 65% of the gas reserves occur in these deposits. Progradational sands coincide with other factors (e.g., alternating reservoir-quality sands and sealing shales, roll-over anticlines, and diapiric salt), which also contribute to their high productivity (Bascle et al. 2001). The MMS estimates an additional undiscovered 44.9 billion bbl of oil and 232 tcf of natural gas resources in the Gulf of Mexico OCS (USDOI/MMS 2006e).

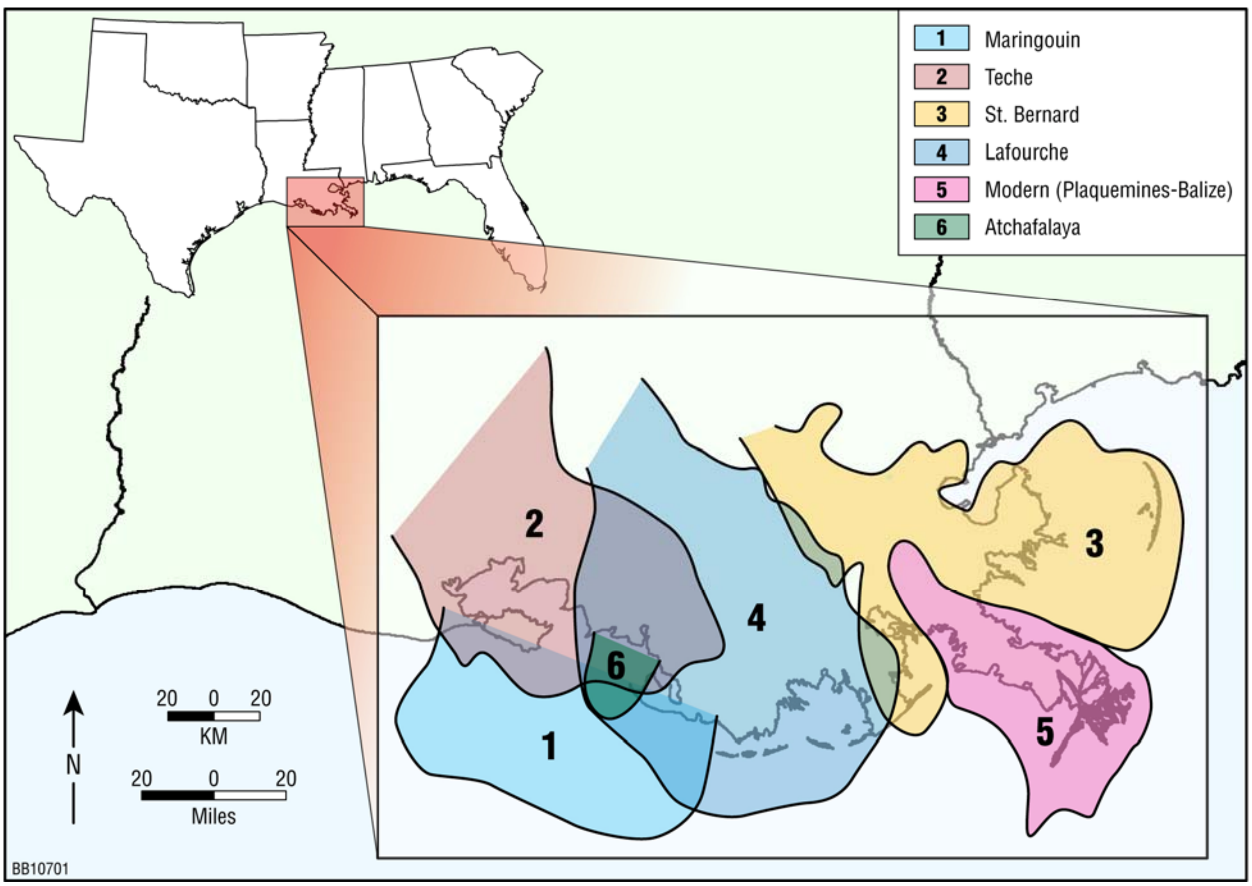

FIGURE 4.3.1-2 Deltaic Lobes of the Mississippi River from Oldest (1) to Youngest (6) (Modified from National Research Council 2006).

Mineral resources, including quartz sand, sulfur, and salt, are currently being extracted for commercial purposes in the northern part of the Gulf. Mineral resource deposits within coastal waters include phosphate, oyster shell, limestone, sand and gravel, and magnesium (Continental Shelf Associates, Inc., 2004).

4.3.1.5 Geologic Hazards

Geologic hazards that may affect offshore operations in the Gulf of Mexico are mainly associated with the scouring action of ocean currents and seafloor instability. Seafloor instability occurs on the northern continental slope because of high sedimentation rates and the compensating movement of underlying salt (Roberts et al. 2005; USDOI/MMS 2000). Potential geohazards include:

- ***Scouring Action of Ocean Currents.*** Vigorous tidal circulation and storm waves have an important effect on the transport of sediments on the surface of the continental shelf. Episodic sediment movement caused by ocean currents and waves can undermine foundation structures and lead to failures. The energy of currents and waves also poses a hazard risk to submarine cables and moorings.

- ***Slope Failures.*** Unconsolidated surficial sediments are water saturated and susceptible to liquefaction and mass movement, which can be triggered by earthquakes, storm surges, faulting, sediment loading, dissociation of hydrates, dewatering processes, diapiric movement, or human activity. The rapid deposition of sediments restricts the release of pore fluids and gases, giving rise to sediments with a high potential for movement via slumping, mudslides, or gravity flows. These present potential hazards to the emplacement of foundational structures, submarine cables, and moorings.

- ***Faulting.*** Faulting in the Gulf of Mexico OCS is expected to occur on the outer shelf and slope (Shideler 1985). Faults provide a conduit through which deep gases may rise to surficial sediments and may represent areas of potential seismic activity. Oil seeps and gas vents may indicate near-surface faulting.

- ***Fluid and Gas Expulsion.*** Gaseous sediments may be present as a result of decomposing organic matter (biogenic) or gas rising along fault planes from a deeper reservoir into surficial sediments (thermogenic). The combination of rapid sediment loading and in-leaking gas can create overpressured pockets in sediments that present a hazard to drilling because of the potential for sudden uncontrolled releases of fluid or gas if the pockets are penetrated. Gaseous sediments tend to have a lower shear strength and less load-bearing capacity than nongaseous sediments and may prove to be an unstable substrate for bottom-founded structures. Fluids and gases containing sulfur, hydrogen sulfide, and/or carbon dioxide are also toxic and corrosive.

- ***Variable Bottom Types.*** Bottom types range from lithified hard bottoms or hardpans to extremely soft, fluid mud bottoms. These substrates vary in density and can affect the mooring and anchoring of structures.

- ***Irregular Topography.*** The topography of the continental slope (and to a lesser extent, the continental shelf) is very irregular. Various features, including mud volcanoes, mud mounds and ridges, salt diapirs, channels and canyons, escarpments, and karst features associated with carbonates (e.g., on the Florida Shelf) are found throughout the Gulf of Mexico OCS. Other features, such as sediment waves and seabed furrows, may also be present. These features are highly variable in load-bearing capacity over short vertical and horizontal distances and may present potential hazards to the emplacement of foundational structures, submarine cables, and moorings. Sediments across irregular topography vary in thickness. Steep slopes and scarps increase the risk of sediment failure.

At water depths of 100 m (328 ft) or less, the most likely geologic hazards are scouring, irregular topography, variable bottom types, and faulting. Mass movement could also be of concern in shelf areas of thick sediment accumulation along steep slopes and scarps.

4.3.2 Meteorology and Air Quality

4.3.2.1 Meteorology

The Gulf of Mexico is influenced by a maritime subtropical climate controlled mainly by the clockwise wind circulation around a semipermanent area of high barometric pressure alternating between the Azores and Bermuda Islands. This circulation around the western edge of the high pressure cell results in the predominance of moist southeasterly wind flow in the region. During the winter months, December through March, cold fronts associated with outbreaks of cold, dry continental air masses influence mainly the northern coastal areas of the Gulf of Mexico. Tropical cyclones may develop or migrate into the Gulf of Mexico during the warmer season, especially in the months of August through October. In coastal areas, the land-sea breeze is frequently the primary circulation feature in the months of May through October.

Predominant wind directions are south-southeast to east-southeast for western and central Gulf of Mexico, and east for eastern Gulf of Mexico (NOAA 2006a) but are more variable in the coastal regions because of effects of the land-sea breeze circulation systems. Winds are more changeable in the winter season because of changing atmospheric pressure patterns and frontal passages. Annual average wind speeds measured by the NDBC (National Data Buoy Center) with moored buoys scattered over the Gulf of Mexico range from 5.4 to 6.4 m/s (12.0 to 14.3 mph). Monthly minimum wind speeds range from 3.9 to 5.1 m/s (8.7 to 11.5 mph) in July and August, while monthly maximum wind speeds range from 6.2 to 7.5 m/s (13.8 to 16.8 mph) from December to March (NOAA 2006a).

In contrast to the Atlantic and Pacific OCS regions, the Gulf of Mexico OCS is situated over a narrow range of latitudes, about 20–25°N latitude, and thus variations in annual average temperatures are relatively small, ranging from 21.1 to 25.2°C (70.0° to 77.4°F) (NOAA 2006a). Average temperatures for the coldest months (January and February) range from 11.7 to 21.4°C (53.1 to 70.5°F). In the colder months, there is more variability in temperature, mainly in the more northern coastal waters. In the warmest months of July and August, average temperatures in the OCS regions range from about 28.2 to 29.0°C (82.8 to 84.2°F). During the warm months, there is little diurnal (daily) or spatial variation in temperature. Air temperatures over the open Gulf exhibit small daily and seasonal variations due to the moderating effects of large bodies of water. In general, temperatures in southern OCS regions (i.e., open waters) are higher and with lower variations than those in coastal waters, and the eastern Gulf of Mexico has higher annual average temperatures. The relative humidity over the Gulf and the coastal areas is high, especially during the warmer months. Lower humidities in the winter season are associated with outbreaks of cool, dry, continental air from the interior.

Precipitation is frequent and abundant throughout the year, but tends to peak in the summer months. Mean annual rainfall ranges from about 77 cm (30 in.) along parts of the Texas Gulf Coast to 155 cm (60 in.) in the Florida Panhandle. Rainfall in the warmer months is usually associated with convective cloud systems that produce showers and thunderstorms. Winter rains are associated with the passage of frontal systems through the area. Fog occurs occasionally in the cooler season as a result of warm, moist Gulf air blowing over cool land or water surfaces. The poorest visibility conditions occur from November through April. During air stagnation, industrial pollution and agricultural burning also can impact visibility.

Atmospheric stability and mixing height provide a measure of the amount of vertical mixing of pollutants. Over water, the atmosphere tends to be neutral to slightly unstable since there is usually a positive heat and moisture flux. Over land, the atmospheric stability is more variable; it is unstable during the day, especially in the summer months due to rapid surface heating, and stable at night, especially under clear conditions in the cooler season. The mixing height over water typically ranges between 500 to 1,000 m (1,640 to 3,281 ft) with a slight diurnal variation (Holzworth 1972). Mixing height over land can be 1,500 m (4,921 ft) or greater during the afternoon in the summer and near zero during clear, calm conditions at night in the winter.

Cyclones frequently affect the Gulf region due to its proximity to tropical waters of the tropical portions of the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Historical data from 1950 to 2005 indicate that cyclones occur as early as May and as late as November, but most frequently in August and September (NOAA 2006b). On average, about 10 tropical cyclones occur in the Atlantic Basin, 5 of which become major hurricanes. About 3.7 tropical cyclones/year affect the Gulf of Mexico (Florida A&M University 1988). Tropical storms cause damage to physical, economic, biological, and social systems in the Gulf, but the severest effects tend to be highly localized. Among Gulf of Mexico OCS regions, cyclones are most frequent in central Gulf of Mexico followed by eastern Gulf of Mexico. Cyclones are least frequent in the western Gulf of Mexico.

4.3.2.2 Air Quality

The Clean Air Act (CAA) established the National Ambient Air Quality Standards (NAAQS) for six pollutants, known as "criteria" pollutants—sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$),[39] and lead (Pb) (40 CFR 50). Collectively, the criteria pollutants are indicative of the quality of the ambient air. Table 4.2.2-1 presents the current primary and secondary NAAQS for six criteria pollutants. The primary standards are referred to as "health effects standards." These standards are set at levels to protect the health of the most susceptible individuals in the population: the very young, the very old, and those with respiratory problems. The U.S. Environmental Protection Agency (USEPA) has designed secondary standards to protect public welfare. These are referred to as the "quality of life standards." All of the standards are expressed in terms of concentration and duration of exposure. Many standards address both short- and long-term exposure. Any individual State may adopt a more stringent set of standards. For example, the State of Florida has ambient standards for SO_2 that are somewhat more stringent than the NAAQS.

When the pollutant levels in an area have caused repeated violations of a particular standard, the area is classified as "nonattainment" for that pollutant. The USEPA has established classification designations based on regional monitored levels of ambient air quality in accordance with the CAA Amendments of 1990. These designations impose Federal regulations on pollutant emissions and a time period in which the area must again attain the standard, depending on the severity of the regional air quality problem. The attainment status for the Federal OCS waters is unclassified because there is no provision for any classification in the CAA for waters outside the boundaries of State waters. Only areas within State boundaries are to be classified as either attainment, nonattainment, or unclassifiable.

In general, ambient air quality on coastal counties along the Gulf of Mexico is relatively good. Currently, all of the coastal counties[40] along the Gulf of Mexico are in attainment for all criteria pollutants except 8-hour ozone (USEPA 2006a).[41] None of the Gulf coastal counties are subject to the 1-hour ozone standard. For 8-hour ozone, all of coastal counties in Mississippi, Alabama, and Florida are classified as in attainment, but a number of counties in Texas and Louisiana are in nonattainment. Precursor emissions of ozone, nitrogen oxides (NO_x) and volatile organic compounds (VOC) are abundant due to substantial contributions of petroleum-related industries such as electric facilities, petroleum refining facilities, chemical plants, and associated vehicular traffic in the area. There are 11 counties in southeast Texas that do not meet the NAAQS. Eight counties in the Houston-Galveston-Brazoria designated area are classified as

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39 PM_{10} and $PM_{2.5}$ are particulate matter with aerodynamic diameters of ≤10 μm and ≤2.5 μm, respectively.

40 Many factors, especially topography, influence the extent to which an air mass over the OCS will migrate inland. The landward penetration of the sea breeze reaches 15 to 50 km (9 to 30 mi) in the temperate zones (http://www.pilotfriend.com/av_weather/meteo/prv_wnd.htm). Topographic features notwithstanding, onshore areas within 50 km (31 mi) of the coastline are considered in these analyses.

41 Because nonattainment status is not static, please refer to the USEPA's Greenbook for the most up-to-date nonattainment status (http://www.epa.gov/air/oaqps/greenbk/).

moderate,[42] while three counties in the Beaumont/Port Arthur designated area are classified as marginal nonattainment areas. During the monitoring period of 2001–2005, the fourth-highest measurements of 0.113 parts per million (ppm) and 0.095 ppm were recorded in the Houston-Galveston-Brazoria and Beaumont/Port Arthur designated areas, respectively (USEPA 2006b). In Louisiana, five parishes in the Baton Rouge designated area are classified as marginal. The 2001–2005 monitoring data indicate that the fourth-highest 8-hour ozone concentration in the Baton Rouge designated area was 0.010 ppm.

Class I Areas are defined in Sections 101(b)(1), 169A(a)(2), and 301(a) of the Clean Air Act as amended (42 USC 7401(b), 7410, 7491(a)(2) and 7601(a)). Class I areas are federally owned properties for which air quality-related values are highly prized and for which no diminution of air quality, including visibility, can be tolerated. Class I Areas are under the stewardship of four Federal agencies: U.S. Department of Interior's (USDOI's) Bureau of Land Management (BLM), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), and the Department of Agriculture's (USDA's) Forest Service (USFS). USEPA has promulgated a list of 156 Federal Class I Areas as mandated in Subpart D of 40 CFR 81.400 et seq. Class I Areas are protected by stringent air quality standards that allow for very little deterioration of their ambient air quality. The Prevention of Significant Deterioration (PSD) regulations (40 CFR 52.21), which are designed to protect ambient air quality, apply to major new sources and major modifications to existing sources located in an attainment or unclassified area. PSD regulations limit the maximum allowable incremental increases in ambient concentrations above established baseline levels of SO_2, NO_2, and PM_{10}, as shown in Table 4.2.2-1. Incremental increases in PSD Class I areas are strictly limited, while increases allowed in Class II areas are less strict.

A number of these Class I areas are located on or near the coastlines adjacent to the Gulf of Mexico OCS areas addressed within this programmatic EIS and, therefore, air quality in these areas could be influenced by activities taking place within the adjacent OCS area. These lands are under the stewardship of three Federal agencies, including the USDOI's NPS and USFWS and the USDA's USFS. A map of the Mandatory Class I Federal Areas potentially affected by OCS activities and their corresponding 100-km and 200-km buffers along the Gulf of Mexico is shown in Figure 4.2.2-1 with information on each of these Class I Federal Areas presented in Table 4.2.2-2. In general, air quality analysis must be made in coordination with the Federal Land Manager if a proposed Federal action is within 100 km of a Class I area (see http://www.epa.gov/fedrgstr/EPA-AIR/1996/July/Day-23/pr-23531.html). However, large emission sources located beyond 200 km of a Class I Federal Area can also trigger PSD Class I requirements if a significant impact on the region is suspected.

4.3.2.3 Regulatory Controls on OCS Activities That Affect Air Quality

Section 4.2.2.3 discusses the unique distribution of authority established in Section 328 of the Clean Air Act Amendments of 1990 (CAA 1990) that exists for control of air quality

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42 The USEPA has established four categories of ozone nonattainment areas depending on the severity of the problem: marginal, moderate, serious, and severe.

affecting activities on the OCS and introduces the concept of a Corresponding Onshore Area (COA) as a critical element in the control of air-impacting activities of OCS sources. Authority over air emissions from OCS sources in the Gulf of Mexico is divided between USEPA and MMS. Air emissions from OCS sources located west of 87.5°W longitude are controlled by MMS regulations and requirements, while air emissions from OCS sources in the remaining portion of the GOM are subject to USEPA requirements. OCS sources are subject to the equivalent requirements of a State or air pollution control district (APCD) program to which USEPA has delegated Federal Clean Air Act implementation authority when the source is located within 25 mi of the seaward boundary of any such delegated State or APCD. OCS sources located beyond 25 mi of the seaward boundaries of delegated State or APCDs are subject to USEPA requirements. Implementing regulations are promulgated by USEPA in 40 CFR Part 55. Regulations deriving from MMS's authority under Section 328 have not yet been published. Finally, irrespective of an OCS facility's specific longitude within the GOM, certain activities associated with the OCS and occurring onshore or offshore at distances greater than 25 mi from the OCS (including vessels en route to or from) are subject to the requirements of Federal conformity regulations appearing in 40 CFR Parts 51 and 93 if the status of the COA is nonattainment or maintenance for any criteria pollutant.

4.3.3 Physical Oceanography

The GOM is a semi-enclosed, subtropical sea with an area of approximately 1.5 million km^2 (0.58 million mi^2). The main physiographic regions of the Gulf Basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, abyssal plains, the Yucatan Channel, and Florida Straits. The continental shelf width along the U.S. coastline is about 16 km (10 mi) off the Mississippi River and 156 km (97 mi) off Galveston, Texas, decreasing to 88 km (55 mi) off Port Isabel near the Mexican border. The depth of the central abyss ranges to approximately 3,700 m (12,136 ft). The water volume of the entire Gulf, assuming a mean water depth of 2 km (1.2 mi), is 2 million km^3. The water volume of the continental shelf, assuming a mean water depth of 50 m (164 ft), is 25,000 km^3.

The Loop Current, the dominant circulation feature in the Gulf, enters through the Yucatan Channel and exits through the Florida Straits. The sill depth at the Florida Straits is about 800 m (2,624 ft); the effective sill depth at the Yucatan Channel is about 1,820 m (5,970 ft) (Sturges et al. 1993). Water masses in the Atlantic Ocean and Caribbean Sea that occur at greater depths cannot enter the GOM. The Loop Current is a part of the western boundary current system of the North Atlantic and is the principal current and source of energy for the circulation in the Gulf. The Loop Current has a mean area of 142,000 km^2 (54,812 mi^2) (Hamilton et al. 2000). It may be confined to the southeastern GOM or it may extend well into the northeastern or north-central Gulf, with intrusions of Loop Current water even to the shelf edge along Louisiana and the Florida Panhandle. The major large-scale permanent circulation feature present in the Western and Central GOM is an anticyclonic (clockwise-rotating) feature oriented about east-northeast to west-southwest with its western extent near 24°N latitude off Mexico.

Closed rings of clockwise-rotating (anticyclonic) water called Loop Current Eddies separate from the Loop Current at intervals of 5 to 19 months (Vukovich 2005). These Loop Current eddies are also called warm-core eddies, since they surround a central core of warm Loop Current water. Cold-core cyclonic (counterclockwise-rotating) eddies have been observed in the study region as well. These cyclones are often cold-core eddies, since they surround a central core of seawater that is cooler and fresher than adjacent waters. Cyclonic circulation is associated with upwelling, which brings cooler, deeper water toward the surface. Small cyclonic eddies around 50 to 100 km (31 to 62 mi) in diameter have been observed over the continental slope off Louisiana (Hamilton 1992). These eddies can persist for six months or longer and are relatively stationary.

Tropical conditions normally prevail over the Gulf from May or June until October or November. Hurricanes increase surface current speeds to 100 to 150 cm/s (39 to 59 in./s) over the continental shelves and cool the surface waters in much the same way as do cold fronts, but they may stir the mixed layer to an even greater depth. Wind events such as tropical cyclones (especially hurricanes), extratropical cyclones, and cold-air outbreaks can result in extreme waves and cause currents with speeds of 100 to 150 cm/s (39 to 59 in./s) over the continental shelves. Examples for the Texas-Louisiana shelf and upper slope are given in Nowlin et al. (1998). Other researchers (e.g., Brooks 1983 and 1984) have measured the effects of such phenomena to depths of 700 m (2,300 ft) over the continental slope in the northwestern Gulf. Hurricanes can trigger a series of internal waves with near inertial period.

Cold fronts, as well as diurnal and seasonal cycles of heat flux at the air/sea interface, affect near-surface water temperatures, although water at depths greater than about 100 m (328 ft) remains unaffected by surface boundary heat flux. Water temperature is greater than air temperature at the air/sea interface during all seasons. Frontal passages over the region can cause changes in temperature and velocity structure in the upper layers, specifically increasing current speeds and variability. These fronts tend to occur with frequencies from 3 to 10 days (weatherband frequency). In the winter, the shelf water is nearly homogeneous because of wind stirring and cooling by fronts and winter storms.

Inner-shelf currents on the Louisiana-Texas continental shelf flow in the downcoast (south or west) direction during nonsummer months, reversing to upcoast flow in the summer (Cochrane and Kelly 1986; Nowlin et al. 1998). Modeling results show that the spring and fall reversals in alongshore flow can be accounted for by local wind stress alone (Current 1996). Monthly averaged alongshore currents on the outer shelf are upcoast in the mean but showed no coherent pattern in the annual signal and often were not in the same alongshore direction at different outer-shelf locations (Nowlin et al. 1998). Mean cross-shelf geostrophic transport observed at the Louisiana-Texas shelf break was offshore during the winter (particularly in the upper 70 m (230 ft) of the water column) and onshore during the summer (Current and Wiseman 2000). Circulation on the continental shelf in the northeastern GOM has been observed to follow a cyclonic pattern, with westward alongshore currents prevailing on the inner and middle shelf and opposing alongshore flow over the outer shelf and slope (Brooks 1991). Inner shelf currents are primarily wind driven and are also influenced by river outflow and buoyancy forcing from water discharged by the Mississippi, Apalachicola, Tombigbee, Alabama, and other rivers in the region. Cold water from deeper off-shelf regions moves onto and off the continental shelf by cross-shelf flow associated with upwelling and downwelling processes.

Mean circulation on the West Florida inner shelf tends to be along the coast toward the southeast during the winter and reverses to be along coast toward the northwest during the summer. These seasonal means in flow direction are due to the influence of seasonal local winds and heat flux forcing. Midshelf flow (around the 50-m [164-ft] isobath) can be in the opposite direction from inner-shelf flow on the broad, gently sloping West Florida shelf because of the partial closure imposed by the Florida Keys to the south. The outer shelf is an area of transition between deep-water currents over the continental slope and the shelf regime. The nearshore regions are influenced by freshwater outflow from rivers and estuaries. Mississippi River water is advected onto the West Florida shelf at times in spring and summer because of strong currents along the shelf break. Fresh water from the Mississippi River is sometimes entrained by the Loop Current as well (Weisberg et al. 2005).

4.3.4 Water Quality

Within the Gulf Coast region, the overall length of the coastline extends for approximately 2,600 km (1,600 mi) through Texas, Louisiana, Mississippi, Alabama, and Florida. Coastal waters include all the bays and estuaries from the Rio Grande River to the Florida Bay. Marine water includes both State offshore water and Federal OCS waters. Nearly all of the Gulf of Mexico OCS region falls within the Louisianian biogeographic province, which extends along the northern coast of the Gulf of Mexico from Cedar Key, Florida, to Port Aransas, Texas. The tidal range is small. The very southern ends of the Texas and Florida coasts fall within the West Indian province (USCG 2006).

In general, coastal water quality is influenced by rivers that drain into the area, the quantity and composition of wet and dry atmospheric deposition, and the influx of constituents from sediments. The most dominant river in the Gulf Coast is the Mississippi River, which drains nearly half of the conterminous United States. The average river discharge from the Mississippi River exceeds the input of all other rivers along the Texas-Louisiana coast by a factor of ten. Human activities influence the waters closest to the land. Circulation or mixing of the water may either improve the water through flushing or degrade the quality by introducing factors that contribute to water quality decline.

4.3.4.1 Coastal Waters

The Gulf Coast contains one of the most extensive estuary systems in the world. The primary variables that influence coastal water quality are water temperature, salinity, suspended solids (turbidity), and nutrients. Hydrodynamic influences include tides, near shore circulation, freshwater discharges from rivers, and local precipitation. Tidal mixing within Gulf estuaries is limited by the small tidal ranges that occur along the Gulf of Mexico Coast. The shallowness of most Gulf estuaries, however, tends to amplify the mixing effect of the small tidal range.
Gulf Coast estuaries exhibit a general east to west trend in selected attributes of water quality

associated with changes in regional geology, sediment loading, and freshwater inflow. For example, the estuarine waters in Florida generally have greater clarity and lower nutrient concentrations than those in the central and western areas of the Gulf Coast.

Coastal water quality is also affected by the loss of wetlands, which is discussed in detail in the Coastal Habitats section of this chapter. Wetlands improve water quality through filtration of runoff water. Suspended particulate material is trapped and removed from the water, resulting in greater water clarity. Nutrients may also be incorporated into vegetation and removed from the water that passes through the wetlands.

Conditions in Gulf Coast estuaries are showing progress; the overall rating of fair (2.4 of 5) in USEPA (2004a) is an improvement from the rating of fair to poor (1.9 of 5) observed in the early 1990s (USEPA 2001). Some of this improvement may be the result of modification of the water quality index to include nitrogen, phosphorus, and chlorophyll *a*. The ranking method was changed between reports, so comparisons are difficult.

The 2004 report gave an overall condition ranking of fair for the Gulf Coast. Thirty-five percent of the estuarine area shows indications of impaired aquatic life use, and 14% shows indications of impaired human use. Twenty percent of the assessed estuaries are in good ecological condition (USEPA 2004a).

4.3.4.2 Marine Waters

Marine water composition in the Gulf of Mexico has two primary influences. These are the configuration of the Gulf of Mexico Basin, which controls the oceanic waters that enter and leave the Gulf, and runoff from the land masses, which controls the quantity of freshwater input into the Gulf. The Gulf of Mexico receives oceanic water from the Caribbean Sea through the Yucatan Channel, and freshwater from major continental drainage systems such as the Mississippi River system. The large amount of freshwater runoff mixes with the Gulf surface water, producing a composition on the continental shelf that is different from that of the open ocean.

Within the Gulf of Mexico, marine waters occur in three regions: (1) the continental shelf west of the Mississippi River, (2) the continental shelf east of the Mississippi River, and (3) deep water. This programmatic EIS does not evaluate deep water, so only the first two areas are discussed here.

4.3.4.2.1 Continental Shelf West of the Mississippi River. The water quality in this area is highly influenced by input of sediment and nutrients from the Mississippi and Atchafalaya Rivers. A turbid surface layer of suspended particles is associated with the freshwater plume from these rivers. The river system supplies nitrate, phosphate, and silicate to the shelf. During summer months, water from the Mississippi River spreads over the shelf, resulting in a stratified water column. Although surface oxygen concentrations are at or near saturation, hypoxia, defined as oxygen concentrations less than 2 mg/L, is observed in bottom waters during the summer months.

The Hypoxic Zone: A zone of hypoxia forms each spring and summer on the Louisiana-Texas shelf beneath a well-defined density stratification. The hypoxic zone increased from an average size of 8,300 km^2 (3,200 mi^2) in 1985−1992 period to more than 16,000 km^2 (6,200 mi^2) in 1993−1997 (Rabalais et al. 2002), and it reached a record 22,000 km^2 (8,500 mi^2) in 2002. The size of the hypoxic zone is directly correlated with the flux of nitrogen from the Mississippi River and river discharge (Scavia et al. 2003). Veil et al. (2005) evaluated the contribution of nutrients and other oxygen-demanding materials discharged from offshore oil and gas platforms located in the hypoxic zone and found that they contributed less than 1% of the total nitrogen and total phosphorus coming from the Mississippi and Atchafalaya Rivers (Goolsby et al. 1999).

The oxygen-depleted bottom waters occur seasonally and are affected by the timing of the Mississippi and Atchafalaya Rivers' peak discharges that carry nutrients to the surface waters. This, in turn, increases the carbon flux to the bottom, which, under stratified conditions, results in hypoxia (oxygen depletion). The variables that control the timing of the event include stratification, weather patterns, temperature, and precipitation in the Gulf and in the drainage basin. The hypoxic conditions persist until local wind-driven circulation mixes the water again.

Other Pollutants: Analysis of shelf waters and sediments off the coast of Louisiana will occasionally detect trace organic pollutants including polynuclear aromatic hydrocarbons (PAH), herbicides such as atrazine, chlorinated pesticides, polychlorinated biphenyls (PCB), and trace inorganic (metals) pollutants (e.g., mercury). The primary source of these contaminants is the river water that feeds into the area. In sediment cores collected in water from 10 to 100 m (33 to 328 ft) deep off of the southwest pass of the Mississippi River, the detection of organochlorine pesticides and PAHs increased in sediments dated post-1940s. The river was identified as the source of both organochlorine and the pyrogenic PAHs (Turner et al. 2003).

The offshore oil and gas industry operates hundreds of platforms throughout this portion of the Gulf of Mexico. Many platforms have discharges of drilling wastes, produced water, and other industry wastewater streams that have adverse impacts on water quality. Except in shallow waters, the effects of these discharges are generally localized near individual points of discharge (Neff 2005).

4.3.4.2.2 Continental Shelf East of the Mississippi River. Water quality on the continental shelf from the Mississippi River Delta to Tampa Bay is influenced by river discharge, runoff from the coast, and eddies from the Loop Current. The Mississippi River accounts for a large percentage of the total discharge onto the shelf. The Loop Current intrudes at irregular intervals onto the shelf, and the water column can change from well mixed to highly stratified very rapidly. Discharges from the Mississippi River can be easily entrained in the Loop Current. Hypoxia is rarely observed on the Mississippi-Alabama shelf.

The Mississippi-Alabama shelf sediments are strongly influenced by fine sediments discharged from the Mississippi River. The West Florida Shelf receives very little sediment input. The water clarity is higher toward Florida, where the influence of the Mississippi River outflow is rarely observed.

Red Tides: Red tides, which are blooms of single-cell algae that produce potent toxins harmful to marine organisms and humans and are a natural phenomenon in the Gulf of Mexico, occur primarily off southwestern Florida and Mexico. These algal blooms can result in severe economic and public health problems, and are responsible for fish kills and invertebrate mortalities. There are ongoing studies to determine whether human-induced nutrient loadings contribute to the frequency and intensity of these red tides.

Baseline Conditions: USDOI/MMS (2007c) reports a summary of a large-scale marine environmental baseline study conducted from 1974 to 1977 in the eastern Gulf of Mexico. The study provided an overview of the Mississippi, Alabama, and Florida (MAFLA) OCS environment to a water depth of 200 m (660 ft). Analysis of water, sediments, and biota for hydrocarbons indicated that the MAFLA area is pristine, with some influence of anthropogenic and petrogenic hydrocarbons from river sources. Analysis of trace metal contamination for the nine trace metals analyzed (barium, cadmium, chromium, copper, iron, lead, nickel, vanadium, and zinc) also indicated no contamination. A decade later, the continental shelf off Mississippi and Alabama was revisited (USDOI/MMS 2007c).

Information about water quality on the Florida portion of the shelf from DeSoto Canyon to Tarpon Springs and from the coast to a water depth of 200 m (660 ft) was summarized by Science Applications International Corporation (SAIC 1997). Several small rivers and the Loop Current are the primary influences on water quality in this region. Because there is very little onshore development in this area, the waters and surface sediments are uncontaminated. The Loop Current flushes the area with clear, low-nutrient water.

More recent investigations of the continental shelf east of the Mississippi River confirm previous observations that the area is highly influenced by riverine input of sediment and nutrients (Jochens et al. 2002) including the Mississippi River, Mobile Bay, and several smaller rivers east of the Mississippi River, including the Apalachicola and Suwannee Rivers.

4.3.4.3 Effects of Hurricanes Katrina and Rita on Water Quality

Hurricanes Katrina and Rita resulted in a number of short-term impacts to water quality of the Gulf of Mexico as a result of storm damage to pipelines, refineries, manufacturing and storage facilities, sewage treatment facilities, and other facilities and infrastructure (Congressional Research Service 2005). For example, Hurricane Katrina damaged 100 pipelines, which resulted in approximately 211 minor pollution reports to MMS, while Hurricane Rita damaged 83 pipelines resulting in 207 minor pollution reports (USDOI/MMS 2006h). In addition, the heavy rainfall associated with Katrina increased agricultural runoff of nutrients into the Gulf. With the exception of depletion of dissolved oxygen, waters generated during the dewatering of Lake Ponchartrain contained contaminants of levels similar to those following a heavy rain. Tidal action and normal current patterns in the Gulf resulted in the dilution and dispersal of any heavily contaminated waters, potentially limiting any long-term effects to Gulf water quality. The effect of the increased contaminant and nutrient loading into the Gulf because of Katrina on the hypoxic zone in the Gulf is unknown.

During 2005, the Atlantic Ocean and Gulf of Mexico experienced a record number of tropical storms. If the frequency of extreme weather events in the region continues to be high, it is likely that Gulf Coast water quality will be affected by a series of storm events. High rainfall associated with tropical storms will increase riverine discharges of pollutants. However, the physical disturbance to the water column caused by strong winds and large waves serves to break up water column stratification and reduce the size of the hypoxic zone (Rabalais et al. 2002; Rabalais 2005).

4.3.5 Acoustic Environment

Section 4.2.5 provides an overview of the acoustic environments of oceans and the sources of ambient ocean noise. That discussion is valid for the Gulf of Mexico (GOM) region and will, therefore, not be repeated here. What follows are data that represent important contributions to ambient ocean noise in the GOM region.

Data from the Department of Transportation's Maritime Administration on shipping activities unique to the Gulf of Mexico region, as well as on activities within the major Gulf of Mexico ports, are provided in Section 4.3.17.

In addition to commercial shipping, anthropogenic sources contributing to background ocean noise in the GOM are numerous and include substantial contributions from both onshore and offshore activities associated with oil and gas exploration. Offshore oil and gas exploration and production and construction and operation of associated logistical infrastructure represent a substantial contribution to ambient noise.[43]

Primary sources of ambient ocean noise from oil and gas exploration include: drilling on both fixed and floating drill rigs, service vessels (boats transporting crews, materials and supplies, derrick barges, construction barges, anchor handling tugs, etc.[44]), and fixed and rotary wing (helicopters) aircraft used to transport crews and equipment and for surveillance purposes. Since 1994, helicopter flights have steadily increased and are estimated at 1.7 million trips annually, Gulf-wide, carrying 3.7 million passengers during 417,000 flight hours (USDOI/MMS 2003a). Helicopter trips typically originate at hubs or "heliports." These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Most of the OCS-related

[43] Virtually all oil and gas exploration and production occurs in deep waters still within the OCS area but well beyond the relatively shallow waters that are the anticipated locations of alternative energy technologies. However, the necessary connections between offshore drilling rigs and onshore logistical support result in acoustic impacts to that near-shore portion of the area being considered for alternative energy installations.

[44] The MMS estimates that there were as many as 376 service vessels operating in 2000 in the study area associated with OCS Oil and Gas Lease Sales 189 and 197 (USDOI/MMS 2003a).

helicopter trips originate at helicopter hubs in coastal Texas and Louisiana. Approximately 247 heliports within the Gulf region support OCS activities; 122 are located in Texas, 81 in Louisiana, 34 in Florida, 6 in Mississippi, and 4 in Alabama (Louis Berger Group, Inc., 2004).

In addition to the use of aircraft and vessels to shuttle crews and equipment between shore facilities and oil rigs, other activities directly associated with oil and gas exploration on the OCS also represent substantial anthropogenic contributions to the ambient ocean noise levels. These include installation, operation, and maintenance of undersea pipelines (including associated pumps and compressors) that connect drilling rigs with the shore, onshore crude oil and product storage facilities, and refineries.[45] Industries providing direct support to the oil and gas industry with equipment fabrication and repair activities are numerous and typically located at or near the shore adjacent to ports or docks. Sounds from such industries also contribute to Gulf background ambient noise. Other activities indirectly related to OCS oil and gas exploration and production include facilities to service and repair the various vessels supporting the industry. Because such facilities are routinely located at or near the shore (and sometimes on the water), they also contribute to ocean background noise.

Mineral mining on the OCS also contributes to the ambient ocean noise in the GOM OCS area. Currently, MMS has cooperative programs with 14 States for sand and gravel mining on the OCS regions including the States of Alabama, Florida, Louisiana, and Texas in the GOM OCS area. Materials are typically removed by dredging and, in most instances, are used for nourishment and/or restoration of beaches in adjacent onshore areas or protection of military training areas or critical infrastructure. Between 1995 and 2006, more than 17.6 million m^3 (23 million yd^3) of sand were mined in 17 coastal projects, providing for the restoration of 145 km (90 mi) of coastline.[46] The use of OCS sands and gravels is expected to increase in the future. An estimated 45.9 million m^3 (60 million yd^3) will be required for Louisiana coastal and barrier island restoration projects planned for the next five years.

Commercial shipping represents substantial contributions to ambient ocean noise in the GOM. Commercial shipping in the GOM includes movements of both foreign and domestic goods in bulk shipments as well as containers. While it is beyond the scope of this programmatic EIS to provide a comprehensive analysis of all commercial shipping in the GOM, the following information provides an appreciation of ship traffic densities in the GOM. The GOM caucus (USEPA 2007) reports that 7 of the nation's top 10 ports and 2 of the world's top 7 ports (as measured by tonnage or cargo value) are located in the GOM. The Port of Houston ranked first in the United States in foreign waterborne commerce, second in total tonnage, and sixth in the world. Vessel calls (displayed by vessel type) for ports in the GOM are displayed in Figures 4.3.17-1 and 4.3.17-2.

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45 Gulf Coast refineries process crude oil and gas recovered from offshore drilling rigs as well as crude products received by ship.

46 More details on the MMS Marine Mineral Program can be obtained from the MMS website: http://www.mms.gov/sandandgravel/.

Crude and petroleum products make up a large portion of total commodities transported through the GOM's ports. Crude oil is tankered into area refineries from domestic production occurring in the Atlantic and Pacific Oceans and from foreign supplies.[47] Crude oil produced within the GOM region is sometimes barged among Gulf terminals to reach refineries and onshore transportation routes. Petroleum products are barged, tankered, piped, or trucked from the large refinery complexes.

More than 50 service bases are in operation in the GOM to support oil and gas activities. Sailings between service bases and offshore drilling platforms and ships also represent a major component of GOM shipping activity, consisting primarily of small- to moderate-sized boats and tug/barges (for equipment, supplies, products, and construction/repair). While many of these Service Bases exist exclusively to serve the oil and gas industry, some (Mobile, Alabama; Pascagoula, Mississippi; Lake Charles, Morgan City, and Port of Plaquemines/Venice, Louisiana; and Corpus Christi, Freeport, Galveston, and Port Arthur, Texas) also provide support for other commercial shipping.

In addition to oil and gas exploration by U.S. companies, the Mexican petroleum industry (PEMEX) estimated that 2,540 million bbl (106,680 gal) of oil and 12.25 million m^3 (433 million ft^3) natural gas per day were produced from Gulf of Mexico offshore operations in 2001 (USEPA 2006e).

Some additional, port-specific data on commercial shipping in selected GOM ports is provided below. The Port of New Orleans handles 10.3 million metric tons (11.4 million tons) of general cargo on average every year. It serves 2,000 vessels each year with massive facilities—2.04 million m^2 (22 million ft^2) of cargo handling area and 8.6×10^3 million m^2 (92.5×10^3 million ft^2) of covered storage area. The Port of New Orleans also serves as a cruise ship port, serving more than one half million passengers annually (New Orleans Online.com 2006). About 181.4 million metric tons (200 million tons) of cargo moved through the Port of Houston in 2005; a total of 7,057 vessel calls were recorded at the Port of Houston during the year 2005 (Port of Houston Authority 2006). The Port of Mobile reported 1,302 vessel calls in fiscal year 2005, comprising 21.9 million metric tons (24.2 million tons) of bulk and containerized cargo (Alabama State Port Authority 2006). The Port of Tampa handles more than 45.3 million metric tons (50 million tons) of cargo annually, with total vessel movements of 3,688 in 2005 (Waino 2005).

Finally, commercial and recreational fishing represents a substantial contribution to ambient ocean noise in the GOM. USEPA offers the following facts regarding fishing in the GOM:

- Gulf fisheries are some of the most productive in the world. In 2002, according to the NMFS, the commercial fish and shellfish harvest from the five U.S. Gulf States was estimated to be 0.77 billion kg (1.7 billion lb) and

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47 More than 60% of the crude oil imported into the United States comes through the GOM (USDOE/EIA 2005).

valued at $705 million. The Gulf also contains four of the top seven fishing ports in the nation by weight.

- Gulf landings of shrimp led the nation in 2002 with 104.8 million kg (231.1 million lb) valued at $382 million dockside, accounting for about 68% of U.S. total. Louisiana led all Gulf States with 48.2 million kg (106.2 million lb); Texas with 34.1 million kg (75.2 million lb); Florida (west coast) with 8.39 million kg (18.5 million lb); Alabama with 6.53 million kg (14.4 million lb); and Mississippi with 7.62 million kg (16.8 million lb).

- The Gulf led in production of oysters in 2002 with 11.07 million kg (24.4 million lb) of meats valued at $51 million and representing 70% of the national total.

- The Gulf also supports a productive recreational fishery. In 2001, more than 3 million marine recreational participants took more than 22.8 million trips, catching a total of 163 million fish. Excluding Texas, U.S. Gulf States accounted for more than 40% of the U.S. recreational finfish harvest in 2000 (USEPA 2006e).

The NMFS compiles data on commercial fish "landings" at GOM ports. Relevant NMFS data are provided in the Fisheries section (Section 4.3.23). While the data may not be sufficient to calculate absolute contributions of commercial fishing boats to ambient ocean noise, the relative values of fish landings is indicative of the density of fishing boat traffic and thus can provide an understanding of the relative contributions of commercial fishing activities to total ambient ocean noise attributable to vessel traffic in those OCS areas where commercial fishing takes place.

4.3.6 Hazardous Materials and Waste Management

As used in this programmatic EIS, the term "hazardous materials" refers to nonwaste substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare or the environment if they are improperly managed or released into the environment. This definition is general in nature and is not intended to suggest that the requirements of any particular law or set of regulations apply to a particular material. Such materials may be transported to and from, stored at, and/or used at alternative energy and alternate use project sites approved on the OCS. Section 4.2.6 lists examples of hazardous materials that may be associated with alternative energy projects likely to be proposed on the OCS within the next 5 to 7 years (Table 4.2.6-1). That section also lists examples of hazardous and nonhazardous solid wastes that may be generated by such projects (Table 4.2.6-2).

The following subsections provide an overview of hazardous materials and waste management in the OCS GOM region.

4.3.6.1 Hazardous Materials Management

When transported on the OCS, hazardous materials are subject to the requirements for classification, documentation, packaging, labeling, and handling established under the Hazardous Materials Transportation Act (HMTA). If they are bound for or came from international waters, they are also subject to similar requirements under the International Maritime Dangerous Goods Code. These requirements are implemented by the USCG. During 2004, cargo shipped on the ocean within the GOM region included a total of approximately 226 billion kg (564 billion lb) of petroleum products and chemical products, not including crude oil and fertilizers (USACE 2004b). Gasoline, lubricants, diesel fuel, and solvents are examples of hazardous materials associated with alternative energy projects that are among the cargos classified as petroleum products. Paints, explosives, dielectric fluids, and hydraulic fluids are examples of hazardous materials associated with alternative energy projects that are among the cargos classified as chemical products.

Section 311(b) of the Clean Water Act and Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), require that a national contingency plan be established for identifying and responding to releases of hazardous substances (as defined in CERCLA §101) and oil. Releases of oil and hazardous substances exceeding reportable quantities, which have been set forth in 40 CFR Part 302, must be reported to the National Response Center, which is staffed by the USCG. National Response Center watch standers enter telephonic reports of pollution incidents into the Incident Reporting Information System and immediately relay each report to the predesignated Federal On-Scene Coordinator (FOSC). The USCG also provides emergency response support to the FOSCs. FOSCs are Federal officials predesignated by USEPA for inland areas and by the USCG for coastal and major navigable waterways. Each year, many spills nationwide are reported to the National Response Center from ocean vessels and platforms. The MMS investigates the causes of spills that occur on Federal leases in the OCS GOM region, if they involve more than 7,949 L (50 bbl or 2,100 gal) of petroleum or other hazardous substances. For each spill investigated, the MMS prepares a description of the circumstances surrounding the incident with the goal of prevention through safety alerts in addition to site-specific corrections. Since January 2004, the MMS has investigated 76 spills in the GOM region, 57 of which were caused by hurricanes (USDOI/MMS 2006i). These spills released approximately 1.456 million L (9,160 bbl or 384,720 gal) of petroleum or other hazardous substances.

4.3.6.2 Waste Management

In 1972, Congress enacted the Marine Protection, Research, and Sanctuaries Act (MPRSA) to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. The MPRSA, also known as the Ocean Dumping Act, implements the requirements of the London Convention, which is the international treaty governing ocean dumping. Under the MPRSA, the USEPA is charged with developing ocean dumping criteria to be used in evaluating permit applications, is responsible for designating recommended sites for ocean dumping, and is the permitting authority for all materials except dredged material. The USACE is the permitting authority for dredged material. However, when issuing a permit, the USACE must obtain USEPA's concurrence, use USEPA-developed dumping criteria, and use USEPA-designated ocean dump sites to the maximum extent feasible. Virtually all material ocean-dumped in the United States today is dredged material (USEPA 2006c).

There are 28 final dredged material disposal sites designated on the Gulf of Mexico OCS (40 CFR 228.15). Additionally, two naval vessels were sunk for military target practice on the OCS during calendar year 2004 (USEPA 2004b). Ocean disposal sites are not currently authorized for disposal of the waste types that may be generated by alternative energy projects likely to be proposed within the next 5 to 7 years.

Certain materials, such as chemical warfare agents, high-level radioactive waste, medical waste, sewage sludge, and industrial waste, may not be dumped in the ocean. Before 1972, however, accepted practices for disposal of chemical weapons by the U.S. military included ocean dumping, because it was thought that the vastness of ocean waters would absorb any chemical agents that leaked. The first recorded instance of ocean disposal of chemical weapons was in 1918 at an unknown location in the Atlantic Ocean between the United States and England. The last recorded instance occurred in 1970, approximately 402 km (250 mi) off the coast of Florida (Bearden 2006). The Department of Defense first publicly acknowledged ocean disposal of chemical weapons by the U.S. military in the late 1960s, but little information about specific disposal locations was provided. In 2001, the Army published more information on this topic than had previously been released. Even so, the Army's records included exact coordinates for only a few disposal sites. The locations of most disposal sites were indicated by using general references to the sites being offshore from specified States or cities, and sometimes the approximate distance from shore was provided. Six sites appear to be in the vicinity of the Gulf of Mexico region. Figures 4.3.17-1 and 4.3.17-2 show the approximate locations of known dump sites. Chemical agents disposed of in the vicinity of the Gulf of Mexico region include phosgene and mustard gas.

Another source of wastes placed in the oceans is oceangoing vessels, including military craft (U.S. Navy and Coast Guard), commercial business craft (freighters, tug boats, fishing vessels, ferries, and passenger ships), commercial recreational craft (cruise ships and fishing/sightseeing charters), research vessels, and personal craft (fishing boats, house boats, yachts, and other pleasure craft). The extent to which these vessels are present in the Gulf of Mexico region is discussed in Section 4.3.17.

Wastes that may be generated by these vessels include gray water, bilge water, blackwater (sewage), ballast water, antifouling paints (and their leachate), hazardous materials, and municipal and commercial garbage and other wastes. Large cruise ships and military vessels generate wastes in volumes comparable to small cities. For example, a single large passenger vessel is capable of producing more than 379,000 L (100,000 gal) of wastewater per day. Such vessels also generate significant volumes of other waste materials that are released to the ocean, disposed of onshore, and/or incinerated (CEPA 2003).

The discharge of wastes on the OCS by oceangoing vessels is governed by a set of international treaties, known collectively as the MARPOL convention, as well as by U.S. Federal and State laws. For example, the USCG limits the oil content of discharges to the oceans from nonmilitary ships to no more than 15 ppm, and oil pollution control equipment, called an oil water separator, is required to achieve this limit (see 33 CFR 155). Also, the USCG controls generation, handling, storage, and disposal of solid waste (i.e., garbage) on vessels in the oceans (33 CFR 151). These regulations specify minimum distances for the disposal of the principal types of garbage. Section 312 of the Clean Water Act (CWA) requires the use of marine sanitation devices (MSDs), on-board equipment for treating and discharging or storing sewage, on all commercial and recreational vessels that are equipped with installed toilets. There are three types of MSDs. For Type I MSDs (vessels equal to or less than 65 ft), the effluent produced must have a fecal coliform bacteria count no greater than 1,000/100 mL and no visible floating solids. For Type II MSDs (vessels greater than 65 ft), the effluent produced must have a fecal coliform bacteria count no greater than 200/100 mL and suspended solids no greater than 150 mL/L. Type III MSDs are designed to prevent the overboard discharge of treated or untreated sewage. They are commonly called holding tanks because the sewage flushed from the marine head is deposited into a tank containing deodorizers and other chemicals. The contents of the holding tank are stored until they can be properly disposed of at a shore-side pumpout facility. Section 312 does not apply to: vessels with portable toilets or any other on-board portable sewage reception system; gray water from bath or kitchen sinks; or vessels beyond the 3 nautical mi limit of U.S. territorial waters.

Section 312 also allows the USEPA or States to establish no-discharge zones in which the discharge of sewage from all vessels into specified waters is prohibited. There are three objectives for this designation. Under CWA Section 312 (f)(3), a State may designate portions of its waters as no-discharge zones if the State determines that the protection and enhancement of the quality of the waters require greater environmental protection than current Federal standards allow. In this instance, the USEPA is required to determine if there are adequate pumpout facilities available. Additionally, a State may make a written application to the Administrator, under CWA Sections 312(f)(4)(A) or 312(f)(4)(B), for the issuance of a regulation completely prohibiting discharges from a vessel of any sewage, whether treated or not, into specified waters that have environmental importance or waters that serve as drinking water intakes, respectively. The application requirements may vary depending on whether it is an application under CWA Sections 312 (f)(3), 312 (f)(4)(A), or 312 (f)(4)(B). Currently, in the Gulf of Mexico region, Florida and Texas have designated all or certain segments of their surface waters as no-discharge zones.

The States partially bounded by coastal waters adjacent to the OCS GOM region contain many public and commercial municipal solid waste and sanitary landfills capable of accepting general refuse. A number of public and commercial industrial waste landfills that would be capable of accepting nonhazardous industrial wastes not suitable for disposal in sanitary or municipal solid waste landfills are also operating in these States. Two States contain active commercial hazardous waste landfill facilities (USEPA 2006d).

4.3.7 Electromagnetic Fields

Section 4.2.7 discusses the hazards posed by submarine power cables. Such power cables are sometimes used to provide electricity to island communities within State waters. However, use of submarine power cables on the OCS is limited.

4.3.8 Marine Mammals

Twenty-nine species of marine mammals occur in the Gulf of Mexico (Davis et al. 2000). The Gulf of Mexico's marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (the baleen whales) and Odontoceti (the toothed whales), as well as the order Sirenia, which includes the manatee and dugong. Within the northern Gulf of Mexico, there are 28 species of cetaceans (7 mysticete and 21 odontocete species) and 1 sirenian species, the West Indian manatee (*Trichechus manatus*) (Würsig et al. 2000; Waring et al. 2007) (Table 4.3.8-1). Some of these species are composed of distinct stocks that exhibit separate distributions within overall population distributions. Killer whales are the most widely distributed cetacean species in the world. In the eastern North Pacific, they have been reported from the eastern Bering Sea to the Aleutian Islands, in the waters of southeastern Alaska and the intercoastal waters of British Columbia and Washington State, and along the coasts of Washington, Oregon and California. In the eastern North Pacific, there are three distinct forms of killer whales: residents, transients, and offshore, which represent different populations that vary in morphology, ecology, behavior, and genetics. The eastern North Pacific killer whale southern resident distinct population is listed as endangered. Most sightings of this population have occurred in the summer in inland waters of Washington and southern British Columbia, although sightings of some pods have been reported from coastal waters off Vancouver Island and Washington State, and more recently as far south as central California (Carretta et al. 2007). On the basis of yearly direct counts of individually identifiable animals, the minimum population size of the eastern North Pacific killer whale southern resident distinct population has been estimated at 91 animals.

4.3.8.1 Factors Influencing Cetacean Distribution and Abundance

The distribution and abundance of cetaceans within the northern Gulf of Mexico are strongly influenced by various mesoscale oceanographic circulation patterns. These patterns are primarily driven by river discharge (primarily from the Mississippi and Atchafalaya Rivers), wind stress, and the Loop Current and its derived circulation phenomena. Circulation on the continental shelf is largely wind-driven, with localized effects from freshwater (i.e., river) discharge. Beyond the shelf, mesoscale circulation is largely driven by the Loop Current in the eastern Gulf. Approximately once or twice a year, the Loop Current sheds anticyclonic eddies (also called warm-core rings). Anticyclones are long-lived, dynamic features that generally migrate westward and transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. These anticyclones, in turn, spawn cyclonic eddies (also called cold-core rings) during interaction with one another and upon contact with

TABLE 4.3.8-1 Marine Mammals in the Gulf of Mexico[a]

		General Occurrence[c]			Typical Habitat		
Family/Species	Status[b]	Western Gulf of Mexico[d]	Central Gulf of Mexico[e]	Eastern Gulf of Mexico[f]	Coastal	Shelf	Slope/ Deep
Order Cetacea							
Suborder Mysticeti (Baleen whales)							
Family Balaenidae							
North Atlantic right whale (*Eubalaena glacialis*)	E/D	EX[g]	EX	EX	–	X	X
Family Balaenopteridae							
Bryde's whale (*Balaenoptera edeni*)		O	O	O	–	X	X
Fin whale (*Balaenoptera physalus*)	E/D	O	O	O	–	X	X
Humpback whale (*Megaptera novaeangliae*)	E/D	O	O	O	–	X	X
Minke whale (*Balaenoptera acutorostrata*)		O	O	O	–	X	X
Sei whale (*Balaenoptera edeni*)	E/D	O	O	O	–	X	X
Blue whale (*Balaenoptera musculus*)	E/D	EX	EX	EX	–	X	X
Suborder Odontoceti (Toothed whales and dolphins)							
Delphinidae							
Atlantic spotted dolphin (*Stenella frontalis*)		C	C	C	–	X	X
Bottlenose dolphin (*Tursiops truncatus*)		C	C	C	X	X	X
Clymene's dolphin (*Stenella clymene*)		C	C	C	–	–	X
False killer whale (*Pseudorca crassidens*)		O	O	O	–	–	X
Fraser's dolphin (*Lagenodelphis hosei*)		O	O	O	–	–	X
Killer whale (*Orcinus orca*)		O	O	O	–	X	X
Melon-headed whale (*Peponocephala electra*)		UC	UC	O	–	–	X
Pantropical spotted dolphin (*Stenella attenuata*)		C	C	C	–	–	X

TABLE 4.3.8-1 (Cont.)

		General Occurrence[c]			Typical Habitat		
Family/Species	Status[b]	Western Gulf of Mexico[d]	Central Gulf of Mexico[e]	Eastern Gulf of Mexico[f]	Coastal	Shelf	Slope/ Deep
Delphinidae (Cont.)							
Pygmy killer whale (*Feresa attentuata*)		O	O	O	–	–	X
Risso's dolphin (*Grampus griseus*)		UC	UC	UC	–	–	X
Rough-toothed dolphin (*Steno bredanensis*)		UC	UC	UC	–	–	X
Short-finned pilot whale (*Globicephala macrorhynchus*)		UC	UC	O	–	–	X
Spinner dolphin (*Stenella longirostris*)		O	O	O	–	–	X
Striped dolphin (*Stenella coeruleoalba*)		UC	UC	UC	–	–	X
Kogiidae							
Dwarf sperm whale (*Kogia sima*)		O	O	O	–	–	
Pygmy sperm whale (*Kogia breviceps*)		O	O	O	–	–	
Physeteridae							
Sperm whale (*Physeter macrocephalus*)	E/D	C	C	C	–	–	
Ziphidae							
Blainville's beaked whale (*Mesoplodon densirostris*)		O	O	O	–	X	
Cuvier's beaked whale (*Ziphius cavirostris*)		O	O	O	–	–	
Gervais' beaked whale (*Mesoplodon europaeus*)		O	O	O	–	X	
Sowerby's beaked whale (*Mesoplodon bidens*)		EX	EX	EX	–	X	
Sirenidae							
West Indian manatee, Florida subspecies (*Trichechus manatus latrostris*)	E	O	O	UC	X	–	

Footnotes on next page.

TABLE 4.3.8-1 (Cont.)

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[a] Source: Waring et al. (2007).

[b] E = Endangered under the Endangered Species Act; D = Depleted under the Marine Mammal Protection Act.

[c] The indicated occurrence does not reflect the distribution and occurrence of individual stocks of marine mammals within localized geographic areas, but rather the broad distribution of the species within the larger categories of OCS waters.

[d] Western Gulf of Mexico includes OCS waters from the Texas-Mexico border to the Texas-Louisiana border.

[e] Central Gulf of Mexico includes OCS waters from the Texas-Louisiana border to the Alabama-Florida border.

[f] Eastern Gulf of Mexico includes OCS waters of the west coast of Florida.

[g] A = Absent – not recorded from the area; C = Common – regularly observed throughout the year; EX = Extralimital – known only on the basis of a few records that probably resulted from unusual wanderings of animals into the region; O = Occasional – relatively few observations throughout the year, but some species may be more frequently observed in some locations or during certain times (e.g., during migration); and UC = Uncommon – infrequently observed throughout the year, but some species may be more common in some locations or during certain times of the year (e.g., during migration or when on summer calving grounds or wintering grounds).

topographic features of the continental slope and shelf edge. These cyclones contain and maintain high concentrations of nutrients and stimulate localized production (Davis et al. 2000).

In the north-central Gulf of Mexico, the relatively narrow continental shelf south of the Mississippi River Delta may be an additional factor affecting cetacean distribution (Davis et al. 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow also may be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity, and may explain the persistence of aggregations of sperm whales within 50 km (31 mi) of the Mississippi River Delta in the vicinity of the Mississippi Canyon.

4.3.8.2 Threatened or Endangered Species

Five baleen whales (the northern right, blue, fin, sei, and humpback), one toothed whale (the sperm whale), and one sirenian (the West Indian manatee) occur in the Gulf of Mexico and are listed as endangered under the Endangered Species Act (ESA). The sperm whale is common in oceanic waters of the northern Gulf of Mexico and may be a resident species, while the baleen whales are considered rare or extralimital in the Gulf (Würsig et al. 2000). All of the endangered cetacean species are also designated as depleted under the MMPA. The West Indian manatee inhabits only coastal marine, brackish, and freshwater areas.

4.3.8.2.1 Cetaceans—Mysticetes. The species of endangered and threatened mysticetes reported in the Gulf of Mexico region are the North Atlantic right whale, blue whale, fin whale, sei whale, and humpback whale.

The western stock of the North Atlantic right whale (*Eubalaena glacialis*) inhabits primarily temperate and subpolar waters. Right whales forage primarily on subsurface concentrations of zooplankton (Watkins and Schevill 1976; Jefferson et al. 1993). This species ranges from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding, nursery, and mating grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Five major congregation areas have been identified for the western stock of the North Atlantic right whale (southeastern U.S. coastal waters, Great South Channel, Cape Cod Bay, Bay of Fundy, and Scotian Shelf). This species is extralimital in the Gulf of Mexico (Würsig et al. 2000), and confirmed records in the Gulf consist of a single stranding in Texas in 1972 (Schmidly et al. 1972) and infrequent sighting elsewhere (Waring et al. 2007). There are no abundance estimates for the North Atlantic right whale in the Gulf of Mexico.

The blue whale (*Balaenoptera musculus*) is the largest of all marine mammals. The blue whale occurs in all major oceans of the world; some blue whales are resident, some are migratory (Jefferson et al. 1993; Waring et al. 2007). Those that migrate move to feeding grounds in polar waters during spring and summer after wintering in subtropical and tropical waters (Yochem and Leatherwood 1985). They feed almost exclusively on concentrations of zooplankton (Yochem and Leatherwood 1985; Jefferson et al. 1993). They are considered extralimital in the Gulf of Mexico (Würsig et al. 2000), with the only records consisting of two strandings on the Texas coast. There are no abundance estimates for the blue whale in the Gulf of Mexico.

The fin whale (*Balaenoptera physalus*) is an oceanic species that occurs worldwide and is most commonly sighted where deep water approaches the coast (Jefferson et al. 1993). Fin whales feed on concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves 1983; Jefferson et al. 1993). Fin whale presence in the northern Gulf of Mexico is considered rare (Würsig et al. 2000), with few reliable reports, indicating that fin whales are not abundant in the Gulf of Mexico (Jefferson and Schiro 1997).

The sei whale (*Balaenoptera borealis*) is an oceanic species that occurs in tropic to polar regions, and is more common in the mid-latitude temperate zones. It is not often seen close to shore (Jefferson et al. 1993). Sei whales feed on concentrations of zooplankton, small fishes, and cephalopods (Gambell 1985; Jefferson et al. 1993). They are considered rare in the Gulf of Mexico (Würsig et al. 2000), based on records of one stranding in the Florida Panhandle and three in eastern Louisiana (Jefferson and Schiro 1997). There are no abundance estimates for the sei whale in the Gulf of Mexico.

The humpback whale (*Megaptera novaeangliae*) occurs in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical banks, where they breed and calve (Jefferson et al. 1993). Humpback whales feed on concentrations of zooplankton and fishes by using a variety of techniques that concentrate prey for easier feeding (Winn and Reichley 1985; Jefferson et al. 1993). Humpback whales are considered rare in the Gulf of Mexico (Würsig et al. 2000) based on a few confirmed sightings and one stranding event. There are no abundance estimates for the humpback whale in the Gulf of Mexico.

4.3.8.2.2 Cetaceans—Odontocetes. The sperm whale (*Physeter macrocephalus*) is found worldwide in deep waters between approximately 60°N and 60°S latitudes, although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al. 1993). As deep divers, sperm whales generally inhabit oceanic waters, but they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al. 1993). Sperm whales prey on cephalopods, demersal fishes, and benthic invertebrates (Rice 1989; Jefferson et al. 1993).

The sperm whale (northern Gulf of Mexico stock) is the only great whale that is considered common in the northern Gulf of Mexico (Fritts et al. 1983b; Mullin et al. 1991; Davis and Fargion 1996; Jefferson and Schiro 1997). Aggregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River Delta in waters that are 500 to 2,000 m (1,641 to 6,562 ft) in depth (Mullin et al. 1994a; Davis and Fargion 1996; Davis et al. 2000). They are often concentrated along the continental slope in or near cyclones and zones of confluence between cyclones and anticyclones (Davis et al. 2000). Consistent sightings and satellite tracking results indicate that sperm whales occupy the northern Gulf of Mexico throughout all seasons (Mullin et al. 1994a; Davis and Fargion 1996; Sparks et al. 1996; Jefferson and Schiro 1997; Davis et al. 2000). For management purposes, sperm whales in the Gulf of Mexico are provisionally considered a separate stock from those in the Atlantic and Caribbean (Waring et al. 1997). Estimated abundance for sperm whales in the northern Gulf of Mexico is 1,349 individuals (Waring et al. 2007).

4.3.8.3 Nonendangered Species

The Gulf of Mexico supports a diverse nonendangered and nonthreatened cetacean fauna represented by 23 species (Table 4.3.8-1). The odontocetes (the toothed whales and dolphins) account for 21 of the species observed in the northern Gulf of Mexico; the only nonendangered mysticetes (the baleen whales) reported from the northern Gulf of Mexico are the Bryde’s (*Balaenoptera edeni*) and minke (*Balaenoptera acutorostrata*) whales. Breeding and calving activities may occur for many of these species throughout the northern Gulf of Mexico.

With the exception of the bottlenose dolphin (*Tursiops truncatus*), these cetacean species are typically found in waters on the continental shelf or deeper areas such as the shelf edge, slope, and canyons (such as the DeSoto Canyon in the eastern Gulf). The bottlenose dolphin is the only cetacean to also regularly use coastal habitats. Many of the species may be found year-round in waters of the northern Gulf of Mexico, although some species such as the minke whale and the spinner dolphin (*Stenella longirostris*) occur only sporadically in some or all portions of the Gulf (Table 4.3.8-1). Sowerby’s beaked whale (*Mesoplodon bidens*) is considered extralimital to the Gulf of Mexico. This species occurs in cold temperate to subarctic waters of the North Atlantic and is represented in the Gulf by a single record, a stranding in Florida (Waring et al. 2007).

Abundance estimates of the nonendangered cetaceans range widely. No abundance estimates are available for the minke whale in the northern Gulf, and as mentioned, Sowerby's beaked whale is considered extralimital in the Gulf (Waring et al. 2007). The combined abundance of Gervais, Blanville, and Cuvier beaked dolphins in the northern Gulf is estimated at about 80 individuals (Waring et al. 2007). The combined abundance of the dwarf sperm and pygmy sperm whales in the northern Gulf has been estimated at about 740 animals, while the estimated abundance in the northern Gulf for Fraser's dolphin, killer whale, and pygmy killer whale is 726, 133, and 400 individuals, respectively (Waring et al. 2007). Abundance estimates for the false killer whale, short-finned pilot whale, Risso's dolphin, rough-toothed dolphin, and melon headed whale range from 1,000 to about 3,500 individuals in the northern Gulf. The dolphins are the most abundant cetaceans in the northern Gulf of Mexico; abundance estimates range from about 12,000 spinner dolphins to more than 91,000 pantropical spotted dolphins (Waring et al. 2007).

4.3.9 Marine and Coastal Birds

The northern Gulf of Mexico possesses a diverse bird fauna composed of resident marine and coastal species (Clapp et al. 1983; National Geographic Society 1999). In addition, the bird fauna of the Gulf also includes many species that inhabit northern latitudes and pass through the region in large numbers during spring and fall migrations (Russell 2005). For example, in the fall, many migratory species (including waterfowl, shorebirds, blackbirds, sparrows, hummingbirds, warblers, and thrushes) arrive at the Gulf Coast and then fly several hundred miles across the open waters of the Gulf of Mexico straight for Central and South America (Lincoln et al. 1998). The northern Gulf of Mexico also is used by seven bird species that are listed as threatened or endangered under the Endangered Species Act.

4.3.9.1 Threatened and Endangered Species

Several species of federally endangered, threatened, or candidate species of birds occur in the northern Gulf of Mexico during at least part of the year. Habitats used by these species include offshore areas, coastal beaches, and contiguous wetlands (USDOI/MMS 2002a). The threatened or endangered species are the eastern brown pelican, Eskimo curlew, piping plover, roseatte tern, whooping crane, and wood stork. The candidate species are the southeastern snowy plover and the red knot.

The eastern brown pelican (*Pelicanus occidentalis carolinensis*) is one of two pelican species occurring in North America. It inhabits coastal habitats and forages within coastal waters and waters of the inner continental shelf, typically less than 32 km (20 mi) from the coast. Subsequent to the ban of DDT and especially endrin, it has been listed as endangered over its entire range except for the U.S. Atlantic Coast, Florida, and Alabama, where it is not listed. No critical habitat has been designated for this species.

The Eskimo curlew (*Numenius borealis*) is a migrant shorebird. This species currently remains listed as endangered over its entire range, though it may be extinct primarily as a result of extensive hunting pressure (USFWS 2006b). It historically nested in wetlands of open tundra within the high arctic (Alaska and northern Canada) and overwintered within southern South America. Most sightings of this species over the last century have been along the Texas coast during the spring (USFWS 2006b). No critical habitat has been designated for this species.

The piping plover (*Charadrius melodus*) is a shorebird that inhabits coastal sandy beaches and mudflats. This species is currently in decline and listed as endangered in the Great Lakes watershed (breeding range of the Great Lakes population of this species) and as threatened in the remainder of its range. It is listed as a result of historic hunting pressure, and loss and degradation of habitat (USFWS 2006b). Critical wintering habitat has been established in each of the Gulf Coast States for all three populations (Atlantic, Great Lakes, and Great Plains) of the piping plover (66 FR 36038–36143).

The roseate tern (*Sterna dougallii dougallii*) is a seabird that commonly ventures into oceanic waters; however, its western Atlantic population is known to occur in the far southeastern Gulf to breed in scattered colonies along the Florida Keys (Saliva 1993; USFWS 1999). It is currently listed as endangered for populations along the U.S. Atlantic Coast from Maine to North Carolina, Canada and Bermuda; it is listed as threatened in Florida, Puerto Rico, the Virgin Islands, and the remaining western hemisphere and adjacent oceans. It historically has ranged along the Atlantic tropical and temperate coasts south to North Carolina; in Newfoundland, Nova Scotia, and Quebec, Canada; and in Bermuda (USFWS 2006b). No critical habitat has been designated for this species.

The whooping crane (*Grus americana*) is a wetland species that nests within western Canada and the north-central United States, and overwinters on salt flats and wetland habitats along the Aransas National Wildlife Refuge on the Texas Coast (USFWS 2006b). It is currently listed as endangered over its entire range, except where listed as an experimental population. It is endangered because of historic hunting pressure and habitat loss and degradation. Critical habitat has been designated for this species in the Gulf of Mexico along the Texas coast (including Aransas National Wildlife Refuge) (43 FR 20938–20942).

The wood stork (*Mycteria americana*) is the only stork that regularly occurs in North America. The published range of this wading bird is Alabama, Florida, Georgia, and South Carolina, where this species is classified as endangered (USFWS 2006b). While a year-round resident of Florida and Georgia, the woodstork does occur in other Gulf Coast States. Wood storks frequent freshwater and brackish coastal wetland habitats. No critical habitat has been designated for this species.

4.3.9.2 Nonendangered Species

There are four general groups of marine and coastal birds that occur in the Gulf of Mexico region for at least some portion of their life cycle. These groups include: seabirds, shorebirds, wading and diving birds, and waterfowl (Table 4.3.9-1).

TABLE 4.3.9-1 Marine and Coastal Birds of the Gulf of Mexico

Category	Order	Family	Common Name
Seabirds	Charadriiformes	Laridae	Gulls and terns
		Scolopacidae	Phalaropes
	Gaviiformes	Gaviidae	Loons
	Pelicaniformes	Fregatidae	Frigatebirds
		Pelicanidae	Pelicans
		Phaethontidae	Tropicbirds
		Phalacrocoracidae	Cormorants
		Sulidae	Gannets and boobies
	Procellariiformes	Diomedeidae	Albatrosses
		Hydrobatidae	Storm-petrels
		Procellariidae	Petrels and shearwaters
Shorebirds	Charadriiformes	Charadriidae	Plovers
		Haematopodidae	Oystercatchers
		Recurvirostridae	Stilts and avocets
		Scolopacidae	Sandpipers, snipes, and allies
Wetland birds	Charadriiformes	Jacanidae	Jacanas
	Ciconiiformes	Ardeidae	Bitterns, egrets, and herons
		Ciconiidae	Storks
		Threskiornithidae	Ibises and spoonbills
	Gruiformes	Gruidae	Cranes
		Aramidae	Limkins
		Rallidae	Rails and coots, moorhens, and gallinules
	Pelicaniformes	Anhingidae	Anhingas
	Podicipediformes	Podicipedidae	Grebes
Waterfowl	Anseriformes	Anatidae	Ducks, geese, and swans

Seabirds (species that spend a large portion of their lives on or over seawater) may be found in both offshore and coastal waters of the northern Gulf of Mexico. The birds eat fish and invertebrates (such as squid). Some species (such as the boobies, petrels, and shearwaters) inhabit only pelagic habitats in the Gulf. Most Gulf seabird species, however, inhabit waters of the continental shelf and adjacent coastal and inshore habitats. Gulf of Mexico seabirds were categorized by Fritts and Reynolds (1981) as follows:

- Summer migrants: These pelagic species are present in the Gulf during the summer but breed primarily elsewhere. Examples include black terns, boobies, shearwaters, storm-petrels, and tropicbirds.

- Summer residents: These birds are present, and also breed, in the Gulf during summer months. Examples include least terns, sandwich terns, and sooty terns.

- Wintering marine birds: These species are found in the Gulf only during winter months. Examples of wintering species include herring gulls, jaegers, and northern gannets.

- Permanent residents: These species are found in the Gulf year-round. Examples of permanent residents include bridled terns, laughing gulls, magnificent frigate birds, and royal terns.

Shorebirds are typically small wading birds that feed on invertebrates in shallow waters and along beaches, mudflats, sand bars, and other similar areas. Shorebirds are generally restricted to coastline margins except when migrating. Many North American shorebirds seasonally migrate between the high Arctic and South America, passing through the Gulf during migration (Lincoln et al. 1998). Certain coastal and adjacent inland wetlands of the Gulf of Mexico serve as important habitats for overwintering shorebirds, and as temporary feeding and resting habitats for migrating shorebirds. Shorebirds may be solitary or occur in small to moderate-sized single-species flocks, although large aggregations of several species may be encountered.

Overwintering shorebird species remain within specific areas throughout the season and utilize the same areas year after year. These species may be especially susceptible to localized impacts resulting in habitat loss or degradation unless they move to more favorable habitats when their habitats are disturbed.

The wading and diving bird group includes a diverse array of birds that typically inhabit most Gulf Coast aquatic habitats ranging from freshwater swamps and waterways to brackish and saltwater wetlands and embayments. This group includes the large wading birds such as herons, egrets, cranes and storks, as well as diving birds such as cormorants and grebes. Many wetland birds are year-round residents of Gulf of Mexico coastal areas. Wetland birds exhibit diverse diets (which may include fish and invertebrates) and foraging strategies (National Geographic Society 1999).

Waterfowl include ducks, geese and swans, and can be found in coastal waters, beaches, flats, sandbars, and wetland habitats throughout the Gulf of Mexico (National Geographic Society 1999). These birds forage on surface and submerged aquatic vegetation and aquatic invertebrates.

4.3.9.3 Use of Gulf of Mexico Habitats by Migratory Birds

The Gulf of Mexico is an important pathway for migratory birds, including many coastal and marine species, and large numbers of terrestrial species (Lincoln et al. 1998). Most of the migrant birds (especially passerines or perching birds) that overwinter in the neotropics (tropical south Florida, Mexico, the Caribbean, Central America, and South America) and breed in eastern North America either directly cross the Gulf of Mexico (trans-Gulf migration) or move north or south by traversing the Gulf Coast or the Florida Peninsula (Figure 4.3.9-1) (Lincoln et al. 1998; Russell 2005). Florida migrants then either remain in place, cross to the Bahamas Archipelago,

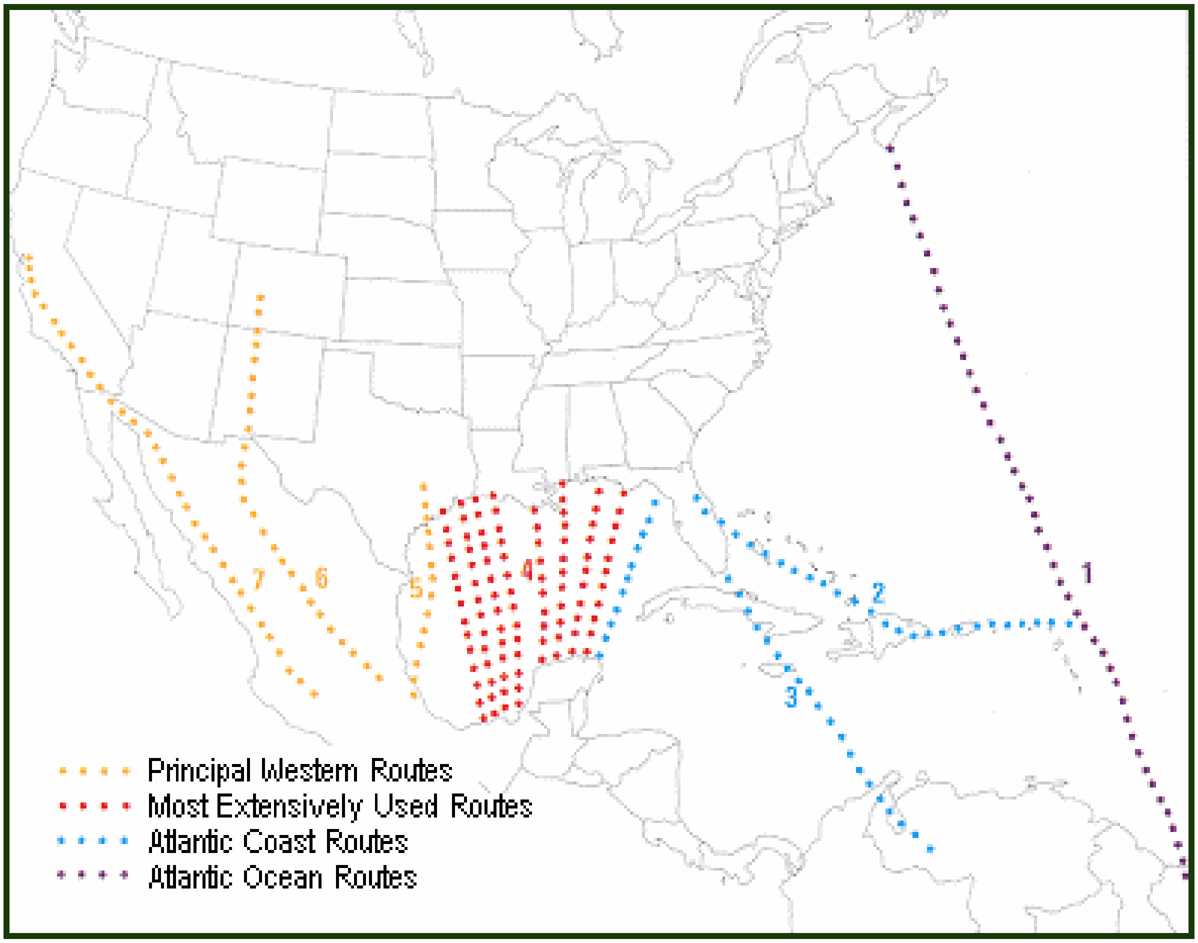

FIGURE 4.3.9-1 Primary Migration Routes Used by Birds in Passing from North America to Winter Quarters in the West Indies, Central America, and South America (Route 4, which crosses the Gulf of Mexico, is the most extensively used route by birds and is also used by many species returning to North America in spring). Specific Routes Taken by Migrating Birds May Vary Within and Between Years, Depending on Local and Regional Weather Conditions, Including Storms and Prevailing Winds. (Source: Lincoln et al. 1998)

or travel directly across the Florida Straits and into the Antilles (Lincoln et al. 1998). Recent studies indicate that the flight pathways of the majority of the trans-Gulf migrant birds during spring are directed toward the coastlines of Louisiana and eastern Texas. As many as 300 million birds may cross the Gulf of Mexico each spring (Russell 2005). During overwater flights, migrant birds (other than seabirds) sometimes use offshore structures, such as oil and gas production platforms, for rest stops or as temporary shelter from inclement weather.

4.3.10 Terrestrial Biota

Ecoregions are areas with generally similar ecosystems and similar types, qualities, and quantities of environmental resources as a result of patterns of vegetation, animal life, geology, soils, water quality, climate, and human land use, as well as other living and nonliving ecosystem components (Omernik 1987). The following discussions of terrestrial biota along the U.S. coastline of the Gulf of Mexico are based on the Level III ecoregion classification of Omernik (1987) as refined through collaborations among USEPA regional offices, State resource management agencies, and other Federal agencies (USEPA 2004c).

The Gulf Coast of the United States supports a great diversity of terrestrial biota. This diversity is a function of the combinations of geology, topography, and climate that occur along the coast from the Texas border with Mexico east to the Florida Keys. The Gulf Coast has five ecoregions (Figure 4.3.10-1), each with relatively unique ecosystems and biota. Descriptions of these ecoregions are presented in Table 4.3.10-1.

Each of these ecoregions support a vast variety of plant and animal species, some of which inhabit or visit coastal habitats of the OCS region. Included among these species of terrestrial biota are numerous species that have been listed as threatened or endangered under the Endangered Species Act of 1973, species being considered for listing under the Act, as well as many species listed by individual States. The numbers of threatened, endangered, or candidate species listed under the Endangered Species Act are presented in Table 4.3.10-2. These listed species include plants, invertebrates, amphibians, reptiles, birds, and mammals. While many of these species occur inland, well away from coastal areas, some inhabit or visit coastal habitats within the Gulf of Mexico OCS region. For example, there are there are four subspecies of endangered beach mice (*Peromyscus polionotus ammobates*, *P. p. trissyllepsis*, *P. p. allophrys*, and *P. p. peninsularis*) that are found in very limited coastal habitats of Alabama and Florida.

4.3.11 Fish Resources and Essential Fish Habitat

The Gulf of Mexico's marine habitats, ranging from coastal marshes to the deep-sea abyssal plain, support a varied and abundant fish fauna, including threatened and endangered species, nonlisted species, and fishes important to commercial and recreational fisheries. Given the diversity of fish species and habitats, various State and Federal agencies are involved in the management of fish resources in the Gulf of Mexico. The NMFS manages commercial and recreational fisheries within Federal waters under the Magnuson-Stevens Fishery Conservation and Management Act (FCMA; 16 USC 1801–1883). Section 303(a)(7) of the Act designates Essential Fish Habitat (EFH) to help conserve Gulf of Mexico fishery resources. Fishery management plans for fishery resources in the Exclusive Economic Zone (EEZ) of the Gulf of Mexico, which extends from where state waters end out to the 200-mi limit of the Gulf of Mexico, are typically prepared by the Gulf of Mexico Fishery Management Council (GMFMC) and submitted to the NMFS for implementation. The GMFMC has developed or assisted with development of fishery management plans for reef fish, shrimp, spiny lobster, stone crab, coastal migratory pelagic species, corals, red drum, dolphin (fish), and wahoo (Table 4.2.11-1). The Interjurisdictional Fisheries Program of the Gulf States Marine Fisheries Commission (GSMFC) develops management plans for fishery stocks that migrate freely through State and Federal waters. Fishery management plans for striped bass, Spanish mackerel, blue crab, oyster, black drum, striped mullet, and menhaden have been developed by the GSFMC. The U.S. Fish and Wildlife Service (USFWS) is responsible for management of threatened and endangered fish

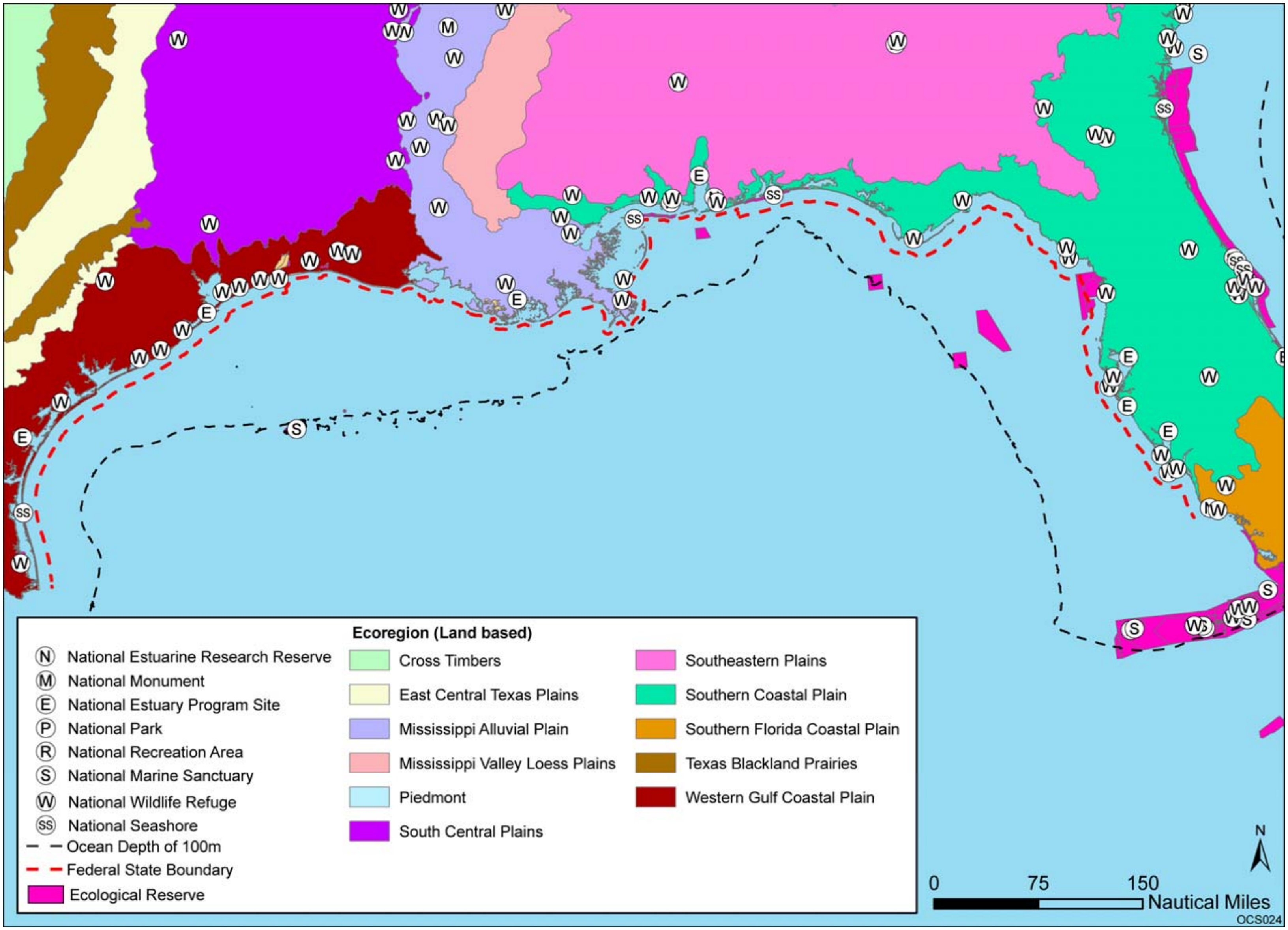

FIGURE 4.3.10-1 Ecological Resources in the Gulf of Mexico Region

TABLE 4.3.10-1 Ecoregions and Terrestrial Ecological Setting of the Gulf of Mexico

Ecoregion	Gulf of Mexico OCS Planning Area (State)	Description
Western Gulf Coast Plain	Western and Central (TX, LA)	The ecoregion encompasses the entire Texas coastline as well as the western third of the Louisiana coast. The principal distinguishing characteristics of the Western Gulf Coastal Plain are its relatively flat coastal plain topography and mainly grassland potential natural vegetation. Inland from this region the plains are more irregular and have mostly forest or savanna-type vegetation potentials. Largely because of these characteristics, a higher percentage of the land is in cropland than in bordering ecological regions. Recent urbanization and industrialization have become concerns in this region.
Mississippi Alluvial Plain	Central (LA)	This riverine ecoregion extends from southern Illinois, at the confluence of the Ohio River with the Mississippi River, south to the Gulf of Mexico. It is mostly a broad, flat alluvial plain with river terraces, swales, and levees providing the main elements of relief. Winters are mild and summers are hot, with temperatures and precipitation increasing from north to south. Bottomland deciduous forest vegetation covered the region before much of it was cleared for cultivation. Presently, most of the northern and central parts of the region are in cropland and receive heavy treatments of insecticides and herbicides. Soybeans, cotton, and rice are the major crops.
Southern Coastal Plain	Central and Eastern (MS, AL, FL)	This ecoregion encompasses the entire coastlines of Mississippi and Alabama, as well as all but the very southern portion of the Gulf Coast of Florida. The Southern Coastal Plain consists mostly of flat plains, with barrier islands, beaches, coastal lagoons, marshes, and swampy lowlands along the coast. Land cover of the region is mostly slash and loblolly pine with oak-gum-cypress forest in some areas.
Southern Florida Coastal Plain	Eastern (FL)	This ecoregion encompasses the far southern end of Florida peninsula and the Florida Keys. This frost-free region is characterized by flat plains with wet soils, marshland, and swamp land cover with everglades and palmetto prairie vegetation types.

Source: USEPA (2004c).

TABLE 4.3.10-2 Numbers of Terrestrial (Nonmarine) Endangered, Threatened, and Candidate Species Listed under the Endangered Species Act of 1973[a]

State	Gulf of Mexico Area	Endangered Species	Threatened Species	Candidate Species
Florida	Eastern	74	27	25
Alabama	Central	80	30	22
Mississippi	Central	23	12	3
Louisiana	Central	14	9	3
Texas	Western	73	13	19

[a] Numbers of species, per category, cannot be summed, as many listed species occur in multiple States.

Source: USFWS (2006b).

species in the Gulf of Mexico, including the Gulf sturgeon and smalltooth sawfish. In addition, State fish and wildlife agencies assist in the management of fish species in State waters. There also exist several areas of special concern, including national parks, refuges, sanctuaries, and estuaries, within the Gulf of Mexico region that afford fish resources extra protection and management (Section 4.3.15).

4.3.11.1 Threatened or Endangered Species

4.3.11.1.1 Gulf Sturgeon. The Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) is a geographic subspecies of the Atlantic sturgeon. After a review by NMFS in 2003, critical habitat for Gulf sturgeon was designated in a final rulemaking (68 FR 13370–13495, 2003). The disjunct distribution of the Atlantic sturgeon is due to zoogeographic and life-history patterns. Sturgeons require freshwater rivers for spawning. Because there are no adequate riverine habitats in southern Florida, this portion of the peninsula acts as a barrier to interchange between the Atlantic and Gulf of Mexico stocks (Bowen and Avise 1990).

The Gulf sturgeon is an anadromous fish that migrates from the sea upstream into coastal rivers to spawn in freshwater. Historically, it ranged from the Mississippi River to Charlotte Harbor, Florida; today, this range has contracted to encompass major rivers and inner shelf waters from the Mississippi River to the Suwannee River, Florida. Populations have been depleted or driven to localized extirpation throughout this range by fishing, shoreline development, dam construction, declining water quality, and other factors (Barkuloo 1988). These declines prompted the listing of the Gulf sturgeon as a threatened species in 1991. Subsequently, a recovery plan was developed to ensure the preservation and protection of Gulf sturgeon spawning habitat (USFWS and Gulf States Marine Fisheries Commission 1995). The best known populations occur in the Apalachicola and Suwannee Rivers in Florida (Carr 1996;

Sulak and Clugston 1998), the Choctawhatchee River in Alabama (Fox et al. 2000a), and the Pearl River in Mississippi/Louisiana (Morrow et al. 1998). The largest existing population is thought to be in Florida's Suwannee River (Gilbert 1992). Genetic studies show that the populations among different rivers are fairly distinct and that the Gulf sturgeon may even be river specific (Stabile et al. 1996).

Most of the relevant ecological information on Gulf sturgeon comes from studies conducted on the Suwannee River population. Spawning occurs from March to May with a peak in April (Huff 1975; Sulak and Clugston 1998; Fox et al. 2000a). Females lay large numbers of eggs (>3 million) in freshwater reaches of rivers, usually in deep areas or holes with hard bottoms and where some current is present (Sulak and Clugston 1998; Fox et al. 2000a). Eggs are adhesive and will attach to rocks, vegetation, or other objects. These eggs hatch in about 1 week depending upon the temperature of the water. The young fish remain in freshwater reaches of the rivers for about 2 years then begin to migrate back downstream to feed in estuarine and marine waters.

The adults spend March through October in the rivers and November through February in estuarine or shelf waters. Upstream and downstream migrations appear to be triggered by changes in water temperature. While in the riverine environment, the young feed upon larger planktonic organisms (crustaceans and insect larvae), and adults feed on clams and snails. Near the river mouths and on the inner continental shelf, adults continue to feed upon clams and snails but include other items in their diet such as crabs, shrimps, worms, brachiopods, amphipods, isopods, and small fishes (Gilbert 1992). The Gulf sturgeon grows to 2.4 m (7.9 ft) in length and can attain an age of 42 years, with adult females being larger than males. Females reach sexual maturity between 8 and 17 years of age, whereas males reach sexual maturity between 7 and 21 years of age (Huff 1975). These life history attributes, particularly slow growth and late age of maturity, contribute to the Gulf sturgeon's vulnerability (Huff 1975).

4.3.11.1.2 Smalltooth Sawfish. See Section 4.2.11.1.2 for a description of the smalltooth sawfish.

4.3.11.2 Other Fish Species

A wide variety of fish species inhabit waters of the Gulf of Mexico region, with variation in the numbers and types of species present changing to reflect differences in habitat conditions such as topography, depth, substrate conditions, and availability of appropriate food sources. Fish assemblages in State and Federal waters of the Gulf of Mexico are described below, generally classified according to life habits or preferred habitat associations.

4.3.11.2.1 Diadromous Fishes. Diadromy, anadromy, and catadromy are defined in Section 4.2.11.2.

There are three anadromous fish species in the Gulf of Mexico: Gulf sturgeon, striped bass, and Alabama shad (*Alosa alabamae*). Gulf sturgeon, a federally listed threatened species is described in Section 4.3.11.1. These species spawn in rivers but spend part of their lives in oceans.

Striped bass are native to rivers entering the Gulf of Mexico from the Suwannee River in Florida to at least the rivers draining into Lake Pontchartrain in eastern Louisiana and southwestern Mississippi. Striped bass populations began declining earlier this century, and by the mid-1960s had disappeared from all Gulf rivers except for the Apalachicola River system of Alabama, Florida, and Georgia. The USFWS and the Gulf States initiated cooperative efforts to restore and maintain striped bass populations in the late 1960s, primarily through stocking of hatchery-raised fingerlings, and this effort continues today.

The historic range of Alabama shad was similar to that of the striped bass but extended well up the Mississippi River drainage. Populations of Alabama shad are thought to have declined significantly over the years, and population data are currently being evaluated by the USFWS to determine what actions, if any, should be taken regarding this species. Dams that have been built on many southeastern rivers are thought to be a major reason for the decline of anadromous fish species in the Gulf of Mexico.

The catadromous American eel also occurs within waters of the Gulf of Mexico, with young and maturing individuals found in nearly all the rivers, bays, lakes and estuaries in the vicinity. Adults return to oceanic waters to spawn.

4.3.11.2.2 Pelagic Fishes. Coastal pelagic fishes include larger predatory species such as king and Spanish mackerels, bluefish, cobia, dolphin, jacks (family Carangidae), and little tunny (*Euthynnus alletteratus*), as well as smaller forage species such as Gulf menhaden (*Brevoortia patronus*), Atlantic thread herring (*Opisthonema oglinum*), Spanish sardine (*Sardinella aurita*), round scad (*Decapterus punctatus*), and anchovies (family Engraulidae). These species typically form schools, undergo migrations, grow rapidly, mature early, and exhibit high fecundity. Each of these species is important to some extent to regional fisheries. The larger predatory species may be attracted to large concentrations of anchovies, herrings, and silversides (family Atherinidae) that sometimes congregate in nearshore areas.

Epipelagic fishes inhabit the upper 200 m (700 ft) of the water column in oceanic waters beyond the continental shelf edge (Bond 1996). This group includes several shark species, billfishes, herrings, flyingfishes, halfbeaks (family Hemiramphidae), bluefish, jacks, dolphin, tunas, and others. A number of the epipelagic species, such as dolphin, sailfish, white marlin, blue marlin, and tunas are important to commercial and recreational fisheries (NMFS 1999). All of these epipelagic species are migratory, but specific patterns are not well understood. Many of the oceanic species associate with flotsam such as floating seaweed (*Sargassum* spp.), jellyfishes, siphonophores, and driftwood, which provides forage areas and/or nursery refuges. Most fish associated with floating seaweed are temporary residents, such as juveniles of species that reside in shelf or coastal waters as adults (USDOI/MMS 1999).

Below the epipelagic zone, the water column may be layered into mesopelagic (200–1,000 m [656–3,281 ft]) and bathypelagic (>1,000-m [>3,281-ft]) zones. In the mesopelagic zone of the Gulf of Mexico, fish assemblages are numerically dominated by lanternfishes (family Myctophidae), bristlemouths (family Gonostomatidae), and hatchetfishes (family Sternoptychidae) (USDOI/MMS 1999). Lanternfishes are small silvery fishes that can be extremely abundant, often responsible for the deep scattering layer in sonar images of the deep sea. Lanternfishes and other mesopelagic fishes spend the daytime in depths of 200–1,000 m (656–3,281 ft), but migrate vertically at night into food-rich, near-surface waters. Mesopelagic fishes, while less commonly known, are important ecologically because they transfer significant amounts of energy between mesopelagic and epipelagic zones over each daily cycle. The lanternfishes are important prey for meso- and epipelagic predators (e.g., tunas) (Hopkins et al. 1997).

Deeper dwelling (bathypelagic) fishes inhabit the water column at depths greater than 1,000 m (3,000 ft). This group is composed of strange, little known species such as snipe eels (family Nemichthyidae), slickheads (family Alepocephalidae), bigscales (family Melamphaidae), and whalefishes (family Cetomimidae) (McEachran and Fechhelm 1998). Most species are capable of producing and emitting light (bioluminescence) to aid communication in an environment devoid of sunlight. Little scientific information is available on bathypelagic fishes of the Gulf of Mexico.

4.3.11.2.3 Demersal Fishes. Demersal fish fauna in the Gulf of Mexico can be generally characterized as soft-bottom fishes or hard-bottom fishes according to their association with particular substrate types and water depth. Chittenden and McEachran (1976), Darnell et al. (1983), and Darnell and Kleypas (1987) have described this fauna in detail. From the Rio Grande to the Florida Keys, a total of 372 demersal fish species were recorded (Darnell and Kleypas 1987). While some species are widespread, the number of species is much higher in the northeastern Gulf of Mexico. Coastal estuaries serve as significant nursery areas for juveniles and provide diverse habitat for demersal fishes.

Soft-bottom fishes generally prefer certain types of sediments over others; this tendency led to the naming of three primary fish assemblages according to the dominant shrimp species found in similar sediment/depth regime. Common members of the pink shrimp assemblage include Atlantic bumper (*Chloroscombrus chrysurus*), sand perch (*Diplectrum formosum*), silver jenny (*Eucinostomus gula*), dusky flounder (*Syacium papillosum*), and pigfish (*Orthopristis chrysoptera*). This assemblage occurs on the west Florida shelf. Longspine porgy (*Stenotomus caprinus*), horned sea robin (*Bellator militaris*), and dwarf goatfish (*Upeneus parvus*) characterize the brown shrimp assemblage. Most of these species spend their entire life cycle in marine waters. The white shrimp assemblage consists of species such as Atlantic croaker (*Micropogonias undulatus*), star drum (*Stellifer lanceolatus*), Atlantic cutlassfish (*Trichiurus lepturus*), sand seatrout (*Cynoscion arenarius*), silver sea trout (*Cynoscion nothus*), Atlantic threadfin (*Polydactylus octonemus*), and hardhead catfish (*Ariopsis felis*). Most of these species spawn in shelf waters and spend their early life stages in estuarine waters.

In some areas offshore west Florida, particularly the Big Bend area and Florida Bay, soft-bottom areas are vegetated with seagrasses and macroalgae. These vegetated bottoms support numerous fishes including red drum (*Sciaenops ocellatus*), pinfish (*Lagodon rhomboides*), spotted sea trout (*Cynoscion nebulosus*), filefishes (family Monacanthidae), and spot (*Leiostomus xanthurus*). Both adults and juveniles of these species utilize the vegetated habitats (Gulf of Mexico Fishery Management Council [GMFMC] 1998).

Another important habitat for demersal fishes on the continental shelf is the hard bottom. The term hard bottom generally refers to exposed rock, but can refer to other substrata such as coral and clay, or even artificial structures. The estimated areal extent of natural hard bottom in the Gulf of Mexico is 4,772,600 ha (11,793,300 acres), and 94% of this exists on the west Florida shelf from the Dry Tortugas to Pensacola (GMFMC 1998). Outside of the Florida shelf, hard bottom occurs on the Mississippi-Alabama shelf, the Texas-Louisiana shelf, and the south Texas shelf. Colonized by stony corals, sea whips, sponges, tunicates, and algae, these structures provide shelter, food, and spawning sites for fishes. Fishes found over hard-bottom habitats in middle (50–100 m [164–328 ft]) and outer (100–200 m [328–656 ft]) shelf waters include reef and coastal pelagic forms. Reef fishes such as snappers, groupers, grunts (family Haemulidae), porgies (family Sparidae), squirrelfishes (family Holocentridae), angelfishes (family Pomacanthidae), damselfishes (family Pomacentridae), butterflyfishes (family Chaetodontidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and wrasses (family Labridae) inhabit hard-bottom habitats in the Gulf of Mexico (Dennis and Bright 1988).

Some species utilize the hard-bottom habitat as adults and juveniles, whereas others undergo ontogenetic migrations from adjacent habitats such as seagrass meadows. Some species, such as gag grouper (*Mycteroperca microlepis*), aggregate to spawn on hard-bottom sites that may be used by the population for many generations (GMFMC 1998). Some species deposit demersal eggs on the substrate, whereas other species shed eggs and sperm into the water column where they are fertilized and then transported to areas often many kilometers from the spawning site.

Artificial hard-bottom sites, including sunken vessels, oil and gas platforms, and debris, represent 1.3% of all hard bottoms in the Gulf of Mexico (GMFMC 1998). Nevertheless, these structures support abundant fish populations in the shelf waters of all Gulf Coast States (GMFMC 1998). Single offshore platforms of average size have been found to provide habitat for an average number of 10,000 to 30,000 fish within 50 m (164 ft) of the structure (Stanley and Wilson 2000).

The deep-sea demersal fish fauna occur from the shelf-slope transition down to the abyssal plain in the Gulf of Mexico and includes about 300 species. The most diverse group is the cod-like fishes such as hakes and grenadiers (family Macrouridae), followed by eels, cusk-eels (family Ophidiidae), sharks, and flatfishes. Members of these groups were collected during MMS-sponsored demersal sampling programs (Pequegnat 1983; Gallaway and Kennicutt 1988). In general, fish species diversity decreases with increasing water depth. The highest diversity and density of demersal fishes was found along the continental slope in the eastern Gulf. Deep-sea demersal fishes consume a wide range of organisms including fishes and invertebrates. In general, most of these deep-water species produce demersal eggs (Bond 1996) that are attached to the substrate.

4.3.11.3 Essential Fish Habitat

Marine fish depend on healthy habitats to survive and reproduce. Throughout their lives, fish use many types of habitats including seagrass, salt marsh, coral reefs, rocky intertidal areas, and hard/live bottom areas, among others. Various activities on land and in the water may threaten to alter, damage, or destroy these habitats, thereby affecting the fishery resources that utilize them. The NMFS, regional Fishery Management Councils, interstate Marine Fisheries Commissions, and other Federal and State agencies work together to address these threats by identifying EFH for each federally managed fish species and developing conservation measures to protect and enhance these habitats. Fish and invertebrate species in the Gulf of Mexico for which EFH designations have been completed are presented in Table 4.3.11-1. The listed species account for approximately one-third of the species managed by the Gulf of Mexico Fishery Management Council. They are considered ecologically representative of the remaining species and collectively occur commonly throughout all of the marine and estuarine waters of the Gulf of Mexico falling under an EFH designation.

In addition to designating EFH, the NMFS requires fishery management councils to identify habitat areas of particular concern (HAPCs) within fishery management plans. HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. Councils may designate a specific habitat area as an HAPC based on: (1) importance of the ecological function provided by the habitat; (2) extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; or (4) rarity of the habitat type. While the HAPC designation does not confer additional protection for or restrictions on an area, it can help prioritize conservation efforts. Healthy populations of fish require not only the relatively small habitats identified as HAPCs, but also other areas that provide suitable habitat functions. Thus, HAPCs alone may not suffice in supporting the larger numbers of fish needed to maintain sustainable fisheries and a healthy ecosystem.

The HAPCs designated within the Gulf of Mexico by the GMFMC to date include the Florida Middle Grounds, Madison-Swanson Marine Reserve, Tortugas North and South Ecological Reserves, Pulley Ridge, and individual reefs and banks of the northwestern Gulf of Mexico (East and West Flower Garden Banks, Stetson Bank, Sonnier Bank, MacNeil Bank, 29 Fathom, Rankin Bright Bank, Geyer Bank, McGrail Bank, Bouma Bank, Rezak Sidner Bank, Alderice Bank, and Jakkula Bank). Most of these HAPCs are important with respect to corals and coral reefs, and provide habitats for reef species such as snappers, groupers, and spiny lobster.

TABLE 4.3.11-1 Fish Species for Which Essential Fish Habitat Has Been Designated in the Gulf of Mexico Region

Invertebrate Fishery Management Plans
Brown shrimp (*Penaeus aztecus*)
Pink shrimp (*Penaeus duorarum*)
Royal red shrimp (*Hymenopenaeus robustus*)
Spiny lobster (*Panulirus argus*)
Stone crab (*Menippe* spp.)
White shrimp (*Penaeus setiferus*)

Reef Fish Fishery Management Plan
Black grouper (*Mycteroperca bonaci*)
Gag (*Mycteroperca microlepis*)
Gray snapper (*Lutjanus griseus*)
Gray triggerfish (*Balistes capriscus*)
Greater amberjack (*Seriola dumerili*)
Lane snapper (*Lutjanus synagris*)
Lesser amberjack (*Seriola fasciata*)
Red grouper (*Epinephelus morio*)
Red snapper (*Lutjanus campechanus*)
Scamp (*Mycteroperca phenax*)
Tilefish (*Lopholatilus chamaeleonticeps*)
Vermillion snapper (*Rhomboplites aurorubens*)
Yellowtail snapper (*Ocyurus chrysurus*)

Coastal Migratory Pelagic Fishes Fishery Management Plan
Bluefish (*Pomatomus saltatrix*)
Cobia (*Rachycentron canadum*)
Dolphin (*Coryphaena hippurus*)
King mackerel (*Scomberomorus cavalla*)
Little tunny (*Euthynnus alletteratus*)
Spanish mackerel (*Scomberomorus maculatus*)

Red Drum Fishery Management Plan
Red drum (*Sciaenops ocellatus*)

Highly Migratory Species Fishery Management Plan
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)
Blacknose shark (*Carcharhinus acronotus*)
Blacktip shark (*Carcharhinus limbatus*)
Bluefin tuna (*Thunnus thynnus*)
Bonnethead (*Sphyrna tiburo*)
Bull shark (*Carcharhinus leucas*)
Caribbean reef shark (*Carcharhinus perezi*)
Dusky shark (*Carcharhinus obscurus*)
Great hammerhead (*Sphyrna mokarran*)
Lemon shark (*Negaprion brevirostris*)
Longfin mako shark (*Isurus paucus*)
Nurse shark (*Ginglymostoma cirratum*)
Sandbar shark (*Carcharhinus plumbeus*)
Scalloped hammerhead (*Sphyrna lewini*)
Silky shark (*Carcharhinus falciformis*)
Skipjack tuna (*Katsuwonus pelamis*)
Spinner shark (*Carcharhinus brevipinna*)
Swordfish (*Xiphias gladius*)
Tiger shark (*Galeocerdo cuvieri*)
Yellowfin tuna (*Thunnus albacares*)

4.3.12 Sea Turtles

There are five species of sea turtle that may be encountered in the northern Gulf of Mexico: green, hawksbill, Kemp's ridley, leatherback, and loggerhead. All of these species may be found in the northern Gulf as hatchlings, juveniles, and adults. All but the hawksbill have been reported to nest on beaches within the northern Gulf, and the number and distribution of nests differ among these species across the bordering States (Table 4.3.12-1) (Pritchard 1997). While sea turtles are distributed within nearshore waters and waters of the continental shelf throughout the Gulf, they appear to occur in greatest abundance east of Mobile, Alabama (Davis et al. 2000). All five are listed as either endangered or threatened species under the Endangered Species Act (ESA) (USFWS 2006b).

TABLE 4.3.12-1 Sea Turtles of the Northern Gulf of Mexico

Species	Status[a]	Typical Adult Habitat	Juvenile/ Hatchlings Potentially Present?	Nesting
Family Cheloniidae				
Loggerhead turtle (*Caretta caretta*)	T	Estuarine, coastal, and shelf waters	Yes	Some nesting along northern Gulf Coast; main U.S. nesting beaches are in southeast Florida
Green turtle (*Chelonia mydas*)	T, E[b]	Shallow coastal waters, seagrass beds	Yes	Isolated and infrequent nesting in northern Gulf
Hawksbill turtle (*Eretmochelys imbricata*)	E	Coral reefs, hard-bottom areas in coastal waters; adults not often sighted in northern Gulf	Yes	Nesting in continental U.S. is limited to southeastern Florida and Florida Keys
Kemp's ridley turtle (*Lepidochelys kempi*)	E	Shallow coastal waters, seagrass beds	Yes	Nests mainly at Rancho Nuevo, Mexico; minor nesting on Padre and Mustang Islands, Texas
Family Dermochelyidae				
Leatherback turtle (*Dermochelys coriacea*)	E	Slope, shelf, and coastal waters; considered the most "pelagic" of the sea turtles	Yes	Some nesting in northern Gulf, especially Florida Panhandle; nearest major nesting concentrations are in Caribbean and southeast Florida

[a] Status: E = endangered species; T = threatened species (under the Endangered Species Act of 1973).

[b] Green sea turtles are listed as threatened except for the Florida where breeding populations are listed as endangered.

Source: USFWS (2006b).

The life history of sea turtles is discussed in Section 4.2.12. Sea turtles nest along the entire northern Gulf of Mexico Coast. There are reports of recent nesting in Alabama (loggerhead and green turtles) along Dauphin Island and the Gulf Islands National Seashore; Mississippi (loggerhead turtles) along the Gulf Islands National Seashore; and Louisiana (loggerhead turtles) within the Breton National Wildlife Refuge. Sea turtles also nest along areas of the Texas coast (Padre Island National Seashore), including loggerhead, green, and Kemp's ridley turtles. Hatchling turtles found in the offshore waters of the northern Gulf of Mexico may have originated from these nesting beaches or adjacent areas such as the southern Gulf of Mexico and Caribbean Sea. Juvenile turtles may move into shallow water developmental habitats across the entire northern Gulf. In some species or populations, adult foraging habitats may be geographically distinct from their developmental habitats (Musick and Limpus 1997).

There are no designated critical habitats or migratory routes for sea turtles in the northern Gulf of Mexico. The NMFS does recognize many coastal areas of the Gulf as preferred habitat (i.e., important sensitive habitats that are essential for the species within a specific geographic area), such as seagrass beds in Texas lagoons and other nearshore or inshore areas (including jetties) for green turtles, and bays and lakes, especially in Louisiana and Texas, for ridleys. Sargassum mats are also recognized as preferred habitat for hatchlings (Carr and Meylan 1980).

The green sea turtle (*Chelonia mydas*) is found throughout the Gulf of Mexico. It occurs in small numbers over seagrass beds along the south Texas coast and the Florida Gulf Coast. Reports of green turtles nesting along the Gulf of Mexico Coast are infrequent, and the closest important nesting aggregations are along the east coast of Florida and the Yucatan Peninsula (NMFS and USFWS 1991b).

The hawksbill sea turtle (*Eretmochelys imbricate*) has been recorded in all the Gulf of Mexico States (NMFS and USFWS 1993). However, sightings north of Florida are rare. The hawksbill is the least common sea turtle in the Gulf of Mexico (Hildebrand 1995). Hawksbill nesting within the continental United States is limited to southeastern Florida and the Florida Keys.

The Kemp's ridley sea turtle (*Lepidochelys kempi*) is the smallest of sea turtles. Survey data from the Gulf of Mexico suggest that Kemp's ridley turtles occur mainly on the continental shelf. Juvenile and adult Kemp's ridleys are typically found in shallow coastal areas and especially in areas of seagrass habitat (NMFS and USFWS 1992b; Ernst et al. 1994). The major nesting area for this species is near Rancho Nuevo, along the northeastern coast of Mexico (Tamaulipas), although scattered nesting has also been reported in other areas of Mexico and in Colombia, and Texas, Florida, and South Carolina (Ernst et al. 1994). Adult Kemp's ridleys exhibit extensive internesting movements. They appear to also travel near the coast and are especially common within shallow waters along the Louisiana coast.

The leatherback sea turtle (*Dermochelys coriacea*) is the most abundant turtle on the northern Gulf of Mexico continental slope (Davis et al. 2000). It is the most pelagic and wide-ranging sea turtle, undertaking extensive migrations from the tropics to boreal waters. Leatherback nesting within the continental United States is limited to eastern Florida (NMFS and USFWS 1992a; Ernst et al. 1994). Leatherbacks appear to use both continental shelf and slope habitats in the Gulf of Mexico (Fritts et al. 1983a, b; Collard 1990; Davis and Fargion 1996; Davis et al. 2000). Results of MMS-sponsored surveys (i.e., GulfCet I and II) suggest that the region from Mississippi Canyon to De Soto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Davis et al. 2000). Temporal variability in leatherback distribution and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. During the GulfCet I and II programs, leatherbacks were sighted frequently during both summer and winter (Davis et al. 2000).

The loggerhead sea turtle (*Caretta caretta*) is the most abundant sea turtle in the Gulf of Mexico (Dodd 1988). Loggerhead nesting along the Gulf Coast occurs primarily along the Florida Panhandle, although some nesting has also been reported from Texas through Alabama (NMFS and USFWS 1991a). Loggerhead turtles have been primarily sighted on the continental shelf, although many sightings of this species have also been made in the deeper slope waters at depths of greater than 1,000 m (3,281 ft). Sightings of loggerheads on the continental slope suggest that they may be in transit through these waters to distant foraging sites or while seeking warmer waters during winter. Although loggerheads were widely distributed across the shelf during both summer and winter, their abundance on the slope was greater during the winter (Davis et al. 2000).

The recent hurricanes that hit the Gulf Coast have adversely affected sea turtle habitats. Some nesting sites (approximately 50 nests) for Kemp's ridley sea turtle were destroyed along the Alabama coast (Congressional Research Service 2005; USFWS 2006c), and the loss of beaches through the affected coastal areas has probably affected other existing nests and nesting habitats of this species as well as the loggerhead turtle. Similarly, impacts to seagrass beds may affect the local distribution and abundance of sea turtle species that use these habitats, such as the green sea turtle and the Kemp's ridley sea turtle.

4.3.13 Coastal Habitats

The Gulf Coast shoreline is constantly changing as a result of the action of wind-driven waves and longshore currents that cause sediment transport (see Section 4.3.12). The coastline has a narrow tidal range, and energy forces tend to be storm-dominated, with episodic high wave energy. Coastal barrier landforms extend across the nearshore waters of the Gulf of Mexico from the Texas/Mexico border to southern Florida. These elongated, narrow islands, spits, and beaches are composed of sand and other unconsolidated, predominantly coarse sediments, and are continually modified by waves, currents, storm surges, and winds. Coastal currents in the Gulf of Mexico transport sediments in a counter-clockwise direction from east to west, and contribute to the sediment accretion as well as erosion of coastal landforms. Over extended time periods, landforms may move landward (transgressive), seaward (regressive), or laterally along the coast. Sediments are also transported to coastal areas from rivers that discharge to the Gulf. Barrier islands and sand spits protect wetlands and other estuarine habitats located behind them from the direct impacts of the open ocean, and slow the dispersal of freshwater into the Gulf, thus contributing to the total area and diversity of estuarine habitat.

On barrier landforms, the nonvegetated foreshore slopes up from the low-tide line to the beach berm-crest. The backshore is found between the beach berm-crest and the dunes, and it may be sparsely vegetated. The berm-crest and backshore may occasionally be absent due to storm activity. The dune zone of a barrier landform consists of one or more low dune ridges that may be stabilized by vegetation such as grasses and scrubby woody vegetation. During storms, waves can overwash lower barrier landforms, and vegetation communities on these are often sparse and in early successional stages. On higher, more stabilized landforms, vegetation behind the dunes consists of scrubby woody vegetation, marshes, and maritime forests. Fresh and saltwater ponds may occur on landward flats or between dunes. On the landward side of island and spits, low flats grade into intertidal wetlands or mudflats.

Barrier islands are prevalent along the Texas coast from the Bolivar Peninsula southward to the Mexican border. The barrier islands in this region are arranged symmetrically around old, eroding delta headlands, and tend to be narrow and sparsely vegetated, exhibiting a low profile with numerous washover channels. The barrier islands and beaches are moving generally to the southwest. Net coastal erosion has been occurring in some areas. Inland beaches of sand and shells are found along the shores of bays, lagoons, and tidal streams.

The coast of the Chenier Plain, which includes eastern Texas and western Louisiana, is composed of sand beaches and extensive intertidal mudflats. A subtidal mud bottom extends a great distance seaward in shallow water, reducing wave energy and resulting in minimal longshore sediment transport (USDOI and USGS 1988), and helping to protect coastal wetland communities. Barrier beaches in the Chenier Plain area are narrow, low, thin sand deposits present along the seaward edge of the coastal marsh, and have poorly developed dunes and numerous washover channels. In some western areas of the Chenier Plain, the beach and subtidal substrates are composed of shelly sand (Fisher et al. 1973). Subtidal substrates in eastern portions are mud and muddy sand. Most of the shoreline of the Chenier Plain is sediment starved and transgressive.

Most barrier shorelines of the Mississippi River Delta complex in Louisiana occur along the outward remains of a series of old abandoned river deltas and are transgressive. Only a minor portion of the sediments of the Mississippi River, now channelized, enter longshore currents and contribute to barrier landforms. The Mississippi River Delta in Louisiana has the most rapidly retreating beaches in North America. Regressive shorelines occur, however, at the mouth of the Atchafalaya River, where sediment discharges from that river are forming new deltas. Most of the barrier beaches of southeast Louisiana are composed of medium to coarse sand. Mudflats occur in lower intertidal areas. Gentle slopes of subtidal substrates in much of the area reduce wave energies and erosion.

Most dune areas of the delta consist of low single-line dune ridges that are sparsely to heavily vegetated, depending on the length of time between major storms. Short time intervals between storms can cause reductions in the size and resiliency of barrier islands and shorelines. Hurricane Katrina in 2005 caused severe erosion and land loss for the coastal barrier islands of the Deltaic Plain.

The Mississippi Sound barrier islands, along the coast of Mississippi and Alabama, are separated from each other by fairly wide, deep channels, and are offset from the coast by as much as 16 km (10 mi). They are generally regressive and stable in size, and slowly migrating westward. These islands have high beach ridges and prominent sand dunes, and sand shoals typically occur adjacent to the islands. The dunes and pond margins on the islands are well vegetated, with mature southern maritime forests of pine and palmetto behind some dunes areas. Although some of these islands may experience washover during significant storms, washover channels are not common. Wide beaches and a large dune system are located on the Alabama coast.

Barrier islands and sand beaches occur along the southwest Florida coastline, north of the Everglades, except in the Big Bend area. The barrier islands and mainland beaches of the Florida Panhandle typically are stable, with broad, high-profile beaches backed by high dunes. The Florida Keys, at the southern tip of Florida, are limestone islands, an unusual landform type that does not occur elsewhere in the Gulf of Mexico, and they provide unique habitats in the region (USDOI/MMS 1996).

A number of coastal habitat protection and restoration projects have been initiated along the Gulf Coast to address the issue of erosion and land losses. Many of these projects have focused on the rebuilding of barrier islands and coastal beaches for shoreline maintenance as well as protection of coastal salt marshes. Modern techniques used for navigation channel dredging and maintenance use the dredged sediments to nourish adjacent coastal landforms, minimizing potential erosion impacts. The MMS, in cooperation with State and local agencies, has been involved in the development of habitat restoration projects using OCS sand resources.

Wetland habitats along the coast of the Gulf of Mexico consist of seagrass beds; fresh, brackish, and salt marshes; mudflats; and forested wetlands of bottomland hardwoods, cypress-tupelo swamps, and mangrove swamps. Wetland habitats may occupy only narrow bands along the shore, or they may cover vast expanses of the coastline. Seagrass beds occur in shallow subtidal areas, while marshes and mangroves swamps are primarily intertidal habitats. Forested wetlands are generally found inshore, above the tidal influence.

High organic productivity, including detritus, and efficient nutrient recycling characterize coastal wetlands. They provide habitat for numerous species of plants, invertebrates, fish, reptiles, birds, and mammals. Freshwater marshes generally support a greater diversity of plant and animal species than do brackish and salt marshes.

Along the Texas coast, from the Mexican border to the Bolivar Peninsula, estuarine marshes occur in discontinuous bands around the bays, lagoons, on the inner sides of barrier islands, and in the deltas and tidally influenced reaches of rivers. Salt marshes, composed primarily of smooth cordgrass (*Spartina alterniflora*), are evident nearest to the mouths of bays and lagoons, in areas of higher salinities. Salt-tolerant species, such as saltwort (*Batis maritima*) and glasswort (*Salicornia* spp.), are among the dominant species. Brackish water marshes, some of which are infrequently flooded, occur farther landward. Freshwater marshes occur along the major rivers and tributaries, lakes, and catchments (White et al. 1986). Broken bands of black mangroves (*Avicennia germinans*) also occur in this area (Brown et al. 1977; White et al. 1986). Mud and sand flats occur around shallow bay margins and near shoals, increasing toward the south as marshes decrease. Freshwater swamps and bottomland hardwoods are uncommon, and do not occur in the southern third of this coastal area.

The Chenier Plain is a series of sand and shell ridges separated by progradational mudflats, marshes, and open water lakes. Few tidal passes are located along the Chenier Plain, and the tidal movement of saline water is reduced. Salt marshes are not widely distributed on the Chenier Plain. They are generally directly exposed to Gulf waters and are frequently inundated. Brackish marshes are dominant in estuarine areas and are the most extensive and productive in the Louisiana portion of this coastal area. Marsh-hay cordgrass (*Spartina patens*) is generally the dominant species. Freshwater wetlands are extensive on the Chenier Plain. While tidal influence is minimal, these wetlands may be inundated by strong storms. Detritus tends to collect in freshwater marshes and may form thick accumulations, sometimes forming floating marshes in very low energy areas. Forested wetlands of cypress-tupelo swamps, black willow stands, and bottomland hardwoods occur only in the floodplains of major streams.

Wetlands in the Mississippi Deltaic Plain are associated with a series of overlapping riverine deltas. These wetlands developed in shallow areas that received flow and sediments from the Mississippi River. Extensive salt and brackish marshes occur throughout the southern half of the plain and east of the Mississippi River. Further landward, extensive intermediate and freshwater marshes are found. In freshwater areas, cypress-tupelo swamps occur along the natural levees and in areas that are impounded by dredged materials, levees, or roads. Bottomland hardwoods occur on natural levees and in drained levee areas. Extensive freshwater marshes, swamps, and hardwood forest also occur in Atchafalaya Bay in association with the delta sediments. Sparse stands of black mangrove are scattered in some high-salinity areas of the Mississippi Deltaic Plain.

Most marshes around Mississippi Sound and associated bays occur as discontinuous wetlands associated with estuarine environments. The more extensive coastal wetland areas in Mississippi are associated with the deltas of the Pearl River and Pascagoula River. The marshes in Mississippi are more stable than those of either Alabama or Louisiana, reflecting a more stable substrate and continued active sedimentation in the marsh areas. In Alabama, most of the wetlands are located in Mobile Bay and along the northern side of Mississippi Sound. Forested wetlands are the predominant wetland type along the coast of Alabama; large areas of estuarine marsh and smaller areas of freshwater marsh also occur (Wallace 1996). Major causes of marsh loss in Alabama have included industrial development, navigational dredging, natural succession, and erosion-subsidence (Roach et al. 1987).

Along the southwest coast of Florida, a large area of coastal wetlands, including those in the Florida Everglades, extends from Cape Sable to Cape Romano. This area primarily supports a mangrove swamp community where it fronts on the open Gulf. Throughout the Florida Big Bend area, the coastal habitat consists of mudflats, oyster bars, and salt marsh habitats along the coast, grading into coastal hammocks and maritime hardwoods farther inland. Because of the reduced erosive forces there, forested wetlands occur down to the water's edge.

Losses of coastal wetlands have been occurring along the Gulf Coast for decades, as wetlands have been converted to open and deeper water. Coastal land loss is a particular problem in Louisiana. Coastal wetlands are lost due to the effects of large storm events, subsidence, sea-level rise, saltwater intrusion, drainage and development, canal construction, herbivory, and induced subsidence and fault reactivation. The sediment load of the Mississippi River has been greatly reduced, and levees constructed along the Mississippi River prevent seasonal overbank flooding and sediment deposition in coastal marshes. Projects undertaken through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, or Breaux Act) program (LCWCRTF 2003), Coast 2050 Plan (LCWCRTF 1998), and Louisiana Coastal Area Plan (USACE 2004c) are designed to contribute to ecosystem-scale restoration and sustainability.

Seagrass beds grow in shallow, relatively clear and protected waters with predominantly sand bottoms. Extensive areas of seagrass beds occur in exposed, shallow subtidal coastal waters of the northern Gulf of Mexico and in protected, natural embayments. Seagrasses are uncommon where freshwater inflow is high and salinities average less than 20 parts per thousand (ppt), as well as the upper portions of most estuaries. The area off Florida contains approximately 98.5% of all coastal seagrasses in the northern Gulf of Mexico; Texas and Louisiana contain approximately 0.5%. Mississippi and Alabama have the remaining 1% of seagrass beds. Seagrass beds provide habitat for a high diversity of marine species.

Primarily because of low salinity and high turbidity, robust seagrass beds are found only within a few scattered, protected locations in the Western and Central Gulf of Mexico, although seagrass meadows occur in nearly all bay systems along the Texas coast. Seagrasses in the Western Gulf are widely scattered beds in shallow, high-salinity coastal lagoons and bays. Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays. The distribution of seagrass beds in coastal waters of the Western and Central Gulf has diminished during recent decades.

The turbid waters and soft, highly organic sediments of Louisiana’s estuaries and offshore areas limit widespread distribution of higher salinity seagrass beds. Consequently, only a few areas in offshore Louisiana support seagrass beds. In Mississippi and Alabama, seagrasses occur within the Mississippi Sound. Widgeon grass (*Ruppia maritima*), an opportunistic species, is tolerant of low salinities and occurs in some estuaries.

As discussed above, Gulf of Mexico coastal habitats are continually modified by waves, currents, winds, storm surges, and subsidence. In a number of areas, the declines and losses of coastal habitats have been ongoing concerns. However, the storm surges, winds, and flooding associated with hurricanes Katrina and Rita resulted in considerable additional impacts to coastal habitats. Impacts included substantial erosion of beaches, dunes, and barrier islands, and damage or loss of wetlands and seagrass beds (Congressional Research Service 2005). Large areas of coastal marsh were degraded to open water areas. Approximately 562 km^2 (217 mi^2) of land, primarily marsh, was lost along the Louisiana coast (Barras 2006). An estimation of permanent losses will require several growing seasons, as transitory impacts are accounted for. Indirect impacts included the release of many non-native species of plants and animals into the environment; saltwater intrusion and degraded habitat quality, which may be conducive to the establishment of invasive aquatic and terrestrial species; release of debris, silt, and hazardous materials into the water column; and storm-deposited sediments, which may have long-term effects (USFWS 2006c).

4.3.14 Seafloor Habitats

The major benthic habitat of the northern Gulf of Mexico consists of a soft muddy bottom, dominated by polychaetes. Other important seafloor habitats on the continental shelf of the northern Gulf that are more at risk to potential impacts from alternative energy development include topographic features and live-bottom areas and submerged seagrass beds. Important features on the continental slope include chemosynthetic (seep) communities and deep-water coral habitats. These and other benthic communities of the shelf and slope are discussed below.

4.3.14.1 Topographic Features

Topographic features (or banks) and associated hard-bottom communities occur on the continental shelf and shelf edge, primarily in the western and central portions of the Gulf of Mexico. The major topographic features of the Gulf of Mexico are listed in Table 4.3.14-1. These features are elevated above the surrounding seafloor and are characterized as either midshelf bedrock banks or outer shelf bedrock banks with carbonate caps (Rezak et al. 1985). Although these topographic features are small, the hard-bottom faunal assemblages associated with them often have high diversity, species richness, and biomass; they also provide habitat for important commercial and recreational fish species.

The East and West Flower Garden Banks are two of the most prominent topographic features in the Gulf of Mexico, covering approximately 50 km^2 and 74 km^2 (50 mi^2 and 29 mi^2), respectively. These features rise from surrounding water depths greater than 100 m (328 ft) to a depth of 20 m (66 ft) at the crests. The banks formed over salt domes or diapirs, which forced the overlying bedrock upward, providing substrate for the colonization and growth of reef

TABLE 4.3.14-1 Principal Topographic Features of the Gulf of Mexico

Shelf Edge Banks	Midshelf Banks	South Texas Banks
Bright Bank	Sonnier Bank	Mysterious Bank
McGrail Bank	29 Fathom Bank	Baker Bank
Rankin Bank	Fishnet Bank	Aransas Bank
Alderdice Bank	Claypile Lump	Southern Bank
Rezak Bank	32 Fathom Bank	North Hospital Bank
Sidner Bank	Coffee Lump	Hospital Bank
Ewing Bank	Stetson Bank	South Baker Bank
Jakkula Bank		Dream Bank
Bouma Bank		Blackfish Ridge
Parker Bank		Big Dunn Bar
Sackett Bank		Small Dunn Bar
Diaphus Bank		
Sweet Bank		
East Flower Garden Bank		
West Flower Garden Bank		
Geyer Bank		
Elvers Bank		
MacNeil Bank		
Applebaum Bank		

Source: USDOI/MMS (1996).

organisms. The crests of these features are carbonate rock formed by reef-building corals, coralline algae, and other lime-secreting creatures. The dominant community on these banks at water depths less than 36 m (120 ft) is composed of about 20 species of hermatypic corals, with an average coverage of more than 50% (Bright et al. 1984; Dokken et al. 1999). Additionally, more than 80 species of algae, approximately 250 species of macroinvertebrates, and more than 120 species of fishes are associated with these features (Dokken et al. 1999).

Pulley Ridge is another unique topographic feature in the Gulf of Mexico. This area consists of a series of underwater ridges located on the southwest Florida shelf approximately 250 km (155 mi) west of Cape Sable, Florida. These ridges, which have less than 10 m (33 ft) of vertical relief and are located at depths of 60 to 80 m (200 to 260 ft), are oriented north-south over an area approximately 100 km (62 mi) long by 5 km (3 mi) wide. The southern portion of the ridge hosts an unusual variety of reef-building hard corals, green, red and brown macroalgae, and typically shallow-water tropical fishes. Because of its unique biological and ecological characteristics, the Pulley Ridge is a habitat area of particular concern; fishing-gear regulations that restrict the use of anchors, fish traps, lobster pots, trawling gear, or bottom longlines have been implemented within this area.

4.3.14.2 Live-Bottom Areas

Live bottoms are high-productivity communities generally characterized by a high diversity of attached biota on rock or firm substrate. The sessile epibiota typically found in live-bottom areas may include macroalgae, seagrasses, sponges, hydroids, octocorals, antipatharians, hard corals, bryozoans, and ascidians. In the Gulf of Mexico, these communities are found across the length of the west Florida shelf and in more restricted locations off Alabama, Mississippi, and Louisiana (Roberts et al. 2005).

Parker et al. (1983) estimated the amount of reef habitat or hard bottom on the Gulf of Mexico continental shelf at water depths between 18 and 91 m (59 and 299 ft) by lowering a camera system to the bottom at randomly selected locations. Between Key West and Pensacola, Florida, it was estimated that 38% of the seafloor consisted of hard-bottom/reef habitat. From Pensacola west to Pass Cavallo, Texas, only about 3% of the seafloor consisted of such habitat.

The live-bottom communities on the west Florida shelf are tropical to temperate in nature, with the number of tropical species decreasing to the north. The live-bottom communities are predominantly algal/sponge/coral assemblages, with the shallow-water octocorals and the hard corals significantly decreasing in abundance at depths greater than about 40 m (131 ft). Most of the hard bottom on the west Florida shelf is low relief (<1 m [<3 ft]), with a thin sand veneer often covering underlying rock (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983, 1985; Continental Shelf Associates, Inc., 1987). Despite the relatively small amount of actual exposed rock outcrops across this shelf, dense assemblages of attached epifauna are common.

The Florida Middle Ground, an area of high-relief, hard-bottom features located approximately 160 km (99 mi) northwest of Tampa Bay, Florida, has generally been accepted as the northerly limit of significant coral communities in the eastern Gulf of Mexico (Grimm and Hopkins 1977). These reef features rise from the seafloor at a 40-m (131-ft) water depth and crest at a depth of 23 m (75 ft). The coral assemblage is relatively low in diversity due to its location at the northern range of hermatypic corals.

Live-bottom communities on the shelf in the northeastern Gulf of Mexico are typically composed of small areas of low-relief rock in primarily sandy bottom areas. The hard bottom, found in water depths of 20 to 36 m (66 to 118 ft), ranges from low-relief exposed rock in shallow depressions to rock outcrops with a few meters of vertical relief. The dominant biota include coralline algae, hydroids, sponges, octocorals, solitary hard corals, bryozoans, and ascidians (Schroeder et al. 1989; Continental Shelf Associates, Inc., 1992a, 1994; Thompson et al. 1999).

Shipp and Hopkins (1978) conducted submersible surveys along the northwestern rim of the De Soto Canyon and reported a block-like limestone substrate with a relief of up to 10 m (33 ft) at 50- to 60-m (164- to 197-ft) water depths. Subsequent mapping and monitoring surveys have been conducted in this area by Continental Shelf Associates, Inc. (1989, 1992a, 1994) and Barry A. Vittor & Associates, Inc. (1985). The variable-relief, hard-bottom substrates of this feature are primarily colonized by sponges, octocorals, antipatharians, bryozoans, and calcareous algae.

4.3.14.3 Pinnacle Trend

Ludwick and Walton (1957) described a region of discontinuous carbonate reef structures along the shelf edge between the Mississippi River Delta and De Soto Canyon. Subsequent MMS-sponsored studies (Brooks 1991; Continental Shelf Associates, Inc., 1992b; Continental Shelf Associates, Inc., and Texas A&M University, Geochemical and Environmental Research Group 1999) have provided further information about these features. Thousands of carbonate mounds ranging in size from less than a few meters in diameter to nearly a kilometer have been mapped and fall primarily in two parallel bands along isobaths. The largest of these features are found between depths of 74 to 82 m (243 to 269 ft) and 105 to 120 m (344 to 394 ft), and have vertical relief ranging from 2 to 20 m (7 to 66 ft). Although the Pinnacle Trend is considered a specific region, features occurring there are also considered as a category of live bottom.

The pinnacle features provide a significant amount of hard substrate for colonization by suspension-feeding invertebrates and support relatively rich live bottom and fish communities. At the tops of the shallowest features in water depths of less than approximately 70 m (230 ft), assemblages of coralline algae, sponges, octocorals, crinoids, bryozoans, and fishes are present. On the deeper features, as well as along the sides of these shallower pinnacles, ahermatypic corals may be locally abundant, along with octocorals, crinoids, and basket stars. The diversity and abundance of the associated species appear to be related to the size and complexity of the features, with the low-relief rock outcrops (< 1 m [<3 ft] height) typically having low faunal densities, and higher relief features having the more diverse faunal communities.

4.3.14.4 Submerged Seagrass Beds

Seagrass beds (also considered as a category of live bottom) are extremely productive marine habitats that support a tremendously complex ecosystem. They provide nursery grounds for vast numbers of commercially and recreationally important fisheries species, including shrimps, black drum, snappers, groupers, spotted sea trout, southern flounder, and many others.

Seagrasses generally grow on sand bottoms in shallow, relatively clear water in areas with low wave energy. There are more than 500,000 ha (1,235,522 acres) of seagrass in the Northern Gulf of Mexico. It is estimated that about 85% of the seagrass beds in the Gulf of Mexico are located in the eastern Gulf, off the coast of Florida (USGS 2001).

Inshore of the Central and Western Gulf of Mexico regions, the coastal waters of Mississippi and Alabama contain approximately 30,000 ha (74,131 acres) of seagrass growing along the inner edges of the barrier islands of Mississippi Sound and along the shorelines of prominent bays. To the west, Texas nearshore waters contain approximately 80,000 ha (197,684 acres) of seagrass beds, most of which are located in the Laguna Madre (USGS 2001).

Seagrass distributions inshore of the Eastern, Central, and Western Gulf of Mexico Planning Areas have declined over the last several decades due to a number of natural and manmade factors, including recent hurricanes, trawling, dredging, dredge material disposal, housing development, water quality degradation, and levee construction.

4.3.14.5 Other Benthic Habitats (Continental Shelf)

The continental shelf in the Gulf of Mexico extends from the coastline out to the shelf break at water depths ranging about 118 to 150 m (387 to 492 ft). Continental shelf soft-bottom communities in the Gulf of Mexico are described in numerous studies, including Lyons and Collard (1974); Defenbaugh (1976); Pequegnat et al. (1976); Dames and Moore (1979); Flint and Rabalais (1980); Bedinger (1981); Woodward-Clyde Consultants and Continental Shelf Associates, Inc. (1983, 1985); Continental Shelf Associates, Inc. (1987); and Brooks (1991).

Continental shelf soft-bottom communities are made up of various assemblages of animals comprising a large number of species. Species composition and abundance are affected by a variety of environmental conditions such as substrate type, temperature, salinity, water depth, ocean currents, dissolved oxygen levels, nutrient availability, and turbidity.

Infaunal communities on the Gulf of Mexico continental shelf are generally dominated, in both number of species and individuals, by polychaete worms, followed by crustaceans and mollusks (Dames and Moore 1979; Woodward–Clyde Consultants and Continental Shelf Associates, Inc., 1983, 1985; Continental Shelf Associates, Inc., 1987, 1992a, 1996; Brooks 1991). These animals are typically distributed on the basis of water depth and sediment composition or grain size, with seasonal components also present in shallower water areas.

4.3.15 Areas of Special Concern

Executive Order 13158 on Marine Protected Areas, signed May 26, 2000, directs the Departments of Commerce and Interior, in consultation with other departments, to strengthen and enhance the Nation's system of marine protected areas (MPAs). Through existing authorities, current sites will be augmented, and new sites will be established or recommended, as appropriate. A Federal Advisory Committee was established to provide guidance on the framework for the national system, stewardship of MPAs, and coordination of interested parties. The National Marine Protected Areas Center, administered by NOAA, provides coordination for the Committee, manages the website (www.mpa.gov), and provides technical assistance and training. At present, 54 MPAs, have been designated within the Gulf of Mexico region (Table 4.3.15-1). National marine sanctuaries, national parks, national wildlife refuges, national estuarine research reserves, and National Estuary Program sites are discussed in the following sections. In addition, there are a number of coastal and aquatic reserves managed by State agencies or nongovernmental organizations. Figure 4.3.10-1 shows the locations of offshore Federal and State ecological reserves, including marine sanctuaries, wildlife refuges, and other protected areas such as critical habitats. Effects of recent hurricanes on areas of special concern are also discussed in this section.

4.3.15.1 Marine Sanctuaries

Two national marine sanctuaries have been established in the Gulf of Mexico—the Florida Keys National Marine Sanctuary in south Florida and the Flower Garden Banks National Marine Sanctuary located off the coast of Texas/Louisiana (Table 4.3.15-1). The Florida Keys National Marine Sanctuary, designated in November 1990, was established to allow management and protection of the marine ecosystems around the Florida Keys. The boundaries of the sanctuary include various types of coral reef areas, seagrass beds, mangrove shorelines, and sand flats. The reefs and surrounding environments contain high-diversity biological communities that are easily impacted by the activities of man. To better allow the protection and management of the sanctuary, special restriction zones were established to protect the sensitive habitat within these areas. These zones include wildlife management areas, ecological reserves, sanctuary preservation areas, existing management areas, and special-use areas.

The Flower Garden Banks National Marine Sanctuary, designated in 1992, is located about 175 km (109 mi) southeast of Galveston, Texas, and represents the northernmost coral reef system in the United States. Together, the East and West Banks cover an area of 124 km^2 (48 mi^2) and contain 142 ha (351 acres) of reef crest. In October 1996, Congress expanded the sanctuary by adding a small third bank, Stetson Bank, which is about 800 m (2,625 ft) long and 300 m (984 ft) wide and is located about 113 km (70 mi) south of Galveston, Texas. Environmental conditions at Stetson Bank do not support the growth of reef-forming corals like those found at the East and West Flower Garden Banks. The reef areas of the Flower Garden Banks National Marine Sanctuary are dominated by hermatypic corals, along with associated fishes and invertebrates. The MMS has protected the biological resources of the Flower Garden Banks National Marine Sanctuary from potential damage due to oil and gas exploration by establishing a "No Activity Zone" and by other operational restrictions in the vicinity of the

TABLE 4.3.15-1 Marine Protected Areas in the Gulf of Mexico Region[a]

Site Name	State	Managing Agency (Office/Bureau)[b]	Type of Site[c]
Florida Middle Grounds Habitat Area of Particular Concern	FL	NOAA (NMFS)	FFHCZ
Tortugas Marine Reserves	FL	NOAA (NMFS)	FFHCZ
West and East Flower Garden Banks Habitat Area of Particular Concern	TX	NOAA (NMFS)	FFHCZ
Closure of the Madison and Swanson Sites	FL	NOAA (NMFS)	FFMZ
Steamboat Lumps	FL	NOAA (NMFS)	FFMZ
Desoto Canyon Closed Area	LA	NOAA (NMFS)	FFMZ
Reef Fish Longline and Buoy Gear Restricted Area	MS	NOAA (NMFS)	FFMZ
Reef Fish Stressed Area	MS	NOAA (NMFS)	FFMZ
Weeks Bay National Estuarine Research Reserve	AL	Alabama Department of Conservation and Natural Resources (Division of State Lands, Coastal Section)	NERR
Apalachicola National Estuarine Research Reserve	FL	Florida DEP (Florida DEP)	NERR
Rookery Bay National Estuarine Research Reserve	FL	Florida DEP (Office of Coastal and Aquatic Managed Areas)	NERR
Grand Bay National Estuarine Research Reserve	MS	Mississippi Department of Marine Resources (Mississippi Department of Marine Resources)	NERR
Jean Lafitte National Historical Park and Preserve, Barataria Preserve	LA	USDOI (NPS)	NHPP
Florida Keys National Marine Sanctuary	FL	NOAA (National Ocean Service)	NMS
Flower Garden Banks National Marine Sanctuary	LA	NOAA (National Ocean Service)	NMS
Dry Tortugas National Park	FL	USDOI (NPS)	NP
Everglades National Park	FL	USDOI (NPS)	NP
Gulf Islands National Seashore	MS	USDOI (NPS)	NS
Padre Island National Seashore	TX	USDOI (NPS)	NS
Bon Secour National Wildlife Refuge	AL	USDOI (USFWS)	NWR
Cedar Keys National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Chassahowitzka National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Crocodile Lake National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Crystal River National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Egmont Key National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Great White Heron National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Island Bay National Wildlife Refuge	FL	USDOI (USFWS)	NWR
J.N. “Ding” Darling National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Key West National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Lower Suwannee National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Matlacha Pass National Wildlife Refuge	FL	USDOI (USFWS)	NWR
National Key Deer Refuge	FL	USDOI (USFWS)	NWR
Passage Key National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Pine Island National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Pinellas National Wildlife Refuge	FL	USDOI (USFWS)	NWR
St. Marks National Wildlife Refuge	FL	USDOI (USFWS)	NWR

TABLE 4.3.15-1 (Cont.)

Site Name	State	Managing Agency (Office/Bureau)[b]	Type of Site[c]
St. Vincent National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Ten Thousand Islands National Wildlife Refuge	FL	USDOI (USFWS)	NWR
Bayou Sauvage National Wildlife Refuge	LA	USDOI (USFWS)	NWR
Big Branch Marsh National Wildlife Refuge	LA	USDOI (USFWS)	NWR
Breton National Wildlife Refuge	LA	USDOI (USFWS)	NWR
Delta National Wildlife Refuge	LA	USDOI (USFWS)	NWR
Sabine National Wildlife Refuge	LA	USDOI (USFWS)	NWR
Shell Keys National Wildlife Refuge	LA	USDOI (USFWS)	NWR
Grand Bay National Wildlife Refuge	MS	USDOI (USFWS)	NWR
Anahuac National Wildlife Refuge	TX	USDOI (USFWS)	NWR
Aransas National Wildlife Refuge	TX	USDOI (USFWS)	NWR
Big Boggy National Wildlife Refuge	TX	USDOI (USFWS)	NWR
Brazoria National Wildlife Refuge	TX	USDOI (USFWS)	NWR
Laguna Atascosa National Wildlife Refuge	TX	USDOI (USFWS)	NWR
McFaddin National Wildlife Refuge	TX	USDOI (USFWS)	NWR
Moody National Wildlife Refuge	TX	USDOI (USFWS)	NWR
San Bernard National Wildlife Refuge	TX	USDOI (USFWS)	NWR
Texas Point National Wildlife Refuge	TX	USDOI (USFWS)	NWR

[a] Includes sites designated by the U.S. Department of the Interior and NOAA. Sites designated by State, Territory, and Commonwealth agencies are not included, but can be obtained from the lists on the Marine Protected Areas of the United States website at http://www3.mpa.gov/exploreinv/status.aspx.

[b] USDOI = U.S. Department of the Interior; NMFS = National Marine and Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NPS = National Park Service; USFWS = U.S. Fish and Wildlife Service.

[c] FFHCZ = Federal Fishery Habitat Conservation Zone; NERR = National Estuarine Research Reserve; NHPP = National Historic Park and Preserve; NMS = National Marine Sanctuary; NP = National Park; NS = National Seashore; NWR = National Wildlife Refuge.

Source: U.S. Department of Commerce and U.S. Department of the Interior (2006).

banks. By designating the area as a national marine sanctuary, other protective measures have been provided by regulating the following activities:

- Injuring, removing, possessing, or attempting to injure or remove living or nonliving sanctuary resources;
- Feeding fishes and certain methods of taking fishes;
- Vessel anchoring and mooring;
- Discharging or depositing polluting materials within the sanctuary;

- Discharging or depositing polluting materials outside the sanctuary boundaries that subsequently enter the sanctuary and injure a sanctuary resource or quality; and

- Altering the seabed or constructing, placing, or abandoning any structure or material on the seabed.

A long-term ecological monitoring program has been ongoing at the Flower Garden Banks National Marine Sanctuary since 1989. On the basis of all growth measures applied, the East and West Banks coral communities appear to be healthy and growing (Dokken et al. 2003; Precht et al. 2006). These reports indicate that, through the 1998–2001 sample periods, these banks appeared to be healthy and productive during the periods sampled. No significant upward or downward trends in growth rates were evident during the 1998–2001 survey period, and no correlations of growth to environmental parameters could be ascertained. Rates of coral growth at the Flower Garden Banks National Marine Sanctuary were in the midrange to upper range of growth rates of corals among Caribbean Sea reefs (Dokken et al. 2003).

4.3.15.2 National Park System

The National Park System ensures protection and interpretation of the country's natural, cultural, and recreational resources. Park System Lands along the coast or in coastal areas of the Gulf of Mexico include the Padre Island National Seashore, Jean Lafitte National Historic Park, Gulf Islands National Seashore, DeSoto National Memorial, Big Cypress National Preserve, Everglades National Park (see Section 4.2.15.2), and Dry Tortugas National Park (Table 4.3.15-1).

Florida's Everglades National Park and Big Cypress National Preserve contain more than 890,340 ha (2,200,069 acres) of marshes, wetlands, and estuaries that provide habitat for unique species of temperate and tropical flora and fauna.

The Dry Tortugas National Park is located in the southeastern Gulf of Mexico, approximately 48 km (30 mi) west of the Florida Keys. The park encompasses seven small islands within its 259-km^2 (100-mi^2) jurisdiction that are composed of coral reefs and sand. The park contains Fort Jefferson, originally built to guard the major sea lane between the Caribbean and the Gulf of Mexico. The Dry Tortugas are situated on the edge of the main ship channel between the Gulf of Mexico, the western Caribbean, and the Atlantic Ocean. Since the days of Spanish exploration, the reefs and shoals of the Dry Tortugas have been a serious hazard to navigation and the site of hundreds of shipwrecks. The Dry Tortugas National Park includes a relatively pristine portion of the Florida Keys coral reef ecosystem and supports abundant bird and marine life.

More than 177 km (110 mi) of coastal beaches and barrier islands in Texas, Mississippi, and Florida are used by millions of visitors each year at Padre Island National Seashore and Gulf Islands National Seashore. In addition to providing a popular destination for tourists, Padre Island National Seashore protects the largest portion of undeveloped barrier island in the world, supports a wide variety of flora and fauna, and is the most important nesting site for the Kemp's ridley sea turtle in the United States. Padre Island National Seashore also includes approximately 8,094 ha (20,000 acres) of the Laguna Madre, which is one of only five hypersaline lagoons in the world.

The Gulf Islands National Seashore includes major portions of the barrier islands off the coasts of Florida and Mississippi, including beaches, coastal marshes, maritime forests, and offshore areas. The park also contains historic sites dating to 16th-century European exploration and occupation.

4.3.15.3 National Wildlife Refuges

There are more than 30 national wildlife refuges located along the coastline or within the coastal areas of the Gulf of Mexico from Texas through Florida. Most refuges along the Gulf coastline were established to provide wintering areas for ducks, geese, coots, and other migratory waterfowl and shorebirds. Threatened and endangered species including the bald eagle, brown pelican, American alligator, and West Indian manatee also use the refuges along the Gulf of Mexico.

4.3.15.4 National Estuarine Research Reserves

The National Estuarine Research Reserve Program was established by the Coastal Zone Management Act of 1972 and is administered by the Sanctuaries and Reserves Division, National Ocean Service, NOAA. One of the primary objectives for establishing this program was to provide research information to be utilized by coastal managers and the fishing industry to help ensure the continued productivity of estuarine ecosystems. Four estuarine research reserves have been established in the Gulf of Mexico area (Table 4.3.15-1).

Weeks Bay National Estuarine Research Reserve in coastal Alabama includes a small estuary covering approximately 1,225 ha (3,027 acres). The reserve is composed of open shallow waters, with an average depth of less than 1.5 m (4.9 ft) and extensive vegetated wetland areas. Freshwater enters from the Fish and Magnolia Rivers, and the reserve connects with Mobile Bay through a narrow opening.

The Rookery Bay National Estuarine Research Reserve, south of Naples, Florida, covers approximately 5,060 ha (12,503 acres) and includes mangroves, open bays, creeks, pine flats, hardwood hammocks, oyster reefs, and seagrass beds. A marine laboratory is located within the reserve, with management of the reserve provided by the Florida Department of Environmental Protection, the Nature Conservancy, and the National Audubon Society.

The Apalachicola National Estuarine Research Reserve, southeast of Panama City, Florida, covers approximately 78,500 ha (193,977 acres) that consists of forested flood plains, salt and freshwater marshes, barrier islands, and open bays. A Federal refuge and a State park are within the reserve boundaries. An oyster fishery is the prime business of the adjacent Apalachicola area.

The Grand Bay National Estuarine Research Reserve supports several rare or endangered plant and animal species, numerous important marine fishery resources, diverse habitat types, and important archaeological sites. The reserve contains a diverse range of habitats, including coastal bay, saltwater marshes, maritime pine forest, pine savanna, and pitcher plant bogs. It supports extensive and productive oyster reefs and seagrass habitats and serves as nursery area for many important recreational and commercial marine species, such as shrimp, blue crab, speckled trout, and red drum.

4.3.15.5 National Estuary Program

In 1987, an amendment to the Clean Water Act, known as the Water Quality Act (P.L. 100-4), established the National Estuary Program. The purposes of the program are to identify nationally significant estuaries, to protect and improve their water quality, and to enhance their living resources. Under the administration of the USEPA, comprehensive administration plans are generated to protect and enhance environmental resources of estuaries designated to be of national importance. The governor of a State may nominate an estuary for the program and may request that a Comprehensive Conservation and Management Plan be developed. Over a 5-year period, representatives from Federal, State, and interstate agencies; academic and scientific institutions; and industry and citizens groups work to define objectives for protecting the estuary, select the chief problems to be addressed in the plan, and ratify a pollution control and resource management strategy to meet each objective.

Eight Gulf of Mexico estuarine watersheds are within the National Estuary Program including: Coastal Bend Bays and Estuaries, Galveston Bay, Barataria-Terrebonne Estuarine Complex, Mobile Bay, Tampa Bay, Sarasota Bay, Charlotte Harbor, and Indian River Lagoon (Table 4.2.15-1). Together, these estuarine watersheds encompass more than 284,000 km^2 (109,653 mi^2) of surface area.

4.3.15.6 Effects of Hurricanes on Areas of Special Concern

Recent hurricane events (i.e., Ivan, Katrina, and Rita) have severely impacted numerous areas of special concern in the Gulf, including national parks, National Wildlife Refuges, marine sanctuaries, and national estuaries. For example, in 2004, Hurricane Ivan caused considerable damage to 10 National Wildlife Refuges in Alabama, Mississippi, Louisiana, and the Florida panhandle (USFWS 2004). More recently, Hurricane Katrina affected 16 coastal National Wildlife Refuges in Alabama, Mississippi, and Louisiana, temporarily closing all of them and resulting in initial damage estimates exceeding $94 million (USFWS 2006c). Impacts included damages to beaches, dunes, vegetation, and infrastructure. The Breton National Wildlife Refuge in Louisiana, which is part of the Chandeleur Islands, was reduced to about half its pre-Katrina size (from 5,261 ha [13,000 acres] to about 2,630 ha [6,500 acres]). Many of the affected refuges remain impacted by tons of debris and large amounts of hazardous liquids deposited by the storm. For example, Sabine National Wildlife Refuge remains closed to the public, with an estimated 7 million m^3 (9 million yd^3) of debris and between 435,322 and 1,324,894 L (115,000 and 350,000 gal) of hazardous liquids and gases spread over 716 ha (1,770 acres) of marsh (Hall 2006). Characterization, monitoring, and cleanup activities are underway and will likely continue for several years or more.

4.3.16 Military Use Areas

See Section 4.2.16, which identifies the general nature of military uses on the OCS. Refer to Figures 4.3.16-1 and 4.3.16-2 for a depiction of military use areas in the GOM region. The GOM region supports a wide variety of military test and training activities that stretch from the eastern Gulf adjacent to Key West to include the onshore and offshore areas of Texas.

4.3.17 Transportation

As discussed in Section 4.2.17, transportation operations for alternative energy source site locations on the OCS may be influenced by existing ocean port capabilities and vessel activities. The locations of major commercial ocean ports on the Gulf Coast are shown in Figures 4.3.17-1 and 4.3.17-2. Of these ports, the commercial freight ports handling larger vessels are listed in Table 4.3.17-1. As listed for oceangoing vessels of 10 deadweight tons (DWT) or larger, the ports of Houston and New Orleans handled the most vessel calls in 2005, with 5,891 and 3,749 vessels, respectively (MARAD 2006a). Such detailed statistics are not available for smaller commercial vessels, but such traffic is expected to have a similar trend at these ports because of the available infrastructure such as cargo handling/storage capabilities and connecting roads and railroads, as well as the need to provide support craft (e.g., tugboats or lightering vessels) for the larger vessels. In addition, these larger vessels are more likely to travel into Federal waters (e.g., to international destinations) than smaller craft. Another measure of vessel traffic and port size and capabilities is the annual volume of goods shipped and received. Table 4.3.17-2 lists the ports in the Gulf of Mexico that were within the top 149 U.S. ports in 2004 for the amount of cargo handled.

Commercial fishing ports could also provide a base of support operations for OCS alternative energy facilities. For smaller commercial freight vessels, no detailed statistics of total vessel activity at fishing ports are available, but the total fish landings at a port can be used as a rough estimate of vessel activity. Fish landings and the correlation to vessel trips will vary somewhat depending on vessel size (i.e., the amount of fish a vessel can carry) and what percentage of that capacity was actually used on each trip. Table 4.3.23-2 presents the amount of fish landed in 2004 by State off the Gulf Coast. Also given is the breakdown between the amount caught within State waters (0 to 5 km [0 to 3 mi] from shore) and within the Federal waters (5 to 322 km [3 to 200 mi] from shore). Overall, about one-quarter of the fish landed off the Gulf Coast were caught in Federal waters, with Texas having the largest percentage of landings from Federal waters (71%). The lower overall number from Federal waters is due to the large fish landings within Louisiana State waters. Louisiana dominated the total landings for the Gulf Coast region with two fishing ports, Empire-Venice and Intracoastal City, leading the way

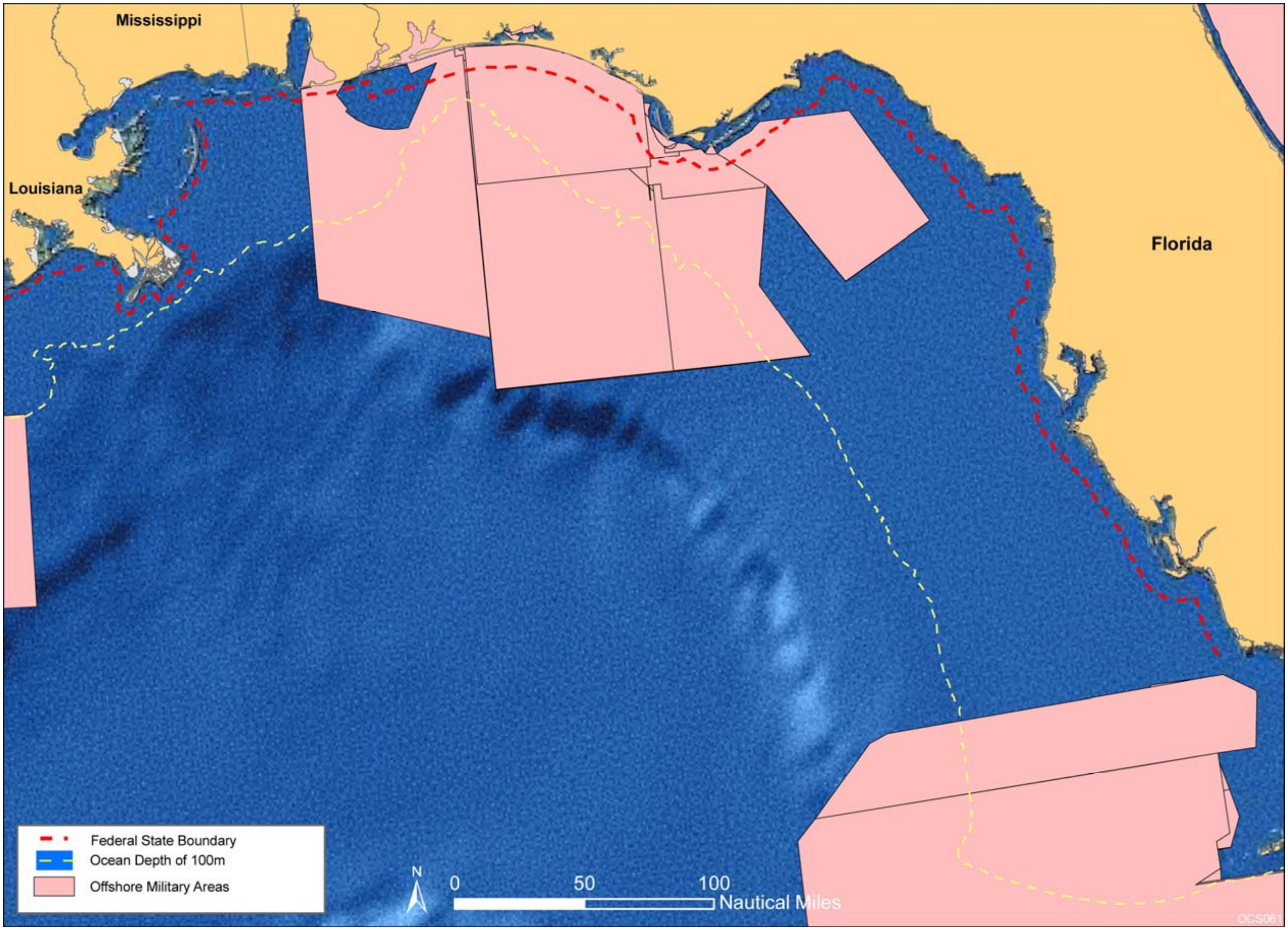

FIGURE 4.3.16-1 Eastern Gulf of Mexico Military Areas (Sources: NOAA 2006h; Parisi 2007)

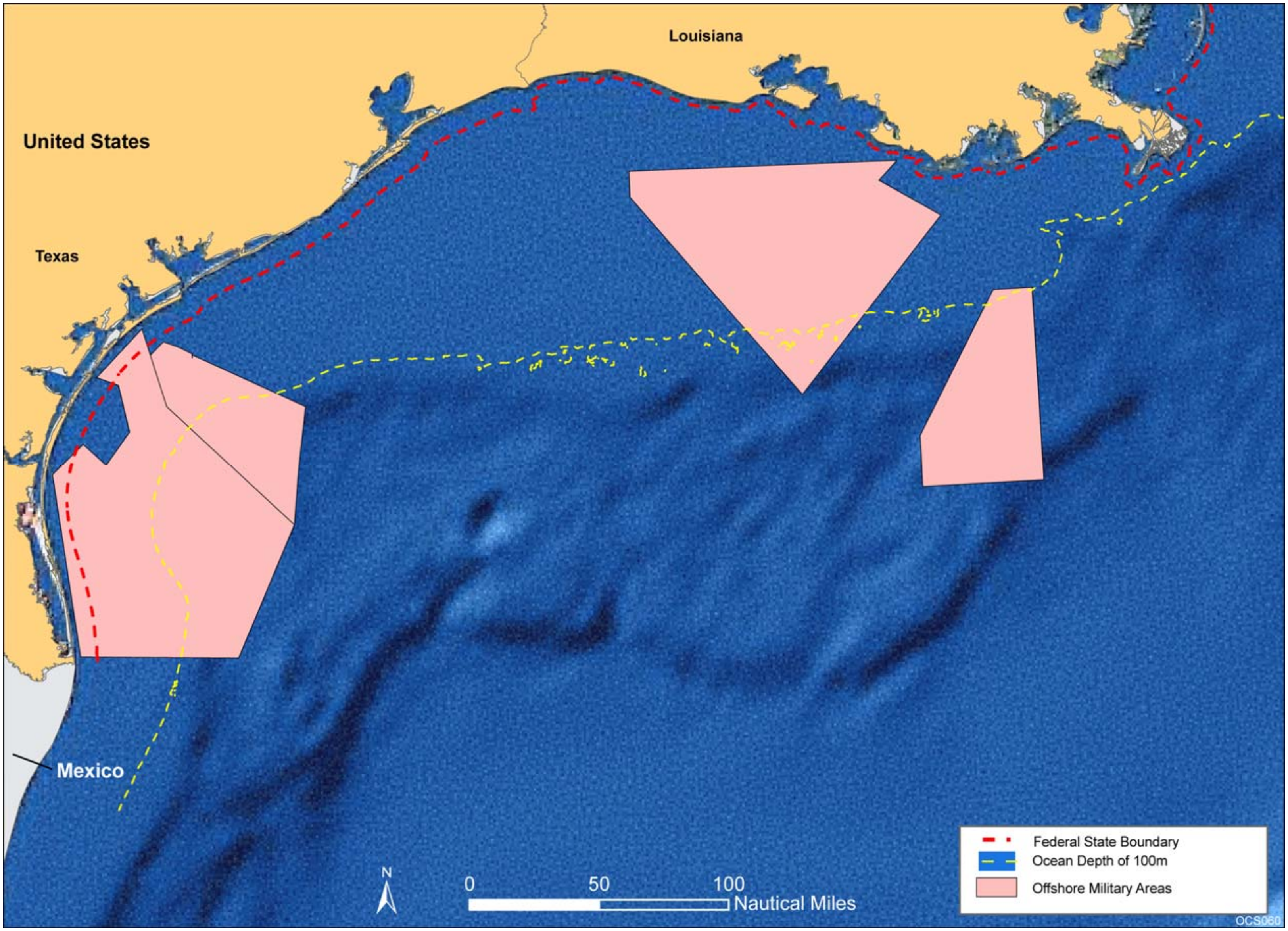

FIGURE 4.3.16-2 Western Gulf of Mexico Military Areas (Source: NOAA 2006h; Parisi 2007)

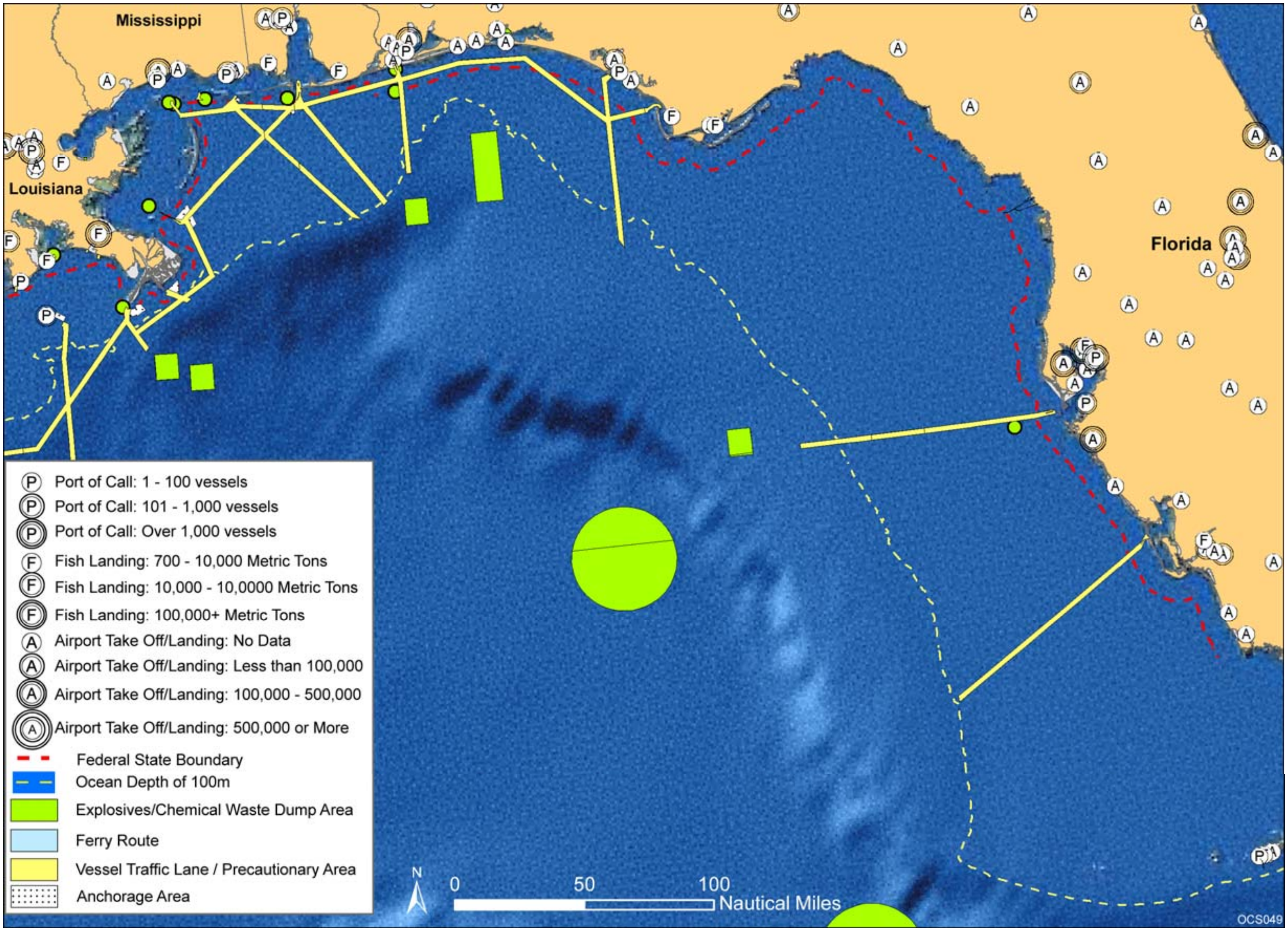

FIGURE 4.3.17-1 Eastern Gulf of Mexico Offshore Dump Sites and Transportation Features (Source: NOAA 2006h and references in text)

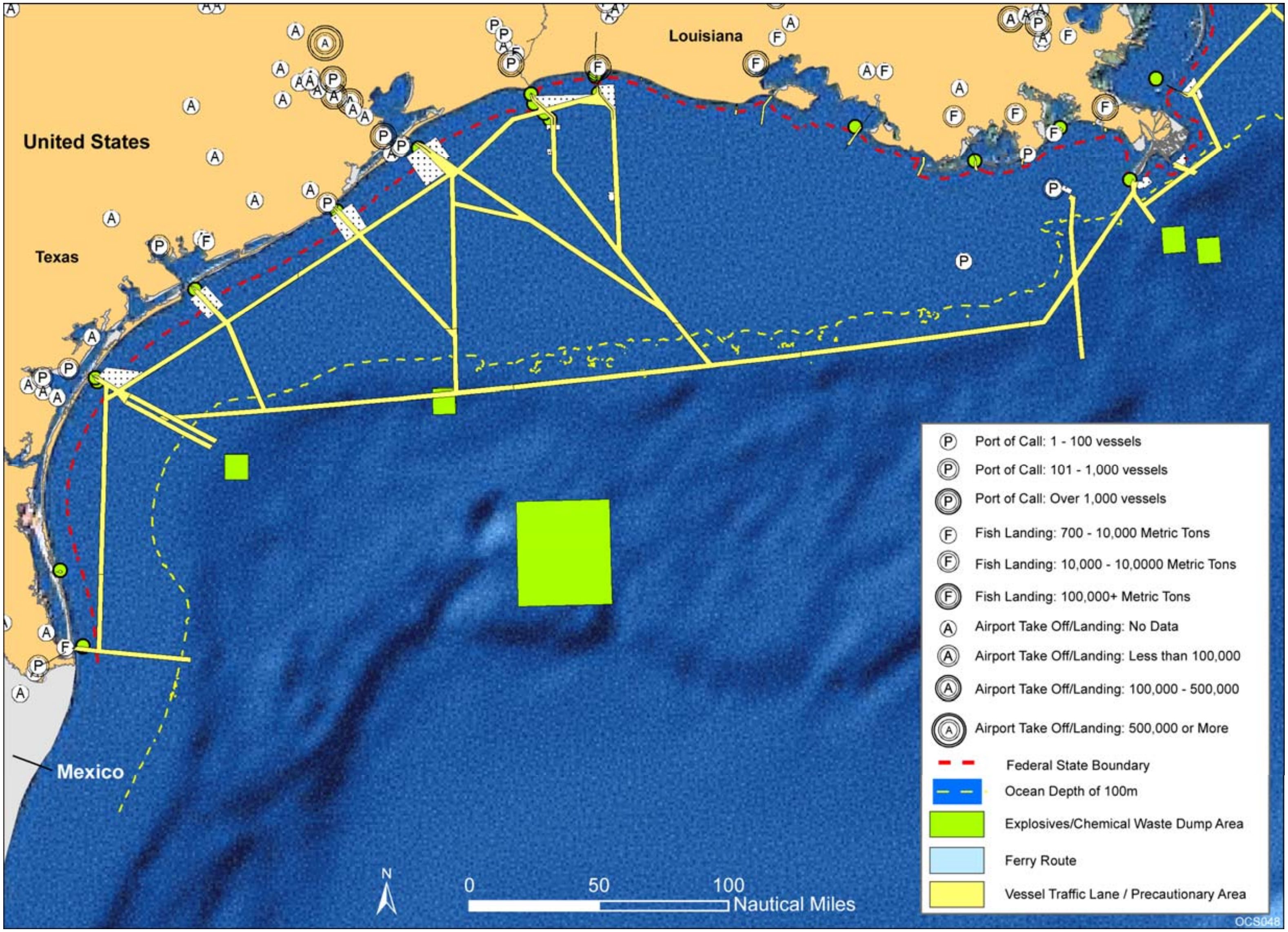

FIGURE 4.3.17-2 Western Gulf of Mexico Offshore Dump Sites and Transportation Features (Source: NOAA 2006h and references in text)

TABLE 4.3.17-1 U.S. Gulf of Mexico Port Calls by Port and Commercial Vessel Type for 2005[a]

Port	State	All Types Calls	Tanker[b] Calls	Container Calls	Dry Bulk Calls	Ro-Ro[c] Calls	Gas Carrier Calls	Combination Calls	General Cargo Calls
Houston	TX	5,891	3,392	874	765	183	193	73	411
New Orleans	LA	3,749	1,121	310	1,962	29	112	26	189
Port Arthur	TX	1,563	1,270	1	179	6	22	6	79
Texas City	TX	1,142	1,074	0	59	0	0	5	4
Tampa	FL	1,003	401	38	396	26	94	1	47
Corpus Christi	TX	989	788	0	145	1	1	46	8
Mobile	AL	811	187	35	415	5	0	23	146
Freeport	TX	760	561	87	30	0	56	1	24
Lake Charles	LA	701	434	1	164	0	34	10	58
Galveston	TX	429	150	3	114	78	5	7	72
LOOP Terminal	LA	401	400	0	1	0	0	0	0
Point Comfort	TX	321	251	0	36	0	34	0	0
Pascagoula	MS	233	189	0	29	0	2	1	12
Port Manatee	FL	159	21	0	76	0	0	0	62
Brownsville	TX	158	28	3	109	0	0	0	18
Ingleside	TX	107	52	0	53	0	0	1	1
Galveston lightering area	TX	98	97	0	0	0	0	1	0
Beaumont	TX	72	25	0	30	2	3	0	12
Gulfport	MS	39	1	26	2	6	1	0	3
Pensacola	FL	19	2	0	8	0	0	0	9
S. Sabine Point lightering area	TX	17	17	0	0	0	0	0	0
Panama City	FL	6	0	0	1	0	0	0	5
Pascagoula lightering area	MS	5	4	0	1	0	0	0	0
Southwest Pass lightering area	LA	3	3	0	0	0	0	0	0
Gulf Gateway Terminal	LA	2	1	0	0	0	1	0	0
Key West	FL	2	2	0	0	0	0	0	0
Smith's Bluff	TX	1	1	0	0	0	0	0	0
Freeport lightering area	TX	1	1	0	0	1	0	0	0
Port Fourchon	LA	1	1	0	0	0	0	0	0

Footnotes on next page.

TABLE 4.3.17-1 (Cont.)

[a] For vessels of 10 dead weight tons (DWT) or larger.

[b] Includes product tanker and crude tanker.

[c] Includes vehicle carriers.

Source: MARAD (2006a).

TABLE 4.3.17-2 U.S. Gulf of Mexico Ports by Cargo Volume for 2004

U.S. Rank	Port, State	Metric Tons
1	South Louisiana, LA	203,379,319
2	Houston, TX	183,294,254
4	Beaumont, TX	83,186,980
6	Corpus Christi, TX	71,599,336
7	New Orleans, LA	70,837,711
9	Texas City, TX	61,945,207
10	Baton Rouge, LA	51,784,666
11	Mobile, AL	50,994,484
12	Lake Charles, LA	49,684,986
13	Plaquemines, LA	49,355,132
16	Tampa, FL	43,807,166
22	Pascagoula, MS	30,934,990
23	Freeport, TX	30,760,842
29	Port Arthur, TX	25,011,119
49	Matagorda Ship Channel, TX	11,361,314
61	Galveston, TX	7,360,228
82	Port Manatee, FL	4,017,459
83	Brownsville, TX	3,783,806
90	Victoria, TX	3,367,492
108	Panama City, FL	2,496,173
111	Biloxi, MS	2,422,394
114	Gulfport, MS	2,154,347
146	Weedon Island, FL	906,833

Source: AAPA (2006).

as shown in Table 4.3.23-3. Figures 4.3.17-1 and 4.3.17-2 show port locations and relative commercial freight and fishing vessel activity (Tables 4.3.17-1 and 4.3.23-3) for the Gulf Coast. Also shown in Figures 4.3.17-1 to 4.3.17-2 are the designated shipping fairways and anchorage areas on the Gulf of Mexico OCS for handing vessel traffic amid the extensive oil and gas exploration and production activities.

Larger ports also service and are departure points for cruise ships. Approximately 17 major cruise lines operate cruises with a U.S. port of call (MARAD 2006b). Table 4.3.17-3 lists the annual number of cruises departing Gulf of Mexico ports from 2003 to 2005. These cruise ships are larger oceangoing vessels, often with international ports of call, that frequent OCS waters.

As mentioned in Section 4.2.17, helicopter support of alternative energy operations on the OCS may be expected for crew and supply transportation. In the Gulf of Mexico, such helicopter transport is a mainstay of oil and gas operations. More than 16,000 workers a day are estimated to be transported back and forth from oil and gas drilling and production platforms (Louis Berger Group, Inc. 2004). While supply boats are typically used for short-haul service,

TABLE 4.3.17-3 U.S. Gulf of Mexico Cruises by Departure Point

	Annual		
Departure Port	2003	2004	2005
Galveston, TX	203	208	222
Tampa, FL	216	198	192
New Orleans, LA	143	178	121
Mobile, AL	–	18	58
Houston, TX	8	55	56
Gulfport, MS	17	1	–

Source: MARAD (2006b).

helicopters are the primary means of transportation for distances more than 250 km (150 mi) into the Gulf. Heliports can be found at small- and medium-sized regional airports across the region. Figures 4.3.17-1 and 4.3.17-2 show the locations of airports in the Gulf of Mexico area (BTS 2006; ACI-NA 2006). There were 247 heliport facilities identified in this region that support the oil and gas industry (Louis Berger Group, Inc. 2004), with 122 in Texas, 81 in Louisiana, 34 in Florida, 6 in Mississippi, and 4 in Alabama.

4.3.18 Socioeconomic Resources

4.3.18.1 Regional Population, Employment, and Income

In 2004, there were 16.0 million persons living in the coastal counties in the Gulf of Mexico region, which includes all the Gulf states (Table 4.3.18-1). Population in the region is projected to reach 16.2 million by 2007 and 16.5 million by the end of the OCS planning period in 2014. Regional population grew at an annual average rate of 1.6% over the period 1990 through 2004. Growth is expected to decline for the period 2004 through 2014, with a projected annual average rate of 0.3%. Within the region, the majority of the coastal population in the region is concentrated in Florida (7.2 million in 2004) and Texas (5.6 million), with a smaller population in Louisiana (2.2 million).

Employment in the Gulf of Mexico region stood at 9.0 million in 2004 and, on the basis of population growth rates, is expected to reach 9.1 million by 2007 and 9.2 million at the end of the planning period in 2014 (Table 4.3.18-1). Growth rates in employment in the region have exceeded those in population, with annual growth rates over the period 1990 through 2004 averaging 2.1%. Average annual growth in personal income of 3.1% in the Gulf of Mexico region over the period 1990 through 2004 exceeded growth rates in both population and employment (Table 4.3.18-1). Personal income in the region rose from $0.3 trillion in 1990 to $0.5 trillion in 2004 and, on the basis of population growth rates, is expected to grow slowly over

TABLE 4.3.18-1 Socioeconomic Environment for the Coastal Economy in the Gulf of Mexico Region (millions, except where noted)[a]

	1990			2004			2007[b]			2014[b]		
State	Population	Employment	Income ($b)[c]	Population	Employment	Income ($b)	Population	Employment	Income ($b)	Population	Employment	Income ($b)
AL	0.5	0.2	10.4	0.6	0.3	14.4	0.6	0.3	14,5	0.6	0.3	14.6
FL	5.5	2.8	146.6	7.2	4.0	226.9	7.4	4.0	228.0	7.5	4.1	228.8
LA	2.0	1.0	47.5	2.2	1.2	64.5	2.2	1.2	64.8	2.2	1.2	65.1
MS	0.3	0.2	6.3	0.4	0.2	10.2	0.4	0.2	10.2	0.4	0.2	10.2
TX	4.4	2.6	127.0	5.6	3.3	200.1	5.7	3.4	201.0	5.8	3.4	201.7
Total	12.8	6.7	337.8	16.0	9.0	516.1	16.2	9.1	518.5	16.5	9.2	520.4

[a] Coastal economy applies to counties wholly or partly within 50 mi of the coast in each state.

[b] Projections based on annual population growth for each state.

[c] $b = billions of dollars.

Sources: U.S. Bureau of the Census (2006a); USDOC (2006a,b).

the planning period 2007 through 2014. Per capita income in the region grew from $26,485 to $32,261 between 1990 and 2004.

Within the region, employment is concentrated in Florida (4.0 million in 2004) and Texas (3.3 million), with smaller levels in Louisiana (1.2 million). In 2004, there was some variation in per capita incomes among the States having coastal counties in the region, ranging from $31,324 in Florida to $25,916 in Alabama. The average for all coastal counties in the region was $30,267 in 2004.

The Gulf of Mexico region consists of a number of contrasting types of economic areas. There are a number of large metropolitan areas located in the region, including New Orleans and Houston, and a large number of smaller urban and suburban areas located in each State. All of the metropolitan areas and many of the larger urban areas have highly complex economic structures, containing a wide range of industries, with wide and diverse labor markets and a comprehensive range of occupations. The Gulf of Mexico region also includes a number of urban areas that serve a smaller number of more specialized economic functions, including renewable and nonrenewable resource development, maritime shipping, power generation, recreation, tourism, and residential retirement. Outside urban areas, there are a large number of local and regional market areas serving the resource extraction, agriculture, power generation, and transportation industries. These areas have simpler economic structures, and contain smaller, less-diversified labor markets.

4.3.18.2 Sociocultural Systems

There are a wide variety of demographic, employment, income, land-use, and infrastructure patterns in the coastal areas along the Gulf of Mexico, reflecting heterogeneous sociocultural systems in these areas. This rich diversity is evident in a variety of cultural centers, including the Hispanic enclaves of south Texas, the Acadian “French Triangle” of south Louisiana, the Vietnamese communities of coastal Louisiana and Mississippi, and the Greek residents of Florida’s Tarpon Springs. The State of Louisiana alone contains numerous cultural groups of Native American, African, European, Asian, Latin American, and Middle Eastern origins (U.S. Bureau of the Census 2006a).

The metropolitan areas of the Gulf Coast are located off the open coast in estuaries and host extensive port facilities, with waterborne commerce an important aspect of their economies. On the fringes of Houston and New Orleans, there are extensive suburban developments. These metropolitan areas represent important destinations of opportunity for many individuals, and this is reflected in the diverse racial and cultural composition of these major cities. Many of the smaller communities in the region maintain sociocultural environments that are less diverse, often supporting a small number or a single cultural group in the most important community economic activity.

4.3.18.3 Environmental Justice

Under Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629), Federal agencies are required to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations. The analysis of potential environmental justice issues associated with offshore energy developments followed guidelines described in the Council on Environmental Quality's Environmental Justice Guidance under the National Environmental Policy Act (CEQ 1997). Section 4.2.18.3 provides more information on the methods, definitions, and data used in the analysis of environmental justice issues.

Table 4.3.18-2 shows the minority and low-income composition of total population for the coastal counties (U.S. Bureau of the Census 2006b) in the Gulf Coast region based on 2000 Census data and CEQ Guidelines. Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals identifying themselves as being part of one or more of the population groups listed in the table.

Data in Table 4.3.18-2 show that 39.9% of individuals in coastal counties in the Gulf of Mexico region identified themselves as minority, while 15.7% of individuals had an annual income in 2000 at or below the poverty line. For the coastal counties in the region as a whole, the percent of individuals identifying themselves minority was slightly less than in the reference group, the Gulf of Mexico region as a whole (40.2%). Similarly, the percentage of individuals below the poverty line was slightly less than in the Gulf of Mexico region as a whole (14.7%). Because the percentage of low-income and minority individuals in the Gulf of Mexico region does not exceed 50% of the total population, or is not more than 20 percentage points above the corresponding percentage for the United States as a whole, according to CEQ guidelines, there are no minority or low-income populations in the Gulf of Mexico region.

Within the Gulf of Mexico region, there is a diversity of population groups. Metropolitan and larger urban areas have a wide variety of ethnic and racial groups, reflecting heterogeneous sociocultural systems in these areas, with cultural centers containing population groups of African, European, Asian, and Latin American origins. Smaller urban centers and rural areas tend to be less diverse, with a smaller number of cultural and racial and ethnic groups present. There are also a number of Indian tribes located on land along the coast within the region.

4.3.19 Cultural Resources

As defined in the ACHP regulations at 36 CFR 800.16, *historic property* means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria. As used in this analysis, the more general term,

TABLE 4.3.18-2 Minority and Low-Income Populations in the Gulf Coast Region (Millions)

Total population	18.0
White, Non-Hispanic	10.8
Hispanic or Latino	3.4
Non-Hispanic or Latino minorities	3.8
One race	3.6
Black or African American	3.1
American Indian or Alaskan Native	0.1
Asian	0.4
Native Hawaiian or Other Pacific Islander	0.0
Some other race	0.0
Two or more races	0.2
Total minority	7.2
Low income	2.8
Percent minority	*39.9*
Percent low income	*15.7*

Source: U.S. Bureau of the Census (2006a).

cultural resources, also includes those historic resources not yet determined eligible for the National Register.

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA; 16 USC 470(f)) requires that Federal agencies such as the MMS take into account the effect of an undertaking under their jurisdiction on significant cultural resources. A cultural resource is considered significant when it meets the eligibility criteria for listing on the National Register of Historic Places (36 CFR 60.4). The Section 106 process requires the identification of cultural resources within the area of potential effect of a Federal project, consideration of a project's impact on cultural resources, and the mitigation of adverse effects to significant cultural resources. The process also requires consultation with State Historic Preservation Officers, the Advisory Council on Historic Preservation, Native American tribes, and interested parties. In the case of oil, gas, and sulfur leases, the MMS has established regulations (e.g., 30 CFR 250.194) and issues guidance to lessees (e.g., Notice to Lessees [NTL] No. 2005-G07 and G10, NTL No. 2006-G07, NTL No. 2005-A03, NTL No. 2006-PO3) to ensure compliance with Section 106 of the NHPA and its implementing regulations in 36 CFR Part 800. The NTLs provide guidance on the regulations regarding archaeological discoveries and the conduct of archaeological surveys and identify specific OCS lease blocks with a high potential for containing cultural resources on the basis of previous studies.

The MMS can only consider the effects on cultural resources of projects over which it has permitting authority (Sansonetti 1987). The MMS does not have the legal authority to manage cultural resources on the OCS outside of its lease areas (Solicitor 1980). The only impacts that the MMS can consider off of the OCS are the indirect visual impacts to historic properties on land. The MMS intends to develop additional guidance on the issue of indirect visual impacts through consultation with the Advisory Council on Historic Preservation and other interested parties. Once a project's footprint enters State waters, the project is no longer under MMS control but is subject to the requirements identified by the State.

The Gulf of Mexico region consists of approximately 2,600 km (1,600 mi) of coastline. Onshore cultural resources are highly varied in coastal areas, from small, temporary use sites to substantial permanent settlements ranging in age from the earliest known human occupation of the area, approximately 12,000 years ago, through the postcontact period (e.g., the last several hundred years). It is estimated that the current level of the Gulf of Mexico was reached approximately 3,500 years ago. Therefore, sites predating this period could be located under water.

Offshore cultural resources include numerous shipwrecks dating from as early as the 16th century. Historic structures, such as the Ship Shoal Lighthouse, can also be found offshore. Literature searches can be completed for reported ship losses and known shipwrecks, but they offer only a partial understanding of the resources that may be present. It can be assumed that some percentage of the reporting is inaccurate, some locations were imprecisely recorded, some of the ships were badly broken up and widely dispersed during drift, and additional ship losses may not have been documented (e.g., the losses of small coastal fishing boats were largely unreported, and the regular reporting of other larger boats did not occur until the 19th century). These records also provide no information regarding the preservation potential of the shipwreck. Water depth, type of bottom, nature of adjacent coast, strength and direction of storm currents and waves, size, and type of the vessel are all factors that can contribute to the condition of the shipwreck and the spatial distribution of materials and artifacts associated with the shipwreck. The condition of the shipwreck can be determined only by visiting the site.

Several studies have been conducted for the MMS to model areas in the Gulf of Mexico where shipwrecks have the highest potential to exist. The first study, conducted in 1977, concluded that two-thirds of all shipwrecks in the northern Gulf are located within 1.5 km (0.9 mi) of the shore (CEI 1977). A second study in 1989 (Garrison et al. 1989) concluded that the highest frequency of shipwrecks occurred in areas of the highest volume of marine traffic (e.g., approaches to seaports and mouths of navigable rivers and straits). This study also reported an increased frequency in shipwrecks in the open sea in the Eastern Gulf that was double that reported for the Western or Central Gulf and attributed this to changes in sailing routes in the late-19th and early 20th century. In addition, the study looked at distribution patterns of shipwrecks relative to ocean currents, storm tracks, natural navigational hazards, and economic histories of ports. The final study was conducted in 2003 (Pearson et al. 2003). This study incorporated new data that had been compiled over 15 years of high-resolution shallow hazard surveys for oil and gas development and sonar surveys. To date, shipwrecks have been discovered in water depths up to 1,981 m (6,500 ft). Many of the deepwater wrecks, at least their locations, were not previously known; several of the deepwater shipwrecks date to the World

War II era. As a result of the findings in this study, the MMS updated their guidelines to include lease blocks in deepwater areas within the approach to the Mississippi River as high-potential areas requiring archaeological survey (NTL No. 2006-G07).

The preservation potential of shipwrecks varies throughout the Gulf of Mexico. Deepwater shipwrecks are expected to have a moderate to high preservation potential because the water is colder; this slows the oxidation process and eliminates the occurrence of wood-eating shipworms. Shipwrecks in areas with high sediment loads are also expected to be well-preserved. The sediment protects the site from the effects of severe storms and wood-eating shipworms. The coasts of Texas, Louisiana, Mississippi, and Alabama are likely to have sufficient sediment load to preserve shipwrecks. However, as a result of differences in sedimentation rates, it is anticipated that preservation would be slightly better off the Mississippi/Alabama coast than off the Louisiana coast. The west coast of Florida is not expected to have good preservation potential because of low sediment rates, oxygenated bottom waters, and strong currents. Finally, the cause of the shipwreck would also affect its preservation potential. Ships that went down in violent storms would likely be broken up and scattered over some distance on the ocean floor. One such shipwreck documented by the MMS was scattered along 457 m (1,500 ft) of the ocean floor. Also, shipwrecks nearer to the shoreline have a greater potential to be further scattered by subsequent storms.

Offshore resources also include submerged prehistoric archaeological sites. Approximately 19,000 years ago, during the late Wisconsinan glacial advance, much of the OCS constituted dry land as the sea level was approximately 120 m (390 ft) lower than present levels. During the earliest period of uncontested human prehistoric populations in the Gulf Coast region (approximately 12,000 years ago), the sea level would have been approximately 45 to 60 m (150 to 200 ft) lower than present (CEI 1982). The submerged area between the paleoshoreline (vicinity of the 45- to 60-m [150 to 200 ft] bathymetric contour) to the present-day shoreline would, therefore, have the potential to contain prehistoric sites.

Geographic features associated with onshore prehistoric archaeological sites in coastal areas in the western and central Gulf include river channels and associated floodplains, terraces, levees and point bars, barrier islands, back barrier embayments, and salt dome features. In the eastern Gulf, off the coast of Florida, additional features include chert outcrops, solution caverns, and sinkholes. These same types of features are present on the OCS, are submerged and often buried by estuarine and marine sediments, and have the same potential for being associated with prehistoric site locations in this region. The MMS requires high-resolution remote sensing surveys prior to any bottom-disturbing activities associated with oil, gas, and sulfur leasing. These surveys have successfully identified geographic features that are associated with prehistoric site locations.

As with shipwrecks, site preservation of underwater prehistoric archaeological sites is subject to many factors. Low-energy environments with little current or sedimentary movement have the best preservation potential. These areas would include previous floodplains, bays, lagoons, river terraces, and subsiding deltas that are now buried by marine sediments. The preservation of organic materials (e.g., wood, seeds, fibers, skins, and possibly animal or human soft-tissue remains) is possible under such conditions (Purdy 1988). Other protected areas, such as sinkholes, depressions, ponds, and lakes, and other areas with only low-wave energy also would provide an environment with good potential for site preservation. Sites that are fully or partially exposed in near-shore or high-energy environments are likely to erode over time, displacing and/or destroying the artifacts and their primary context. Shell midden sites seem to be able to withstand higher energy environments (Delgado 1998).

4.3.20 Land Use and Existing Infrastructure

There are five coastal States within the Gulf of Mexico region containing approximately 2,600 km (1,600 mi) of coastline. Land use is a heterogeneous mix of urban areas; recreation areas; tourist attractions; and manufacturing, marine, shipping, agricultural, and oil and gas activities. Urbanized areas are well established in the area, and a complexity of land use associated with urbanization can be found there. The area is composed of 67 metropolitan and 65 rural counties. The Gulf of Mexico region contains two of the United States' 50 largest cities, 13% of the nation's coastal population, and 13 of the nation's 50 largest ports. The Gulf of Mexico region also contains a rich, natural mix of bays, estuaries, wetlands, barrier islands, and beaches. Although accessibility is sometimes limited, these areas are very popular for recreation and tourism. Along the Gulf Coast are numerous State Parks and beaches as well as units of both the National Park Service and the U.S. Fish and Wildlife Service. Notable features in the area include Padre Island National Seashore, the Mississippi Delta, Mobile Bay, and Everglades National Park. Agriculture is an important activity in many of the States.

All of the States in the Gulf of Mexico region are participants in the Coastal Zone Management Program and have taken various approaches to managing their coastal lands. The coastal area of the States in this region is very diverse (see the discussion of the Coastal Zone Management Act in Section 1.7). The military areas in this region are discussed in Section 4.3.16. Areas of special concern, including the National Marine Sanctuaries, National Parks, National Wildlife Refuges, and National Marine Protected Areas, are discussed in Section 4.3.15. The population along the Gulf of Mexico Coast is described in Section 4.3.18. Similar to the Atlantic region, the States along the Gulf of Mexico Coast also have authority over submerged lands out to 3 nautical mi (approximately 5.6 km [3.5 statute mi]) with the exception of Texas and Florida, which have jurisdiction out to 3 leagues (approximately 14.5 km [9 mi]).

The western and central portions of the Gulf of Mexico region (offshore Texas, Louisiana, Mississippi, and Alabama) are two of the most active offshore oil and gas areas in the world (Gramling 1994), and most of the equipment and facilities supporting offshore Gulf of Mexico oil and gas operations are located in these areas. Only limited offshore activities (i.e., exploratory activities, single major project) have occurred in the eastern portion of the region, and there is very little infrastructure in place to support exploration and development of offshore oil and gas off the Gulf Coast of Florida. Current MMS data (http://www.mms.gov/state/index.htm) indicate there are more than 3,900 offshore production facilities located in the Gulf of Mexico.

A recent MMS-sponsored study of this region (Louis Berger Group, Inc., 2004) describes the existing OCS-related infrastructure for 13 major categories: platform fabrication yards, port facilities, shipyards and shipbuilding yards, support and transport facilities, waste management facilities, pipelines, pipe coating yards, natural gas processing facilities, natural gas storage facilities, refineries, and petrochemical facilities. There are 81 counties within the Gulf of Mexico region that host OCS-related facilities.

4.3.21 Visual Resources

Description of the visual resources potentially affected by the proposed facilities involves establishing landscape types and scenic quality in the areas in which energy facilities would be located, followed by an assessment of the potential sensitivity to changes in the visual environment, including the likely number of viewers.

The shorefronts along the Gulf Coasts of Florida, Alabama, Mississippi, Louisiana, and Texas offer a diversity of natural and developed landscapes and seascapes, including coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marches. Coastal barrier landforms of the Gulf of Mexico consist of islands, spits, and beaches that extend from Florida to the United States/Mexico border. Coastal landforms are transitory in nature and are constantly being sculpted and modified by the same forces that led to their original deposition. Barrier islands and sand spits protect coastal habitats located behind them from the direct impacts of the open ocean, increasing the amount of available estuarine habitat for a large number of bird and other animal species. Wetland habitats along the coast of the Gulf of Mexico consist of seagrass beds; mangroves; fresh, brackish, and salt marshes; mudflats; forested wetlands of hardwoods; and cypress-tupelo swamps. Wetland habitats may occupy only narrow bands along the shore, or they may cover vast expanses of the coastline. Most of the coastal wetlands present in the Gulf of Mexico are found in Louisiana, and have developed in shallow areas that received flow and sediments from the Mississippi River.

On the Texas coast to the west of Atchafalaya Bay is a series of sand and shell ridges formed as sand dunes. These ridges are now separated by mudflats, marshes, and open water. Estuarine marshes along the rest of the Texas coast occur in discontinuous bands around the bays and lagoons, on the inner sides of the barrier islands, and in the tidal reaches of rivers. Salt marshes, composed primarily of smooth cordgrass, are evident nearest to the mouths of bays and lagoons, in areas of higher salinities. Brackish water marshes are seen farther inland, and freshwater marshes occur along the major rivers and tributaries.

Beaches along the Gulf Coast are heavily used for recreation, particularly near large urban areas. Gulf Coast beaches are also heavily used by tourists attracted by the climate. Views of the Gulf are an important element of the recreational experience for beach users. The number of potential viewers and the recreational nature of the activities they are engaged in make viewsheds from beaches particularly sensitive to offshore impacts.

In addition, in some areas residences are located at or very close to the Gulf shore; many people choose to live in these areas because of the open water views from their homes or nearby shore front. Residents living within sight of the Gulf, and to a somewhat lesser extent living close to the Gulf but not in sight of it, would likely have frequent and extended views of offshore energy developments, and many will have strong emotional attachments to the visible waterscapes, especially if those seascapes are relatively free of development and visual clutter. Because residents living on or close to the Gulf would potentially be very sensitive to changes visible from the shore, viewsheds from these residences are of particular concern for potential visual impacts.

As is true for other coastal areas, ocean views are highly valued by residents and tourists along the Gulf Coast. In some areas along the Gulf Coast, oil and gas platforms are visible from the shore, as are activities associated with oil and gas development, such as marine vessel and helicopter traffic. While the platforms are located sufficiently far from shore that they do not dominate ocean views, they introduce man-made industrial structures into these views.

4.3.22 Tourism and Recreation

Coastal areas in the Gulf of Mexico are extensively and intensively utilized for tourist and recreational activity by residents of the Gulf South and others (USDOI/MMS 2007c). Barrier islands and beaches are prime tourist and recreation areas. Publicly owned and administered areas (such as national seashores, parks, beaches, and wildlife lands), as well as specially designated preservation areas (such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers), attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments (such as resorts, marinas, amusement parks, and ornamental gardens) also serve as primary interest areas and support services for people who seek enjoyment from the recreational resources associated with the Gulf of Mexico (USDOI/MMS 2007c).

Tourism and recreation are important activities for many communities on the Gulf of Mexico Coast. However, for the coastal States, these activities do not make a significant contribution to overall employment or wages (Table 4.3.22-1). Less than 4% of total coastal county employment in 2004 was in the ocean-related sectors in which tourism and recreation expenditures occur.

4.3.23 Fisheries

4.3.23.1 Commercial Fisheries

Commercial fisheries are very important to the economies of the Gulf Coast States (Browder et al. 1991). In 2004, commercial marine fishery landings in the Gulf of Mexico, which includes western Florida, Alabama, Mississippi, Louisiana, and Texas, totaled approximately 669 million kg [1.475 billion lb], worth more than $667 million (Table 4.2.23-1). Of the individual States, Louisiana led in total commercial fishery landings and value in 2004 with 497 million kg (1,096 million lb) of landings, worth more than $274 million. Mississippi was second in terms of total landings (83 million kg [183 million lb]), followed by Texas

TABLE 4.3.22-1 Ocean-Related Tourism and Recreation (T&R) Economy, 2004

State	T&R Sector[a] Employment	Sector Share of Total Coastal County[b] Employment (%)	T&R Sector Wages ($ millions)
AL	13,981	0.8	165.5
FL	262,643	3.7	4,668.9
LA	61,495	3.3	898.2
MS	8,671	0.8	101.6
TX	69,533	0.8	919.9
Total	416,323	2.0	6,754.0

[a] T&R sectors are Amusement and Recreation Services, Boat Dealers, Eating and Drinking Places, Hotels and Lodging Places, Marinas, RV Parks and Campsites, Scenic Water Tours, Sporting Goods Retailers, Zoos, and Aquaria.

[b] Economic activity in counties wholly or partly within 50 mi of the coast in each State.

Source: NOAA (2006d).

(39 million kg [86 million lb]), Florida's west coast (38 million kg [84 million lb]), and Alabama (12 million kg [26 million lb]) (Table 4.2.23-1).

Many species are caught and landed in Gulf of Mexico commercial fisheries. Browder et al. (1991) stated that the Gulf of Mexico commercial fishery includes at least 97 species from 33 families. They considered the most important species groups to be oceanic pelagic (epipelagic) fishes, reef (hard bottom) fishes, coastal pelagic species, and estuarine-dependent species. The primary estuarine dependent species targeted are menhaden, penaeid shrimps (brown, white, and pink [*Penaeus aztecus, p. setiferus*, and *P. duorarum*]), and blue crab (*Callinectes sapidus*). (Oysters are important, but not considered here because they are harvested exclusively in inshore waters.) Targeted species from the other groups include yellowfin tuna (*Thunnus albacares*) and swordfish (*Xiphias gladius*) (epipelagic); king and Spanish mackerels (*Scomberomorus cavalla* and *Scomber scombrus*) (coastal pelagic); and spiny lobster (*Panulirus argus*), red snapper (*Lutjanus campechanus*), red grouper (*Epinephelus morio*), and gag (reef/hard bottom).

On the basis of reported commercial fishery landing data (NMFS 2005), the two most valuable commercial fisheries in the Gulf of Mexico are for white and brown shrimp, which accounted for 26% and 23%, respectively, of the entire Gulf of Mexico commercial fishery in 2004 (Table 4.3.23-1). Other invertebrates such as blue crab, spiny lobster, and stone crab (*Menippe* spp.) also contributed significantly to the value of commercial landings. Finfish species that contributed substantially to the overall commercial value of the Gulf of Mexico fisheries in 2004 included red grouper ($13.3 million), red snapper ($11.7 million), and

TABLE 4.3.23-1 Total Weights and Values of Commercially Important Fishery Species in the Gulf of Mexico Region

Species	Total Weight Landed (kg)	Total Weight Landed (lb)	Total Value ($)	% Weight[a]	% Value[a]
White shrimp	51,039,776	112,524,033	175,299,603	7.62	26.20
Brown shrimp	54,192,195	119,473,963	151,353,980	8.09	22.62
Eastern oyster	11,363,195	25,051,687	60,844,882	1.70	9.09
Atlantic menhaden	464,140,375	1,023,259,717	44,921,369	69.29	6.71
Blue crab	27,296,015	60,177,727	40,951,707	4.08	6.12
Pink shrimp	6,921,376	15,259,101	27,734,129	1.03	4.14
Florida stone claws crab	2,707,901	5,969,931	26,704,032	0.40	3.99
Caribbean spiny lobster	2,064,473	4,551,408	20,658,366	0.31	3.09
Red grouper	3,086,311	6,804,186	13,306,762	0.46	1.99
Red snapper	2,121,337	4,676,772	11,675,974	0.32	1.74
Yellowfin tuna	1,584,579	3,493,418	11,606,295	0.24	1.73
Striped mullet	5,902,125	13,012,026	8,397,463	0.88	1.25
Gag	1,397,920	3,081,902	7,681,677	0.21	1.15
Vermilion snapper	980,564	2,161,785	4,093,026	0.15	0.61
Black drum	2,526,088	5,569,100	3,729,126	0.38	0.56
Yellowtail snapper	627,284	1,382,931	2,988,337	0.09	0.45
Yellowedge grouper	479,843	1,057,878	2,612,050	0.07	0.39
Sharks	618,181	1,362,862	2,311,583	0.09	0.35

[a] Percent weight and percent value are based upon all reported commercial fishery landings for the Gulf of Mexico

Source: NMFS (2005).

yellowfin tuna ($11.6 million). In terms of landing weight, Atlantic menhaden (a small coastal pelagic species) far surpassed other commercial fish species in the Gulf of Mexico, accounting for approximately 69% of the total weight of landed commercial species with more than 460 million kg (1.02 billion lb) reported (Table 4.3.23-1). However, Atlantic menhaden accounted for only about 6.7% of the total value of the Gulf of Mexico commercial fishery.

Each species or species group is caught by using various methods and gear types. Shrimps are taken by bottom trawling, menhaden are caught in purse nets, yellowfin tuna are caught on surface longlines, and snapper and grouper are caught by hook and line; pots and traps are used for crab, spiny lobster, and some fish species. Generally, Gulf of Mexico fishing activities with the highest potential for interactions (or conflicts) with OCS activities (e.g., oil and gas operations) are bottom trawling (potential for snagging on pipelines, cables, and debris) and surface longlining (potential for space-use conflicts with seismic survey vessels and possible entanglement with thrusters on dynamically positioned drillships). Deepwater fisheries, such as longlining for swordfish, and nearshore fisheries, such as net fisheries for menhaden, are least likely to occur within areas where OCS alternative energy development is most likely. The portion of commercial fishery landings that occurred in nearshore and offshore waters of Gulf States is presented in Table 4.3.23-2.

TABLE 4.3.23-2 Gulf Coast Fish Landings by Distance from Shore by State for 2004 (1,000 kg)

	Distance from Shore (mi)			
State	0–3	3–200	Total	% from OCS Waters
Florida (Gulf)	16,166	22,030	38,196	57.7
Alabama	6,687	5,360	12,047	44.5
Mississippi	77,253	6,100	83,353	7.3
Louisiana	384,283	113,121	497,405	22.7
Texas	11,328	27,480	38,808	70.8
Total	495,717	174,091	669,809	26.0

Source: NMFS (2006b).

Fishery statistics for major U.S. ports in the Gulf of Mexico region are presented in Table 4.3.23-3. In terms of reported total landing weight, the top U.S. ports in the Gulf of Mexico region in 2004 were Empire-Venice, Louisiana (172 million kg [379 million lb]); Intracoastal City, Louisiana (137 million kg [302 million lb]); and Cameron, Louisiana (110 million kg [242 million lb]). Gulf ports with the highest reported total catch values were Empire-Venice, Louisiana ($60.2 million); Key West, Florida ($43.2 million); and Dulac-Chauvin, Louisiana ($42.8 million).

4.3.23.2 Recreational Fisheries

The primary source for marine recreational fisheries data in U.S. waters is the Marine Recreational Fisheries Statistics Survey (MRFSS) conducted by the NMFS (NMFS 2005). This survey combines random telephone interviews and on-site intercept surveys of anglers to estimate recreational catch and effort for inland, State, and Federal waters. In the Gulf of Mexico, surveys are conducted in western Florida, Alabama, Mississippi, and Louisiana. Texas conducts its own survey of recreational fishing (see Anderson and Ditton 2004), and these data, which are for State fiscal year 2001, are also summarized in this section. Additional information on recreational fishing is available in Hiett and Milon (2002).

Approximately 3.6 million residents participated in marine recreational fishing in the Gulf of Mexico region during 2004. These anglers took more than 24 million trips and caught more than 187 million fish (excluding Texas). About 68% of the trips were made in west Florida, followed by 20% in Louisiana, 8% in Alabama, and 4% in Mississippi (NMFS 2005). The mode of fishing that was most common in all Gulf of Mexico States was the use of private or rental boats, comprising approximately 58% of the trips in the region. This was followed by fishing from shore (39% of trips) and distantly by fishing from charter vessels (3% of trips). Approximately 59% of the recreational fishing trips occurred in inshore saltwater and brackish water bodies (e.g., bays, estuaries, and sounds). Thirty-four percent of the trips occurred in the ocean within 16 km (10 mi) of the shore, and 7% of the trips occurred in the ocean at more than 16 km (10 mi) from shore (NMFS 2005).

TABLE 4.3.23-3 Reported Total Landing Weights and Values for Major Ports in the Gulf of Mexico Region in 2004

Rank among All U.S. Commercial Fishing Ports	Port	State	Total Landing Weight (millions kg)	Total Landing Value (millions $)
3	Empire-Venice	LA	171.9	60.2
5	Intracoastal City	LA	136.9	20.3
6	Cameron	LA	110.3	27.6
8	Pascagoula-Moss Point	MS	73.8	11.9
23	Dulac-Chauvin	LA	18.3	42.8
35	Golden Meadow-Leeville	LA	11.8	31.6
39	Port Arthur	TX	8.8	38.9
40	Bayou La Batre	AL	8.7	28.4
42	Brownsville-Port Isabel	TX	8.5	40.3
44	Morgan City-Berwick	LA	8.1	6.6
46	Gulfport-Biloxi	MS	7.4	26.2
47	Galveston	TX	7.3	31.4
48	Key West	FL	7.3	43.2
50	Delcambre	LA	6.6	20.7
52	Palacios	TX	6.1	27.6
53	Grand Isle	LA	5.7	14.2
54	Tampa Bay-St. Petersburg	FL	5.6	21.6
56	Delacroix-Yscloskey	LA	5.4	14.4
60	Fort Myers	FL	4.3	15.9
63	Lafitte-Barataria	LA	4	10.9
64	Apalachicola	FL	3.9	5.2
69	Port St. Joe	FL	3.4	8.4
77	Bon Secour-Gulf Shores	AL	2.7	7

Source: NMFS (2005).

Spotted seatrout, white grunt (*Haemulon plumieri*), groupers, snappers, black sea bass (*Centropristis striata*), and red drum were among the most commonly caught nonbait species, in terms of numbers of fish (Table 4.3.23-4). The largest harvests by weight were for groupers, red snapper, red drum, king mackerel, Spanish mackerel, greater amberjack, and spotted seatrout, which together accounted for approximately 55% of the overall catch in 2004. More than 7.2 million groupers, 3.1 million red snapper, and 1.1 million red drum were taken in the Gulf of Mexico recreational fishery in 2004 (Table 4.2.23-4).

In FY 2001, 1,382,015 Texas resident fishing licenses were purchased (Anderson and Ditton 2004). It is estimated that 1,160,893 (or 84%) of these license holders actually fished one or more days in Texas during the year. Of those who fished, 82% participated in freshwater fishing, and 52% participated in saltwater fishing. Freshwater anglers fished an average of 26 days, with 10 (or 38%) of these days involving fishing lakes and reservoirs from a boat, while saltwater anglers fished an average of 18 days, with 8 (or 44%) of these days involving fishing saltwater bays from a boat (Anderson and Ditton 2004).

TABLE 4.3.23-4 Estimated Total Numbers and Total Weights for Fish Species Most Commonly Captured in the Marine Recreational Fishery of the Gulf of Mexico Region[a]

Species Name	Number	% Number	Weight (kg)	% Weight
Herrings	12,624,477	17.3	NR[b]	NR
Spotted seatrout	5,509,813	7.5	964,324	4.9
Blue runner	4,723,834	6.5	447,972	2.3
White grunt	4,519,247	6.2	706,692	3.6
Pinfishes	4,339,333	5.9	469,633	2.4
Mycteroperca groupers	3,607,555	4.9	2,116,689	10.8
Epinephelus groupers	3,564,868	4.9	1,483,571	7.6
Spanish mackerel	3,220,899	4.4	1,028,787	5.3
Red snapper	3,163,564	4.3	1,837,943	9.4
Saltwater catfishes	2,907,916	4.0	68,995	0.4
Gray snapper	1,962,130	2.7	750,333	3.8
Black sea bass	1,274,071	1.7	70,175	0.4
Atlantic croaker	1,204,913	1.6	15,782	0.1
Kingfishes	1,139,140	1.6	132,568	0.7
Red drum	1,133,629	1.5	1,261,577	6.5
Sheepshead	1,059,027	1.4	781,669	4.0
Sand seatrout	822,832	1.1	136,830	0.7
Crevalle jack	603,249	0.8	95,940	0.5
Vermilion snapper	595,801	0.8	225,165	1.2
Triggerfishes/filefishes	591,780	0.8	374,692	1.9
Bluefish	573,167	0.8	217,451	1.1
Yellowtail snapper	548,750	0.7	177,006	0.9
Dolphins	445,280	0.6	940,618	4.8
King mackerel	428,621	0.6	1,078,404	5.5
Lane snapper	366,600	0.5	100,998	0.5
Little tunny/Atlantic bonito	362,404	0.5	502,716	2.6
Mullets	335,261	0.5	100,097	0.5
Silver perch	278,435	0.4	9,398	<0.1
Puffers	270,385	0.4	594	<0.1
Greater amberjack	252,997	0.3	1,010,790	5.2

[a] Values for fish captured in the recreational fishery of Texas are not included.

[b] NR = weight not reported.

Source: NMFS (2005).

Recreational fishing in State and offshore waters often occurs around artificial structures. Off Alabama, Mississippi, Louisiana, and Texas, these structures include oil and gas platforms. A recent MMS study estimated that during 1999 there were 980,264 fishing trips taken within 91.5 m (300 ft) of an oil or gas structure or an artificial reef created from such structures (Hiett and Milon 2002). This represented approximately 22% of the total (4.4 million) marine recreational fishing trips taken that year in the Gulf from Alabama through Texas. The study found that approximately $159.7 million in direct expenditures was associated with these visits.

4.4 PACIFIC REGION

4.4.1 Geology

4.4.1.1 General Description and Physiography

4.4.1.1.1 North Pacific Region. The continental shelf in the northern Pacific region ranges in width from 14 km (8.8 mi) at Cape Blanco, Oregon, to about 68 km (42 mi) at Heceta Bank, Oregon (Figure 4.4.1-1). The continental slope off Oregon is steep with a northward trend; off Washington, the continental slope is fairly gentle and irregular with a northwest trend. The continental shelf and slope widen progressively to the north, ranging from 28.2 km (17.5 mi) at Cape Blanco to 145 km (90 mi) off the Hoh River in northern Washington (Snavely et al. 1977). The 100-m (330-ft) water-depth contour occurs fairly close to shore, usually within 40 km (25 mi).

The continental shelf in this region is characterized by the following physiographic features (based on Snavely et al. 1977):

- ***Series of north- and northwest-trending ridges.*** A series of ridges, likely of diapiric origin, occur in deep waters (greater than 1,000 m [3,280 ft]) on the Washington shelf.

- ***Broad terrace or bench.*** This feature occurs off the central coast of Oregon, at water depths of 350 to 750 m (1,150 to 2,460 ft). The terrace is widest in areas where the shelf is most narrow.

- ***Submarine banks (shoals).*** Several prominent banks, representing structural highs, occur on the Oregon shelf; these include Siltcoos, Heceta, Perpetua, Coquille, Nehalem, and Stonewall. The largest of these, Heceta Bank, is about 40 km (25 mi) long and 10 to 13 km (6 to 8 mi) wide. The shallowest of these is Stonewall Bank, where water depth may be as little as 7 m (23 ft). There is another bank, known as Swiftsure Bank, just north of the international boundary between Canada and the United States.

- ***Submarine canyons and channels.*** The Washington shelf is cut by several large submarine canyons, including Willapa, Guide, Grays, Quinault, Juan de Fuca, and Nitinat. These deep valleys were cut by large rivers that dissected soft marine sediments during the late Pleistocene, a period when sea level was much lower than it is today. Only one large canyon, called Astoria Canyon, exists on the Oregon shelf about 16 km (10 mi) west of the mouth of the Columbia River. Astoria Canyon extends about 97 km (60 mi) seaward to a depth of about 1,800 m (6,000 ft), where it joins the Astoria Fan.

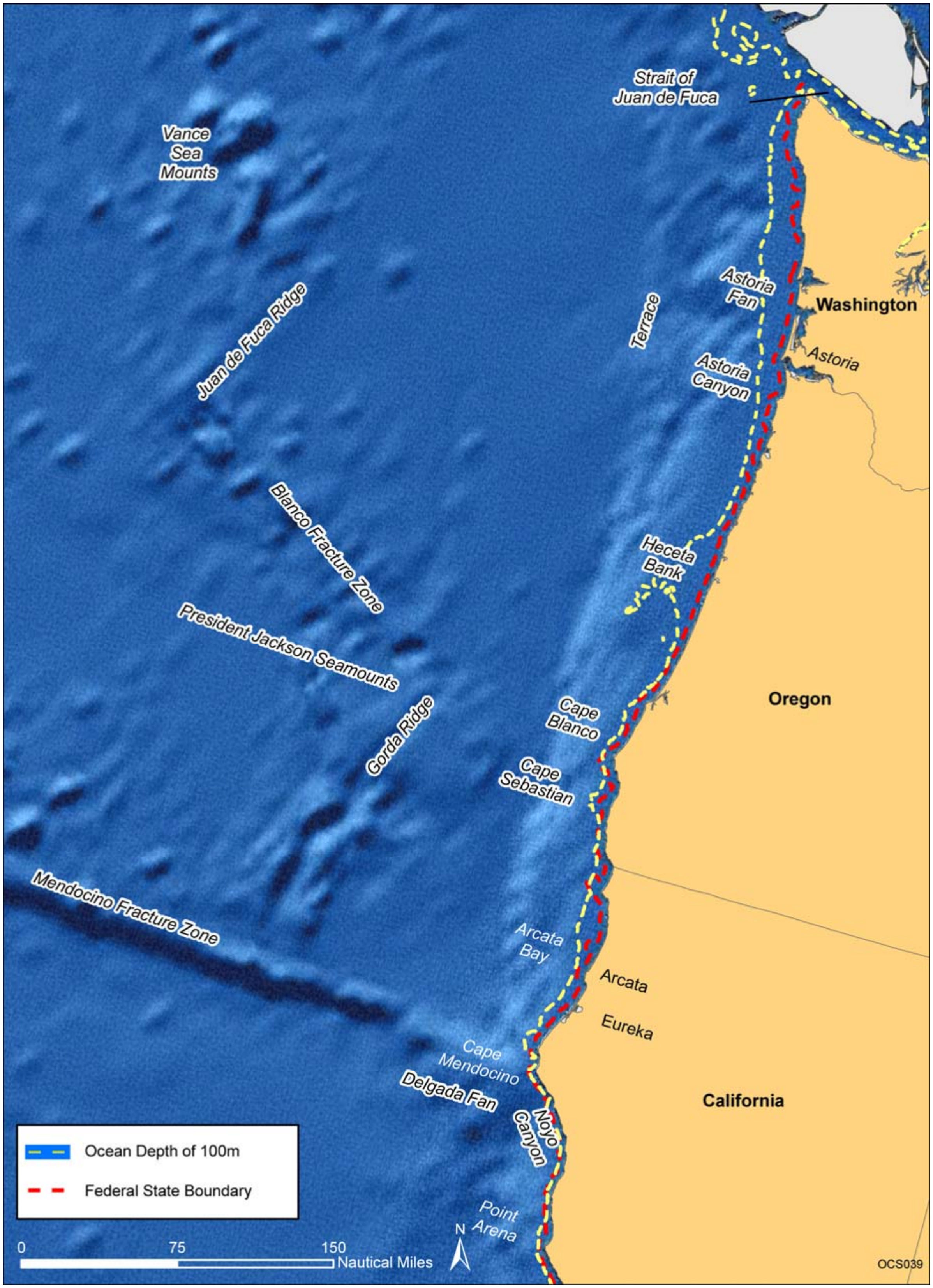

FIGURE 4.4.1-1 Physiographic Features along the Northern Pacific Coast

- ***Submarine fans.*** Two of the largest submarine fans are Astoria Fan, on the Oregon shelf, and the Nitinat Fan, on the Washington shelf. The Astoria Fan extends across the continental slope from a depth of about 1,800 m (6,000 ft) along the slope to 2,700 m (9,000 ft) at the abyssal plain.

- ***Seastacks and small islands.*** Numerous seastacks and small islands exist along the northern part of the Washington coastal region and the southern Oregon coast.

- ***Seamount chains.*** Seamounts are submerged mountains (formerly volcanoes) that usually occur in chains, either associated with intraplate hotspots or spreading centers. Two seamount chains, the Vance Seamounts and the President Jackson Seamounts, occur near the Juan de Fuca and Gorda ridges just off the coast of Oregon (Monterey Bay Aquarium Research Institute 2006).

The main physiographic feature of the northern California area is the Eel River Basin, which has a northern trend and extends 200 km (125 mi) south from near Cape Sebastian on the southern Oregon coast to Cape Mendocino on the northern California coast and about 70 km (44 mi) from the coastline seaward to the continental slope (Figure 4.4.1-3). The south end of the basin extends about 50 km (30 mi) inland in the lower Eel River-Arcata Bay area. Several high-angle reverse faults (predominantly west-side down) and en-echelon folds occur on the continental slope and adjacent marginal plateau with the same trend as the basin as a result of compression of the continental margin (McCulloch et al. 1977). The 100-m (330-ft) water-depth contour typically occurs within 24 km (15 mi) of the shoreline in this area.

4.4.1.1.2 Central and South Pacific Region. The geology of the central California continental shelf and slope records a history of accretion and subduction that continues to change by the active transform motion between the Pacific and North American Plates (McCulloch 1989). In this area, the 100-m (330-ft) water-depth contour occurs fairly close to the shore; its maximum distance from the shoreline is about 40 km (25 mi) at the Farallon Islands, just south of Point Reyes and west of San Francisco Bay. The physiography of the area, shown in Figure 4.4.1-2, varies from north to south and consists of two major end provinces and a middle transition zone (based on McCulloch et al. 1977, 1980; McCulloch 1989; Normark and Gutmacher 1989):

- ***Northern province.*** The northern province extends south from Cape Mendocino to the vicinity north of Point Sur. The shelf in this province is well developed and varies in width from 10 to 40 km (6.2 to 25 mi). The shelf meets the upper edge of the slope at a depth of about 180 m (600 ft) and merges with the ocean floor at a depth of about 3,500 m (11,400 ft). There are four structural basins within this province (from north to south): Point Arena Basin, Cordell Basin, Bodega Basin, and Año Nuevo Basin (Figure 4.4.1-3). The Point Arena Basin is a fairly shallow, fan-shaped feature that widens toward its northern boundary at the Mendocino Escarpment, between the San

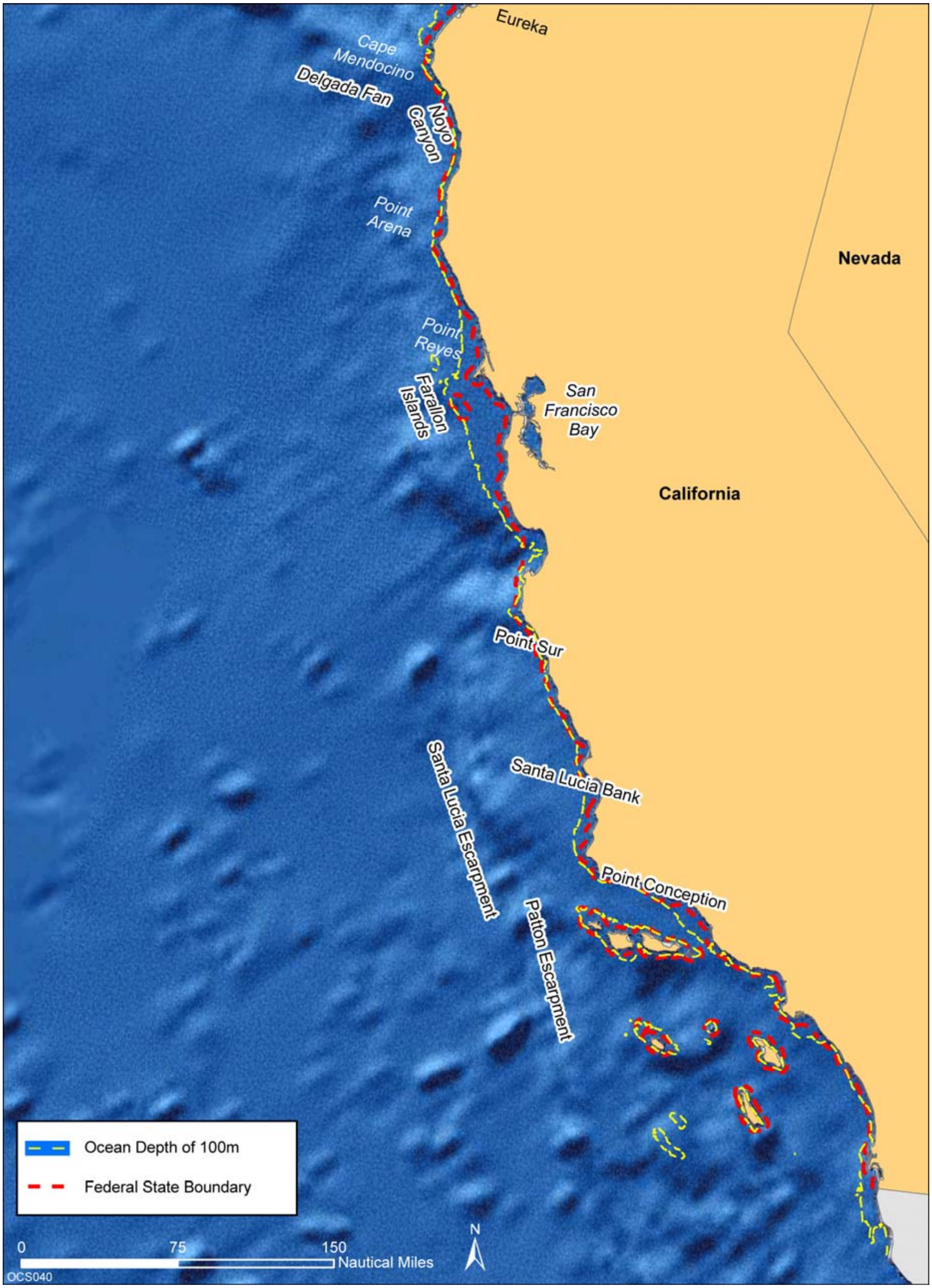

FIGURE 4.4.1-2 Physiographic Features along the Southern Pacific Coast

Andreas fault on the east and the Oconostota ridge on the west. The Bodega Basin, just off Point Reyes Peninsula, is bounded by the offshore extensions of the San Gregorio and San Andreas faults on the east and by a subsurface ridge that extends to the vicinity of Point Arena. The Farallon Islands are highs along this ridge. Two major submarine fans, the Monterey Fan and the Delgada Fan, make up most of the continental rise in this area. The Monterey Fan extends 350 km (220 mi) to the west and southwest from Monterey Canyon; the Delgada Fan also extends 350 km (220 mi) west and southwest from Noyo Canyon, about 275 km (170 mi) north of San Francisco Bay.

- ***Transition zone.*** The transition zone marks the area near Monterey Bay between the northern and southern provinces in the central California shelf. The shelf in this zone is not well developed, and the slope is long and gentle, merging with the seafloor without a distinct change in topography. The main physiographic feature in this region is the Outer Santa Cruz Basin, an elongate syncline trending northwest across the continental shelf to the toe of the continental slope.

- ***Southern province.*** The southern province extends south from Point Sur to the vicinity of Point Conception. The shelf is not well developed in this area, and there is not a well defined topographic break between the shelf and the slope. Instead, the shelf merges with the Santa Lucia Bank (a structural high) at a depth of about 550 m (1,805 ft). The shelf drops steeply (about 2,740 m [8,100 ft]) at the Santa Lucia Escarpment, just to the west of the Santa Lucia Bank. There are three structural basins within the southern province: Santa Maria, Sur, and Santa Lucia (Figure 4.4.1-3). The elongate Santa Maria Basin is the largest of the three and runs parallel to the coastline; it is bounded on the northeast and southwest by basement blocks (Franciscan) elevated along major coastal faults (Hosgri fault to the northeast and the Santa Lucia fault to the southwest).

The southern California area extends from about 120 km (75 mi) north of Point Conception (California) to the United States-Mexico border and coincides with the U.S. portion of a physiographic region known as the California Continental Borderland. The California borderland continues beyond the United States to Viscaino Bay, Mexico, and is bounded to the south by the volcanic province of south-central Baja California (Gorsline and Teng 1989).

The California borderland is a complex of basins and ridges/islands/banks. These features follow the northwest-southeast trends of the Transverse Range, with a secondary east-west trend in the northernmost part, and they are arranged in rough rows that converge to the south. Structurally, the region is a sequence of elongate thrust blocks separated by major transform faults. A total of 16 basins have been identified in this region (Figure 4.4.1-3); these basins and their dimensions are provided in Table 4.4.1-1. The basins deepen toward the south and west and then become shallower to the south of the Santo Tomas Fault (Gorsline and Teng 1989; Norris and Webb 1990).

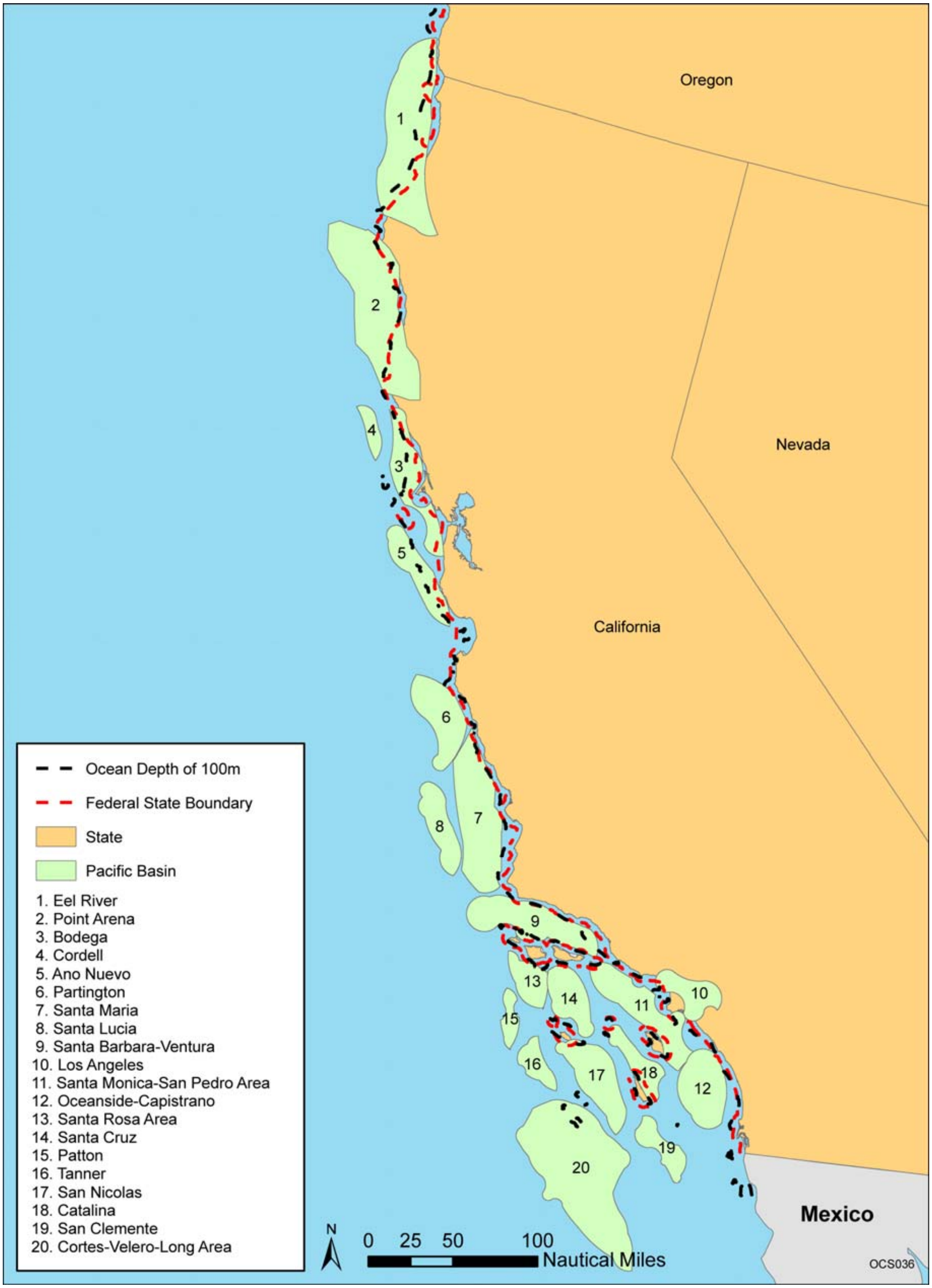

FIGURE 4.4.1-3 Major Basins on the Outer Continental Shelf in the Pacific Region (Source: Dunkel 2001)

TABLE 4.4.1-1 Basins within the Southern California Area

Basin	Width (km)	Length (km)	Depth (m)	Area (km^2)	Sill Depth (m)[a]
Santa Barbara	27	54	615	815	468
San Miguel	10	18	1,380[b]	100[b]	1,230
Santa Cruz	36	80	1,935	2,225	1,067
Santa Monica	36	72	925	2,255	725
San Pedro	27	36	898	819	725
Patton	9	27	1,300[b]	160	NA
Tanner	36	108	1,526	1,577	1,146
San Nicolas	54	90	1,803	3,327	1,089
Santa Catalina	36	90	1,335	2,676	966
San Diego Trough	27	108	900–1,350	NA[c]	1,350
Long	14	80	1,908	1,036	1,670
West Cortes	18	72	1,768	1,257	1,340
East Cortes	27	63	1,947	1,320	1,594
Velero	36	72	2,530	1,640	1,872
San Clemente	36	108	2,074	1,865	1,787
No name	18	36	1,885	380	1,530

[a] Sill depth, also called threshold depth, is the maximum depth at which there is horizontal communication between an ocean basin and the open ocean.

[b] Estimated.

[c] NA = Data not available.

Source: Gorsline and Teng (1989).

The submerged part of the California borderland has a length of about 900 km (560 mi). The continental shelf is fairly narrow in this region and typically does not exceed 8 km (5 mi) in width. Its maximum width (about 250 km [155 mi]) occurs at the United States-Mexico border. The 100-m (330-ft) water-depth contour also occurs at distances of up to 8 km (5 mi) offshore. The borderland contains several submarine canyons. The Patton Escarpment marks the seaward edge of the continental shelf. Basin floor depths range from 600 m (1,970 ft) to more than 3,000 m (9,800 ft) (Gorsline and Teng 1989; Norris and Webb 1990).

4.4.1.2 Coastal Features and Processes

The U.S. Pacific Coast extends from the northern tip of the Olympic Peninsula (Washington) to San Diego, California. The northern part of the coastline has a north-south trend that changes to a northwest-southeast trend just south of Cape Mendocino (California). The region is seismically active and characterized by a variety of coastal features, including narrow beaches and high bluffs, rocky headlands, mountains, dune-backed shores, marine terraces, estuaries, bays and lagoons, and tidal inlets. In many areas along this stretch, the continental margin is narrow and the ocean bottom drops precipitously from the beach to deep water (Washington State Department of Ecology 2001; Oregon Ocean-Coastal Management Program 2006; Harden 1998).

The largest ocean currents and storm waves approach the Pacific Coast from the west and northwest. As a result, the predominant megascale drift direction (i.e., longshore current) is from north to south. South of Point Conception, the longshore current runs east, then southeast because of the curve in the coastline. Drift directions vary locally due to the presence of features like submarine canyons, which intercept the longshore current and redirect the transport of sediment seaward, causing beaches in these areas to become abruptly narrower. Other coastal features, like the protruding headlands on either side of Monterey Bay, also affect the cycles of erosion and deposition on a local scale (Washington State Department of Ecology 2006; Oregon Ocean-Coastal Management Program 2006; Harden 1998; USACE 1992).

Erosion rates are high along the California coast and are typically episodic, with major cliff retreat, landsliding, and sand removal taking place during large storms. However, as a result of tectonic uplift, the coastline continues to rise relative to sea level. Evidence of this can be seen in the San Diego area in which ancient beach ridges are preserved in marine terraces along the coast (Harden 1998).

4.4.1.3 Geologic History

The geologic history of the Pacific region is dominated by the tectonic activity of the Pacific Plate and its interaction with the North American Plate, two smaller plates (the Juan de Fuca and Cocos Plates), and several microplates (e.g., the Gorda Plate). Atwater (1989) has defined three general periods of plate movement based on the paleomagnetic record. In the late Middle Jurassic to middle Early Cretaceous (160 to 118 million years ago), the Pacific Plate began a period of growth in three directions away from a central core, forming two triple junctions: the first, between the Pacific-Izanagi-Farallon Plates, spread to the east and north; and the second, between the Pacific-Farallon-Phoenix Plates, spread to the east and south (Figure 4.4.1-4a). This was followed by a "quiet" period (118 to 84 million years ago) in the Cretaceous, during which few magnetic anomalies were recorded in the seafloor record. It is thought, however, that spreading between the Pacific and Farallon Plates continued throughout this period and into the early Cenozoic, becoming increasingly complex as the spreading center (known as the East Pacific Rise) reached the western rim of the North American Plate. The North American Plate was itself moving west as a result of spreading along the Mid-Atlantic Ridge (Tucholke and McCoy 1986).

The final period, between the Late Cretaceous and the present, marks a time (about 30 million years ago) during which the Farallon Plate gradually fragmented into several microplates. As these plates continue to move east, they are being subducted beneath the North American Plate along the Cascadia subduction zone, just off the coast of Washington, Oregon, and northern California (Figure 4.4.1-4b). This subduction zone is responsible for the volcanic activity in the Cascade Range (Atwater 1989).

South of Cape Mendocino (California), where the spreading center has been subducted beneath North America, the plate boundary along the western edge of the North American plate has changed from a subduction zone to a transform boundary. Figure 4.4.1-4c shows the

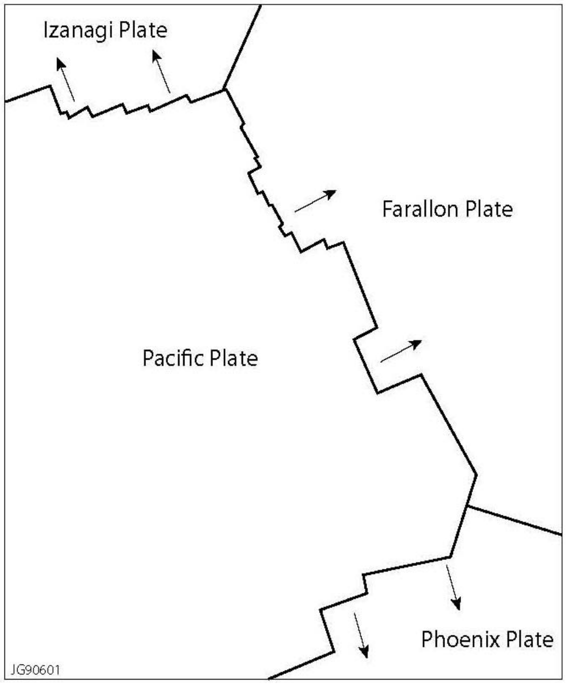

FIGURE 4.4.1-4a Initial Plate Motion in Three Directions from a Central Core along the Pacific Plate about 160 to 118 Million Years Ago; Figure Shows Spreading along the Rifts of Two Triple Junctions, the Pacific-Izanagi-Farallon and the Pacific-Farallon-Phoenix (modified from Atwater 1989)

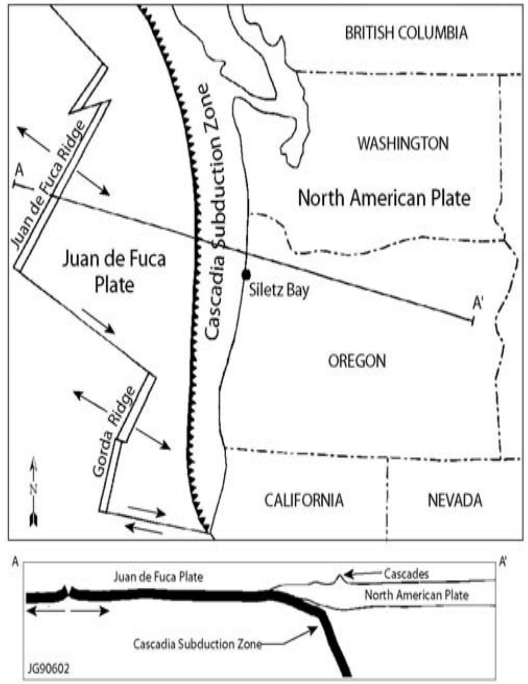

FIGURE 4.4.1-4b Subduction of the Juan de Fuca and Gorda Plates under the North American Plate Caused by Spreading along the Juan de Fuca and Gorda Ridges (modified from Priest 1995)

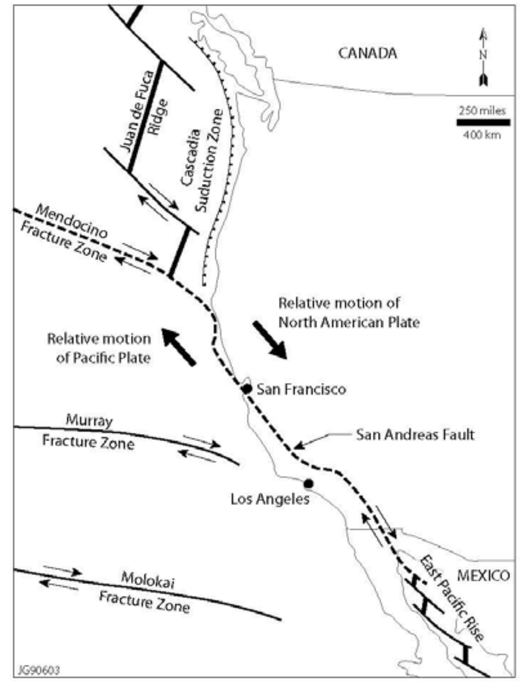

FIGURE 4.4.1-4c The San Andreas Fault in Relation to the Greater Plate Tectonic Setting of Western North America and the Northeastern Pacific Ocean Basin (the San Andreas fault system extends between the spreading centers in the East Pacific Rise to the south and the Juan de Fuca and Gorda Ridges to the north) (Stoffer 2006)

right-lateral strike-slip (transform) faulting along the San Andreas fault system that marks the areas of offset within the East Pacific Rise and the boundary along which the Pacific plate (to the west) moves north relative to the North American plate (to the east) (Atwater 1989; Harden 1998). Vertical displacement has also occurred along the San Andreas fault system (Norris and Webb 1990).

4.4.1.4 Mineral Resources

As of January 1999, about 2.64 billion barrels (bbl) of oil and 3.08 trillion cubic feet (tcf) of natural gas resources had been discovered on the Pacific Outer Continental Shelf (OCS). This includes 915 million bbl (oil) and 873 tcf (gas) of cumulative production and 1.7 billion bbl and 2.21 tcf of remaining reserves. These resources are estimated to exist within 38 fields in three assessment areas off the central and southern coasts of California: Santa Maria-Partington basin (14 fields); Santa Barbara-Ventura basin (22 fields); and the Los Angeles basin (2 fields). No resources had been discovered in the Pacific Northwest or Outer Borderland provinces as of January 1999 (Dunkel 2001). The MMS estimates an additional undiscovered 10.5 billion bbl of oil and 18.3 tcf of natural gas resources in the Pacific OCS (USDOI/MMS 2006e).

Mineral resources extracted for commercial purposes on the Pacific OCS include sand and gravel (e.g., on the San Diego Shelf); heavy minerals providing titanium, gold, rare-earth elements, and platinum; barite nodules (e.g., on the Patton Escarpment); manganese nodules (mainly on the abyssal ocean floor and lower continental shelf); and polymetallic sulfides (off the coast of Oregon). Mineral resource deposits within coastal waters include sodium chloride; magnesium and magnesium compounds, bromine; stone (for rip-rap); silt, sand, and gravel; and oyster shells. Small-scale jade collection occurs along various portions of the coast (e.g., Big Sur coastline) (Resources Agency of California 1997; U.S. Commission on Ocean Policy 2004).

4.4.1.5 Geologic Hazards

Geologic hazards that may affect offshore operations off the U.S. Pacific Coast are mainly associated with the scouring action of ocean currents and seafloor instability, either from seismic activity or sedimentary processes. Potential geohazards include:

- ***Scouring action of ocean currents.*** Vigorous tidal circulation and storm waves have an important effect on the transport of sediments on the surface of the continental shelf. Episodic sediment movement caused by ocean currents and waves can undermine foundation structures and lead to failure. The energy of currents and waves also poses a hazard risk to submarine cables and moorings.

- ***Slope failures.*** Unconsolidated surficial sediments are water saturated and susceptible to liquefaction and mass movement (slumping, mudslides, or gravity flows), which can be triggered by earthquakes, storm surges, faulting, sediment loading, dissociation of hydrates, dewatering processes, or human activity. Studies have shown that areas of moderate and relatively steep slopes on the Oregon-Washington shelf contain slump features, especially in areas where thick sediments have accumulated on the shelf-slope interface and on the flanks of submarine canyons. Volcanic ash has been found in cores on the Oregon shelf. The ash, which was deposited via rivers and ash falls from the Cascade Range, devitrifies in a marine environment, reducing its load-bearing capacity (Snavely et al. 1977). All these factors present potential hazards to the emplacement of foundation structures, submarine cables, and moorings.

- ***Faulting and warping.*** Numerous faults have been mapped off the U.S. Pacific Coast. Ground-shaking, fault displacements, and tectonic warping associated with earthquake activity may contribute to mass movement of unstable water-saturated or highly sheared sediments. Warping due to diapiric intrusion also contributes to unstable conditions (there are up to 100 diapirs on the Washington shelf and the outer shelf of Oregon). Gas seeps are found along the flanks of these diapirs and can produce mud mounds in these areas (Snavely et al. 1977).

- ***Tsunamis.*** Submarine earthquakes along faults with large vertical displacement anywhere in the Pacific Basin may create a tsunami. More locally, ruptures along the Cascadia subduction zone have the greatest potential to produce large tsunamis along the Pacific Coast (Native American accounts of past Cascadia earthquakes suggest wave heights of 18 m (60 ft). Submarine landslides also have the potential to create tsunamis locally (Geist 2005; California Seismic Safety Commission 2005).

- ***Fluid and gas expulsion.*** Gaseous sediments may be present as a result of decomposing organic matter (biogenic) or gas rising along fault planes from a deeper reservoir into surficial sediments (thermogenic). McCulloch et al. (1980) have noted the presence of shallow subsurface biogenic methane gas along the edge of the Central California shelf; in places, the gas appears to have migrated up the slope where it is confined by less permeable strata along the shelf edge. Gaseous sediments tend to have a lower shear strength and less load-bearing capacity than nongaseous sediments and may prove to be an unstable substrate for bottom-founded structures. Fluids and gases containing sulfur, hydrogen sulfide, and/or carbon dioxide are also toxic and corrosive.

- ***Irregular topography.*** Topography of the continental slope (and to a lesser extent, the continental shelf) is irregular due to the exposure of bedrock and the presence of salt diapirs, submarine channels, and canyons. These features are highly variable in load-bearing capacity over short vertical and horizontal distances and may present potential hazards to the emplacement of foundational structures, submarine cables, and moorings. Sediments across irregular topography vary in thickness. Steep slopes and scarps increase the risk of sediment failure.

At water depths of 100 m (328 ft) or less, the most likely geologic hazards to be encountered are scouring, irregular topography, faulting, and the effects of tsunamis, if they were to occur anywhere in the Pacific Basin. Mass movement could also be of concern in shelf areas of thick sediment accumulation along steep slopes and scarps.

4.4.2 Meteorology and Air Quality

4.4.2.1 Meteorology

The climate of the coastal areas of Washington, Oregon, and California is temperate with mild, wet winters and dry summers moderated by cool ocean breezes. During the winter season, Pacific storms dominate the weather in the Pacific Northwest and, less frequently, affect California. In late fall and winter, high pressure across the Great Basin periodically produces warm, dry Santa Ana winds over southern California. In the summer, a persistent high-pressure system in the eastern Pacific expands and moves northward, thereby becoming the dominant weather feature throughout the area. Precipitation is, therefore, inhibited and in California is almost entirely absent throughout the summer period. Due to chilling of air from coastal water upwelling along the California coast, there are frequent occurrences of fog and low clouds.

On the open waters off Washington and Oregon, the most frequent wind directions measured by National Data Buoy Center buoys are between southeasterly and southwesterly, while winds between northwesterly and northeasterly directions are also common (NOAA 2006a). The average wind speeds are between 5.0 and 7.3 m/s (11.3 to 16.2 mph). Monthly minimum wind speeds range from 3.6 to 6.1 m/s (8.1 to 13.6 mph) and occur in July to September, while monthly maximum wind speeds range from 7.0 to 8.9 m/s (15.8 to 19.9 mph) and occur in December or February. The variability of the winds reflects the frequent passage of Pacific storm systems. Nearshore winds are strongly influenced by coastal and topographic features, especially in the Strait of Juan de Fuca and the Puget Sound. Off the northern and central California coasts, the prevailing winds are northwesterly with average wind speeds between 5.1 and 7.0 m/s (11.4 to 15.7 mph). Off the southern California coast, the prevailing wind direction is westerly with an average speed of about 3.5 to 8.1 m/s (7.9 to 18.1 mph). In southern California, maximum and minimum wind speeds occur any month in a year, different from typical summer minimums and winter maximums for other OCS regions.

Although the Pacific OCS regions are located over a fairly wide range of latitudes (32–49°N latitude), differences in annual average temperatures between Washington (10.7–13.0°C [51.3–55.4°F]) and Southern California (13.3–15.9°C [55.9–60.6°F]) are relatively small. In addition, differences between monthly maximums and minimums are relatively small, ranging from 2.5 to 7.6°C (4.5–13.7°F). This is primarily due to the southerly flow of the California Current of cold waters off the West Coast. Minimum temperatures, ranging from 7.5–13.9°C (45.5–57.0°F), occur from January to March in Washington/Oregon and northern/central California, and April in southern California. Maximum temperatures, ranging from 12.3–18.4°C (54.1–65.1°F), mostly occur in September (August secondarily) in the Pacific Ocean OCS regions.

Rainfall is plentiful in Washington, Oregon, and northern California, while the southern California coast is semi-arid. For example, the average annual precipitation is about 240 cm (96 in.) along the Washington coast and around 30 cm (12 in.) in parts of the Los Angeles Basin.

In general, sea surface temperatures within the Pacific region are slightly higher than air temperatures. This condition would tend to result in a slightly unstable atmosphere over water. Atmospheric stability provides a measure of the amount of vertical mixing of air pollutants. Dispersion of pollutants is favored when the atmosphere is unstable. However, off northern California and the Pacific Northwest, the sea surface temperature in the summer season is somewhat lower than the air temperature, which would tend to result in stable atmospheric conditions. The stable atmosphere would tend to limit mixing and dispersion.

Mixing height provides a measure of the height of the lower atmosphere through which atmospheric pollutants are dispersed. The mixing height depends on heat flux (rate of warming of the surface layer) and wind speed. Over water, the air-sea temperature differences change slowly with time; thus, mixing heights are relatively constant. Over land, there is considerable diurnal variation, with low mixing heights at night and high mixing heights associated with daytime heating. During the summer, mixing heights along the coastal areas are reduced as a result of subsidence (sinking air motion) from the Pacific High as well as the relatively cool ocean temperatures due to upwelling. The mixing height over water typically ranges between 500 and 1,000 m (1,640 to 3,280 ft) with a slight diurnal variation (Holzworth 1972). Mixing height over land can be 1,500 m (4,920 ft) or greater during the afternoon in the summertime and near zero during clear, calm conditions at night in the wintertime.

Hurricanes are a severe form of a tropical cyclone. In the Pacific, hurricanes and tropical storms are formed off the coast of Central America and Mexico. Hurricanes need warm water, at least 27°C (80°F), for their formation and to sustain them. However, waters off the California Coast are cool, rarely above 15°C (60°F), because they originate in the Arctic and move south. This cool water will weaken any hurricane that moves toward the California Coast. Accordingly, hurricanes rarely hit California (NOAA 2006b). Hurricanes dissipate before they reach California and, therefore, the State has been hit only infrequently by the remnants of hurricanes and tropical storms. In addition, the general trend in hurricane motion is to the west-northwest due to the prevailing winds. Hurricanes that form in the Pacific follow this trend, which takes hurricanes away from the West Coast of the United States. Historically, no hurricanes or tropical storms have hit the areas north of central California.

4.4.2.2 Air Quality

The Clean Air Act (CAA) established the National Ambient Air Quality Standards (NAAQS) for six pollutants, known as “criteria” pollutants—sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$),[48] and lead (Pb) (40 CFR 50). Collectively, the criteria pollutants are indicators of the quality of the

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48 PM_{10} and $PM_{2.5}$ are particulate matter with aerodynamic diameters of ≤ 10 μm and ≤ 2.5 μm, respectively.

ambient air. Table 4.2.2-1 presents the current primary and secondary NAAQS for the six criteria pollutants. The primary standards are referred to as "health effects standards." These standards are set at levels to protect the health of the most susceptible individuals in the population: the very young, the very old, and those with respiratory problems. The U.S. Environmental Protection Agency (USEPA) has designed secondary standards to protect public welfare. These are referred to as the "quality of life standards." All of the standards are expressed in terms of concentration and duration of exposure. Many standards address both short- and long-term exposures. Any individual State may adopt a more stringent set of standards. For example, the State of California has ambient standards that are more stringent than the NAAQS for all criteria pollutants and has additional 1-hour standards for SO_2 and NO_2. In addition, it has adopted standards for visibility-reducing particles, sulfates, hydrogen sulfide, and vinyl chloride.

When the pollutant levels in an area have caused repeated violations of a particular standard, the area is classified as "nonattainment" for that pollutant. The USEPA has established classification designations based on regional monitored levels of ambient air quality in accordance with the CAA Amendments of 1990. These designations impose Federal regulations on pollutant emissions and a time period in which the area must again attain the standard, depending on the severity of the regional air quality problem. The attainment status for the Federal OCS waters is unclassified because there is no provision for any classification in the CAA for waters outside the boundaries of State waters. Only areas within State boundaries are to be classified as either attainment, nonattainment, or unclassifiable.

In general, air quality within the Washington and Oregon coastal counties is better than the national standards. Currently, all of the coastal counties[49] in Washington and Oregon are in attainment for all criteria pollutants (USEPA 2006a).[50,51] None of the coastal counties along the West Coast is subject to the 1-hour ozone standard or violates the NAAQS for SO_2, NO_2, or Pb. However, coastal counties in southern California are nonattainment areas for CO, O_3, and PM_{10}/$PM_{2.5}$. In particular, the Los Angeles-South Coast Air Basin, which includes Los Angeles, Orange, western Riverside, and western San Bernardino Counties, is classified as a serious nonattainment area for CO and PM_{10} and as severe for O_3. In the coastal valleys, and particularly in the South Coast Air Basin, topography, temperature inversions over Los Angeles, and recirculation due to land/sea breeze effects inhibit atmospheric transport and dispersion. Because these areas also harbor emissions from large population centers, they tend to experience poor air quality. The Los Angeles-South Coast Air Basin, notorious for smog but much improved over the past 20 years, recorded its cleanest year ever in 2004, due to improving pollution controls and favorable weather. San Diego County, San Francisco Bay Area, and Ventura County in California are in nonattainment for ozone.

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49 Many factors, especially topography, influence the extent to which an air mass over the OCS will migrate inland. The landward penetration of the sea breeze reaches 15 to 50 km (9 to 31 mi) in the temperate zones (http://www.pilotfriend.com/av_weather/meteo/prv_wnd.htm). Topographic features notwithstanding, onshore areas within 50 km (31 mi) of the coastline are considered in these analyses.

50 Because nonattainment status is not static, please refer to the USEPA's Greenbook for the most up-to-date nonattainment status (http://www.epa.gov/air/oaqps/greenbk/).

51 There are coastal counties in nonattainment for CO and PM_{10} in Oregon, but only portions of counties more than 50 km (31 mi) of the coastline are designated nonattainment.

The South Coast Air Basin has met Federal standards for CO since 2001. In 2004, the South Coast Air Basin exceeded the Federal 8-hour ozone standard of 0.08 ppm on 90 days, a significant decrease from 120 days in 2003 and once again the lowest since 1976 (Chang 2005). The highest measured 8-hour ozone concentration for the 2001–2005 period was 0.137 ppm (Chang 2005). Monitoring data for annual PM_{10} indicate that there was a slight downward trend in the South Coast Air Basin during that period. Exceedances of the Federal annual PM_{10} standard[52] in the South Coast Air Basin were confined to Riverside and San Bernardino counties with a maximum of 62 μg/m^3. In 2003, the South Coast Air Basin experienced six days of exceedance of 24-hour PM_{10} standard of 150 μg/m^3, but it had no exceedance in 2002, 2004, and 2005. While the annual average $PM_{2.5}$ concentration in the South Coast Air Basin tended to decline, it continued to exceed the Federal standards of 15 μg/m^3. $PM_{2.5}$ concentrations, like PM_{10}, were high in the inland valley areas of San Bernardino and Riverside counties, with a maximum of 31.0 μg/m^3 for 2001–2005. However, $PM_{2.5}$ concentrations were also high in the metropolitan areas of Los Angeles and Orange counties mainly due to the secondary formation of smaller-sized particulates resulting from emissions from primary sources. While the South Coast Air Basin did not have any exceedance of the 24-hour $PM_{2.5}$ in 2005, it exceeded the 24-hour standard on seven days in 2004, a decrease from 14 days in 2003.

In the San Diego County, the fourth-highest 8-hour ozone measurement was 0.096 ppm between 2001 and 2005 at one monitoring station. The San Francisco Bay Area is classified as a marginal nonattainment area for ozone. In 2001 through 2005, ozone exceedances were infrequent and the fourth-highest measured 8-hour average ozone concentration was 0.094 ppm.

The South Central Coast Air Basin, where the majority of Pacific OCS oil and gas facilities are now located, includes San Luis Obispo, Santa Barbara, and Ventura counties. Power plants, oil extraction and refining, transportation, and agricultural operations are the major emission sources within the basin (CARB 2006). The basin is currently in attainment for all criteria pollutants, except Ventura County, which is classified as moderate for 8-h O_3 (USEPA 2006a). During the 2001–2005 period, ozone frequently exceeded the Federal standard in Ventura County, mostly among the three which is influenced by and influences to the South Coast Air Basin. The fourth highest 8-h ozone measurement was 0.101 ppm. Santa Barbara and Ventura counties are currently classified as nonattainment areas for O_3 and PM_{10}, in terms of California State Ambient Air Quality Standards (SAAQS), which are more stringent than NAAQS (CARB 2006).

The Pacific region has a unique structure regarding air quality regulations. As proposed in the forthcoming regulations, alternative energy projects will fall under the regulatory scheme presently applied to Pacific region oil and gas projects, with USEPA delegating regulatory authority for air quality to local air pollution control and management districts. OCS sources that fall within 25 mi of a State's seaward boundary must comply with the same State regulations as those of the nearest onshore area, which may have more stringent regulations than those of the USEPA. Local agencies may be responsible for permit processes of OCS sources. For example, in California, depending on the OCS location, permit activity for OCS sources is governed by the

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52 Effective December 17, 2006, USEPA revoked the annual PM_{10} standard of the current 50 μg/m^3 (refer to http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-8477.pdf).

Santa Barbara Air Pollution Control District, South Coast Air Quality Management District, San Luis Obispo Air Pollution Control District, and the Ventura County Air Pollution Control District. Outside of this region, the USEPA's general provisions apply.

Class I Areas are defined in Sections 101(b)(1), 169A(a)(2), and 301(a) of the Clean Air Act as amended (42 USC 7401(b), 7410, 7491(a)(2) and 7601(a)). Class I areas are federally owned properties for which air quality-related values are highly prized and for which no diminution of air quality, including visibility, can be tolerated. Class I Areas are under the stewardship of four Federal agencies: U.S. Department of Interior's (USDOI's) Bureau of Land Management (BLM), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), and the Department of Agriculture's (USDA's) Forest Service (USFS). USEPA has promulgated a list of 156 Federal Class I Areas as mandated in Subpart D of 40 CFR 81.400 et seq. Class I Areas are protected by stringent air quality standards that allow for very little deterioration of their ambient air quality. The Prevention of Significant Deterioration (PSD) regulations (40 CFR 52.21), which are designed to protect ambient air quality, apply to major new sources and major modifications to existing sources located in an attainment or unclassified area. PSD regulations limit the maximum allowable incremental increases in ambient concentrations above established baseline levels of SO_2, NO_2, and PM_{10}, as shown in Table 4.2.2-1. Incremental increases in PSD Class I areas are strictly limited, while increases allowed in Class in Class II areas are less strict.

A number of Class I areas are located on or near the coastlines adjacent to the Pacific OCS regions addressed in this programmatic EIS and, therefore, air quality in these areas could be influenced by activities taking place within the adjacent OCS regions. These lands are under the stewardship of two Federal agencies, including the USDOI's NPS and USDA's USFS. A map of the Mandatory Class I Federal Areas potentially impacted by OCS activities and their corresponding 100-km and 200-km buffers along the Pacific Ocean is shown in Figure 4.2.2-1, with information on each of these Class I Federal Areas presented in Table 4.2.2-2. In general, air quality analysis must be made in coordination with the Federal Land Manager if a proposed Federal action is within 100 km of a Class I area (see http://www.epa.gov/fedrgstr/EPA-AIR/1996/July/Day-23/pr-23531.html). However, large emission sources located beyond 200 km of a Class I Federal Area can also trigger PSD Class I requirements if a significant impact on the region is suspected.

4.4.2.3 Regulatory Controls on OCS Activities That Impact Air Quality

Section 4.2.2.3 discusses the unique distribution of Federal authority over OCS sources established by Section 328 of the Clean Air Act Amendments of 1990 (CAAA 1990) and introduces the concept of Corresponding Onshore Area (COA) as a critical element in the control of activities affecting air at OCS sources. Within the Pacific OCS, USEPA has primary authority over air-impacting activities. USEPA regulations implementing the agency's Section 328 authority are published in 40 CFR Part 55. OCS sources located within 25 mi of the seaward boundaries of those States and air pollution control districts (APCDs) to which USEPA has delegated the authority to implement the Federal Clean Air Act requirements are subject to the requirements and controls of those delegated programs. OCS sources beyond 25 mi of the seaward boundaries of the delegated program States or APCDs are subject to USEPA requirements. Finally, any OCS source, irrespective of its specific location, is subject to the requirements of Federal conformity regulations in 40 CFR Parts 51 and 93 if the COA is in nonattainment or maintenance status for any criteria pollutant.

4.4.3 Physical Oceanography

The western coast of North America is characterized by a narrow Outer Continental Shelf. The shelf (waters typically <200 m [660 ft] deep) is less than 80 km (50 mi) wide along the coast of Oregon and Washington (Norman et al. 2004). Currents are very variable, with seasonal variability increasing to the north. Freshwater input to the Pacific generally increases from south to north. The Columbia River in Washington and the Fraser River in British Columbia, Canada, contribute significant quantities of freshwater to the Pacific Ocean, thereby affecting stratification on the shelf (NAP 1990). The Columbia River contributes approximately 60% of the freshwater entering the Pacific Ocean between San Francisco and the Strait of Juan de Fuca (strait between Washington and Vancouver Island) in the winter, and up to more than 90% in the remainder of the year.

Two of the principal currents that occur along the western coast of the United States are the California Current and the Davidson Current. The California Current is a Pacific Ocean current that originates from the Aleutian Current. The Aleutian Current is a north Pacific current that flows eastward and divides into the Alaska Current and the California Current as it approaches the North American continent. The Alaska Current flows northward, while the California Current flows to the south. The position of the divergence is about 45°N in winter and 50°N in summer (Pickard and Emery 1990). The California Current is a broad, shallow, slow-moving current that exhibits high spatial and temporal variability. Although the California Current is one of the most-studied oceanographic features, it is difficult to predict at any particular time the location of its velocity core, its speed, or direction (Broenkow 2006; Pickard and Emery 1990).

The California Current is usually located several kilometers offshore. The Current represents the eastward portion of the North Pacific Gyre and transports cool water with low salinity toward the equator (Broenkow 2006; Pickard and Emery 1990). The North Pacific Gyre occupies the northern basin of the Pacific and is a clockwise-rotating flow of water produced by the earth’s rotation. The California Current begins off southern British Columbia and ends off southern Baja California. The movement of northern waters southward makes the coastal waters cooler than coastal areas of comparable latitude on the east coast of the United States. Additionally, extensive upwelling of colder subsurface waters occurs, caused by prevailing northwesterly winds.

The core of the California Current off Point Sur, California, lies about 100 to 200 km (60 to 125 mi) from shore and has maximum equator-trending velocities of less than 5 to 10 cm/s (0.2 to 0.4 ft/s) (Chelton 1984). The offshore portion of southward flow is seen up to 1,000 km (600 mi) offshore and extends deeper than 500 m (1,640 ft), but the inshore section of the Current is limited to the upper 200 m (660 ft) over the continental slope (Hickey 1979). In addition to being influenced by the California Current, currents near the coast are affected by a variety of forces and boundary conditions, including local winds, upwelling, lateral and vertical mixing, tides, freshwater inflow, solar heating, bathymetric changes, and El Niño episodes (NOAA 1992). Coastal currents are separate from the large-scale flow of the California Current and are primarily driven by local winds. During periods of El Niño, the California Current can be disrupted, changing its direction of flow, primarily south of Point Conception, California, near the Santa Barbara Channel.

The California Current is complex and has many semistationary jets and eddies. Satellite imagery has shown cold filaments on the order of 50-km (31-mi) wide extending several hundred kilometers offshore (Broenkow 2006). The importance of these features (i.e., upwelling) lies in their offshore transport of cool, nutrient-rich water from depths to the surface.

The California Current is modified by seasonal variations in wind direction. Beginning in March, prevailing westerly winds, combined with the effects of the earth's rotation, drive surface waters offshore. These waters are replaced by deep, cold water that flows up over the continental shelf to the surface, carrying with it dissolved nutrients. The upwelling period continues until September when northwesterly winds die down and the cold upwelling begins to sink. This period, characterized by relatively high surface temperatures, is known as the oceanic period, and lasts through October (NOAA 1992). In winter, changes in atmospheric conditions over the Pacific Ocean bring southwesterly wind to the California coast. In response to these winds, the California Current moves further offshore, and a northward surface current begins and flows along the coast inland of the California Current. This current, called the Davidson Current, generally lasts through February, when the prevailing winds shift and the cycle begins again.

The Davidson Current is a narrower, weaker countercurrent that occasionally moves somewhat warmer water northward during the winter. The current runs north along the west coast of the United States from northern California to Washington to at least latitude 48°N during the winter. The current can exhibit strong seasonal variability in intensity but maintains a sustained northward movement at depth (Pickard and Emery 1990). Peak surface velocities of 0.2 to 0.3 m/s (0.7 to 1.0 ft/s) occur in January and February (Tomczak and Godfrey 2003).

4.4.4 Water Quality

Along the Pacific Coast, the coastline extends for approximately 2,100 km (1,300 mi) from north to south. The Pacific coastal region covers two major biogeographic provinces. The Columbian province extends from the Canadian border to Cape Mendocino in northern California. Estuaries are strongly influenced by freshwater runoff. The province is influenced by both the Aleutian and California Currents. The tidal range is moderate to large. The Californian province extends from Cape Mendocino to the Mexican border. Freshwater runoff is limited. The climate is Mediterranean and is influenced by the California Current. The tidal range is moderate (USCG 2006).

4.4.4.1 Coastal Waters

The Pacific coastline comprises more than 410 estuaries, bays, and subestuary systems associated with larger estuaries. The total area of the West Coast estuaries, bays, and subestuaries is 10,000 km^2 (3,900 mi^2), 61.5% of which is made up of the three large systems—the San Francisco Estuary, Columbia River, and Puget Sound system (including the Strait of Juan de Fuca) (USEPA 2004a). The Pacific Coast has several very large population centers (e.g., Seattle/Tacoma, Portland, San Francisco Bay area, Los Angeles, and San Diego). Human activities in these urban areas affect local and regional water quality.

Based on data from 1999–2000, 14% of the estuarine area in the Pacific Coast region is unimpaired for aquatic life and human uses, 17% is impaired for aquatic life use, and 27% is impaired for human use. An additional 59% is considered threatened for these uses (USEPA 2004a).

The water quality index for the Pacific Coast region is fair, primarily because of elevated phosphorus levels (USEPA 2004a). The sediment quality index received a score of fair to poor.

4.4.4.2 Marine Waters

Most of the Pacific Coast has a narrower Continental Shelf than the Atlantic or Gulf Coasts. The rate of depth drop off of the Pacific Continental Shelf tends to be greater than for the other regions too. This allows for greater mixing and dilution of coastal and offshore waters. It also limits the extent of the Pacific OCS that fits within the scope of this programmatic EIS.

The California Current flows southward along the Pacific Coast during the spring and summer. A combination of the northwesterly winds and the earth's rotation causes the surface waters to be deflected offshore. As the surface water moves offshore, it is replaced with cold, nutrient-rich waters from below. This process of upwelling introduces the nutrients (nitrates, phosphates, and silicates) to the water column (NMFS 2003).

Water quality off the coasts of Washington and Oregon is very good, in part because of the limited number of sewage outfalls (and relatively low effluent volumes) found along the coast. Although the plume from the Columbia River has been tracked as far north as the Strait of Juan de Fuca in winter and as far south as northern California in summer, its overall effects on water quality have been limited (USDOI/MMS 2002b).

Off the northern California coast, factors affecting water quality include municipal sewage outfalls and riverine input. Marine and coastal water quality along the northern California coast is generally excellent (USDOI/MMS 2002b) with select contaminants (e.g., heavy metals, petroleum, and chlorinated hydrocarbons) producing only localized degradation. Coastal and marine water quality off the central California coast is very good, with minor exceptions. Portions of Monterey Bay have degraded water quality as a result of sewage effluent and riverine input from several local rivers (USDOI/MMS 2002b).

Coastal and marine water quality off southern California is generally good, but, as with the central California coast, localized areas of water quality degradation exist due to high volume point sources (e.g., municipal wastewater outfalls in Los Angeles, Orange County, and San Diego), coupled with the combined effects of discharges from numerous small sources (USDOI/MMS 2002b).

Partly as a result of offshore oil and gas exploration and production in southern California, more environmental studies have been conducted to evaluate water quality conditions in that portion of the Pacific Coast. USDOI/MMS (2002c) describes detailed water quality impacts to the Southern California Bight region (roughly equivalent to the MMS southern California Planning Area).

Natural petroleum seeps are recognized as significant sources of hydrocarbons in the southern California area. One of the world's largest natural oil and gas seeps lies offshore from Goleta, just west of Santa Barbara (USDOI/MMS 2005).

The 1975–1978 BLM-sponsored baseline studies in the Southern California Bight indicated that most of the metal and hydrocarbon loads of the four basins examined (Santa Barbara Channel, San Pedro, Santa Monica, and San Nicolas) were derived from industrial and municipal wastes, entering the marine environment through direct discharge, indirect runoff, and atmospheric transport, all centering around the Los Angeles metropolitan area (USDOI/MMS 2005).

Lead was the only metal that was detected in the Santa Barbara Channel Basin in anything but natural amounts (USDOI/MMS 2005). Lead, apparently, is more susceptible to atmospheric transport, and was thus carried to the far reaches of the Southern California Bight from the sources (primarily industry and automobile gasoline exhaust).

Analysis of hydrocarbons in the Southern California Bight showed significant increases over the last 50 years (as ascertained by using age-dated box cores). In part, this increase was due to pulses of natural seepage; however, the majority was attributed to human-related combustion and sewage outfall sources. USDOI/MMS (2005) noted that the degree of anthropogenic input to the Santa Barbara Channel Basin has been relatively constant in recent years.

4.4.5 Acoustic Environment

The fundamentals of sound generation and propagation in the ocean, as well as the natural and anthropogenic sources of ambient ocean noise, were described in Section 4.2.5. As with the Atlantic and Gulf of Mexico, those sources contribute to ambient ocean noise in the Pacific, although the proportional contributions of each source are unique to this region.

As was established in Section 4.2.5, commercial shipping is one of the largest sources of anthropogenic sound in the ocean. General trends in commercial shipping over the past few years were also presented. As with the Atlantic and Gulf of Mexico, commercial shipping is expected to increase, and vessel-related noise is expected to continue as a major contribution to ambient ocean noise from anthropogenic activities within the Pacific region. Data from the U.S. Department of Transportation's Maritime Administration representative of commercial shipping activities at ports on the Pacific seaboard are displayed in Table 4.4.17-1.

The Pacific Coast ports of San Francisco, Los Angeles/Long Beach, Seattle, and Tacoma ranked among the top 20 U.S. ports of call for all vessel types in 2004, with Los Angeles/Long Beach ranking second and San Francisco ranking fifth among all U.S. ports. In addition to the coastal ports, ports along the Columbia River (accessed via Pacific Ocean shipping lanes) also ranked within the top 20 in 2004.

Commercial and recreational fishing along the Pacific Coast can also be expected to contribute to ambient ocean noise. A January 2004 survey identified 19 commercial fishing ports/harbors and 46 recreational fishing ports[53] along the Pacific Coast from Washington to California (Pollock 2004).

Relevant NMFS data are provided in the Fisheries section (Section 4.4.23). NMFS data are insufficient to calculate the absolute contribution to ambient ocean noise from commercial fishing vessel traffic. However, the fish "landings" data can be used to infer the relative contribution of commercial fishing vessels to all vessel traffic noise in those areas where commercial fishing occurs.

4.4.6 Hazardous Materials and Waste Management

As used in this programmatic EIS, the term "hazardous materials" refers to nonwaste substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare or the environment if they are improperly managed or released into the environment. This definition is general in nature and is not intended to suggest that the requirements of any particular law or set of regulations applies to a particular material. Such materials may be transported to and from, stored at, and/or used at alternative energy and alternate use project sites approved on the OCS. Section 4.2.6 lists examples of hazardous materials that may be associated with alternative energy projects likely to be proposed on the OCS within the next 5 to 7 years (Table 4.2.6-1). That section also lists examples of hazardous and nonhazardous solid wastes that may be generated by such projects (Table 4.2.6-2).

The following subsections provide an overview of hazardous materials and waste management in the OCS Pacific region.

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53 According to the survey's parameters, commercial fishing ports are those where >5% of the fishing vessels using that port are involved in commercial fishing. Likewise, recreational fishing ports are those where the preponderance of fishing vessels (>95%) using that port are engaged in recreational fishing.

4.4.6.1 Hazardous Materials Management

When transported on the OCS, hazardous materials are subject to the requirements for classification, documentation, packaging, labeling, and handling established under the Hazardous Materials Transportation Act (HMTA). If they are bound for or came from international waters, they are also subject to similar requirements under the International Maritime Dangerous Goods Code. These requirements are implemented by the U.S. Coast Guard (USCG). During 2004, cargo shipped on the ocean within the Pacific region included a total of approximately 111 billion kg (244 billion lb) of petroleum products and chemical products, not including crude oil and fertilizers (USACE 2004d). Gasoline, lubricants, diesel fuel, and solvents are examples of hazardous materials associated with alternative energy projects that are among the cargos classified as petroleum products. Paints, explosives, dielectric fluids, and hydraulic fluids are examples of hazardous materials associated with alternative energy projects that are among the cargos classified as chemical products.

Section 311(b) of the Clean Water Act and Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), require that a national contingency plan be established for identifying and responding to releases of hazardous substances (as defined in CERCLA §101) and oil. Releases of oil and hazardous substances exceeding reportable quantities, which have been set forth in 40 CFR Part 302, must be reported to the National Response Center, which is staffed by the USCG. National Response Center watch standers enter telephonic reports of pollution incidents into the Incident Reporting Information System and immediately relay each report to the predesignated Federal On-Scene Coordinator (FOSC). The USCG also provides emergency response support to the FOSCs. FOSCs are Federal officials predesignated by USEPA for inland areas and by the USCG for coastal and major navigable waterways. Each year, many spills nationwide are reported to the National Response Center from ocean vessels and platforms. The MMS investigates the causes of spills that occur on Federal leases in the OCS Pacific region. For each spill investigated, the MMS prepares a description of the circumstances surrounding the incident, with the goal of prevention through safety alerts in addition to site-specific corrections. Since January 2004, no spills in the Pacific region involving more than 7,949 L (50 bbl or 2,100 gal) of petroleum or other hazardous substances have been reported to the MMS (USDOI/MMS 2006i).

4.4.6.2 Waste Management

In 1972, Congress enacted the Marine Protection, Research and Sanctuaries Act (MPRSA) to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. The MPRSA, also known as the Ocean Dumping Act, implements the requirements of the London Convention, which is the international treaty governing ocean dumping. Under the MPRSA, the USEPA is charged with developing ocean dumping criteria to be used in evaluating permit applications, is responsible for designating recommended sites for ocean dumping, and is the permitting authority for all materials except dredged material. The USACE is the permitting authority for dredged material. However, when issuing a permit, the USACE must obtain USEPA's concurrence, use

USEPA-developed dumping criteria, and use USEPA-designated ocean dump sites to the maximum extent feasible. Virtually all material ocean-dumped in the United States today is dredged material (USEPA 2006c).

There are 22 final dredged material disposal sites on the Pacific OCS (40 CFR 228.15). Other materials that were ocean disposed of on the OCS during calendar year 2004 were vessels (two sites). Additionally, two naval vessels were sunk for military target practice in the vicinity of the OCS during calendar year 2004 (USEPA 2004b). Ocean disposal sites are not currently authorized for disposal of the waste types that may be generated by alternative energy projects likely to be proposed within the next 5 to 7 years.

Certain materials, such as chemical warfare agents, high-level radioactive waste, medical waste, sewage sludge, and industrial waste, may not be dumped in the ocean. Before 1972, however, accepted practices for disposal of chemical weapons by the U.S. military included ocean dumping, because it was thought that the vastness of ocean waters would absorb any chemical agents that leaked. The first recorded instance of ocean disposal of chemical weapons was in 1918 at an unknown location in the Atlantic Ocean between the United States and England. The last recorded instance occurred in 1970, approximately 402 km (250 mi) off the coast of Florida (Bearden 2006). The Department of Defense first publicly acknowledged ocean disposal of chemical weapons by the U.S. military in the late 1960s, but little information about specific disposal locations was provided. In 2001, the Army published more information on this topic than had previously been released. Even so, the Army's records included exact coordinates for only a few disposal sites. The locations of most disposal sites were indicated by using general references to the sites being offshore from specified States or cities, and sometimes the approximate distance from shore was provided. Two sites appear to be in the vicinity of the Pacific region (U.S. Army 2001). Figures 4.4.17-1 and 4.4.17-2 show the approximate locations of known dump sites. Chemical agents disposed in the vicinity of the Pacific region include Lewisite and mustard gas.

Another source of wastes placed into the oceans is oceangoing vessels, including military craft (U.S. Navy and Coast Guard), commercial business craft (freighters, tugboats, fishing vessels, ferries, and passenger ships), commercial recreational craft (cruise ships and fishing/sightseeing charters), research vessels, and personal craft (fishing boats, house boats, yachts, and other pleasure craft). The extent to which these vessels are present in the Pacific region is discussed in Section 4.4.17.

Wastes that may be generated by these vessels include gray water, bilge water, blackwater (sewage), ballast water, antifouling paints (and their leachate), hazardous materials, and municipal and commercial garbage and other wastes. Large cruise ships and military vessels generate wastes in volumes comparable to those of small cities. For example, a single large passenger vessel is capable of producing more than 379,000 L (100,000 gal) of wastewater per day. Such vessels also generate significant volumes of other waste materials that are released to the ocean, disposed of onshore, and/or incinerated (CEPA 2003).

The discharge of wastes on the OCS by oceangoing vessels is governed by a set of international treaties, known collectively as the MARPOL convention, as well as by U.S. Federal and State laws. For example, the USCG limits the oil content of discharges to the oceans from nonmilitary ships to no more than 15 parts per million (ppm), and oil pollution control equipment, called an oil water separator, is required to achieve this limit (see 33 CFR 155). Also, the USCG controls generation, handling, storage, and disposal of solid waste (e.g., garbage) on vessels in the oceans (33 CFR 151). These regulations specify minimum distances for the disposal of the principal types of garbage. Section 312 of the Clean Water Act (CWA) requires the use of marine sanitation devices (MSDs), on-board equipment for treating and discharging or storing sewage, on all commercial and recreational vessels that are equipped with installed toilets. There are three types of MSDs. For Type I MSDs (vessels equal to or less than 65 ft), the effluent produced must have a fecal coliform bacteria count no greater than 1,000/100 mL and no visible floating solids. For Type II MSDs (vessels greater than 65 ft), the effluent produced must have a fecal coliform bacteria count no greater than 200/100 mL and suspended solids no greater than 150 mL/L. Type III MSDs are designed to prevent the overboard discharge of treated or untreated sewage. They are commonly called holding tanks because the sewage flushed from the marine head is deposited into a tank containing deodorizers and other chemicals. The contents of the holding tank are stored until they can be properly disposed of at a shore-side pumpout facility. Section 312 does not apply to: vessels with portable toilets or any other on-board portable sewage reception system; gray water from bath or kitchen sinks; or vessels beyond the 3 nautical mi limit of U.S. territorial waters.

Section 312 also allows the USEPA or States to establish no-discharge zones in which the discharge of sewage from all vessels into specified waters is prohibited. There are three objectives for this designation. Under CWA Section 312 (f)(3), a State may designate portions of its waters as no-discharge zones if the State determines that the protection and enhancement of the quality of the waters require greater environmental protection than current Federal standards allow. In this instance, the USEPA is required to determine if there are adequate pumpout facilities available. Additionally, a State may make a written application to the Administrator, under CWA Sections 312(f)(4)(A) or 312(f)(4)(B), for the issuance of a regulation completely prohibiting discharges from a vessel of any sewage, whether treated or not, into specified waters that have environmental importance or waters that serve as drinking water intakes, respectively. The application requirements may vary depending on whether it is an application under CWA Sections 312 (f)(3), 312 (f)(4)(A), or 312 (f)(4)(B). Currently, California is the only State in the Pacific region that has designated segments of its surface waters as no-discharge zones.

The States partially bounded by coastal waters adjacent to the OCS Pacific region contain many public and commercial municipal solid waste and sanitary landfills capable of accepting general refuse. A number of public and commercial industrial waste landfills that would be capable of accepting nonhazardous industrial wastes not suitable for disposal in sanitary or municipal solid waste landfills are also operating in these States. Three States contain active commercial hazardous waste landfill facilities (USEPA 2006d).

4.4.7 Electromagnetic Fields

Section 4.2.7 discusses the hazards posed by submarine power cables. Such power cables are used to supply power to 17 of the 23 OCS oil and gas facilities in California. Otherwise, use of submarine power cables on the OCS is limited.

4.4.8 Marine Mammals

At least 39 species of marine mammals, including cetaceans (whales, porpoises, dolphins), pinnipeds (seals, sea lions), and a single fissiped (the southern sea otter) occur in the marine waters off the coasts of Washington, Oregon, and California (Carretta et al. 2007). While some species are year-round residents, others occur as seasonal residents or as migrants. Several species, such as some of the Mesoplodon beaked whales, are rarely observed. Many of the species reported from Pacific OCS waters are represented by one or more distinct stocks, which exhibit distinct distributions within a species overall population distribution (Carretta et al. 2007). Many of these stocks may be locally abundant in some OCS waters but absent from other areas of the Pacific OCS. The 39 species of marine mammals reported from Pacific OCS waters are presented in Table 4.4.8-1, which also provides information on the general distribution of each species (but not individual stocks) within the OCS waters.

4.4.8.1 Threatened or Endangered Species

4.4.8.1.1 Cetaceans. There are seven cetacean species federally listed as endangered under the Endangered Species Act of 1973 that may occur in nearshore or offshore waters of the Pacific region, including the blue whale, fin whale, humpback whale, North Pacific right whale, sei whale, and the sperm whale (Table 4.4.8-1). These species are also designated as depleted under the MMPA.

The eastern stock of the North Pacific blue whale (*Balaenoptera musculus*) feeds in California waters from June through November and migrates south for the winter and spring months (ACS 2004b). This species has been sighted most often in California waters, suggesting that blue whales have increased in abundance in California waters, possibly the result of increased use of California as a feeding area (Carretta et al. 2007). The best current estimate for the eastern stock of the North Pacific blue whale abundance is 1,384 individuals (Carretta et al. 2007).

Recent observations show aggregations of fin whales (*Balaenoptera physalus*) year-round in southern/central California and in summer in Oregon (Carretta et al. 2007). Acoustic signals from fin whales have also been detected year-round off northern California, Oregon and Washington, with a concentration of vocal activity between September and February. A minimum population size of fin whales in the Pacific OCS waters has been estimated at 2,541 animals (Carretta et al. 2007).

TABLE 4.4.8-1 Marine Mammals of Southern California, Central California, Northern California, and Washington/Oregon OCS Waters[a]

Species	Status[b]	General Occurrence[c]				Typical Habitat		
		Southern California[d]	Central California[e]	Northern California[f]	Washington/ Oregon[g]	Coastal	Shelf	Slope/ Deep
Order Cetacea								
Suborder Mysticeti (baleen whales)								
Family Balaenidae								
North Pacific right whale (*Eubalaena japonica*)	E/D	O[h]	O	O	O		X	X
Family Balaenopteridae								
Blue whale (*Balaenoptera musculus*)	E/D	O	O	O	O		X	X
Bryde's whale (*Balaenoptera edeni*)		O	O	O	O		X	X
Fin whale (*Balaenoptera physalus*)	E/D	UC	UC	UC	UC		X	X
Humpback whale (*Megaptera novaeangliae*)	E/D	UC	O	O	O	X	X	
Minke whale (*Balaenoptera acutorostrata*)		UC	UC	UC	UC	X	X	
Sei whale (*Balaenoptera borealis*)	E/D	O	O	O	O			X
Family Eschrichtiidae								
Gray whale (*Eschrichtius robustus*)		UC	UC	UC	UC	X	X	
Suborder Odontoceti (toothed whales and dolphins)								
Family Kogiidae								
Dwarf sperm whale (*Kogia sima*)		EX	EX	EX	EX			X
Pygmy sperm whale (*Kogia breviceps*)		O	O	O	O			X
Family Physteridae								
Sperm whale (*Physeter macrocephalus*)	E/D	O	O	O	O			X

TABLE 4.4.8-1 (Cont.)

Species	Status[b]	General Occurrence[c]				Typical Habitat		
		Southern California[d]	Central California[e]	Northern California[f]	Washington/ Oregon[g]	Coastal	Shelf	Slope/ Deep
Family Ziphiidae								
Perrin's beaked whale (*Mesoplodon perrini*)		O	O	O	O			X
Baird's beaked whale (*Berardius bairdii*)		O	O	O	O			X
Cuvier's beaked whale (*Ziphius cavirostris*)		O	O	O	O			X
Lesser beaked whale (*Mesoplodon peruvianus*)		O	O	O	O			X
Stejneger's beaked whale (*Mesoplodon stejnegri*)		O	O	O	O			X
Hubbs' beaked whale (*Mesoplodon carlhubbsi*)		O	O	O	O			X
Ginko-toothed beaked whale (*Mesoplodon gingkoodens*)		O	O	O	O			X
Blainville's beaked whale (*Mesoplodon densirostris*)		O	O	O	O			X
Family Delphinidae								
Short-beaked common dolphin (*Delphinus delphis*)		C	C	UC	EX		X	X
Long-beaked common dolphin (*Delphinus capensis*)		UC	O	A	A	X	X	
Bottlenose dolphin (*Tursiops truncatus*)		C	C	C	C	X	X	X
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)		C	C	C	C		X	X
Northern right-whale dolphin (*Lissodelphis borealis*)		C	C	C	C		X	X
Killer whale (*Orcinus orca*)	E[i]/D	O	O	O	UC	X	X	X
Dall's porpoise (*Phocoenoides dalli*)		C	C	C	C	X	X	X
Short-finned pilot whale (*Globicephala macrorhynchus*)		O	O	O	O	X	X	
Risso's dolphin (*Grampus griseus*)		C	C	C	C		X	
Striped dolphin (*Stenella coeruleoalba*)		UC	UC	UC	EX		X	X
Harbor porpoise (*Phocoena phocoena*)		C	C	C	C	X	X	

TABLE 4.4.8-1 (Cont.)

Species	Status[b]	General Occurrence[c]				Typical Habitat		
		Southern California[d]	Central California[e]	Northern California[f]	Washington/ Oregon[g]	Coastal	Shelf	Slope/ Deep
Order Carnivora								
Suborder Pinnipedia								
Family Phocidae								
Harbor Seal (*Phoca vitulina*)		C	C	C	C	X		
Northern elephant seal (*Mirounga angustirostris*)		C	C	UC	UC	X	X	
Family Otariidae								
California sea lion (*Zalophus califorianus*)		C	C	O	O	X		
Guadalupe fur seal (*Arctocephalus townsendi*)	T	O	O	O	A	X		
Northern fur seal (*Callorhinus ursinus*)		UC	O	O	O	X	X	
Steller sea lion (*Eumetopias jubatus*)	T	UC	UC	UC	UC	X	X	
Suborder Fissipedia								
Family Mustelidae								
Southern sea otter (*Enhydra lutris nereis*)	T	UC	C	UC	O	X		

[a] Sources: Carretta et al. (2007); Angliss and Outlaw (2007).

[b] E = Endangered under the Endangered Species Act; T = Threatened under the Endangered Species Act; D = Depleted under the Marine Mammal Protection Act.

[c] The indicated occurrence does not reflect the distribution and occurrence of individual stocks of marine mammals within localized geographic areas, but rather the broad distribution of the species within the larger categories of OCS waters.

[d] Southern California includes OCS waters from the California-Mexico border to approximately San Simeon, CA.

[e] Central California includes OCS waters from approximately San Simeon to Mendocino, CA.

Footnotes continued on next page.

TABLE 4.4.8-1 (Cont.)

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[f] Northern Calfornia includes OCS waters from approximately Mendocino to the California-Oregon border.

[g] Washington/Oregon includes OCS waters of Washington and Oregon.

[h] A = Absent – not recorded from the area; C = Common – regularly observed throughout the year; EX = Extralimital – known only on the basis of a few records that probably resulted from unusual wonderings of animals into the region (Würsig et al. 2000); O = Occasional – relatively few observations throughout the year, but some species may be more frequently observed in some locations or during certain times (e.g., during migration); UC = Uncommon – infrequently observed throughout the year, but some species may be more common in some locations or during certain times of the year (e.g., during migration or when on summer calving grounds or wintering grounds).

[i] Only the Eastern Pacific southern resident Killer whale distinct population segment has been listed as endangered.

The humpback whale (*Megaptera novaeangliae*) is found in all the world's oceans (ACS 2004e). Most populations follow regular migration routes, summering in temperate and polar waters for feeding and wintering in tropical waters for mating and calving. The eastern North Pacific stock spends the winter in coastal waters of Central America and Mexico, and migrates in spring along the coast of California and southern British Columbia where it can be found in summer and fall (Carretta et al. 2007). The eastern North Pacific stock has been increasing in size since the early 1990s, and a minimum population size of 1,158 individuals has been estimated for the California/Mexico stock (Carretta et al. 2007).

While the sei whale (*Balaenoptera borealis*) was the fourth most common whale taken by California coastal whalers in the 1950s–1960s, it is now extremely rare in California waters (Carretta et al. 2007). The minimum population of sei whales of the eastern North Pacific stock (which occurs in Pacific OCS waters) has been estimated at only 35 animals (Carretta et al. 2007).

The sperm whale (*Physeter macrocephalus*) is found in all oceans of the world. Males, either alone or in groups, are found at higher latitudes, and may migrate to lower latitudes (ACS 2004f). Only the largest whales are thought to migrate to breeding grounds near the equator. Females, calves, and juveniles remain in warmer tropical waters year-round (ACS 2004f). Sperm whales comprising the California/Oregon/Washington stock are found year-round in California waters, where they reach peak abundance from April through mid-June and from the end of August through mid-November (Carretta et al. 2007). The minimum population estimate for sperm whales of the California/Oregon/Washington stock has been estimated at 885 individuals (Carretta et al. 2007).

The distribution of the eastern stock of the North Pacific right whale (*Eubalaena japonica*) includes waters of the Pacific OCS (Angliss and Outlaw 2007). Right whales in the North Pacific historically ranged across the entire North Pacific north of 35°N and occasionally as far south as 20°N, with North American concentrations in the Gulf of Alaska, eastern Aleutian Islands, south central Bering Sea. While sightings of the North Pacific right whale have been reported as far south as Baja California (Angliss and Outlaw 2007), this species may be considered extremely uncommon in the Pacific OCS waters and may be extralimital in these waters. While no reliable estimate of the North Pacific right whale is available, the population of the eastern stock of this species has been estimated at perhaps less than 100 individuals (ACS 2004a).

Killer whales are the most widely distributed cetacean species in the world. In the Eastern North Pacific Ocean, they have been reported from the eastern Bering Sea to the Aleutian Islands, in the waters of southeastern Alaska and the intercoastal waters of British Columbia and Washington State, and along the coasts of Washington, Oregon and California. In the eastern North Pacific, there are three distinct forms of killer whales: residents, transients, and offshore, which represent different populations that vary in morphology, ecology, behavior, and genetics. The eastern North Pacific killer whale southern resident distinct population is listed as endangered. Most sightings of this population have occurred in the summer in inland waters of Washington and southern British Columbia, although sightings of some pods have been reported from coastal waters off Vancouver Island and Washington State, and more recently as far south as central California (Carretta et al. 2007). On the basis of yearly direct counts of individually identifiable animals, the minimum population size of the eastern North Pacific killer whale southern resident distinct population has been estimated at 91 animals.

4.4.8.1.2 Pinnipeds. There are two pinniped species federally listed as threatened under the Endangered Species Act found within waters of the Pacific region: the Guadalupe fur seal and Steller sea lion (Table 4.4.8-1). Specific locations recognized as important congregation areas for pinnipeds in the Pacific region include Grays Harbor and Willapa Bay (Washington), Cape Arago and the Columbia River mouth (Oregon), Cape Mendocino and Pt. St. George (northern California), Año Nuevo Island and the Farallon Islands (central California), and the Channel Islands (southern California).

The range of the Guadalupe fur seal (*Arctocephalus townsendi*) is from Baja California, Mexico, to southern California. In California waters, adult males and juveniles are annually seen on San Nicolas and San Miguel Islands, adult males and nonbreeders have been observed on occasion at the Farallon Islands, and a few seals have been known to inhabit California sea lion rookeries in the Channel Islands (NatureServe 2006; Carretta et al. 2007). The minimum population size in Mexico has been estimated at 3,028 hauled out seals (Carretta et al. 2007).

The Steller sea lion (*Eumetopias jubatus*) inhabiting the Pacific region belongs to the eastern U.S. stock (Angliss and Outlaw 2007). The eastern stock of this species breeds on rookeries in southeast Alaska, British Columbia, Oregon, and California; no rookeries are located in Washington (NatureServe 2006; Angliss and Outlaw 2007). Population estimates for this species include 5,076 individuals in Oregon and 3,208 individuals in California; the total eastern U.S. stock is estimated at 44,996 individuals (Angliss and Outlaw 2007).

4.4.8.1.3 Fissipeds. Historically, the sea otter (*Enhydra lutris*) ranged from Prince William Sound in Alaska to central Baja California. Two subspecies of this species occur in the Pacific region OCS waters: the northern sea otter (*E. l. kenyoni*) and the southern sea otter (*E. l. neries*). In the Pacific region OCS waters, the northern sea otter, which is listed as threatened in southwest Alaska, is found only in Washington (USFWS 2003). The Washington population was established by using translocated Alaskan sea otters and is not federally listed. The southern sea otter is listed as threatened under the Endangered Species Act and can be found along the Pacific Coast of central and southern California from San Mateo County below San Francisco south to Cojo Anchorage in Santa Barbara County; an experimental colony has been established on San Nicolas Island (USFWS 2003). The latest 3-year average (for the years 2005 to 2007) indicates an average of 2,818 southern sea otters along the central California coast (USGS 2007).

Sea otters prefer the shallow, nearshore waters overlying either a sandy or rocky seafloor. Preferred prey items include benthic macroinvertebrates. Over rocky areas, sea otters typically feed on abalone, crab, and sea urchins, while in sandy regions, this species is opportunistic, feeding on bivalves (clams, mussels, scallops), gastropods, echinoderms (sea stars, sea cucumbers), and octopus (USFWS 2003).

4.4.8.2 Nonendangered Species

There are approximately 29 nonendangered marine mammal species that may frequent waters of the Pacific region. Cetaceans included in this group include the eastern North Pacific stock of the gray whale (*Eschrichtius robustis*), several species of beaked whales (*Ziphius* spp., *Mesoplodon* spp.), pilot whales (*Globicephala* spp.), pygmy sperm whales (*Kogia* spp.), the killer whale (*Orcinus orca*), several species of dolphin (*Delphinus* spp., *Grampus* spp., *Tursiops* spp., *Steno* spp., *Stenella* spp.), and porpoise (*Phocoenoides* and *Phocoena* spp.). Also included are four species of pinnipeds (elephant seal, a sea lion, and two seals). All marine mammals are afforded protection under the Marine Mammals Protection Act.

4.4.8.2.1 Cetaceans. There are 24 species of nonendangered cetaceans that have been reported from the Pacific region OCS waters. However, the presence of many of the species depends on the season, as many of the species exhibit seasonal migrations through and into specific waters. Some species, such as the bottlenose dolphin (*Tursiops truncatus*) and the harbor porpoise (*Phocoena phocoena*) can be regularly found along the entire Pacific Coast. Other species, such as the false killer whale (*Pseudorca crassidens*) and striped dolphin (*Stenella coeruleoalba*) are uncommon and only occasionally observed in waters of the Pacific OCS. The Mesoplodon beaked whales (see Table 4.4.8-1) are represented by five species, which are very difficult to differentiate during ship surveys, and are only very occasionally observed and recorded as Mesoplodon beaked whales rather than individual species (Carretta et al. 2007).

Among the nonendangered cetaceans, the short-beaked common dolphin is the most abundant, with an estimated population of more than 365,000 animals. Other relatively abundant species are the northern right-whale dolphin (*Lissodelphis borealis*) (16,400), long-beaked common dolphin (*Delphinus capensis*) (25,100), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) (39,800), and Dall's porpoise (*Phocoenoides dalli*) (75,900). The harbor porpoise is relatively common and widely distributed along the entire Pacific Coast. Along the coast, this species occurs in six distinct stocks: the Morro Bay stock (1,200 individuals), the Monterey stock (1,149), the San Francisco-Russian River stock (6,254), the Northern California/Southern Oregon stock (12,940), the Oregon/Washington Coast stock (28,967), and the Washington Inland stock (2,545) (Carretta et al. 2007).

The least abundant species include the pygmy sperm whale (*Kogia breviceps)* (119 individuals), the short-finned pilot whale (*Globicephala macrorhynchus*) (149 individuals), Baird's beaked whale (*Berardius bairdii*) (152 individuals), the bottlenose dolphin (186 individuals), and the eastern North Pacific offshore stock of the killer whale (361 individuals). The six Mesoplodon beaked whales (Perrin's [*Mesoplodon perrini*], lesser [*M. peruvianus*], Stejneger's [*M. stejnegri*], Hubbs' [*M. carlhubbsi*], ginko-toothed [*M. gingkoodens*], and Balineville's [*M. densirostris*]) have an estimated combined abundance of 645 individuals (Carretta et al. 2007).

The eastern stock of the North Pacific gray whale lives along the Pacific Coast of North America (Angliss and Outlaw 2007). Most of this stock spends the summer feeding in Arctic waters, although individuals have also been reported feeding in summer in waters off of southeast Alaska, British Columbia, Washington, Oregon, and California. Each fall, gray whales migrate south along the North American coast to winter in waters off of Baja California, Mexico (ACS 2004g; Angliss and Outlaw 2007). The minimum population estimate for the eastern North Pacific stock of gray whales is 17,752 individuals (Angliss and Outlaw 2007).

Feeding, breeding, and calving for many of the cetaceans are thought to occur to some degree in the OCS waters, especially in waters off of southern California (Carretta et al. 2007). Some of the species also exhibit seasonal migrations wherein individual move north along the Pacific Coast in spring and summer and south in fall and winter. Depending on the particular species of interest, cetaceans may be found in coastal, shelf, and slope/deep water areas of the Pacific OCS (Table 4.4.8-1). Most of the nonendangered cetaceans (20 species) are associated with slope and deepwater areas, while only six species are typically associated with coastal waters.

4.4.8.2.2 Pinnipeds. Four species of nonendangered pinnipeds may be found in the coastal and offshore habitat of the Pacific OCS area: the harbor seal, the northern elephant seal, the northern fur seal, and the California sea lion (Table 4.4.8-1). Especially important areas include the islands along the southern and central California coast (such as the Channel and Farallon Islands). These pinnipeds feed on fish and invertebrates (Carretta et al. 2007; NatureServe 2006).

The harbor seal (*Phoca vitulina*) is regularly observed in coastal habitats along the Pacific Coast and comprises three separate stocks: the California stock, which occurs along the California coast, the Oregon/Washington Stock found along the Oregon and Washington coast, and the Washington Inland Waters stock, which occupies inland waters of Washington (Carretta et al. 2007). The minimum population size of the California stock has been estimated at 31,600 individuals. The minimum populations of the Oregon/Washington and Washington Inland Waters stocks have been estimated at 22,380 and 12,844 animals, respectively (Carretta et al. 2007). Harbor seals haul out on beaches, rocks, and reefs. This species is generally nonmigratory, with local movements associated with such factors as tides, weather, season, food availability, and reproduction.

The northern elephant seal (*Mirounga angustirostris*) can be found at sea from Mexico to the Gulf of Alaska, with its present breeding range extending from Baja California to Point Reyes in northern California (Carretta et al. 2007). The California breeding population is considered a separate stock and isolated from the Baja California population (Carretta et al. 2007). Elephant seals have also been observed in estuarine and coastal habitats along Oregon and Washington. This species typically remains at sea, returning to land only to breed and molt. Breeding occurs during the winter (December to March), with molting occurring in April-May or mid-summer. More than half of the northern elephant seal population is associated with rookery islands off southern California, including San Miguel, San Nicolas, Santa Barbara, and San Clemente Islands; other California rookeries include Cape San Martin (central California), Año Nuevo Island, Southeast Farallon Island (northern California), and Point Reyes (northern California) (Carretta et al. 2007). Off Washington and Oregon, most elephant seal sightings have been noted over the shelf and slope, usually during summer, while in California waters sightings are predominantly in inshore waters, with only limited sightings beyond the continental slope. The minimum population of the California stock has been estimated at 60,547 individuals (Carretta et al. 2007).

The northern fur seal occurs from southern California to the Bering Sea and west to Japan (Carretta et al. 2007). During the breeding season, approximately 74% of the worldwide population can be found on the Pribilof Islands in the southern Bering Sea (Angliss and Outlaw 2007; Carretta et al. 2007). Of the northern fur seals found in U.S. waters, less than 1% of the world population can be found on San Miguel Island off southern California (the San Miguel Island stock), with temporary haulouts on islets along the U.S. Pacific Coast (Carretta et al. 2007). Adults spend 7 to 8 months at sea, and pups may remain at sea for up to 22 months before returning to their birth rookeries. The minimum population size for the San Miguel Island stock has been estimated at 4,190 animals (Carretta et al. 2007).

The California sea lion (*Zalophus californianus*) ranges throughout the Pacific region, from British Columbia to Mexico. Breeding occurs during the summer on islands off southern California (i.e., San Miguel, San Nicolas, San Clemente, and Santa Barbara islands) and Mexico (Carretta et al. 2007). Most immature and adult males leave their breeding grounds in the fall, migrating northward to the Oregon, Washington, and British Columbia coasts. Peak migrations past central and northern California occur in September, with highest abundance levels seen off Oregon and Washington coasts in fall and winter. The minimum U.S. stock population has been estimated at 138,881 individuals (Carretta et al. 2007).

4.4.9 Marine and Coastal Birds

Under the proposed action, a large variety of marine and coastal birds may be affected by the development of alternative energy and alternate use systems in Pacific OCS waters. Habitats vary widely along the Pacific Coast between the Mexican and Canadian borders, ranging from coastal rainforests in the northern half to low coastal mountains of mixed chaparral vegetation to the south. Major coastal habitat types include: (1) sandy beaches and dunes, (2) rocky shores and intertidal zones, (3) mudflats, (4) rocky cliffs, (5) lagoons and estuaries, (6) freshwater and salt marshes, (7) tidal creeks, and (8) coastal forests and uplands (Airamé et al. 2003; PRBO Conservation Science 2005; USFWS 2005f). In addition, many man-made structures such as bridges, dikes, dredge spoil islands, jetties, navigation structures, and breakwaters provide important roosting and nesting habitats for many seabirds (USFWS 2005f). These habitats support many species of marine and coastal birds. The birds that occur in coastal and offshore areas include species that are considered common, as well as numerous species that are federally or State-listed as threatened or endangered.

4.4.9.1 Threatened or Endangered Species

Fourteen species of birds listed under the Endangered Species Act of 1973 as threatened or endangered may occur in Pacific OCS waters and adjacent coastal habitats (Table 4.4.9-1). In addition, California, Oregon, and Washington have listed numerous species, independent of the

Federal listing, some of which may also occur in coastal or marine habitats along the Pacific Coast.

Among the federally listed species, some, such as the short-tailed albatross (*Phoebastria albatrus*) or California condor (*Gymnogyps californianus*), are very rare and seldom seen (USFWS 2005f). Other species, such as the spotted owl (*Strix occidentalis caurina*), California clapper rail (*Rallus longirostris obsoletus*), and marbled murrelet (*Rachyramphus narmoratus narmoratus*), while more often seen, have ranges restricted to specific areas along or very near coastlines. Still other species, such as those endemic to San Clemente Island, have extremely restricted ranges and occur only within a single planning area. Finally, a number of the listed species such as the brown pelican (*Pelecanus occidentalis*) may be encountered in coastal habitats all along the Pacific Coast.

4.4.9.2 Nonendangered Species

4.4.9.2.1 Marine Birds. Marine birds (seabirds) spend most of their lives at sea, coming ashore mainly to breed or to avoid severe environmental conditions. Included under this group are pelagic birds (e.g., petrels and shearwaters); diving birds (e.g., cormorants and pelicans); and gulls, terns, and skimmers. Pelagic species tend to concentrate in nutrient-rich upwelling areas to feed. Seabird abundance in offshore waters has been estimated at 5.5 to 6 million birds off California and 1.8 million birds off Oregon and Washington, representing more than 100 species (USFWS 2005f).

Twenty species of marine birds breed along the Pacific Coast of the United States (PRBO Conservation Science 2005). Many of the important seabird sites along the Pacific Coast have been designated and protected as national parks and monuments, national wildlife refuges (NWR), national marine sanctuaries and marine protected areas, State parks, and private nature preserves; breeding seabird colonies at many of these locations may exceed 100,000 breeding birds (PRBO Conservation Science 2005). Important seabird sites in California include the Farallon Islands and Castle Rock NWRs, Channel Islands National Park, and the California Coastal National Monument. In Oregon, the Oregon Islands NWR and the Oregon Islands Wilderness Area provide breeding grounds for about 1.2 million birds representing 13 seabird species. In Washington, the Olympic Coast National Marine Sanctuary includes four NWRs (Flattery Rocks, Quillayute Needles, Protection Island, and Copalis) that have been estimated to contain 80–90% of Washington's seabirds. The Protection Island NWR includes one of the largest rhinoceros auklet (*Cerorhinca monocerata*) breeding colonies in the world and the largest glaucous-winged gull (*Larus glaucescens*) colony in Washington (PRBO Conservation Science 2005). The majority of nesting seabirds in Washington occur along the northern half of the State, primarily on islands of the Maritime and San Juan Islands NWRs.

TABLE 4.4.9-1 Federally Endangered and Threatened Birds That May Occur in Coastal and Marine Areas of the Eastern Pacific Ocean

Species	Federal Status[a]	OCS Planning Area (State)	General Ecology
Eskimo curlew (*Numenius borealis*)	E	Southern California, Central California, Northern California, and Washington/ Oregon (CA, WA, OR)	A migrant shorebird that historically nested in the Arctic wetlands and wintered in South America. May be extinct.
Short-tailed albatross (*Phoebastria* [= *Diomedea*] *albatrus*)	E	Southern California, Central California, Northern California, and Washington/ Oregon (CA, WA, OR)	Pelagic species that nests on oceanic islands in the western Pacific. Sightings within 3 mi of shore have been reported along Pacific Coast as far south as Baja California.
California condor (*Gymnogyps californianus*)	E	Southern California, Central California, Northern California, and Washington/ Oregon (CA, OR)	Recent range restricted to chaparral, coniferous forests, and oak savannah habitats in southern and central California. Formerly occurred more widely throughout the Southwest and also fed on beaches and large rivers along the Pacific Coast.
Western snowy plover, California coastal population (*Charadrius alexandrinus nivosus*)	T	Southern California, Central California, Northern California, and Washington/ Oregon (CA, WA, OR)	Shorebird that inhabits coastal sandy beaches and mudflats.
Coastal California gnatcatcher (*Polioptila californica californica*)	T	Southern California (CA)	Found in scrub and maritime succulent scrub habitats from Ventura County south to the Mexican border.
Marbled murrelet (*Brachyramphus marmoratus marmoratus*)	T	Southern California, Central California, Northern California, and Washington/ Oregon (CA, WA, OR)	Least often encountered in southern California. Historically nested in forested coastline areas of central and northern California, Washington, and Oregon.
Northern spotted owl (*Strix occidentalis caurina*)	T	Southern California, Central California, Northern California, and Washington/ Oregon (CA, WA, OR)	Old growth and similar forests. Designated critical habitat includes some coastal areas in Oregon and a small number of locations in California that are less than 5 mi from the coastline.

TABLE 4.4.9-1 (Cont.)

Species	Federal Status	OCS Planning Area (State)	General Ecology
Brown pelican except U.S. Atlantic Coast, FL, AL (*Pelecanus occidentalis*)	E	Southern California, Central California, Northern California, and Washington/ Oregon (CA, WA, OR)	Ranges from British Columbia to southern Mexico. Mainly coastal, rarely out to sea, foraging on fish in shallow waters. Makes extensive use of sand spits, offshore sand bars, and islets for nocturnal roosting and daily loafing. Dry roosting sites are essential. Nesting occurs on Anacapa and Santa Barbara Islands off southern California.
Light-footed clapper rail (*Rallus longirostris levipes*)	E	Southern California (CA)	Found in coastal marsh habitats from Santa Barbara south to Mexico. Coastal marshes considered primary nesting habitat. Feeds on marsh invertebrates.
California clapper rail (*Rallus longirostris obsoletus*)	E	Central California (CA)	Restricted to salt and brackish water marshes of the San Francisco estuary, where the only known breeding populations occur.
San Clemente loggerhead shrike (*Lanius ludovicianus mearnsi*)	E	Southern California (CA)	Endemic to San Clemente Island of the Channel Islands, nesting in trees and shrubs in canyons on the island.
San Clemente sage sparrow (*Amphispiza belli clementeae*)	E	Southern California, Central California, and Northern California (CA)	Endemic to San Clemente Island, occurring in shrub habitats on lower elevations of the western slope of the island.
California least tern (*Sterna antilarum browni*)	E	Southern California and Central California (CA)	Migrates from Central America in spring to breeding colonies along the coast between Baja California and San Francisco. Nests on open sandy beaches.
Least Bell's vireo (*Vireo bellii pusillus*)	E	Southern California (CA)	Shrubby vegetation along coast from Santa Barbara south to Mexico and inland to Imperial Valley. Migrates to Baja California and Pacific Coast of northern and central Mexico to overwinter.

[a] E = Endangered; T = Threatened under the Endangered Species Act of 1973.

Source: USFWS (2006b).

4.4.9.2.2 Coastal Birds. The Pacific Coast also supports a diversity of coastal birds, as well as inland species that occur as year-round or seasonal residents, as well as species that occur only as they migrate along the coast in spring and fall. These species forage and/or nest in coastal habitats such as sandy beaches, wetlands, rocky shores, islands, and coastal forests and uplands. These birds include shorebirds such as sandpipers, plovers, and avocets; wading birds such as herons and egrets; raptors, waterfowl, and numerous passerines such as jays, blackbirds, finches, warblers, and sparrows (National Geographic Society 1999).

Shorebirds exclusively use shorelines of the open coast and offshore rocks, as well as protected shores of wetlands, estuaries, bays, and lagoons. Species that are characteristic of sandy beaches include plovers (black-bellied, semipalmated), willets, whimbrels, marbled godwits, sanderlings, and sandpipers (least, western). Species using rocky shorelines or offshore rocks include oystercatchers, turnstones (black, ruddy), spotted sandpipers, and surfbirds. Many shorebirds that frequent the coasts and shorelines of the Pacific region have migrated from Alaska. Coastal habitats are also used by waterfowl and wading birds.

4.4.9.3 Use of Pacific Coast Habitats by Migratory Birds

Many bird species follow the Pacific Coast to migrate between summer breeding habitats in Alaska and Canada (as far north as the Arctic) and overwintering areas as far south as subtropical and tropical areas of Mexico, and Central, and South America (Lincoln et al. 1998). For example, many of the shorebirds that frequent the Pacific coastline migrate from Alaska between August and October to wintering areas in California, Mexico, and Central and South America (Lincoln et al. 1998). This route (Figure 4.2.9-1), which is not as long or as heavily used as other migratory routes in North America, extends from the Arctic Tundra, Alaska Peninsula, and the Gulf of Alaska, and parallels the coastline of British Columbia, Washington, Oregon, and California. During the spring and fall, migrating gulls and waterfowl (e.g., ducks) use the many beaches, bays, islands, estuaries, marshes, wetlands, and coastal forests of the Pacific Coast for resting and foraging. Important staging areas for migrating shorebirds include Puget Sound and Gray's Harbor in Washington and Humboldt and San Francisco Bays in northern California.

4.4.10 Terrestrial Biota

Ecoregions are areas with generally similar ecosystems and with similar types, qualities, and quantities of environmental resources as a result of patterns of vegetation, animal life, geology, soils, water quality, climate, and human land use, as well as other living and nonliving ecosystem components (Omernik 1987). The following discussion of terrestrial biota along the coastlines adjacent to the Pacific OCS region is based on the Level III ecoregion classification of Omernik (1987) as refined through collaborations among USEPA regional offices, State resource management agencies, and with other Federal agencies (USEPA 2004c).

The Pacific Coast of the United States supports a wide diversity of terrestrial biota. This diversity is a function of the combinations geology, topography, and climate that occur along the coast from the California border with Mexico to the Canadian border with Washington and the ecoregions that encompass these areas. The eastern Pacific Coast falls into three ecoregions (Figure 4.4.10-1), each with relatively unique ecosystems and biota. Descriptions of these ecoregions are presented in Table 4.4.10-1.

Each of these ecoregions support a vast variety of plant and animal species, some of which inhabit or visit coastal habitats. Included among these species of terrestrial biota are numerous species that have been listed as threatened or endangered under the Endangered Species Act of 1973, species being considered for listing under the Act, as well as many species listed by individual States. The numbers of threatened, endangered, or candidate species listed under the Endangered Species Act are presented in Table 4.4.10-2. These listed species include plants, invertebrates, amphibians, reptiles, birds, and mammals. While many of these species occur inland, well away from coastal areas, some inhabit or visit coastal habitats within the OCS Pacific region. For example, there are several subspecies of endangered foxes (*Urocyon littoralis littoralis*, *U. l. catalinae*, and *U. l. santacruzae*) that inhabit the San Miguel, Santa Catalina, and Santa Cruz Islands along the California coast.

4.4.11 Fish Resources and Essential Fish Habitat

The Pacific Ocean off the coasts of Washington, Oregon, and California includes a variety of marine habitats, ranging from coastal beaches, marshes, and rocky intertidal shorelines to submarine canyons. It supports a varied and abundant fish and invertebrate fauna, including threatened and endangered species, nonlisted species, and species important to commercial and recreational fisheries. Given the diversity of species and habitats, several State and Federal agencies are involved in the management of fish resources in this region. The NMFS manages commercial and recreational fisheries within Federal waters under the Magnuson-Stevens Fishery Conservation and Management Act (FCMA; 16 USC 1801–1883), which, in part, calls for the description, identification, and management of Essential Fish Habitat (EFH) to help conserve fishery resources. Fishery management plans for fishery resources in the Exclusive Economic Zone (EEZ) along the Pacific coast of the United States are typically prepared by the Pacific Fishery Management Council (PFMC) and submitted to the NMFS for review, approval, and implementation. The PFMC has developed or assisted with development of fishery management plans for west coast salmon, coastal pelagic species, Pacific coast groundfish, and highly migratory species of the west coast of the United States (Table 4.2.11-1). The Pacific States Marine Fisheries Commission provides input regarding policies and actions for conserving, managing, and developing fishery resources in waters under State jurisdiction. EFH for the Pacific region is discussed further in Section 4.4.11.3.

The NMFS and the USFWS have responsibility for evaluating and managing threatened and endangered species in the Pacific region, including the green sturgeon, delta smelt, tidewater goby, Pacific salmon, and white abalone (Section 4.4.11.1). In addition, State fish and wildlife agencies assist in the management of fishery resources (including both fish and invertebrate species) in State waters. There also exist several areas of special concern, including national parks, refuges, sanctuaries, and estuaries, within the Pacific region that afford fish resources extra protection and management (Section 4.4.15).

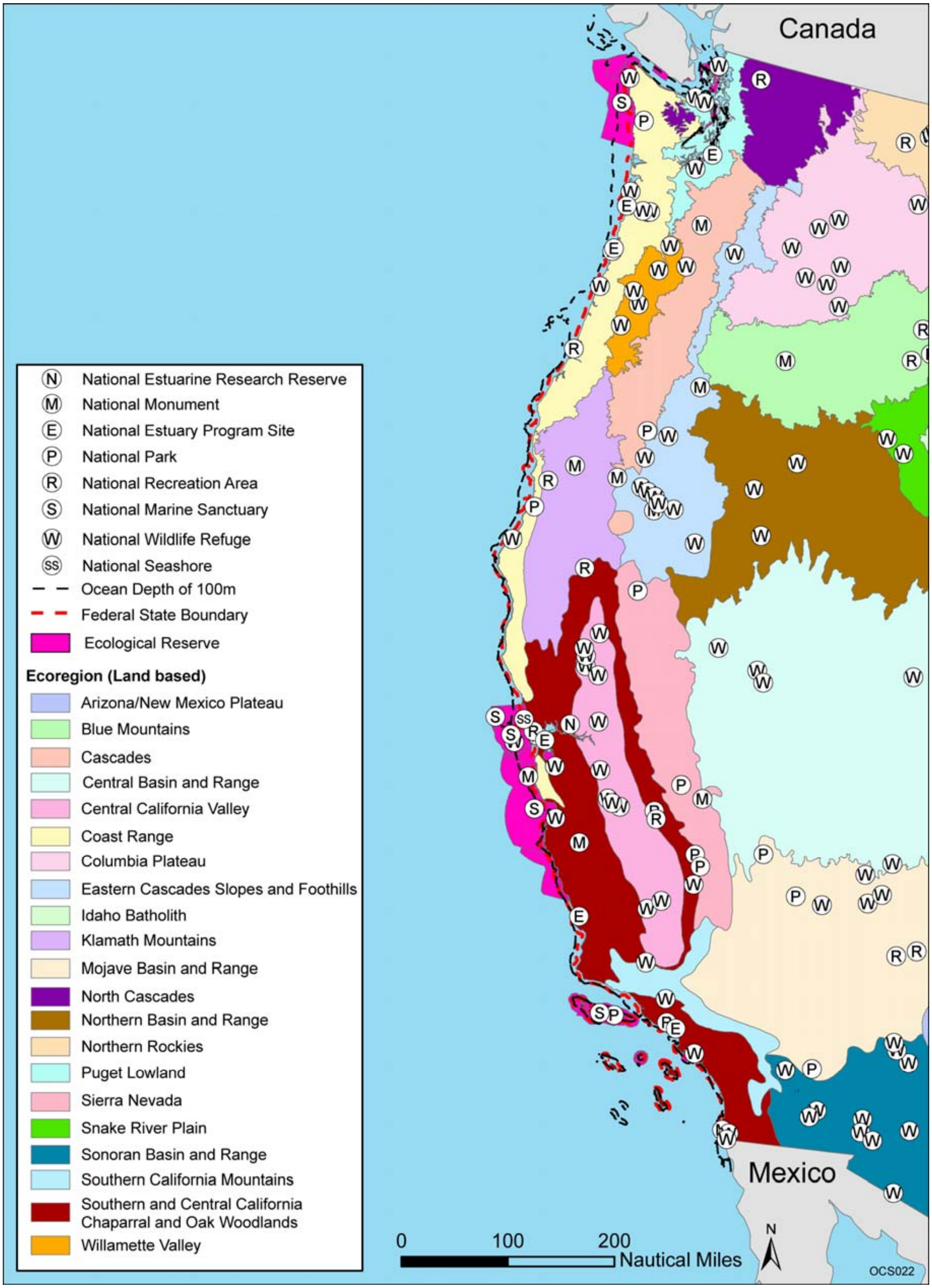

FIGURE 4.4.10-1 Ecological Resources in the Pacific Region

TABLE 4.4.10-1 Ecoregions and Terrestrial Ecological Setting of the U.S. Pacific Coast

Ecoregion	Pacific OCS Planning Area (State)	Description
Southern Coastal Plain	Southern California, Central California, Northern California, (CA)	Most of the southern half of the California coastline falls within this ecoregion. The primary distinguishing characteristic of this ecoregion is its Mediterranean climate of hot dry summers and cool moist winters, and associated vegetative cover comprising mainly chaparral and oak woodlands; grasslands occur in some lower elevations and patches of pine are found at higher elevations. Most of the region consists of open low mountains or foothills, but there are areas of irregular plains in the south and near the border of the adjacent Central California Valley ecoregion. Much of this region is grazed by domestic livestock; very little land has been cultivated. The coastline is generally rugged with interspersed beaches. Numerous islands are also present.
Southern California Mountains	Southern California (CA)	Only a small portion of the California coastline falls within this ecoregion. Like the other ecoregions in central and southern California, the Southern California Mountains have a Mediterranean climate of hot dry summers and moist cool winters. Although Mediterranean types of vegetation such as chaparral and oak woodlands predominate, the elevations are considerably higher in this region, the summers are slightly cooler, and precipitation amounts are greater, causing the landscape to be more densely vegetated and stands of ponderosa pine to be larger and more numerous than in the adjacent regions. Severe erosion problems are common where the vegetation cover has been destroyed by fire or overgrazing.
Coast Range	Central California, Northern California, Washington/Oregon (CA, WA, OR)	This ecoregion encompasses all of the coastlines of Washington and Oregon, and almost all of the northern half of the California coastline. The low mountains of the Coast Range are covered by highly productive, rain-drenched coniferous forests. Sitka spruce and coastal redwood forests originally dominated the fog-shrouded coast, while a mosaic of western red cedar, western hemlock, and seral Douglas-fir blanketed inland areas. Today, Douglas-fir plantations are prevalent on the intensively logged and managed landscape.

Source: USEPA (2004c).

TABLE 4.4.10-2 Numbers of Terrestrial (Nonmarine) Endangered, Threatened, or Candidate Species Listed under the Endangered Species Act of 1973[a]

State	Area	Endangered Species	Threatened Species	Candidate Species
California	Southern California, Central California, Northern California	214	76	18
Washington	Washington/Oregon	12	23	15
Oregon	Washington/Oregon	22	27	9

[a] Numbers of species, per category, cannot be summed, as many listed species occur in multiple States.

Source: USFWS (2006b).

More than 600 species of fishes inhabit the Pacific region as either resident or migrant populations. Large numbers of shellfish and other invertebrate species also occur in this area, with the most important being crabs, shrimp, bivalves, abalone, sea urchins, and squid. This high level of diversity is reflective of the complex chemical, physical, and geologic conditions of the region that interact to provide a wide variety of habitats for fishes and marine invertebrates. Fishes can be classified according to life habits or preferred habitat, as detailed in Section 4.4.11.2.

4.4.11.1 Threatened or Endangered Species

4.4.11.1.1 Green Sturgeon. The green sturgeon (*Acipenser medirostris*) is a broadly distributed, wide-ranging, and marine-oriented fish in the sturgeon family (family Acipenseridae). This species inhabits nearshore marine waters from Mexico to the Bering Sea and enters bays and estuaries along the west coast of North America (Moyle et al. 1995). After completing a study of its status (Adams et al. 2002), the NMFS determined that the green sturgeon is composed of two distinct population segments (DPS) that qualify as species under the ESA, but that neither warranted listing as threatened or endangered (68 FR 4433−4441, 2003). The northern population segment consists of fish that spawn primarily in the Klamath and Rogue River basins, whereas the southern DPS spawns primarily in the Sacramento River Basin. Uncertainties in the structure and status of both DPSs led NMFS to add them to the Species of Concern List (69 FR 19975−19979, 2004). The determination that listing these as threatened or endangered was not warranted was challenged in 2003. Following an updated status review in 2005, NMFS concluded that the northern green sturgeon DPS warranted listing only on the Species of Concern List and proposed that the southern DPS be listed as threatened under the

ESA. NMFS published a final rule listing the Southern DPS of the green sturgeon as threatened (71 FR 17757–17766, 2006).

The green sturgeon is anadromous, utilizing both freshwater and saltwater habitats. Individuals are believed to spend most of their lives in nearshore oceanic waters, bays, and estuaries. Early life stages reside in freshwater, with individual adults returning to freshwater to spawn every 2 to 5 years after they are more than 15 years of age and more than 1.3 m (4 ft) in size. Spawning occurs in deep pools of large, turbulent, freshwater rivers where eggs are primarily broadcast over large cobble substrates (Moyle et al. 1995). Adults typically migrate into freshwater areas beginning in late February, and spawning occurs from March to July, with peak activity from April to June (Moyle et al. 1995). After remaining in freshwater and estuarine areas for 1 to 4 years, juvenile green sturgeon disperse widely into marine habitats (Moyle et al. 1995).

Green sturgeon are known to forage in estuaries and bays ranging from San Francisco Bay to British Columbia. Principal food items include benthic invertebrates such as shrimp, mollusks, and amphipods, although they will also consume small fish (Adams et al. 2002).

The decline of the southern DPS of the green sturgeon is primarily related to the reduction of the available spawning area to a limited section of the Sacramento River. This remains a threat because of increased risk of extirpation due to catastrophic events. Insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), bycatch of green sturgeon in fisheries, potential poaching (e.g., for caviar), entrainment by water projects, influence of exotic species, small population size, impassable barriers, and elevated water temperatures also pose threats to this species.

Currently, fishing regulations and other conservation measures have been implemented to reduce the threats to green sturgeon. California, Oregon, Washington, and British Columbia (Canada) have recently restricted commercial and sport fisheries where green sturgeon occur. Recent implementation of sturgeon fishing restrictions in Oregon and Washington and protective efforts put in place on the Klamath, Trinity, and Eel Rivers since the 1970s may offer protection to the southern DPS. Recent changes have been made in operations of Red Bluff Diversion dam on the Sacramento River in California to improve access to spawning areas above the dam.

4.4.11.1.2 Delta Smelt (*Hypomesus transpacificus*). Delta smelt is currently listed as threatened (58 FR 12863; March 5, 1993). The species is found only from the Suisun Bay, a shallow tidal estuary located off San Francisco Bay in central California, and in upstream locations in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties. The historic range of this species is thought to have extended from Suisun Bay upstream to at least the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River. Delta smelt used to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary (USFWS 1995). Critical habitat has been designated in Suisun Bay, Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs, and in the Sacramento/San Joaquin River Delta (59 FR 65256; December 19, 1994).

Delta smelt are tolerant of a wide salinity range and have been collected from estuarine waters up to 14 parts per thousand (ppt) salinity. For a large part of their one-year life span, delta smelt live along the freshwater edge of the mixing zone (saltwater-freshwater interface), where the salinity is approximately 2 ppt (USFWS 1995). Smelts live together in large schools and feed primarily on zooplankton (i.e., small fishes and invertebrates).

Shortly before spawning, adults migrate upstream from the brackish-water habitat associated with the mixing zone and disperse widely into river channels and tidally influenced backwater sloughs. They spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone. Most spawning happens in tidally influenced backwater sloughs and channel edgewaters. Although spawning has not been observed in the wild, the eggs are thought to attach to substrates such as cattails, tree roots, and submerged branches (USFWS 1995).

Principal causes for decline are believed to include low or excessively high outflows from the Sacramento and San Joaquin Rivers, entrainment of fish into water diversions, changes in the availability of preferred food organisms due either to natural fluctuations or introductions of nonnative species, and introduction of toxic substances into waters used by the delta smelt (USFWS 1995). Because delta smelt are a one-year species, their abundance and distribution may fluctuate widely from year to year. Years of major decline have been unusually dry years with exceptionally low outflows (1987−1991) and unusually wet years with exceptionally high outflows (1982 and 1986). High outflows presumably flush delta smelt out of the system along with much of the zooplankton. This means that not only is potential spawning stock of delta smelt reduced, but its food supply as well. Depletion of established populations of native invertebrates and fish may have made it easier for exotic species of copepods, clams, and fish to colonize the estuary, which may be detrimental to delta smelt populations.

4.4.11.1.3 Tidewater Goby (*Eucyclogobius newberryi*). The tidewater goby is listed as endangered (59 FR 5494; March 7, 1994). It is found only in California, where it is restricted primarily to brackish waters of coastal wetlands. Although the tidewater goby historically occurred in at least 87 California coastal lagoons from San Diego County to Humboldt County, it has disappeared from most of these sites. Critical habitat has been designated in San Diego and Orange Counties (65 FR 69693; November 20, 2000).

The tidewater goby's habitat consists of brackish shallow lagoons and lower stream reaches where the water is fairly still but not stagnant. Tidewater gobies have been documented in water with salinity levels from 0 to 10 ppt, temperature levels from 1.7 to 22.8°C (35 to 73°F), and water depths from 1.5 to 2.3 m (5 to 7.5 ft). This species may enter the marine environment when forced out of the lagoon by strong storms. Small crustaceans, aquatic insects, and mollusks are its primary diet. Reproduction occurs year-round, although distinct peaks in spawning, often in April and May, do occur.

The decline of the tidewater goby can be attributed to upstream water diversions, dredging, changes in salinity, pollution, siltation, and urban development that results in loss of coastal saltmarsh habitat. Competition from the introduced yellowfin goby (*Acanthogobius flavimanus*) is also a potential threat. These threats continue to affect the remaining populations of tidewater gobies. Because the species does not normally enter the ocean, colonization of new locations is unlikely.

4.4.11.1.4 West Coast Salmon and Steelhead (*Oncorhynchus* spp.). The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) has listed as threatened or endangered 16 evolutionarily significant units (ESUs) of West Coast anadromous salmon species (chum, *Oncorhynchus keta*; coho, *O. kisutch*; sockeye, *O. nerka*; and chinook salmon, *O. tshawytscha*), some of which occur in coastal streams of California, Oregon, and Washington (Table 4.4.11-1). Each ESU is treated as a separate species under the Endangered Species Act. Of these 16 ESUs, 4 are listed as endangered, and 12 are listed as threatened (70 FR 37160; June 28, 2005). Ten distinct population segments of steelhead (*Onchorhynchus mykiss*) are also currently listed as endangered or threatened, each treated as a species under the Endangered Species Act (Table 4.4.11-1).

Although there are distinct differences in the life history characteristics for each of these species, there are some general similarities. Adults migrate to freshwater areas to spawn, and the resulting young fish eventually enter marine waters to mature. While in marine waters, some salmon species remain primarily in coastal areas, while others travel farther offshore.

A number of factors have contributed to the declines in populations of west coast salmon species over recent decades, including natural conditions (e.g., drought conditions), water management activities (e.g., construction of dams and depletion of water supplies), overharvesting (both recreational and commercial), predation and competition from introduced nonnative species, and changes in water quality. In an attempt to mitigate for lost habitat and reduced fisheries, extensive salmon and steelhead hatchery programs have been implemented throughout the West Coast area.

4.4.11.1.5 White Abalone (*Haliotis sorenseni*). The white abalone, a marine shellfish, was listed as an endangered species throughout its range along the Pacific Coast (Point Conception, California, USA, to Punta Abreojos, Baja California, Mexico) as of June 2001 (66 FR 29054; May 29, 2001). White abalone is the first marine invertebrate to be listed under the Endangered Species Act (ESA), and the NMFS serves as the agency responsible for the recovery and conservation of this species. While it is not a fish, *per se*, information about white abalone is included here because of its past use as a fishery resource.

Surveys conducted in southern California indicate that there has been a 99% reduction in white abalone abundance between the 1970s and today (NMFS 2006d). Regulatory measures taken by the State of California during the past 30 years, including the closure of the white abalone fishery in 1996 and the closure of all abalone fisheries in central and southern California in 1997, have proven inadequate for the recovery of white abalone (NMFS 2006d). The depleted status of the white abalone is attributed primarily to overharvest by commercial and recreational fisheries. Because white abalone are long-lived, slow-moving bottom dwellers with external fertilization and variable recruitment rates, they are believed to be particularly susceptible to the pressures imposed by intense commercial and recreational fishing. It is believed that adults do

TABLE 4.4.11-1 Endangered Species Act Status of West Coast Salmon and Steelhead

Species	Ecologically Significant Unit or Distinct Population Segment[a]	Current Endangered Species Act Listing Status
Sockeye salmon	Snake River	Endangered
(*Oncorhynchus nerka*)	Ozette Lake	Threatened
	Baker River	Not Warranted
	Okanogan River	Not Warranted
	Lake Wenatchee	Not Warranted
	Quinalt Lake	Not Warranted
	Lake Pleasant	Not Warranted
Chinook salmon	Sacramento River winter-run	Endangered
(*Oncorhynchus tshawytscha*)	Upper Columbia River spring-run	Endangered
	Snake River spring/summer-run	Threatened
	Snake River fall-run	Threatened
	Puget Sound	Threatened
	Lower Columbia River	Threatened
	Upper Willamette River	Threatened
	Central Valley spring-run	Threatened
	California Coastal	Threatened
	Central Valley fall/late fall-run	Species of Concern
	Upper Klamath-Trinity Rivers	Not Warranted
	Oregon Coast	Not Warranted
	Washington Coast	Not Warranted
	Middle Columbia River spring-run	Not Warranted
	Upper Columbia River summer/fall-run	Not Warranted
	Southern Oregon and Northern California Coast	Not Warranted
	Deschutes River summer/fall-run	Not Warranted
Coho salmon	Central California Coast	Endangered
(*Oncorhynchus kisutch*)	Southern Oregon/Northern California	Threatened
	Lower Columbia River	Threatened
	Oregon Coast	Not Warranted
	Southwest Washington	Undetermined
	Puget Sound/Strait of Georgia	Species of Concern
	Olympic Peninsula	Not Warranted
Chum salmon	Hood Canal summer-run	Threatened
(*Oncorhynchus keta*)	Columbia River	Threatened
	Puget Sound/Strait of Georgia	Not Warranted
	Pacific Coast	Not Warranted
Steelhead	Southern California	Endangered
(*Oncorhynchus mykiss)*	Upper Columbia River	Threatened
	Central California Coast	Threatened
	South Central California Coast	Threatened
	Snake River Basin	Threatened
	Lower Columbia River	Threatened
	California Central Valley	Threatened
	Upper Willamette River	Threatened

TABLE 4.4.11-1 (Cont.)

Species	Ecologically Significant Unit or Distinct Population Segment[a]	Current Endangered Species Act Listing Status
Steelhead (Cont.)	Middle Columbia River	Threatened
	Northern California	Threatened
	Oregon Coast	Species of Concern
	Southwest Washington	Not Warranted
	Olympic Peninsula	Not Warranted
	Puget Sound[b]	Proposed Threatened
	Klamath Mountains Province	Not Warranted
Pink salmon	Even-year	Not Warranted
(Oncorhynchus gorbuscha)	Odd-year	Not Warranted

[a] The ESA defines a species to include any Distinct Population Segment (DPS) of any species of vertebrate fish or wildlife. For Pacific salmon, NMFS considers an Evolutionarily Significant Unit (ESU) to be a species under the ESA. For Pacific steelhead, NMFS has delineated DPSs for consideration as species under the ESA.

[b] The Puget Sound steelhead DPS was proposed for listing as a threatened species on March 29, 2006 (*Federal Register* 71:15666).

Sources: *Federal Register* 70:37160 (June 28, 2005); *Federal Register* 71:834 (January 5, 2006); *Federal Register* 70:52488 (September 2, 2005); *Federal Register* 70:52630 (September 2, 2005).

not currently occur in sufficient densities to successfully reproduce, thereby resulting in repeated recruitment failure and an effective population size near zero (NMFS 2006d).

White abalones are reported to be most abundant at depths of 25 to 30 m (80 to 100 ft). Historically, they occurred along the mainland coast and at offshore islands and banks. Fishery data collected in California from 1955–1993 by the California Department of Fish and Game suggest that the highest percentage of total landings occurred in the vicinity of San Clemente Island and Tanner and Cortes Banks. White abalone are found in open, low- and high-relief rock or boulder habitat that is interspersed with sand channels. Sand channels may be important for the movement and concentration of drift macroalgae, such as *Laminaria farlowii*, *Agarum fimbriatum*, and a variety of red algae, upon which white abalone are known to feed (NMFS 2006d).

4.4.11.2 Other Fish Species

4.4.11.2.1 Diadromous Fishes. Diadromy, anadromy, and catadromy are defined in Section 4.2.11.2.

The endangered or threatened status of some populations of anadromous salmon is discussed in Section 4.4.11.1.4. Five species of salmon (*Oncorhynchus* spp.) use nearshore and offshore waters, as well as spawning streams inshore of the Pacific region. Chinook and coho salmon are the predominant species caught and managed under the Pacific Fishery Management Council (PFMC) salmon management plan. Sockeye, chum, and steelhead are only rarely caught in the PFMC ocean fisheries. The abundance of salmon is influenced by numerous natural and manmade phenomena and is highly variable. Distribution and life history information of Pacific salmon are detailed in Hart (1973).

Steelhead trout (*Oncorhynchus mykiss*) are anadromous fish that primarily use streams from central California to the Bering Sea for spawning. Important spawning streams occur in Washington, Oregon, and northern California (Barnhart 1986; Pauley et al. 1986). There are both winter and summer spawning stocks of steelhead. Winter run steelhead migrate and spawn in their natal streams from November to April, while summer run steelhead migrate upstream from May through October. The abundance of steelhead in Washington and Oregon has declined because of excessive sportfishing pressure and habitat loss and/or degradation (Pauley et al. 1986). Population declines in California are attributed primarily to loss of freshwater and estuarine habitat and to increased mortality of smolts from activities such as dam construction and operations, water diversion, and sportfishing activities (Barnhart 1986).

Another anadromous salmonid, coastal (sea-run) cutthroat trout (*Oncorhynchus clarki clarki*), also utilizes coastal marine waters and freshwater rivers and streams along the Pacific coast of the western United States. Unlike most of the other anadromous salmon species, coastal cutthroat trout can return to spawn more than once. Adults of this species commonly enter streams during the fall and feed on eggs spawned by other salmon species. Coastal cutthroat trout utilize a wide variety of habitat types during their complex life cycle. Good recreational fisheries for coastal cutthroat trout exist throughout the Pacific Northwest, although it is believed that coastal cutthroat trout numbers are declining in Oregon.

The white sturgeon (*Acipenser transmontanus*) is the largest freshwater fish in North America, where it can reach weights of over 680 kg (1,500 lb) and lengths up to 6 m (20 ft). Along the Pacific coast, the white sturgeon is found in most estuaries from California to Alaska, especially those associated with large rivers. The white sturgeon is a slow-growing fish that is thought to reach maturity at ages between 15 to 25 years; individuals can reach more than 100 years of age. The white sturgeon spawns in large rivers. The young remain in fresh water while older juveniles and adults are found in rivers, estuaries, and nearshore marine environments. The white sturgeon is an economically and culturally important resource throughout the northwestern United States. In the Columbia River basin, sturgeon production supports a fishery to obtain roe for caviar. The white sturgeon is also a fishery resource for Native American fishermen on the Columbia and Klamath rivers.

The American shad (*Alosa sapidissima*) is a highly migratory anadromous species that was introduced in the Pacific Northwest in the late 1800s and is now found along the Pacific coast from California to Alaska. The species is used as bait for other fisheries, is considered a sportfish by recreational anglers, and is also collected for its roe. As a consequence, sport fisheries for American shad have been building in the Pacific Northwest. Although commercial fisheries have existed in the Columbia River since the 1930s, poor market demand and incidental catches of protected salmonids have limited the growth of this fishery. Adults return to spawn in their natal estuaries, streams, and rivers. The fertilized eggs float downstream from the spawning area until they hatch, and the resulting juveniles remain in the general vicinity of hatching areas before migrating downstream toward the ocean. After entering marine waters, American shad normally spend 3 to 4 years at sea before returning to spawn. American shad are an important forage fish for many other species in both freshwater and marine environments, including sturgeon, salmonids, sharks, tuna, seals and sea lions, and birds.

Anadromous lamprey species, including the Pacific lamprey (*Lampetra tridentata*) and the river lamprey (*Lampetra ayresi*), hatch in freshwater streams, migrate out to the ocean, and return to fresh water to spawn. Adults enter streams during summer and fall and die after spawning the following spring. After hatching, young lampreys burrow into soft sediments and remain there for 4 to 6 years before emerging as adults. These new adults migrate to the ocean during subsequent high water periods, where they live as parasites on larger organisms such as salmon and marine mammals. After 2 to 3 years in the ocean, the adults detach from their hosts and return to freshwater to spawn. Adult and larval lampreys provide a high-fat food source for many birds, fish, and mammals, especially seals and sea lions. The availability of migrating adult lampreys as a food source may serve to reduce predation pressure on migrating salmon from seals and sea lions, other fish, and birds.

4.4.11.2.2 Pelagic Fishes. Coastal pelagic species are schooling fishes, not associated with the ocean bottom, that migrate in coastal waters. The Coastal Pelagic Species Fishery Management Plan identifies management provisions for Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), jack mackerel (*Trachurus symmetricus*), Pacific bonito (*Sarda chiliensis*), Pacific saury (*Cololabis saira*), and market squid (*Loligo opalescens*).

Epipelagic fishes include small schooling herbivores (e.g., northern anchovy, Pacific sardine, Pacific mackerel), schooling predators (e.g., Pacific bonito, yellowtail [*Seriola lalandi dorsalis*]), and large solitary predators such as sharks and swordfish (Cross and Allen 1993). Many of these species are commercially harvested. With the exception of several subtropical species, most epipelagic fishes have extensive ranges that cover most of the Pacific region.

Midwater (or mesopelagic) fishes are pelagic species that inhabit water depths ranging between 50 and 600 m (200 and 2,000 ft) or more. In southern California waters, there are approximately 120 species of midwater fishes, with only a few being of commercial importance (Cross and Allen 1993).

Highly Migratory Fishes. Highly migratory species in the Pacific Ocean include tunas, swordfish, marlins, sailfish, oceanic sharks, and others. These species are harvested by U.S. commercial and recreational fisheries. Only a fraction of the total harvest is taken within U.S. waters.

Demersal Fishes. The PFMC has identified 83 species of fish that typically live on or near the bottom along the Pacific Coast; hence, the terms "groundfish" or "bottomfish" are often used to describe them. Species groups include rockfish (55 species), flatfish (12 species), sharks and skates, groundfish, and others (Table 4.4.11-2). Some important groundfish species include Pacific hake, sablefish, and lingcod (PFMC 2006). Currently, seven species of Pacific coast groundfish (widow rockfish, canary rockfish, yelloweye rockfish, darkblotched rockfish, bocaccio, Pacific ocean perch, and cowcod) are considered overfished by NMFS. According to the definitions in the Pacific Groundfish Fishery Management Plan (FMP), a stock (or fish population) is considered overfished when spawning stock abundance declines to 25% of the spawning population size that would exist if the stock had never been fished. Once a stock is declared overfished, the Magnuson-Stevens Fishery Conservation and Management Act requires that measures must be taken to rebuild stock abundance to levels designated in the appropriate FMP. Depth-based fishery restrictions have been adopted by NMFS to reduce harvest of overfished groundfish stocks, and fishery closures to protect EFH for groundfish were implemented in 2005.

Common fish species occurring over soft-bottom areas include skates and rays, smelts, surfperches, and flatfishes; however, other species may predominate in certain areas (e.g., white croaker [*Genyonemus lineatus*], hagfish [family Myxinidae], and ratfishes [family Chimaeridae]). Hard substrates are one of the least abundant benthic habitats, yet they are among the most important habitats for fishes in the Pacific region. Typical shallow water (<50 m [164 ft]), hard-bottom fishes include rockfish (e.g., *Sebastes* spp.), lingcod, and sculpins; deeper reefs are dominated by large, mobile, species (rockfish, sablefish, Pacific hake, spotted ratfish, and spiny dogfish).

4.4.11.3 Essential Fish Habitat

Marine fish depend on healthy habitats to survive and reproduce. Throughout their lives, fish use many types of habitats including seagrass, salt marsh, coral reefs, rocky intertidal areas, and hard/live bottom areas, among others. Various activities on land and in the water may threaten to alter, damage, or destroy these habitats, thereby affecting the fishery resources that utilize them. The NMFS, regional Fishery Management Councils, interstate Marine Fisheries Commissions, and Federal and State agencies work together to address these threats by identifying EFH for each federally managed fish species and developing conservation measures to protect and enhance these habitats.

EFH has been designated for a large number of fishes in the Pacific region under four fishery management plans (Table 4.4.11-2). Under the authority of the Pacific Groundfish Fishery Management Plan, EFH has been identified for a large number of bottom-dwelling fishes, including flounders, soles, rockfish (family Scorpaenidae), greenlings (family Hexagrammidae), sharks, and skates (family Rajidae). The Coastal Pelagic Species Fishery Management Plan identified EFH for eight species of coastal schooling fishes. EFH for Pacific tunas, billfishes, and pelagic sharks is identified in the Highly Migratory Species Fishery Management Plan. Finally, EFH for the three dominant salmon species in Pacific fisheries is identified in the Pacific Coast Salmon Fishery Management Plan.

TABLE 4.4.11-2 Species for Which Essential Fish Habitat Has Been Designated in the Pacific Region

Pacific Coast Groundfish Fishery Management Plan

Arrowtooth founder (*Atheresthes stomias*)	Honeycomb rockfish (*Sebastes umbrosus*)
Big skate (*Raja binoculata*)	Kelp greenling (*Hexagrammos decagrammus*)
Butter sole (*Isopsetta isolepis*)	Kelp rockfish (*Sebastes atrovirens*)
California skate (*Raja inornata*)	Leopard shark (*Triakis semifasciata*)
Curlfin sole (*Pleuronichthys decurrens*)	Lingcod (*Ophiodon elongatus*)
Dover sole (*Microstomus pacificus*)	Longnose skate (*Raja rhina*)
English sole (*Parophrys vetulus*)	Longspine thornyhead (*Sebastolobus altivelis*)
Flathead sole (*Hippoglossoides elassodon*)	Mexican rockfish (*Sebastes macdonaldi*)
Pacific sanddab (*Citharichthys sordidus*)	Olive rockfish (*Sebastes serranoides*)
Petrale sole (*Eopsetta jordani*)	Pacific cod (*Gadus macrocephalus*)
Rex sole (*Glyptocephalus zachirus*)	Pacific hake (Pacific whiting) (*Merluccius productus*)
Rock sole (*Lepidopsetta bilineata* and *L. polyxystra*)	Pacific flatnose (finescale codling) (*Antimora microlepis*)
Sand sole (*Psettichthys melanostictus*)	Pacific grenadier (*Coryphaenoides acrolepis*)
Starry flounder (*Platichthys stellatus*)	Pacific Ocean Perch (*Sebastes alutus*)
Aurora rockfish (*Sebastes aurora*)	Pink rockfish (*Sebastes eos*)
Bank rockfish (*Sebastes rufus*)	Quillback rockfish (*Sebastes maliger*)
Black rockfish (*Sebastes melanops*)	Redbanded rockfish (*Sebastes babcocki*)
Black-and-yellow rockfish (*Sebastes chrysomelas*)	Redstripe rockfish (*Sebastes proriger*)
Blackgill rockfish (*Sebastes melanostomus*)	Rosethorn rockfish (*Sebastes helvomaculatus*)
Blue rockfish (*Sebastes mystinus*)	Rosy rockfish (*Sebastes rosaceus*)
Bocaccio (*Sebastes paucispinis*)	Rougheye rockfish (*Sebastes aleutianus*)
Bronzespotted rockfish (*Sebastes gilli*)	Sharpchin rockfish (*Sebastes zacentrus*)
Brown rockfish (*Sebastes auriculatus*)	Shortbelly rockfish (*Sebastes jordani*)
Cabezon (*Scorpaenichthys marmoratus*)	Shortraker rockfish (*Sebastes borealis*)
Calico rockfish (*Sebastes dalli*)	Shortspine thornyhead (*Sebastolobus alascanus*)
California scorpionfish (*Scorpaena guttata*)	Silvergray rockfish (*Sebastes brevispinis*)
Canary rockfish (*Sebastes pinniger*)	Soupfin shark (*Galeorhinus galeus*)
Chilipepper (*Sebastes goodei*)	Spiny dogfish (*Squalus acanthias*)
China rockfish (*Sebastes nebulosus*)	Speckled rockfish (*Sebastes ovalis*)
Copper rockfish (*Sebastes caurinus*)	Splitnose rockfish (*Sebastes diploproa*)
Cowcod (*Sebastes levis*)	Spotted ratfish (*Hydrolagus colliei*)
Darkblotched rockfish (*Sebastes crameri*)	Squarespot rockfish (*Sebastes hopkinsi*)
Dusky rockfish (*Sebastes variabilis*)	Starry rockfish (*Sebastes constellatus*)
Dark rockfish (*Sebastes ciliatus*)	Stripetail rockfish (*Sebastes saxicola*)
Flag rockfish (*Sebastes rubrivinctus*)	Tiger rockfish (*Sebastes nigrocinctus*)
Gopher rockfish (*Sebastes carnatus*)	Treefish (*Sebastes serriceps*)
Grass rockfish (*Sebastes rastrelliger*)	Vermilion rockfish (*Sebastes miniatus*)
Greenblotched rockfish (*Sebastes rosenblatti*)	Widow rockfish (*Sebastes entomelas*)
Greenspotted rockfish (*Sebastes chlorostictus*)	Yelloweye rockfish (*Sebastes ruberrimus*)
Greenstriped rockfish (*Sebastes elongatus*)	Yellowmouth rockfish (*Sebastes reedi*)
Harlequin rockfish (*Sebastes variegatus*)	Yellowtail rockfish (*Sebastes flavidus*)

Coastal Pelagic Species Fishery Management Plan

Northern anchovy (*Engraulis mordax*)	Pacific herring (*Clupea pallasi*)
Market squid (*Loligo opalescens*)	Pacific sardine (*Sardinops sagax*)
Pacific bonito (*Sarda chiliensis*)	Pacific mackerel (*Scomber japonicus*)
Pacific saury (*Cololabis saira*)	Jack mackerel (*Trachurus symmetricus*)

TABLE 4.4.11-2 (Cont.)

Highly Migratory Species Fishery Management Plan	
Albacore (*Thunnus alalunga*)	Bigeye thresher (*Alopias superciliosis*)
Yellowfin tuna (*Thunnus albacares*)	Shortfin mako (*Isurus oxyrinchus*)
Bigeye tuna (*Thunnus obesus*)	Blue shark (*Prionace glauca*)
Skipjack tuna (*Katsuwonus pelamis*)	Striped marlin (*Tetrapturus audax*)
Bluefin tuna (*Thunnus thynnus*)	Pacific swordfish (*Xiphias gladius*)
Common thresher shark (*Alopias vulpinus*)	Dolphin (*Coryphaena hippurus*)
Pelagic thresher shark (*Alopias pelagicus*)	
Pacific Coast Salmon Fishery Management Plan	
Chinook salmon (*Oncorhynchus tshawytscha*)	
Coho salmon (*Oncorhynchus kisutch*)	
Pink salmon (*Oncorhynchus gorbuscha*)	

In addition to designating EFH, the NMFS requires fishery management councils to identify habitat areas of particular concern (HAPCs) within fishery management plans. HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. Councils may designate a specific habitat area as an HAPC based on (1) importance of the ecological function provided by the habitat; (2) extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; or (4) rarity of the habitat type. While the HAPC designation does not confer additional protection for or restrictions on an area, it can help prioritize conservation efforts. Healthy populations of fish require not only the relatively small habitats identified as HAPCs, but also other areas that provide suitable habitat functions. Thus, HAPCs alone may not suffice in supporting the larger numbers of fish needed to maintain sustainable fisheries and a healthy ecosystem. A variety of general habitat types have been designated as HAPCs for fishery species in the Pacific Region, including estuaries, canopy kelp, seagrass, rocky reef areas, and others. In addition, a large number of specific areas of interest have also been designated as HAPCs. Examples include specific fishing banks or ledges (see Section 4.4.14.1.1), seamounts, marine sanctuaries (Section 4.4.15.1), and fishery conservation areas.

4.4.12 Sea Turtles

Four species of sea turtles—the leatherback, green, Pacific olive ridley, and loggerhead—are known to frequent waters of the Pacific region, although their presence in these waters has been categorized as uncommon. All four are listed as either endangered or threatened species under the ESA. There are no designated critical habitats or migratory routes for sea turtles in the Pacific region. There is no sea turtle nesting on the U.S. west coast (Table 4.4.12-1).

The endangered leatherback sea turtle (*Dermochelys coriacea*) is the largest, deepest diving, and most migratory and wide ranging of all sea turtles (USFWS 2005d). This species is

TABLE 4.4.12-1 Sea Turtles of the U.S. Pacific Coast

Species	Status[a]	Typical Adult Habitat	Juvenile/ Hatchlings Potentially Present?	Nesting
Family Cheloniidae				
Loggerhead turtle (*Caretta caretta*)	T	Estuarine, coastal, and shelf waters	Yes	No nesting occurs on the U.S. Pacific coast; only known nesting areas for loggerheads in the North Pacific are found in southern Japan
Green turtle (*Chelonia mydas*)	T, E[b]	Shallow coastal waters, seagrass beds	Yes	No nesting on U.S. Pacific coast; in U.S. Pacific waters, nesting occurs in the Hawaiian archipelago, the Commonwealth of the Northern Marianas, Guam, and American Samoa; in the western Pacific
Pacific olive ridley turtle (*Lepidochelys olivacea*)	E	Shallow coastal waters, seagrass beds	Yes	No nesting on U.S. Pacific coast; in the eastern Pacific, nesting occurs from Mexico south to at least Colombia
Family Dermochelyidae				
Leatherback turtle (*Dermochelys coriacea*)	E	Slope, shelf, and coastal waters; considered the most "pelagic" of the sea turtles	Yes	No nesting on U.S. Pacific coast; nesting occurs along Pacific coasts of Mexico, Costa Rica, and other Central American countries

[a] Status: E = endangered species; T = threatened species (under the Endangered Species Act of 1973).

[b] Green sea turtles are listed as threatened, except for Florida where breeding populations are listed as endangered.

Source: USFWS (2006b).

typically distributed in tropical and temperate waters, and in eastern Pacific waters is found in small numbers as far north as British Columbia and occasional sightings off Alaska (NMFS and USFWS 1998a). This species is the most pelagic of the sea turtles, with most sightings of this species occurring in deeper shelf and slope waters. Tagging studies indicate that the turtles observed along the California coast are coming to the area from Indonesia (Dutton 2006). The diet consists primarily of invertebrates, including tunicates and jellyfish. The primary threat to the leatherback in U.S. coastal waters is incidental take by fisheries while the leatherback is engaged in pelagic foraging.

The east Pacific population of the green sea turtle (*Chelonia mydas*) is listed as threatened throughout its range except for breeding colony populations in Florida and the Pacific Coast of Mexico (USFWS 2005a). In the eastern North Pacific, green turtles have been sighted from Baja, California, to southern Alaska, but they most commonly occur from San Diego south (NOAA 2006c). As recently as 1984, this species was considered to be the most commonly observed turtle on the Pacific U.S. coast (NMFS and USFWS 1998b). The northernmost population of green sea turtles in coastal mainland Pacific waters occurs in San Diego Bay, where mature and immature turtles concentrate in warm water effluent from an electric generating facility (NMFS and USFWS 1998b). This species is generally found in shallow waters (except when migrating) in reefs, bays, and inlets (USFWS 2005a).

The Pacific olive ridley sea turtle (*Lepidochelys olivacea*) is the smallest of the Pacific sea turtle species. Until recently, this widely distributed species was considered the most abundant sea turtle in the world (NMFS and USFWS 1998c). Because of human harvesting and loss of nesting habitat, this species is now listed as threatened throughout its range except for breeding colony populations along the Pacific Coast of Mexico, which are listed as endangered (NMFS and USFWS 1998c; USFWS 2005g). Pacific ridleys nest along the Pacific Coast from Mexico south to Colombia (USFWS 2005c). This species does not nest in the United States, but during feeding migrations, sea turtles in the Pacific may disperse into open ocean waters of the southwestern United States, occasionally as far north as Oregon. The diet of the olive ridley sea turtle consists primarily of invertebrates such as crabs, tunicates, and jellyfish.

The loggerhead sea turtle (*Caretta caretta*) is listed as threatened throughout its range (USFWS 2005e). This species inhabits subtropical to temperate waters worldwide, preferring continental shelf waters, but is also observed in inshore areas such as lagoons, bays, salt marshes, and river mouths (USFWS 2005e). Major loggerhead nesting grounds are generally found in warm temperate and subtropical regions, with the largest nesting colonies in the world found on Masirah Island, Oman, and along the Atlantic Coast of Florida (NMFS and USFWS 1998d). Nesting in the Pacific Basin is restricted to the western region, primarily Japan and Australia. In the eastern Pacific, loggerheads have been reported as far north as Alaska and as far south as Chile. Most sightings in U.S. waters are of juveniles; while occasional sightings are reported from the coast of Washington, most are off the coast of California (NMFS and USFWS 1998d; USFWS 2005e). Adult loggerhead turtles typically feed on benthic invertebrates in hard-bottom habitats.

4.4.13 Coastal Habitats

The predominant longshore current along the Pacific coastline is from north to south (see Section 4.4.1.2). Drift directions vary locally, and cycles of erosion and deposition are affected by features like protruding headlands or submarine canyons. For example, beaches near submarine canyons become abruptly narrower due to the transport of sediment seaward. Erosion rates along the California coast are high and usually episodic, with cliff retreat, landsliding, and sand removal occurring during large storms.

A variety of shoreline types occur along the U.S. Pacific Coast, including rocky cliffs and rocky, gravel, or sand beaches. The two most prominent beach types found in the Pacific region are rocky shores and sand beaches, the latter of which are the most common in this region. Sand beaches are generally less stable environments than rocky shores, due to seasonal changes in beach profile associated with wind and wave exposure and the effects of nearshore currents. Rocky cliffs are common along the coasts of Washington and Oregon (Oceanographic Institute of Washington 1977).

In Puget Sound, beaches are interrupted by rocky points and steep bluffs (Oceanographic Institute of Washington 1977). Across the strait from Vancouver Island, narrow beaches are backed by steep bluffs of glacial drift. Along the coast of northern Washington, rocky bluffs and cliffs are interspersed with beaches ranging from sand to cobble. Sand dunes occur in areas of the south Washington coast. Sand beaches are scattered along the coast of southern Washington and much of Oregon; an 85-km (53-mi) sand beach occurs along the central Oregon coast. Along the rugged coast of southern Oregon, small bays, with narrow beaches of coarse sand and gravel, and rocky cliffs are frequent. The occurrence of rocky shores in Oregon increases from north to south (USDOI/MMS 1987). Marine terraces, flat, wave-cut platforms of various unconsolidated sedimentary deposits, occur along the Washington and Oregon coast. Bogs form at some locations where impermeable pans occur below the soil surface (Oceanographic Institute of Washington 1977). Most of the northern and central California coast is rocky shore (USDOI/MMS 1987), while sand beaches predominate in southern California (USDOI/MMS 1983).

Rocky shore habitats are more abundant from southern Oregon to central California, and along the Channel Islands offshore southern California. The intertidal rocky shore substrate forms a solid surface on which macroalgae and sessile invertebrates attach and hold firm against the forces of waves, wind, and currents. Numerous, usually smaller invertebrates, including grazers, filter feeders, and predators, live within the cover and protection provided by the larger sessile plants and animals. For example, rockweed (*Pelvetia* spp. with *Pelvetiopsis* spp. in northern California and *Hesperophycus* spp. in southern California) in middle and upper intertidal areas provides cover and protection during low tide for many snails, limpets, crabs, and other species (USDOI/MMS 1983). In some areas, particularly the southern California mainland, intertidal species are exposed to human trampling, collecting, stormwater runoff, and other human-induced impacts.

Descriptions of rocky intertidal communities and species on the west coast of the United States include those of Carefoot (1977); Oceanic Institute of Washington (1977); Power (1980); Dawson and Foster (1982); USDOI/MMS (1983, 1984, 1987); Ricketts et al. (1985); Strickland and Chasan (1989); Murray and Bray (1993); Thompson et al. (1993); and Niesen (1994). Some of the communities on the rocky shore are very long-lived (decades) and have a high diversity of species. The mussel (*Mytilus* spp.) community, red algae (*Endocladia muricata* with *Gigartina papillata* in northern California and *G. canaliculata* in southern California) community, and rockweed community are all examples of long-lived, diverse communities. Although their distribution may be patchy, mussels often are found covering broad expanses of the rocky intertidal zone of central and northern California (Ricketts et al. 1985). The mussel community is often multilayered, up to 20 cm (7.8 in.) thick (Kanter 1980). Surfgrass (*Phyllospadix scouleri* and *P. torreyi*) communities occur in the lower intertidal to subtidal (in southern California only) zones of rocky shores on the outer coast and are a major nursery habitat for a wide variety of fishes and invertebrates. Macroalgae (*Iridaea flaccida*) communities, Rhodomela/Odanthalia, and barnacle (*Chthamalus/Balanus*) communities occur in northern and central California coasts (USDOI/MMS 1987). Brown algae (*Egregia* spp. and *Eisenia* spp.) occur in lower intertidal areas in southern California (USDOI/MMS 1983). Each of the previously described seaweeds and invertebrates are important structural components in their respective zones.

Factors that influence the distribution, abundance, and species composition of rocky intertidal shores include both physical factors and biological factors. Major physical factors include exposure to the air, impact of waves, substrate composition, texture, and slope, water temperature, light, and the previously described human-induced factors. Important biological factors include competition and predation. In general, the upper vertical limits of rocky shore communities are determined by physical conditions, while the lower vertical limits are controlled by biological factors (Carefoot 1977).

Communities of rocky shores typically exhibit zonation (Oceanographic Institute of Washington 1977; Stephenson and Stephenson 1949, 1972), although zonation is not obviously present on all shorelines. Generally, the upper zone contains some species that are transitional between terrestrial and marine and can survive neither completely on land nor completely at sea. The upper intertidal zone grades into the lower intertidal zone, as an increasing number of species occupy more of the available space until, near mid-level and below, all surfaces are occupied by algae or invertebrates. In general, intertidal communities on the islands and mainland coast located away from major metropolitan areas appear to be less altered than those intertidal areas near cities (Littler 1980). Populations of several species appear to be reduced throughout the coast except at a small number of remote locations largely inaccessible to human collecting. Since the mid-1980s, the black abalone (*Haliotis cracherodii*) population on the California Channel Islands and along the mainland in central California has undergone major declines in abundance due to disease (Haaker et al. 1992; Steinbeck et al. 1992).

Sand beaches and associated biotic communities along the Pacific Coast are described in various sources (Hedgpeth 1957; Oceanographic Institute of Washington 1977; Power 1980; USDOI/MMS 1983, 1984, 1987; Ricketts et al. 1985; Strickland and Chasan 1989; Thompson et al. 1993; Niesen 1994; SAIC 2000). Intertidal sand beach habitats are much less stable environments than rocky shores due to the continual shifting of sand by wind, wave, and current actions, and populations of resident biota vary greatly from year to year. The biotic component of sandy intertidal habitats is made up almost exclusively of burrowing animal species, with fewer organisms and species than rocky shores. Permanent residents of sand beaches include crustaceans (isopods and amphipods), polychaete and nemertean worms, and mollusks (snails and bivalves). Razor clams (*Siliqua patula*) occur in northern areas (USDOI/MMS 1987), while the mole crab or sand crab (*Emerita analoga*) occurs along the entire coast (USDOI/MMS 1983; 1987). Other animals that may also be found include grunion, moon snails, crabs, shrimps, and echinoderms. Smaller pelagic fish, such as grunion and smelt, use sandy intertidal areas for spawning (SAIC 2000). Generally, the only flora to be found in this habitat are diatoms and other microscopic species, and bacteria associated with organic detritus in the sand. Although less obvious than the floral component of the rocky intertidal habitat, the sand beach flora constitute a major food base for the numerous meiofauna (minute animals) that inhabit the interstitial spaces between sand grains. Interstitial meiofauna of sand beaches are described in Swedmark (1964) and Hulings and Gray (1971). Sparse vegetation found on sand beaches in central California can include sea rocket (*Cakile maritima*), beach bur (*Ambrosia chamissonis*), saltbush (*Atriplex leucophylla*), and beach verbena (*Abronia* spp.), as occur at South Monterey Bay (SAIC 2000). Sand dunes occur along more than half of Oregon's ocean-facing shoreline, a small portion of Washington's (Oceanographic Institute of Washington 1977), and in central California (SAIC 2000). Foredunes are subject to wave erosion during storms. In many locations along the Oregon coast, dunes are advancing into adjacent forest (Oceanographic Institute of Washington 1977).

Wetlands occur in intertidal and shallow subtidal areas along the Pacific Coast from Puget Sound, Washington, to Southern California. They occur in each of the estuaries, near the mouths of major rivers, and in some spit-protected bays along Washington and Oregon coasts (Oceanographic Institute of Washington 1977). Wetland habitats extend over large areas in estuaries at the mouths of many bays, rivers, and coastal streams, however, in some areas they occupy only narrow bands along the coastline. Salt marshes in central California can include such species as pickleweed (*Salicornia virginiana*), alkali heath (*Frankenia salina*), salt grass (*Distichlis spicata*), and coastal gumplant (*Grindelia stricta var. platyphylla*), as occur at Elkhorn Slough in Monterey Bay (SAIC 2000). In southern California, salt marsh wetlands are restricted to small areas bordering sheltered bays and lagoons; however, nearly all bays and lagoons in that region have been impacted by human activities (USDOI/MMS 1983). Estuaries, which are shallow, semi-enclosed areas where stream or river inflows mix with marine waters, include a range of intertidal and subtidal habitats from fresh to brackish and saline. Estuaries are important for both resident and transitory species, providing spawning, nursery, and foraging habitat for numerous species, including invertebrates, fish, reptiles, birds, and mammals. Wetland habitats along the Pacific Coast consist of salt marshes, fresh and brackish water marshes, and mudflats. Eel grass (*Zostera marina*) beds occur in some subtidal areas, and tend to be associated with estuaries of larger streams (USDOI/MMS 1983). In California, eel grass beds are primarily intertidal or associated with bays or estuaries, in muddy substrates (BLM 1981). Kelp forests of giant kelp (*Macrocystis* spp.) or bull kelp (*Nereocystis* spp.) occur in subtidal areas of central and northern California, decreasing toward the north (USDOI/MMS 1987).

Estuaries and wetlands are characterized by high organic productivity, high detritus production, and efficient nutrient recycling. Estuaries contain a greater diversity of species per unit surface area than any other marine habitat. High levels of nutrient input from terrestrial sources, high levels of freshwater input from streams, high levels of marine-origin nutrient input caused by tidal flushing, shallow depths, and high heat retention are also factors supporting the greater productivity of estuaries. Some plant species, such as cordgrass (*Spartina* spp.), pickleweed (*Salicornia* spp.), and eel grass occur almost exclusively in estuaries and form highly productive salt marshes and eel-grass beds. Mudflats are rich in invertebrates, including clams. Fish and mobile invertebrates occur in channels as well as over mudflats.

Along the coasts of Washington and Oregon, estuaries are typically larger than those found farther south. Important estuaries in this portion of the Pacific region, in decreasing order of size, include Puget Sound, Willapa Bay, the Columbia River estuary, Coos Bay, Tillamook Bay, Umpqua-Winchester Bay, and Grays Harbor.

Major estuaries in Northern and central California include San Francisco Bay, Elkhorn Slough, Bodega Bay, Tomales Bay, Bolinas Lagoon, Humboldt Bay, Eel River, Lake Earl, and Smith River (USDOI/MMS 1996). Major estuaries in southern California have realized significant degradation and loss over the past several decades, primarily as a result of upland and coastal development, channel dredging, and other development activities. At present, major estuaries in this portion of the Pacific region include Mugu Lagoon, the Santa Maria and Santa Ynez River mouths, Anaheim Bay, upper Newport Bay, Goleta Slough, Carpinteria Marsh, and the Tijuana Estuary.

4.4.14 Seafloor Habitats

The Pacific region includes waters along the coasts of Washington, Oregon, and California. Within this region, two major biogeographic provinces that differ in abundance and composition of marine fauna have been identified: the Oregonian Biogeographic Province and the Californian Biogeographic Province (Airamé et al. 2003). A faunal boundary occurs between these two provinces where the California Current meets the Southern California Countercurrent at Point Conception, with the Oregonian Province located northward and the Californian Province located southward. In addition to this latitudinal change in species composition, the diversity of species on the continental shelf also changes with depth due to species-specific tolerances for temperature, exposure to light, nutrient input, and biological interactions among species. Thus, although the biogeographic provinces apply to shallow subtidal and coastal intertidal communities, extrapolation to deeper benthic communities is not well understood due, in part, to a paucity of samples taken from deeper benthic environments.

Subtidal seafloor communities are strongly influenced by sediment type, nutrient input, and depth. Therefore, geology, topography, and bathymetry, together with the oceanographic and biological processes, affect the composition and abundance of marine organisms associated with seafloor habitats. Exposed rock and coarse-grained sediments, such as gravels, generally support larger quantities of animals, including many sessile (attached) organisms. Fine-grained sediments, such as sand, mud, or silt, usually contain a more depauperate seafloor fauna, and attached organisms are less common. While the majority of the continental shelf in the Pacific region is sandy, portions contain softer sediments. There are also rocky outcrops in some areas that form submerged reefs, seamounts, and other important habitat features. Marine algae, unable to firmly attach to shifting sandy or muddy sediments, are typically associated with the substrate on rocky reefs. At the shelf break, the continental slope drops to depths of more than 3000 m (9,840 ft). Sediments, transported down the continental slope and submarine canyons, collect in broad fans at the base of the slope. Below the rise, the abyssal plain is relatively flat, with occasional features such as seamounts and small depressions.

4.4.14.1 Topographic Features

4.4.14.1.1 Fishing Banks and Ledges. Fishing banks and ledges are high-relief areas that provide structure for the development of rich invertebrate communities that, in turn, support fishes and other marine organisms. The importance of these areas to fish and invertebrate resources is often reflected by the implementation of special fishery regulations or designation of such areas as habitats of particular concern under the Magnuson-Stevens Fishery Conservation and Management Act (FCMA). Examples of prominent fishing banks that occur within the Pacific region, include Tolo and Cordell Banks off the California coast, and Heceta, Coquille, Daisy, and Nahelem Banks off the Oregon coast. Although surveys of the marine fauna are not available for all of these banks, information for some of these areas is summarized below.

The Cordell Bank National Marine Sanctuary was established in 1989 to protect and preserve natural resources of Cordell Bank and the surrounding waters. Cordell Bank is located on the continental shelf, about 43 nautical mi (80 km [49 statute mi]) northwest of San Francisco. The bank itself consists of a granite bank 7.2 km (4.5 mi) wide by 15.3 km (9.5 mi) long that rises from the soft sediments of the continental shelf at approximately 120 m (400 ft) and reaches within 40 m (120 ft) of the ocean surface. The topography of Cordell Bank, in combination with its location within an upwelling region, causes deep nutrient-rich water to be forced into relatively shallow areas where photosynthesis can occur. This results in a biologically productive area that supports large and diverse populations of marine life.

In addition to supporting a variety of attached and mobile benthic invertebrates such as corals, sponges, and sea stars, the habitats in Cordell Bank National Marine Sanctuary also support an abundance of fishes. Flatfish, such as sanddabs, are common on the mud and sandy bottom surrounding the bank, while other species of groundfish inhabit the Bank’s granite rocks and pinnacles. Overall, the area around Cordell Bank supports more than 246 species of fish, including 44 species of rockfish.

Heceta, Coquille, and Daisy Banks are located on the Pacific region OCS off the coast of Oregon (Nasby-Lucas et al. 2002). These banks support dense sessile macroinvertebrate communities, composed largely of corals and sponges, on the hard substrates. In the rocky areas of these banks, fishes such as rockfishes, lingcod, and sablefishes are among the most abundant (Hixon et al. 1991; Nasby-Lucas et al. 2002). Over soft substrates, flatfishes such as soles, turbots, halibuts, and sanddabs, are more common. The largest of these reefs, Heceta and Coquille Banks, include important fishery areas and support a trawl fishery for many species of flatfishes, rockfishes, sablefish, and Pacific hake and a longline fishery for rockfishes, sablefish, and Pacific halibut (Hixon et al. 1991).

4.4.14.2 Other Benthic Communities

The benthic invertebrate communities of the OCS shelf, break, and slope areas of the Pacific region are diverse. Sediments on the shelf consist primarily of sands or muds, depending upon location, with occasional rocky areas (see, e.g., Fox et al. 2000b). Shifting sediments often support species such as the polychaetes and clams, which live either in constructed tubes or buried in the sediment (Airamé et al. 2003). Some crab species, such as Dungeness or yellow rock crabs, also occur on sandy or mixed sand/mud substrates. Fish species that occur in these areas include flatfishes, such as sole, halibut, flounder, turbot, and sanddab. On rocky substrates, typical fish species include rockfishes, gobies, wrasses, and sea basses (Fox et al. 2000b; Airamé et al. 2003; Love and Yoklavich 2006).

From the edges of the continental shelf, the continental slope drops steeply to depths of approximately 3,000 to 4,000 m (9,800 to 13,100 ft), where it reaches the abyssal plain. Below about 1,000 m (3,300 ft), it is completely dark, because sunlight cannot penetrate the water at this depth. Because photosynthesis cannot be supported without sunlight, species that live on the continental slope primarily depend on production from surface waters. A portion of the primary production from surface waters sinks to the seafloor where it is either consumed by organisms, decomposed, or buried in sediments.

The types of invertebrates present on seafloor habitats on the continental slope of the Pacific region vary according to depth. A community of ampeliscid amphipods occurs on the continental slope at a depth of approximately 700 m (2,300 ft), while polychaete worms are relatively common at approximately 1,000 m (3,280 ft) depth (Airamé et al. 2003). Similar to the changes in invertebrate communities, the dominant fishes of the continental slope also vary with depth. A description of typical depth assemblages for fishes on the continental slope off California is provided in Airamé et al. (2003).

4.4.15 Areas of Special Concern

At present, nearly 50 Marine Protected Areas have been identified for the Pacific region (Table 4.4.15-1). National marine sanctuaries, national parks, national wildlife refuges, national estuarine research reserves, and national estuary program estuaries within the Pacific region that are considered Marine Protected Areas are discussed in the following sections. In addition, there are a number of coastal and aquatic reserves located along the Pacific Coast that are managed by State agencies or nongovernmental organizations. Figure 4.4.10-1 shows the locations of offshore Federal and State ecological reserves, including marine sanctuaries, wildlife refuges, and other protected areas such as critical habitats.

4.4.15.1 Marine Sanctuaries

Five National Marine Sanctuaries have been established in the Pacific region: Channel Islands National Marine Sanctuary, Cordell Bank National Marine Sanctuary, Gulf of the Farallones National Marine Sanctuary, Monterey Bay National Marine Sanctuary, and the Olympic Coast National Marine Sanctuary (Table 4.4.15-1). The Olympic Coast National Marine Sanctuary is located off the coast of Washington; the remaining four marine sanctuaries are located off the coast of California.

TABLE 4.4.15-1 Marine Protected Areas in the Pacific Region[a]

Site Name	State	Managing Agency (Office/Bureau)[b]	Type of Site[c]
Western and Eastern Cowcod Conservation Areas	CA	NOAA (NMFS)	FFMZ
Yelloweye Rockfish Conservation Area	WA	NOAA (NMFS)	FFMZ
Klamath River Salmon Conservation Zone	CA	NOAA (NMFS)	FT/ESPA
Columbia River Salmon Conservation Zone	WA	NOAA (NMFS)	FT/ESPA
Elkhorn Slough National Estuarine Research Reserve	CA	California DFG (California DFG)	NERR
San Francisco Bay National Estuarine Research Reserve	CA	San Francisco State University (SFSU-Romberg Tiburon Center)	NERR
Tijuana River National Estuarine Research Reserve	CA	California Department of Parks and Recreation (California Department of Parks and Recreation)	NERR
South Slough National Estuarine Research Reserve	OR	Oregon Division of State Lands (South Slough National Estuarine Research Reserve)	NERR
Padilla Bay National Estuarine Research Reserve	WA	Washington State Department of Ecology (Shorelands & Environmental Assistance Program)	NERR
Channel Islands National Marine Sanctuary	CA	NOAA (National Ocean Service)	NMS
Cordell Bank National Marine Sanctuary	CA	NOAA (National Ocean Service)	NMS
Gulf of the Farallones National Marine Sanctuary	CA	NOAA (National Ocean Service)	NMS
Monterey Bay National Marine Sanctuary	CA	NOAA (National Ocean Service)	NMS
Olympic Coast National Marine Sanctuary	WA	NOAA (National Ocean Service)	NMS
Cabrillo National Monument	CA	USDOI (NPS)	NM
Channel Islands National Park	CA	USDOI (NPS)	NP
Golden Gate National Recreation Area	CA	USDOI (NPS)	NP
Redwood National and State Parks	CA	USDOI (NPS)	NP
Olympic National Park	WA	USDOI (NPS)	NP
Point Reyes National Seashore	CA	USDOI (NPS)	NS
Castle Rock National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Don Edwards San Francisco Bay National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Farallon National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Guadalupe-Nipomo Dunes National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Humboldt Bay National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Marin Islands National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Salinas River National Wildlife Refuge	CA	USDOI (USFWS)	NWR
San Diego National Wildlife Refuge	CA	USDOI (USFWS)	NWR
San Pablo Bay National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Seal Beach National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Tijuana Slough National Wildlife Refuge	CA	USDOI (USFWS)	NWR
Bandon Marsh National Wildlife Refuge	OR	USDOI (USFWS)	NWR
Cape Meares National Wildlife Refuge	OR	USDOI (USFWS)	NWR
Lewis and Clark National Wildlife Refuge	OR/WA	USDOI (USFWS)	NWR

TABLE 4.4.15-1 (Cont.)

Site Name	State	Managing Agency (Office/Bureau)[b]	Type of Site[c]
Nestucca Bay National Wildlife Refuge	OR	USDOI (USFWS)	NWR
Oregon Islands National Wildlife Refuge	OR	USDOI (USFWS)	NWR
Siletz Bay National Wildlife Refuge	OR	USDOI (USFWS)	NWR
Three Arch Rocks National Wildlife Refuge	OR	USDOI (USFWS)	NWR
Copalis National Wildlife Refuge	WA	USDOI (USFWS)	NWR
Dungeness National Wildlife Refuge	WA	USDOI (USFWS)	NWR
Flattery Rocks National Wildlife Refuge	WA	USDOI (USFWS)	NWR
Grays Harbor National Wildlife Refuge	WA	USDOI (USFWS)	NWR
Nisqually National Wildlife Refuge	WA	USDOI (USFWS)	NWR
Protection Island National Wildlife Refuge	WA	USDOI (USFWS)	NWR
Quillayute Needles National Wildlife Refuge	WA	USDOI (USFWS)	NWR
San Juan Islands National Wildlife Refuge	WA	USDOI (USFWS)	NWR
Willapa National Wildlife Refuge	WA	USDOI (USFWS)	NWR

[a] Includes sites designated by the U.S. Department of the Interior and NOAA. Sites designated by State, Territory, and Commonwealth agencies are not included but can be obtained from the lists on the Marine Protected Areas of the United States website at www3.mpa.gov/exploreinv/status.aspx.

[b] DNR = Department of Natural Resources; USDOI = U.S. Department of the Interior; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NPS = National Park Service; USFWS = U.S. Fish and Wildlife Service.

[c] FFMZ = Federal Fishery Management Zone; FT/ESPA = Federal Threatened/Endangered Species Protected Area; NERR = National Estuarine Research Reserve; NM = National Monument; NMS = National Marine Sanctuary; NP = National Park; NS = National Seashore; NWR = National Wildlife Refuge.

Source: U.S. Department of Commerce and U.S. Department of the Interior (2006).

The Channel Islands National Marine Sanctuary encompasses the waters surrounding San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands to a distance of 6 nautical mi (10 km) offshore in the Santa Barbara Channel of California. Common habitats within the sanctuary include rocky and sandy beaches, rocky reefs, sandy bottom, kelp forests, and pelagic or open water habitat. The particular combination of warm and cool currents within the sanctuary results in a nutrient-rich environment that supports a great variety of plants and animals, including giant kelp and dense populations of fishes, invertebrates, cetaceans, pinnipeds, and marine birds.

At least 27 species of whales and dolphins have been sighted in the Channel Islands National Marine Sanctuary, which lies on the migratory pathway of gray, humpback, and blue whales. The sanctuary also provides habitat for breeding populations of the California sea lion, the northern fur seal, the northern elephant seal, and the harbor seal. Of the 16 resident species of marine birds in the Southern California Bight, 11 breed in the sanctuary, including Xantus' murrelet, a federally listed threatened species, and the brown pelican, an endangered species.

The Channel Islands National Marine Sanctuary is also the site of over 140 documented aircraft and shipwrecks dating back to the 1542 voyage of explorer Juan Cabrillo, as well as submerged Chumash Native American sites.

Cordell Bank National Marine Sanctuary is an offshore site located about 100 km (60 mi) northwest of San Francisco and 35 km (22 mi) west of Point Reyes, California. The sanctuary encompasses more than 1,350 km^2 (521 mi^2). Cordell Bank is a large granite bank that rises from a depth of approximately 183 m (600 ft) at its base to approximately 37 m (120 ft) on the top of the bank. The specific combination of oceanic conditions and undersea topography creates a highly productive marine environment. Cordell Bank supports approximately 250 species of fish, including 44 species of rockfish. Twenty-six species of marine mammals frequent the waters around the sanctuary, and the site serves as an important feeding area for endangered blue and humpback whales. Because of the high fish and invertebrate productivity, the sanctuary is an important foraging area for seabirds, including resident species and highly migratory pelagic species.

The Gulf of the Farallones National Marine Sanctuary encompasses an area of approximately 3,250 km^2 (1,254 mi^2) that includes the Farallon Islands, a national wildlife refuge, the surrounding waters of the Gulf of the Farallones just outside the Golden Gate of San Francisco Bay, and other unique bodies of water. The shoreline along the coast in the vicinity of the sanctuary is composed of sandy beaches and rocky cliffs. The topography of the continental shelf in the area of the sanctuary, combined with unique characteristics of the nearshore currents, results in ocean upwelling that brings cool, nutrient-rich waters to the surface and supports large phytoplankton blooms and rich zooplankton and fisheries production.

The Gulf of the Farallones National Marine Sanctuary supports some of the largest and most diverse eastern Pacific populations of seabirds and pinnipeds south of Alaska. Large flocks of Cassin's auklets, common murres, western gulls, and the endangered brown pelican feed on the small fish and crustaceans that are abundant in the waters of the sanctuary. This food source also supports California's largest breeding population of harbor seals, as well as a growing population of northern elephant seals. In addition, large numbers of whales and dolphins, including the California gray whale, the Pacific humpback whale, and the blue whale, occur in the area.

The Monterey Bay National Marine Sanctuary is the nation's largest marine sanctuary. Located offshore of California's central coast, it includes approximately 440 km (273 mi) of shoreline and encompasses approximately 13,800 km^2 (5,328 mi^2) of ocean surface. Extending an average distance of 48 km (30 mi) from shore, the Monterey Bay National Marine Sanctuary reaches 3,250 m (10,663 ft) at its deepest point. It supports one of the most diverse marine ecosystems in the world and includes the largest kelp forest in the United States, one of largest underwater canyons in North America, and the closest nearshore deep ocean environment in the continental United States.

The Olympic Coast National Marine Sanctuary includes more than 8,547 km^2 (3,300 mi^2) of marine waters off the coast of the Olympic Peninsula of Washington State. The sanctuary extends over much of the continental shelf within this area, extending approximately

56 km (35 mi) seaward on average. The sanctuary is a critical link in the Pacific bird flyway and protects habitat for a diverse marine mammal fauna. Rocky shores and kelp beds dominate the northern shore, and long expanses of sand beach form the landward edge of the southern sanctuary. In addition, the sanctuary provides protection for a variety of archaeological sites and for culture of the Quinault, Hoh, Quileute, and Makah Tribes.

4.4.15.2 National Park System

Six National Park Service sites found along the coast of the Pacific region are Marine Protected Areas (Table 4.4.15-1). This includes three national parks (Channel Islands National Park, Olympic National Park, and Redwood National and State Park), Point Reyes National Seashore, Golden Gate National Recreation Area, and Cabrillo National Monument. Except for Olympic National Park, which is located along the coast of Washington State, all of these National Park Service sites are located in California.

Channel Islands National Park comprises five southern California islands. The park, which includes offshore waters for a distance of one nautical mile from the islands, encompasses an area of over 1,000 km^2 (386 mi^2), half of which is under the ocean. Habitats within the park include kelp forests, seagrass beds, rock reefs, rock canyons, pelagic waters, coastal marshes and lagoons, sand beaches, sea cliffs, and rocky intertidal benches. Ecological resources in the park include large and diverse pinniped and seabird rookeries and at least 26 species of cetaceans. In addition, archaeological and cultural resources of the site span a period of more than 10,000 years.

Olympic National Park is located in the northeastern Pacific on Washington's Olympic Peninsula. The park is a large wilderness area featuring temperate rainforest, glacier-capped mountains, deep valleys, meadows, lakes, and approximately 100 km (60 mi) of beaches. The Columbia River, the Strait of Juan de Fuca, and upwelled waters from the Pacific Ocean combine to produce a nutrient-rich environment that supports one of the most biologically diverse intertidal communities along the west coast of North America.

Redwood National and State Park is located on the northwestern California coastline and includes pristine Pacific coastline, old-growth redwood groves, coastal grasses and shrubs, coastal Sitka spruce forests, prairie/oak woodlands, and rivers and streams. The coastline is varied, with sandy beaches, rocky cobbles, and rocky cliffs.

Point Reyes National Seashore encompasses approximately 260 km^2 (100 mi^2), including coastal wilderness along the coast of California. Habitats include estuaries, beaches, coastal scrub grasslands, salt and freshwater marshes, and coniferous forests. Biological resources in the area include whales, seals, sea lions, and many species of birds that feed near the tideline. The site includes an active breeding ground for elephant seals.

Golden Gate National Recreation Area is located in the San Francisco Bay Estuary. The park contains numerous historical and cultural resources, including archaeological sites, military forts, and other historic structures that chronicle more than 200 years of history. Golden Gate

National Recreation Area also supports at least 80 sensitive, rare, threatened, or endangered species, including the northern spotted owl, California red-legged frog (*Rana aurora draytonii*), and coho salmon.

Cabrillo National Monument is located in San Diego, California, on the Point Loma peninsula. The peninsula is bordered by the Pacific Ocean on the west, the San Diego Bay on the east, and an urban development on the north. Native coastal sage scrub habitat and a small stretch of rocky-intertidal coastline are the principal habitats at the site.

4.4.15.3 National Wildlife Refuges

Twenty-eight national wildlife refuges located along the Pacific Coast have been designated as Marine Protected Areas (Table 4.4.15-1). Most of these refuges were established to provide feeding, resting, and wintering areas for migratory birds such as waterfowl and shorebirds. Some of these refuges are of international importance, since they serve as stopover areas for neotropical migrants, which travel to various parts of Central and South America. Some are also important to threatened and endangered species.

4.4.15.4 National Estuarine Research Reserves

Five national estuarine research reserves (NERRs), totaling approximately 5,900 ha (14,580 ac), have been established in Pacific region: Elkhorn Slough NERR, San Francisco Bay NERR, Tijuana River NERR, South Slough NERR, and Padilla Bay NERR (Table 4.4.15-1).

4.4.15.5 National Estuary Program

Background on the National Estuary Program is provided in Section 4.3.15.5. The National Estuary Program includes six estuaries in the Pacific region, with a total area of over 838,419 km^2 (323,715 mi^2) (Table 4.2.15-2). Of these, the largest include the Lower Columbia River estuary, San Francisco Bay, and Puget Sound.

4.4.16 Military Use Areas

Section 4.2.16 describes the general nature of military uses of the OCS. Figures 4.4.16-1 and 4.4.16-2 depict military use areas in the Pacific region. Navy Fleet and Marine Corps amphibious training occurs nearly every day along the west coast (Warning Areas and Restricted Areas from Washington to Southern California). The level of activity varies from unit-level training to full-scale Carrier/Expeditionary Strike Group operations and certification.

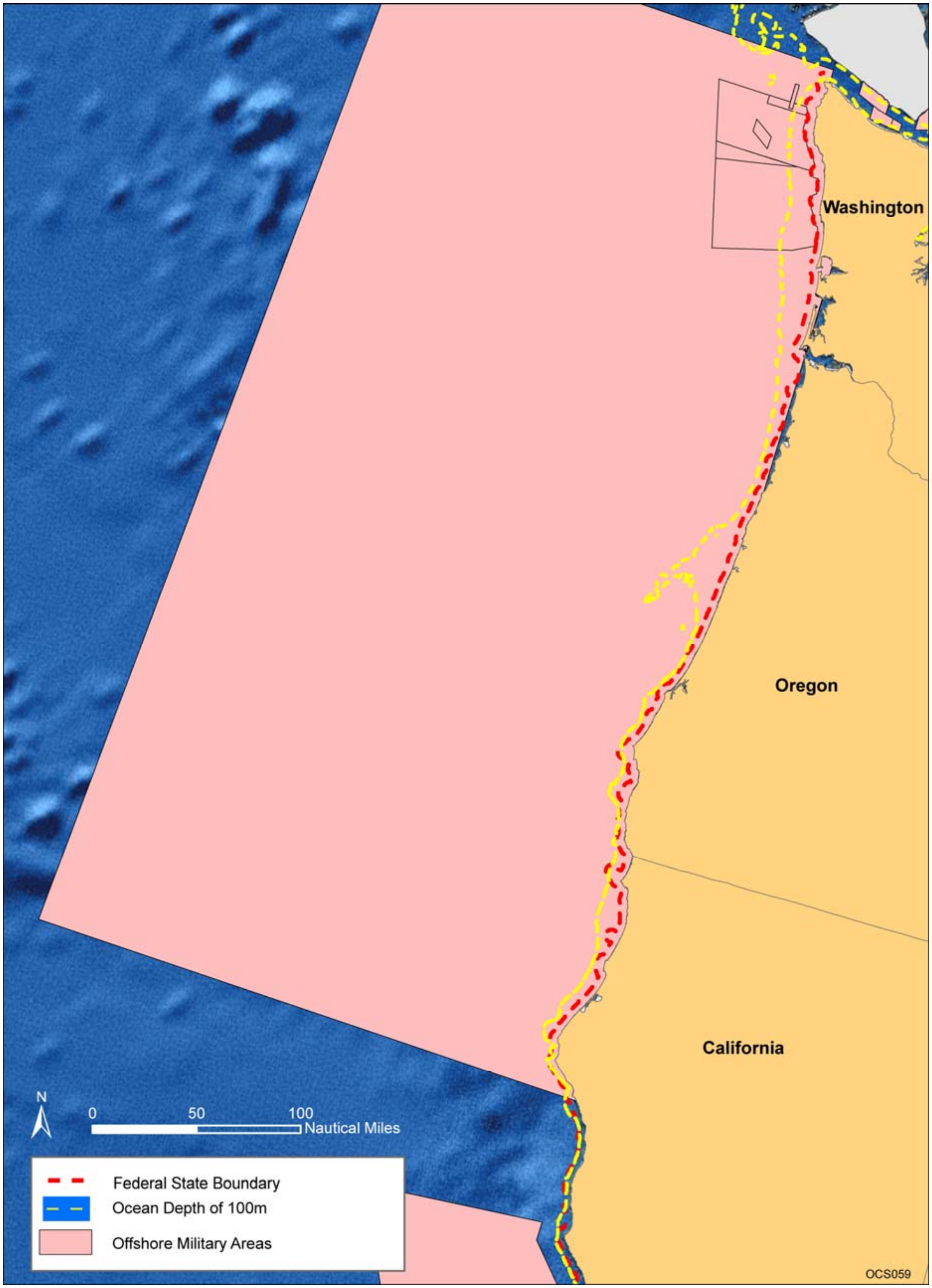

FIGURE 4.4.16-1 North Pacific Military Areas (Sources: NOAA 2006h; Parisi 2007)

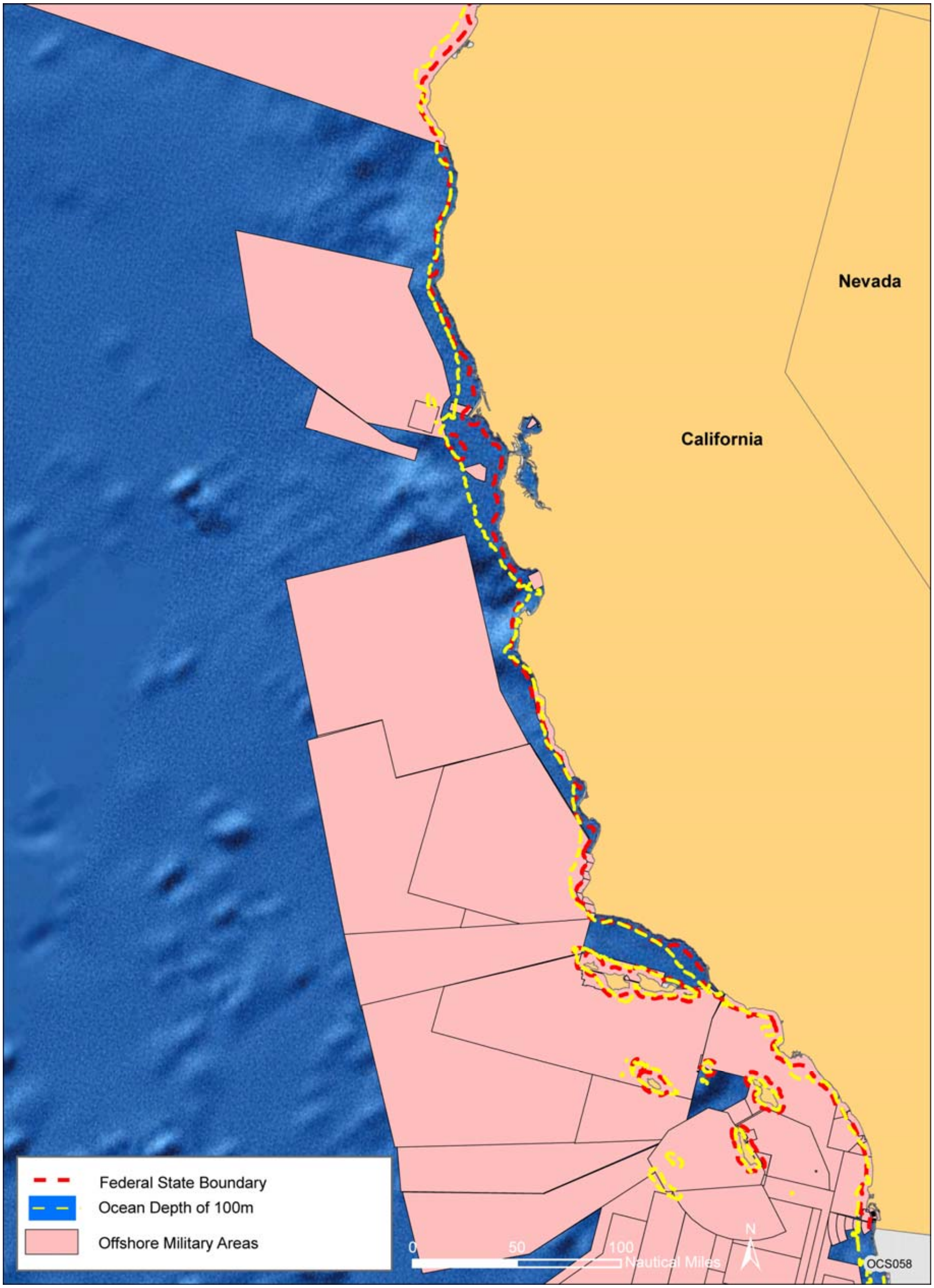

FIGURE 4.4.16-2 South Pacific Military Areas (Sources: NOAA 2006h; Parisi 2007; Creese 2007)

4.4.17 Transportation

As discussed in Section 4.2.17, transportation operations for alternative energy project site locations on the OCS may be influenced by existing ocean port capabilities and vessel activities. The locations of major commercial ocean ports and designated lanes and precautionary areas for vessel traffic on the Pacific Coast are shown in Figures 4.4.17-1 and 4.4.17-2. Of these ports, the commercial freight ports handling larger vessels are listed in Table 4.4.17-1. As listed for oceangoing vessels of 10 deadweight tons (DWT) or larger, the ports of Los Angeles / Long Beach and San Francisco handled the most vessel calls in 2005, with 5,178 and 3,871 vessels, respectively (MARAD 2006a). Such detailed statistics are not available for smaller commercial vessels, but such traffic is expected to have a similar trend at these ports because of the available infrastructure such as cargo handling/storage capabilities and connecting roads and railroads, as well as the need to provide support craft (e.g., tugboats or lightering vessels) for the larger vessels. In addition, these larger vessels are more likely to travel into Federal waters (e.g., to international destinations) than are smaller craft. Another measure of vessel traffic and port size and capabilities is the annual volume of goods shipped and received. Table 4.4.17-2 lists the ports along the Pacific Coast that were within the top 149 U.S. ports in 2004 for amount of cargo handled.

Commercial fishing ports could also provide a base of support operations for OCS alternative energy facilities. As for smaller commercial freight vessels, no detailed statistics of total vessel activity at fishing ports are available, but the total fish landings at a port can be used as a rough estimate of vessel activity. Fish landings and the correlation to vessel trips will vary somewhat depending on vessel size (i.e., the amount of fish a vessel can carry) and what percentage of that capacity was actually used on each trip. Table 4.4.23-3 presents the amount of fish landed in 2004 by State off the Pacific Coast. Also given is the breakdown between the amount caught within State waters (0 to 4.8 km [0 to 3 mi] from shore) and within Federal waters (4.8 to 322 km [3 to 200 mi] from shore). Overall, about half the fish landed off the Pacific Coast were caught in Federal waters. Thus, fishing activity can be significant in certain OCS waters. In this case, most OCS fishing occurred off the coast of Washington, with 80% of the landings originating from OCS waters. Washington also led the total Pacific Coast landings, but California had a much larger percentage of landings originating in State waters (85%). However, two fishing ports in Oregon, Astoria and Newport, led the Pacific Coast with the most landings as shown in Table 4.4.23-4. Figures 4.4.17-1 and 4.4.17-2 show port locations and relative commercial freight and fishing vessel activity (Tables 4.4.17-1 and 4.4.23-4) for the Pacific Coast.

Larger ports also service and are departure points for cruise ships. Approximately 17 major cruise lines operate cruises with a U.S. port of call (MARAD 2006b). Table 4.4.17-3 lists the number of cruises departing Pacific Coast ports from 2003 to 2005. These cruise ships are larger oceangoing vessels, often with international ports of call, and frequent OCS waters.

Helicopters may be used for support operations at OCS alternative energy facilities, ferrying supplies and workers, similar in function to those used in the Gulf of Mexico region for oil and gas operations support. Figures 4.4.17-1 and 4.4.17-2 show the locations of airports in the Pacific Coast region (BTS 2006; ACI-NA 2006).

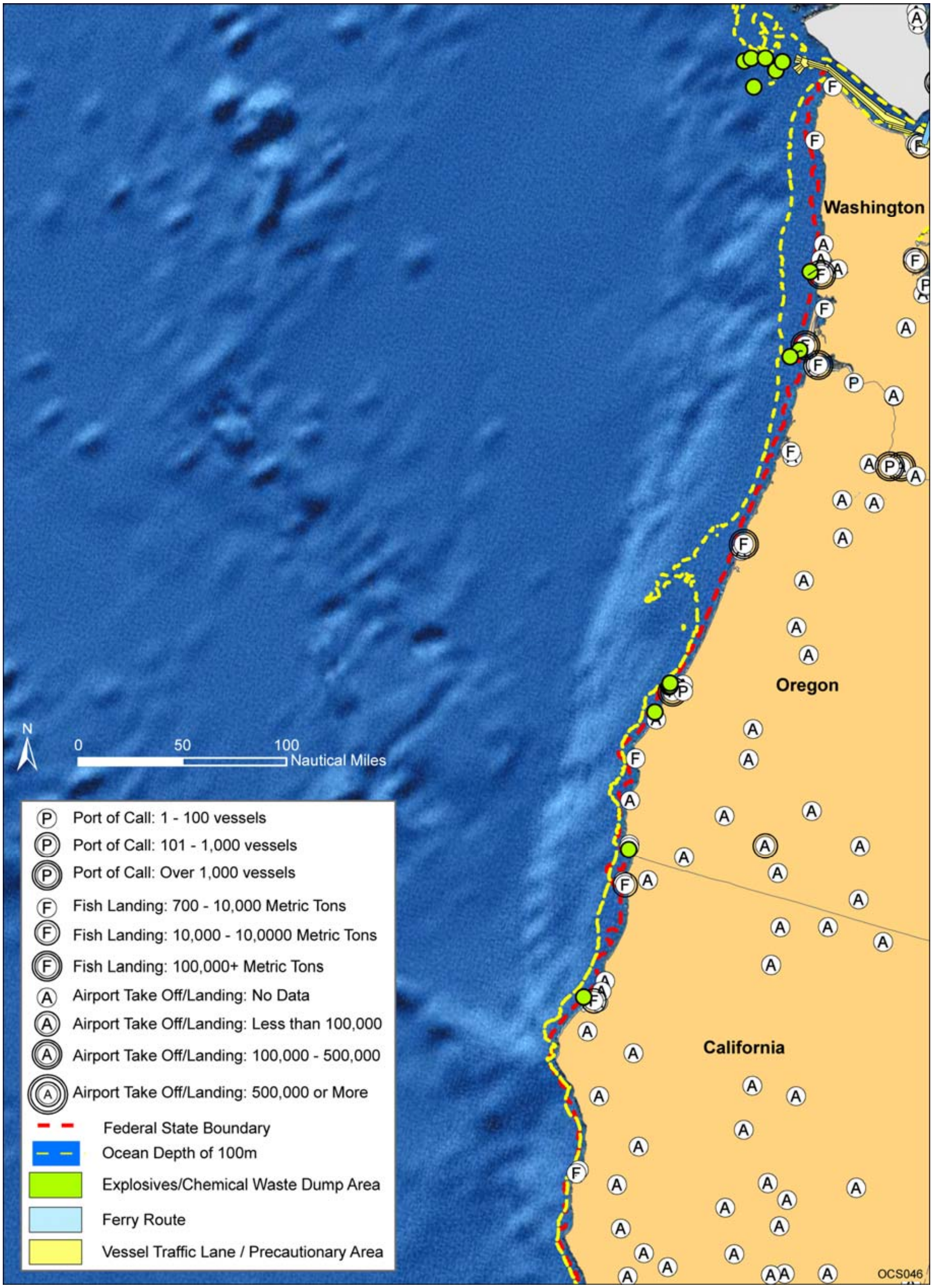

FIGURE 4.4.17-1 North Pacific Offshore Dump Sites and Transportation Features (Source: NOAA 2006h and references in text)

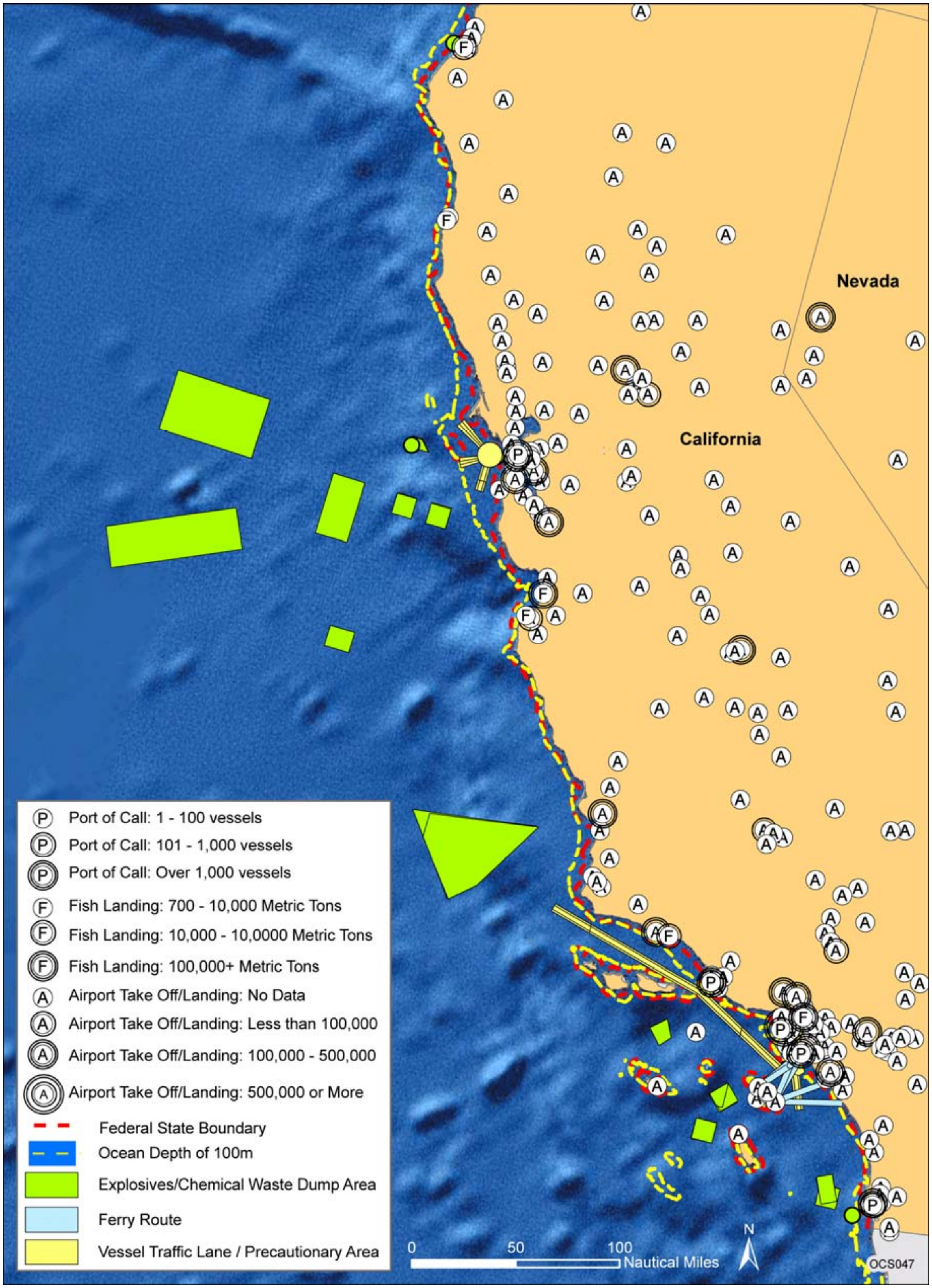

FIGURE 4.4.17-2 South Pacific Offshore Dump Sites and Transportation Features (Source: NOAA 2006h and references in text)

TABLE 4.4.17-1 U.S. Pacific Port Calls by Port and Commercial Vessel Type for 2005[a]

Port	State	All Types Calls	Tanker[b] Calls	Container Calls	Dry Bulk Calls	Ro-Ro[c] Calls	Gas Carrier Calls	Combination Calls	General Cargo Calls
LA/Long Beach	CA	5,178	1,070	2,812	640	345	2	13	296
San Francisco	CA	3,871	692	1,930	792	191	48	0	218
Columbia River	OR	2,189	132	85	1,586	199	8	4	175
Tacoma	WA	1,270	67	618	280	283	0	0	22
Seattle	WA	1,186	8	808	295	5	0	0	70
Port Hueneme	CA	397	16	0	0	218	0	0	163
March Point	WA	342	340	0	1	0	1	0	0
San Diego	CA	319	1	52	45	178	0	0	43
Port Angeles	WA	277	252	5	10	1	7	0	2
El Segundo	CA	245	245	0	0	0	0	0	0
Cherry Point	WA	209	209	0	0	0	0	0	0
Ferndale	WA	123	111	0	8	0	4	0	0
Coos Bay	OR	43	0	0	43	0	0	0	0
Everett	WA	33	0	0	8	16	0	0	9
S. California lightering area	CA	24	24	0	0	0	0	0	0
Olympia	WA	20	0	0	9	10	0	0	1
Point Wells	WA	19	19	0	0	0	0	0	0
Manchester	WA	11	11	0	0	0	0	0	0
Anacortes	WA	8	1	0	7	0	0	0	0
Westport	WA	7	0	0	6	0	0	0	1
Port Townsend	WA	3	0	0	0	0	0	0	3
Bremerton	WA	2	0	0	0	0	0	0	2
Bellingham	WA	2	0	2	0	0	0	0	0

[a] For vessels of 10 deadweight tons (DWT) or larger.

[b] Includes product tanker and crude tanker.

[c] Includes vehicle carriers.

Source: MARAD (2006a).

TABLE 4.4.17-2 U.S. Pacific Coast Ports by Cargo Volume for 2004

U.S. Rank	Port/State	Metric Tons
5	Long Beach, CA	72,634,772
14	Los Angeles, CA	47,111,673
26	Portland, OR	27,211,588
30	Tacoma, WA	23,842,660
33	Richmond, CA	22,446,944
37	Seattle, WA	21,320,086
43	Anacortes, WA	14,791,398
45	Oakland, CA	14,098,618
53	Kalama, WA	9,177,200
69	Vancouver, WA	6,325,421
79	Longview, WA	4,354,812
99	San Diego, CA	2,818,833
102	Everett, WA	2,740,395
106	Stockton, CA	2,542,852
112	San Francisco, CA	2,408,316
119	Coos Bay, OR	1,802,945
126	Olympia, WA	1,543,473
127	Grays Harbor, WA	1,487,658
129	Port Angeles, WA	1,430,678
136	Redwood City, CA	1,290,646
138	Port Hueneme, CA	1,191,879
145	Humboldt, CA	916,007

Source: AAPA (2006).

TABLE 4.4.17-3 U.S. Pacific Coast Cruises by Departure Point

	Annual		
Departure Port	2003	2004	2005
Long Beach, CA	70	166	204
Los Angeles, CA	229	193	176
Seattle, WA	79	135	151
San Diego, CA	65	104	133
San Francisco, CA	51	54	54
Oakland, CA	–	1	–

Source: MARAD (2006b).

4.4.18 Socioeconomic Resources

4.4.18.1 Regional Population, Employment, and Income

In 2004, there were 30.7 million persons living in the in the coastal counties Pacific region, which includes all the West Coast States (Table 4.4.18-1). Population in the region is projected to reach 31.1 million by 2007 and 31.4 million by the end of the OCS planning period in 2014. Regional population grew at an annual average rate of 1.1% over the period 1990 through 2004. Growth is expected to decline slightly for the period 2004 through 2014, with a projected annual average rate of 0.2%. Within the region, the majority of the coastal population is concentrated in California (25.1 million in 2004), with a smaller population in Washington (4.3 million).

Employment in the Pacific region was at 18.4 million in 2004 and, based on population growth rates, is expected to reach 18.6 million by 2007 and 18.8 million at the end of the planning period in 2014 (Table 4.4.18-1). Growth rates in employment in the region have been slightly less than those in population, with annual growth rates from 1990 through 2004 averaging 1.0%. At 2.3%, average annual growth in personal income in the Pacific region from 1990 through 2004 exceeded growth rates in both population and employment (Table 4.4.18-1). Personal income in the region rose from $0.9 trillion in 1990 to $1.2 trillion in 2004 and, on the basis of population growth rates, is expected to grow slowly over the planning period 2007 through 2014. Per capita income in the region grew from $33,659 to $39,655 between 1990 and 2004.

Within the region, employment is concentrated in California (15.0 million in 2004), with smaller levels in Washington (2.6 million). In 2004, there was some variation in per capita incomes among the States having coastal counties in the region, ranging from $40,080 in California and Washington to less than $30,644 in Oregon. The average for all coastal counties in the region was $37,616 in 2004.

The Pacific region consists of a number of contrasting types of economic areas. There are a number of large metropolitan areas in the region, including San Diego, Los Angeles, San Francisco, Portland, and Seattle, and a large number of smaller urban and suburban areas in each State. All of the metropolitan areas and many of the larger urban areas have highly complex economic structures, containing a wide range of industries, with wide and diverse labor markets and a comprehensive range of occupations. The Pacific region also includes a number of urban areas that serve a smaller number of more specialized economic functions, including renewable and nonrenewable resource development, maritime shipping, power generation, recreation, tourism, and residential retirement. Outside urban areas, there are a large number of local and regional market areas serving the resource extraction, agriculture, power generation, and transportation industries. These areas have simpler economic structures and contain smaller, less-diversified labor markets.

TABLE 4.4.18-1 Socioeconomic Environment for the Coastal Economy in the Pacific Region (millions, except where noted)[a]

	1990			2004			2007[b]			2014[b]		
State	Population	Employ-ment	Income ($b) [c]	Population	Employ-ment	Income ($b)	Population	Employ-ment	Income ($b)	Population	Employ-ment	Income ($b)
CA	21.9	13.3	751.1	25.1	15.0	1,005.1	25.4	15.2	1,009.1	25.6	15.3	1,013.5
OR	1.1	0.6	27.8	1.4	0.8	42.9	1.4	0.8	43.1	1.4	0.8	43.3
WA	3.4	2.1	107.6	4.3	2.6	170.8	4.3	2.6	1,771.6	4.4	2.7	172.2
Total	26.3	16.0	886.4	30.7	18.4	1,218.8	31.1	18.6	1,224.6	31.4	18.8	1,229.0

[a] Coastal economy applies to counties wholly or partly within 50 mi of the coast in each state.

[b] Projections based on annual population growth for each state.

[c] $b = billions of dollars.

Sources: U.S. Bureau of the Census (2006a); USDOC (2006a,b).

4.4.18.2 Sociocultural Systems

The demography, employment, income, and land-use characteristics of the coastal communities of the Pacific region are extremely diverse and varied. The rural, generally undeveloped, segments of the Pacific Northwest and northern California coastline are predominantly characterized by small communities that rely, variably, on the timber and fishing industries, as well as recreation and tourism (USDOI/MMS 2002b). The metropolitan areas of Seattle, Portland, and San Francisco are located off the open coast, each hosting extensive port facilities, with waterborne commerce an important aspect of their economies. In contrast, in the largely urban environment of coastal southern California, continuous urban development stretches from 50 km (31 mi) north of Los Angeles to San Diego. The large metropolitan areas of the Pacific region represent destinations of opportunity for many individuals, as evidenced by the diverse racial and cultural composition of the regions major cities. Many of the smaller communities in the region maintain sociocultural environments that are less diverse, often supporting a small number or a single cultural group in the most important community economic activity.

In California, the distribution of gathering for subsistence and ceremonial purposes varies (USDOI/MMS 2002b). In northern California, activities tend to be very similar to those occurring in Oregon and Washington, where the focus is on gathering foodstuffs (salmon and shellfish) and traditional medicines. In Southern California, the intertidal zone is the object of intensive gathering activities by members of various ethnic groups. The traditional Native American gathering in southern California has been reduced in recent years because of a decrease in the supply of traditional plant and animal foods (USDOI/MMS 2002b). These traditional practices are dynamic and take place and manifest themselves among more modern ones. The beach, coast, and the ocean itself exist as important geographic, spiritual, and socially constructed components for many Pacific Coast residents. Recreation and tourism and ocean-related industries provide substantial income for local community economies. Additionally the beach, the coast, and the ocean provide a “coastal connection” between residents and the sea (USDOI/MMS 2002b).

4.4.18.3 Environmental Justice

Under Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629), Federal agencies are required to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations. The analysis of potential environmental justice issues associated with offshore energy developments followed guidelines described in the Council on Environmental Quality’s Environmental Justice Guidance under the National Environmental Policy Act (CEQ 1997). Section 4.2.18.3 provides more information on the methods, definitions, and data used in the analysis of environmental justice issues.

Data in Table 4.4.18-2 show the minority and low-income composition of total population for the Pacific region based on 2000 Census data and CEQ guidelines. Individuals

TABLE 4.4.18-2 Minority and Low-Income Populations in the Pacific Region (millions)

Total population	35.1
White, Non-Hispanic	18.1
Hispanic or Latino	9.6
Non-Hispanic or Latino minorities	7.4
One race	6.4
Black or African American	2.2
American Indian or Alaskan Native	0.2
Asian	3.8
Native Hawaiian or Other Pacific Islander	0.1
Some other race	0.1
Two or more races	1.0
Total minority	17.0
Low income	4.5
Percent minority	*48.5*
Percent low income	*12.8*

Source: U.S. Bureau of the Census (2006a).

identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals also identifying themselves as being part of one or more of the population groups listed in the table.

Data in Table 4.4.18-2 show the minority and low-income composition of total population for the coastal counties (U.S. Bureau of the Census 2000b) in the Pacific region based on 2000 Census data and CEQ guidelines. Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals also identifying themselves as being part of one or more of the population groups listed in the table.

Table 4.4.18-2 shows that 48.5% of individuals in the coastal counties of the Pacific region identified themselves as minority, while 12.8% of individuals had an annual income in 2000 at or below the poverty line. For the coastal counties in the region as a whole, the percentage of individuals identifying themselves minority was slightly less than in the reference group, the nation as a whole (46.0%). Similarly the percentage of individuals below the poverty line was slightly less than in the United States as a whole (13.2%). As the percentage of low-income and minority individuals in the Pacific region does not exceed 50% of the total population, or is not more than 20 percentage points above the corresponding percentage for the

United States as a whole, according to CEQ guidelines, there are no minority or low-income populations in the Pacific region.

Within the Pacific region, there is a diversity of population groups. Metropolitan and larger urban areas have a wide variety of ethnic and racial groups, reflecting heterogenous sociocultural systems, with cultural centers containing population groups of African, European, Asian, Native American, and Latin American origins. Smaller urban centers and rural areas tend to be less diverse, with a smaller number of cultural and racial and ethnic groups present. There are also a number of Indian tribes located on land along the coast within the region.

4.4.19 Cultural Resources

As defined in the ACHP regulations at 36 CFR 800.16, *historic property* means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria. As used in this analysis, the more general term, *cultural resources,* also includes those historic resources not yet determined eligible for the National Register.

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA; 16 USC 470(f)) requires that Federal agencies such as the MMS take into account the effect of an undertaking under their jurisdiction on significant cultural resources. A cultural resource is considered significant when it meets the eligibility criteria for listing on the National Register of Historic Places (36 CFR 60.4). The Section 106 process requires the identification of cultural resources within the area of potential effect of a Federal project, consideration of a project's impact on cultural resources, and the mitigation of adverse effects to significant cultural resources. The process also requires consultation with State Historic Preservation Officers, the Advisory Council on Historic Preservation, Native American tribes, and interested parties. In the case of oil, gas, and sulfur leases, the MMS has established regulations (e.g., 30 CFR 250.194) and issues guidance to lessees (e.g., Notice to Lessees [NTL] No. 2005-G07 and G10, NTL No. 2006-G07, NTL No. 2005-A03, NTL No. 2006-PO3) to ensure compliance with Section 106 of the NHPA and its implementing regulations in 36 CFR Part 800. The NTLs provide guidance on the regulations regarding archaeological discoveries and the conduct of archaeological surveys and identify specific OCS lease blocks with a high potential for containing cultural resources on the basis of previous studies.

The MMS can only consider the effects on cultural resources of projects over which it has permitting authority (Sansonetti 1987). The MMS does not have the legal authority to manage cultural resources on the OCS outside of its lease areas (Solicitor 1980). The only impacts that the MMS can consider off of the OCS are the indirect visual impacts to historic properties on land. The MMS intends to develop additional guidance on the issue of indirect visual impacts through consultation with the Advisory Council on Historic Preservation and other interested parties. Once a project's footprint enters State waters, the project is no longer under MMS control but is subject to the requirements identified by the State.

The Pacific region consists of approximately 2,100 km (1,300 mi) of coastline. Onshore cultural resources are highly varied in coastal areas from small, temporary use sites to substantial permanent settlements ranging in age from the earliest known human occupation of the area, between 10,000 and 12,000 years ago, through the postcontact period (e.g., the last several hundred years).

Offshore cultural resources include numerous shipwrecks dating from as early as the 16th century. Early Spanish exploration occurred all along the Pacific Coast during the 16th century. The earliest known shipwreck in this area was a Spanish Manila galleon, named *San Agustin*, lost in 1595 in Drakes Bay. Late 18th-century maritime activities focused on the fur trade and switched to the lumber trade in the 19th century. In the latter half of the 19th century, the whaling industry grew in importance and grain and lumber became worldwide exports from the Pacific Coast. The potential for finding shipwrecks related to these endeavors increases in areas such as historic shipping routes, approaches to sea ports, reefs, straits, and shoals.

Literature searches can be completed for reported ship losses and known shipwrecks, but they offer only a partial understanding of the resources that may be present. It can be assumed that some percentage of the reporting is inaccurate, some locations were imprecisely recorded, some of the ships were badly broken up and widely dispersed during drift, and additional ship losses, such as the losses of smaller fishing boats, may not have been documented. These records also provide no information regarding the preservation potential of the shipwreck. Water depth, type of bottom, nature of adjacent coast, strength and direction of storm currents and waves, and size and type of the vessel are all factors that can contribute to the condition of the shipwreck and the spatial distribution of materials and artifacts associated with it. The condition of the shipwreck can be determined only by visiting the site. The shipwreck database for the Pacific region, compiled through MMS archaeological baseline studies, estimates 4,676 unique listings for the Pacific Coast prior to the end of World War II. Of these, 80% to 90% are estimated to have occurred in less than 10 m (33 ft) of water (Gearhart et al. 1990).

Offshore cultural resources also include submerged prehistoric archaeological sites. Available data for the Pacific OCS indicate high variability of shoreline elevation along the Pacific Coast at any given time period due to tectonic activity. Much of the OCS at one time constituted dry land. Relative sea levels were approximately 24 m (79 ft) below present levels 12,000 years ago in the area of southern California and fell to 46 m (151 ft) below present levels 10,000 years ago before rising to current levels. Data indicate that the sea level in the San Francisco Bay area was approximately 50 m (164 ft) below present levels approximately 9,700 years ago. The sea level along the Oregon Coast may have been 47 m (154 ft) below present around 12,000 years ago (Stright 1990). The submerged area between these various paleoshorelines (based on bathymetric contour) and the present-day shoreline would, therefore, have the potential to contain prehistoric sites. Oral histories and native mythology include mention of native use areas along the Pacific Coast that are now submerged (Stright 1990).

On the Pacific Coast, three landforms have been identified as potentially sensitive for the presence of prehistoric sites: river valley systems, embayments, and island complexes (Gearhart et al. 1990). Lagoons and estuaries along the California Coast would also be likely areas. These areas would have been attractive to human populations prior to being submerged and thus have the potential to contain preserved archaeological sites. Of all the geographical features, relict river courses have been shown to have higher concentrations of sites in the United States (Delgado 1998). The MMS requires high-resolution remote sensing surveys prior to any bottom-disturbing activities associated with oil, gas, and sulfur leasing. These surveys have been successful in identifying geographic features that are associated with prehistoric site locations.

As with shipwrecks, site preservation of underwater prehistoric archaeological sites is subject to many factors. Low-energy environments with little current or sedimentary movement have the best preservation potential. These areas would include previous floodplains, bays, lagoons, river terraces, and subsiding deltas that are now buried by marine sediments. The preservation of organic materials (e.g., wood, seeds, fibers, skins, and possibly animal or human soft-tissue remains) is possible when buried under such conditions (Purdy 1988). Sites that are fully or partially exposed in near-shore or high-energy environments are likely to erode over time, displacing and/or destroying the artifacts and their primary context. Shell midden sites seem to be able to withstand higher energy environments (Delgado 1998).

4.4.20 Land Use and Existing Infrastructure

The Pacific region includes approximately 2,100 km (1,300 mi) of coastline in the States of California, Oregon, and Washington. This area contains 8 of the 50 largest U.S. cities and 8 of its largest ports. Transportation networks including marine, rail, and highway are well developed. While there are large centers of population and developed infrastructure, there are also large undeveloped and rural areas along the coasts that include numerous State and federally managed units focused on recreation, marine environment protection, resource protection, and wildlife management. The coastal portions of all three States are heavily visited and used by recreation users and are a major recreation destination. Units of both the NPS and USFWS are spread along the coast of all three States. Similar to most other coastal States, the States along the Pacific Coast have authority over submerged lands out to 3 nautical mi (5.6 km [3.5 statute mi]).

All of the States in the Pacific region are participants in the Coastal Zone Management Program (see the discussion of the Coastal Zone Management Act in Section 1.7). The coastal area of the three States in this OCS region is very diverse and is a highly treasured resource whether for its remote shorelines or for its developed beaches. Numerous communities in all three States have long histories as fishing and shellfish centers, and/or as timber harvesting centers. Some of the most notable features of the area include Puget Sound, the Columbia River Bar, Redwood National and State Parks, San Francisco Bay, and the tremendous number of State and local parks located on the coasts of all three States. Military operations are well established along the Pacific Coast, including major facilities for all Services.

The military areas in this region are discussed in Section 4.4.16. Areas of special concern, including the National Marine Sanctuaries, National Parks, National Wildlife Refuges, and National Marine Protected Areas, are discussed in Section 4.4.15. The population along the Pacific Coast is discussed in Section 4.4.18.

Offshore oil and gas resources in the Pacific region have seen little development. Opposition to energy development led to a moratorium on further development that is still in place. There are currently 23 active oil and gas production platforms within the region in southern California. California also has had a long history of wind power development centered in inland areas around Tehachapi, San Gorgonio, and Altamont but to this time has had no major development in offshore or coastal areas. The State has published a wind resource map showing areas of high potential.

4.4.21 Visual Resources

Description of the visual resources potentially affected by the proposed facilities involves establishing landscape types and scenic quality in the areas in which energy facilities would be located, followed by an assessment of the potential sensitivity to changes in the visual environment, including the likely number of viewers.

Various beach types and wetland areas figure prominently in the Pacific region. Beach types include rocky shores and sandy beaches, the latter of which are most common in this region. By their nature, sandy beaches are less stable environments than rocky shores, given the potential for seasonal changes in beach profile associated with wind and wave exposure and the effects of nearshore currents. Rocky shore habitats are more abundant from southern Oregon to central California, and along the Channel Islands offshore southern California. Wetland and estuarine habitats also figure prominently in the visual landscape of the Pacific Coast and consist of salt marshes, eel grass beds, fresh- and brackish-water marshes, and mudflats. Wetland habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams.

A large percentage of the U.S. population lives near the Pacific Coast; consequently, beaches are heavily used for recreation, particularly near large urban areas in southern California, because of the warm and sunny climate. The number of potential viewers and the recreational nature of the activities they are engaged in make viewsheds from beaches particularly sensitive to offshore impacts. Farther north on the Pacific Coast (central California to Washington), colder water and weather, combined with rockier shores, reduce the number of beach users; however, the scenery in some areas is spectacular, so oceanfront viewsheds may be highly sensitive to visual changes offshore.

In addition, in some areas residences are located at or very close to the shore; many people choose to live in these areas because of the ocean views from their homes or nearby ocean front. Seaside residents would likely have frequent and extended views of offshore energy developments, and many will have strong emotional attachments to the visible seascapes, especially if those seascapes are relatively free of development and visual clutter. Seaside residents would potentially be very sensitive to changes visible from the shore, and hence viewsheds from seaside residences are of particular concern for potential visual impacts.

4.4.22 Tourism and Recreation

Recreation and tourism are primary components of the socioeconomic environment of the Pacific region. The Pacific coastline is an outstanding visual resource of great variety, grandeur, contrast, and beauty and contributes to the economic success of the tourist industry. Most of the coastal region is a highly sensitive natural resource area and is an important recreational asset to the residents (USDOI/MMS 2002b). Many of the national parks, reserves, sanctuaries, State parks, and marine protected areas are preferred destinations for residents and visitors. Tourism activities represent an important revenue source to local and State economies. Recreational activities conducted in the coastal zone include sightseeing, camping, clam digging, hiking, biking, beachcombing, picnicking, boating, swimming, diving, wading, sunbathing, surfing, and sportfishing (USDOI/MMS 2002b). Sightseeing and beachcombing are enjoyed along the entire coast and are dependent on the aesthetic aspect of the coastline and ocean view. Most of these activities occur near established shoreline park, recreation, beach, and public-access sites.

The most intense use of available tourist and recreational resources is generally found near the major coastal population centers, notably along the beaches of southern California. Santa Monica Bay has the highest frequency of use, with beach attendance exceeding 75 million/year (USDOI/MMS 2002b). Other areas of high use are beaches in Orange County and in San Diego, with combined attendance of more than 50 million/year. Recreational boating is an especially important activity in coastal waters of the Pacific region. It is estimated that 25% of Oregon’s population participates in some form of boating activity (USDOI/MMS 2002b).

Tourism and recreation are important activities for many communities on the Pacific Coast. However, for the coastal States, these activities do not make a significant contribution to overall employment or wages (Table 4.4.22-1), with less than 5% of total coastal county employment in 2004 in the ocean-related sectors in which tourism and recreation expenditures occurs.

4.4.23 Fisheries

4.4.23.1 Commercial Fisheries

Commercial marine fishery landings in the Pacific region, which includes the coastal and Federal waters off the coasts of Washington, Oregon, and California, totaled approximately 512 million kg (1,129 million lb), worth more than $415 million in 2004 (Table 4.2.23-1). Of the individual States, Washington led in total commercial fishery landings and value in 2004 with 206 million kg (455 million lb) of landings, worth more than $175 million. California was second in terms of total landings and value (172 million kg [379 million lb], $139 million), followed by Oregon (134 million kg [295 million lb], $101 million) (Table 4.2.23-1).

TABLE 4.4.22-1 Ocean-Related Tourism and Recreation (T&R) Economy, 2004

State	T&R Sector[a] Employment	Sector Share of Coastal County[b] Employment (%)	T&R Sector Wages ($ billions)
CA	277,185	1.9	5,405.5
OR	10,613	0.7	148.2
WA	106,764	4.0	1,827.7
Total	394,562	2.1	7,381.4

[a] T&R sectors are Amusement and Recreation Services, Boat Dealers, Eating and Drinking Places, Hotels and Lodging Places, Marinas, RV Parks and Campsites, Scenic Water Tours, Sporting Goods Retailers, Zoos, and Aquaria.

[b] Economic activity in counties wholly or partly within 50 mi of the coast in each State.

Source: NOAA (2006d).

Many species of fish and invertebrates are caught and landed in commercial fisheries of the Pacific region. The most important species groups are benthic invertebrates, oceanic pelagic (epipelagic) fishes, demersal fish species, and anadromous species. Important invertebrate species include Dungeness crab, spiny lobster, squid, and oysters (although oysters are harvested primarily in inland waters). Important targeted fish species include anadromous salmon (chinook, chum, and coho); albacore tuna and swordfish (epipelagic); and sablefish, halibut, and rockfishes (demersal).

On the basis of commercial fishery landing data reported by the National Marine Fisheries Service (NMFS 2006c), the most valuable commercial fisheries in the Pacific region overall and for the three Pacific Coast States in 2004 were for Dungeness crab. This species accounted for almost 28% of the overall commercial fishery value within the region during 2004 and for 29%, 42%, and 18% of the commercial fishery value for California, Oregon, and Washington, respectively (Table 4.4.23-1). Other invertebrates such as squid, Pacific oyster, sea urchins, and California spiny lobster also contributed significantly to the value of commercial landings. Finfish species that contributed substantially to the overall commercial value of the Pacific region fisheries in 2004 included chinook salmon ($35.3 million, 8.7% of regional fishery value), albacore tuna ($27.1 million, 6.7%), and sablefish ($17.3 million, 4.3%) (Table 4.4.23-1). In terms of landing weights, Pacific hake was the dominant species in the Pacific region overall during 2004, although it was only a small component of the commercial fishery reported for California (Table 4.4.23-2). The Pacific sardine, a small coastal pelagic species, was a dominant commercial fish species for all three Pacific coastal States, accounting for approximately 23% of the total weight of landed commercial species for the region with more than 89 million kg (196 million lb) reported (Table 4.4.23-2). Squid, seaweed (kelp), and Dungeness crab were the next most dominant species in the commercial fishery in 2004,

TABLE 4.4.23-1 Reported Landing Values for Predominant Commercial Fishery Species in the Pacific Region

Species	California Value ($)	California % Total Value[a]	Oregon Value ($)	Oregon % Total Value[a]	Washington Value ($)	Washington % Total Value[a]	Overall Pacific Value ($)	Overall Pacific % Total Value[a]
Crab, Dungeness	40,625,137	29.15	42,957,084	42.50	29,023,544	17.67	112,605,765	27.83
Oyster, Pacific	7,338,279	5.27	3,292,485	3.26	29,016,179	17.67	39,646,943	9.80
Salmon, chinook	17,746,439	12.74	12,237,372	12.11	5,300,033	3.23	35,283,844	8.72
Tuna, Albacore	2,439,768	1.75	9,006,482	8.91	15,657,327	9.53	27,103,577	6.70
Clam, Pacific Geoduck		0.00		0.00	25,582,794	15.58	25,582,794	6.32
Squid, California Market	19,723,439	14.15		0.00		0.00	19,723,439	4.87
Sablefish	3,722,345	2.67	7,088,798	7.01	6,517,457	3.97	17,328,600	4.28
Clam, Manila		0.00		0.00	15,395,568	9.37	15,395,568	3.80
Sardine, Pacific	3,956,712	2.84	4,869,916	4.82	1,244,976	0.76	10,071,604	2.49
Halibut, Pacific		0.00	877,877	0.87	7,265,196	4.42	8,143,073	2.01
Sea Urchins	7,300,467	5.24	122,703	0.12	471,613	0.29	7,894,783	1.95
Shrimp, Ocean	925,063	0.66	4,740,467	4.69	2,191,254	1.33	7,856,784	1.94
Hake, Pacific (Whiting)	637,831	0.46	4,640,800	4.59	2,341,078	1.43	7,619,709	1.88
Lobster, California Spiny	5,942,253	4.26		0.00		0.00	5,942,253	1.47
Salmon, Coho		0.00	782,214	0.77	4,942,927	3.01	5,725,141	1.41
Sole, Dover	1,947,425	1.40	3,161,703	3.13	421,354	0.26	5,530,482	1.37
Salmon, Chum		0.00	345	<0.01	5,057,053	3.08	5,057,398	1.25
Swordfish	4,833,695	3.47		0.00		0.00	4,833,695	1.19
Mussel, Blue	586,951	0.42		0.00	3,977,831	2.42	4,564,782	1.13
Sole, Petrale	1,103,332	0.79	2,136,898	2.11	1,141,309	0.69	4,381,539	1.08
Halibut, California	3,110,400	2.23		0.00		0.00	3,110,400	0.77
Shrimp, Spot	2,239,646	1.61		0.00		0.00	2,239,646	0.55
Rockfishes	1,317,167	0.95	520,288	0.51	110,946	0.07	1,948,401	0.48
Thornyhead, Shortspine	1,224,171	0.88	445,069	0.44	45,199	0.03	1,714,439	0.42
Cod, Pacific	104	0.00	566,412	0.56	993,928	0.61	1,560,444	0.39
Sea Cucumber	540,557	0.39		0.00	1,001,866	0.61	1,542,423	0.38
Shrimp, Penaeid	219,593	0.16	13,986	0.01	1,278,082	0.78	1,511,661	0.37
Salmon, Sockeye		0.00	3,601	0.00	1,381,441	0.84	1,385,042	0.34

TABLE 4.4.23-1 (Cont.)

	California		Oregon		Washington		Overall Pacific	
Species	Value ($)	% Total Value[a]	Value ($)	% Total Value[a]	Value ($)	% Total Value[a]	Value ($)	% Total Value[a]
Herring, Pacific	898,560	0.64	26,060	0.03	293,048	0.18	1,217,668	0.30
Crab, Red Rock	1,032,197	0.74	6,156	0.01		0.00	1,038,353	0.26
Sole, English	248,697	0.18	292,016	0.29	385,016	0.23	925,729	0.23
Anchovy, Northern	750,648	0.54	4,632	0.00	63,910	0.04	819,190	0.20
Cabezon	504,998	0.36	203,846	0.20		0.00	708,844	0.18
Sturgeon, White		0.00	342,965	0.34	318,855	0.19	661,820	0.16
Seabass, White	611,355	0.44		0.00		0.00	611,355	0.15
Rockfish, Yellowtail	14,583	0.01	111,211	0.11	466,841	0.28	592,635	0.15
Mackerel, Chub	561,099	0.40	11,235	0.01		0.00	572,334	0.14
Crab, Southern Tanner	559,578	0.40		0.00		0.00	559,578	0.14
Rockfish, Black	261,928	0.19	287,811	0.28		0.00	549,739	0.14
Flounder, Arrowtooth	10,035	0.01	251,516	0.25	282,534	0.17	544,085	0.13
Sole, Rex	191,800	0.14	271,971	0.27	17,364	0.01	481,135	0.12
Tuna, Yellowfin	446,511	0.32		0.00		0.00	446,511	0.11
Shrimp, Brine	261,934	0.19		0.00	177,387	0.11	439,321	0.11
Lingcod	211,864	0.15	164,693	0.16	58,146	0.04	434,703	0.11
Trout, Rainbow		0.00	1,161	0.00	403,993	0.25	405,154	0.10
Clam, Pacific Razor		0.00	115,168	0.11	269,655	0.16	384,823	0.10

[a] Values do not sum to 100% because species that contributed less than 0.1% of the total value for the region were not included.

Source: NMFS (2006c).

TABLE 4.4.23-2 Landing Weights (kg) for Predominant Commercial Fishery Species in the Pacific Region

	California		Oregon		Washington		Overall Pacific	
Species	Weight (kg)	% Total Weight[a]	Weight (kg)	% Total Weight[a]	Weight (kg)	% Total Weight[a]	Weight (kg)	% Total Weight[a]
Hake, Pacific	4,711,519	2.74	59,074,674	44.19	31,350,901	36.21	95,137,095	24.27
Sardine, Pacific	44,217,357	25.74	36,110,468	27.01	8,934,208	10.32	89,262,033	22.77
Squid, California Market	39,962,938	23.26		0.00		0.00	39,962,938	10.19
Seaweed, Kelp	33,723,639	19.63		0.00		0.00	33,723,639	8.60
Crab, Dungeness	11,284,749	6.57	12,369,860	9.25	6,783,543	7.83	30,438,152	7.76
Tuna, Albacore	1,345,567	0.78	4,807,134	3.60	8,184,460	9.45	14,337,161	3.66
Shrimp, Ocean	992,203	0.58	5,536,923	4.14	2,724,917	3.15	9,254,043	2.36
Salmon, Chum		0.00	339	<0.01	7,338,800	8.48	7,339,140	1.87
Salmon, chinook	3,224,452	1.88	2,296,855	1.72	1,813,925	2.10	7,335,232	1.87
Anchovy, Northern	6,792,232	3.95	13,069	0.01	213,414	0.25	7,018,715	1.79
Sole, Dover	2,421,566	1.41	3,801,635	2.84	545,972	0.63	6,769,174	1.73
Sea Urchins	5,542,205	3.23	150,506	0.11	278,429	0.32	5,971,140	1.52
Sablefish	1,431,952	0.83	2,557,117	1.91	1,843,417	2.13	5,832,485	1.49
Oyster, Pacific	563,385	0.33	373,359	0.28	4,489,672	5.19	5,426,416	1.38
Mackerel, Chub	3,578,528	2.08	106,860	0.08		0.00	3,685,387	0.94
Salmon, Coho		0.00	391,721	0.29	2,783,152	3.21	3,174,873	0.81
Flounder, Arrowtooth	44,285	0.03	954,445	0.71	1,240,731	1.43	2,239,462	0.57
Herring, Pacific	1,641,244	0.96	44,187	0.03	327,028	0.38	2,012,460	0.51
Sole, Petrale	489,968	0.29	954,448	0.71	512,171	0.59	1,956,587	0.50
Cod, Pacific	59	0.00	534,738	0.40	967,745	1.12	1,502,541	0.38
Rockfishes	927,633	0.54	383,956	0.29	113,059	0.13	1,424,648	0.36
Sole, English	307,214	0.18	379,856	0.28	515,816	0.60	1,202,886	0.31
Swordfish	1,185,344	0.69		0.00		0.00	1,185,344	0.30
Halibut, Pacific		0.00	156,697	0.12	1,022,480	1.18	1,179,177	0.30
Jack Mackerel	1,027,080	0.60	125,799	0.09	7,078	0.01	1,159,958	0.30
Clam, Pacific Geoduck		0.00		0.00	787,157	0.91	787,157	0.20
Skates	127,144	0.07	444,836	0.33	171,651	0.20	743,630	0.19
Thornyhead, Shortspine	317,896	0.19	304,079	0.23	29,135	0.03	651,110	0.17

TABLE 4.4.23-2 (Cont.)

Species	California Weight (kg)	California % Total Weight[a]	Oregon Weight (kg)	Oregon % Total Weight[a]	Washington Weight (kg)	Washington % Total Weight[a]	Overall Pacific Weight (kg)	Overall Pacific % Total Weight[a]
Rockfish, Yellowtail	9,427	0.01	97,848	0.07	467,040	0.54	574,315	0.15
Salmon, Sockeye		0.00	1,174	<0.01	554,593	0.64	555,767	0.14
Sole, Rex	210,365	0.12	295,628	0.22	21,942	0.03	527,935	0.13
Shrimp, Brine	450,003	0.26		0.00	72,181	0.08	522,184	0.13
Sea Cucumber	260,103	0.15		0.00	262,056	0.30	522,158	0.13
Shark, Spiny Dogfish	27,664	0.02	4,602	<0.01	482,155	0.56	514,421	0.13
Clam, Manila		0.00		0.00	507,630	0.59	507,630	0.13
Tuna, Yellowfin	487,969	0.28		0.00		0.00	487,969	0.12
Halibut, California	456,967	0.27		0.00		0.00	456,967	0.12
Lobster, California Spiny	376,583	0.22		0.00		0.00	376,583	0.10
Flounder, Pacific Sanddab	357,486	0.21		0.00	10,518	0.01	368,003	0.09
Crab, Red Rock	365,071	0.21	1,976	<0.01		0.00	367,046	0.09
Bonito, Pacific	353,873	0.21		0.00		0.00	353,873	0.09
Tuna, Skipjack	306,738	0.18		0.00		0.00	306,738	0.08

[a] Values do not sum to 100% because species that contributed less than 0.1% of the total value for the region were not included.

Source: NMFS (2006c).

accounting for 10%, 9%, and 8%, respectively, of the total weight of commercial fishery landings in the Pacific region (Table 4.4.23-2).

In Washington, the commercial fisheries having the greater landing weights in 2004 were Pacific hake (31.4 million kg [69.2 million lb]), Pacific sardine (8.9 million kg [19.6 million lb]), albacore tuna (8.2 million kg [18.1 million lb]), chum salmon (7.3 million kg [16.1 million lb]), and Dungeness crab (6.8 million kg [15 million lb]) (Table 4.4.23-2). The species that brought the greater dollar amounts were Dungeness crab ($29.0 million), Pacific oyster ($29.0 million), and Pacific geoduck clam (*Panopea abrupta*) ($25.6 million) (Table 4.4.23-1).

In Oregon, the commercial fisheries having the greater landing weights in 2004 were Pacific hake (59.1 million kg [130.3 million lb]), Pacific sardine (36.1 million kg [79.6 million lb]), Dungeness crab (12.4 million kg [27.3 million lb]), and ocean shrimp (5.5 million kg [12.1 million lb]). The species that brought the greater dollar amounts were Dungeness crab ($43.0 million), chinook salmon ($12.2 million), albacore tuna ($9.0 million), and sablefish ($7.1 million).

In California, the commercial fisheries having the greater landing weights in 2004 were Pacific sardine (44.2 million kg [97.4 million lb]), California market squid (40.0 million kg [88.2 million lb]), kelp seaweed (33.7 million kg [74.3 million lb]), and Dungeness crab (11.3 million kg [24.9 million lb]). The species that brought the greater dollar amounts were Dungeness crab ($40.6 million), market squid ($19.7 million), and chinook salmon ($17.7 million).

Each species or species group is caught by using various methods and gear types. Traps are used for crab, spiny lobster and some demersal fish species; sardines are usually caught in surrounding lampara or purse nets; tuna are caught on surface troll lines or longlines; rockfishes are generally captured by using trawls, set longlines, or trolling rigs; and squid are caught by encircling schools with a round-haul net, such as the purse seine or lampara net. Generally, fishing activities in the Pacific region with the highest potential for interactions (or conflicts) with OCS activities (e.g., oil and gas operations) are bottom trawling (potential for snagging on pipelines, cables, and debris) and surface longlining (potential for space-use conflicts with seismic survey vessels and possible entanglement with thrusters on dynamically positioned drillships). The portion of fishery landings that occurred in nearshore and offshore waters of each of the Pacific Coast States is presented in Table 4.4.23-3. Although the available data do not specifically allow the portion of fishery landings to be separated according to water depths, it is anticipated that deepwater fisheries (e.g., longlining) and nearshore fisheries in shallow water are less likely to occur in areas where OCS alternative energy development is most likely.

Fishery statistics for major U.S. ports in the Pacific region are presented in Table 4.4.23-4. For reported total landing value, 13 Pacific Coast ports reported landings worth more than $10 million in 2004. The top U.S. ports in the Pacific region in 2004, in terms of fishery value, were Newport, Oregon ($29.6 million); Shelton, Washington ($27.3 million); Coos Bay-Charleston, Oregon ($25.2 million); Bellingham, Washington ($21.9 million); and Westport, Washington ($20.5 million).

TABLE 4.4.23-3 Pacific Coast Fish Landings by Distance from Shore by State for 2004 (1,000 kg)

	Distance from Shore (mi)				
State	0–3	3–200	High Seas	Total	% from OCS Waters
Washington	40,950	166,252		207,202	80.2
Oregon	52,147	81,578		133,725	61.0
California	145,022	25,652	1,331	172,005	14.9
Total	238,120	273,481		512,932	53.6

Source: NMFS (2006b).

4.4.23.2 Recreational Fisheries

Washington, Oregon, and northern California generally have comparable levels of public participation in recreational fishing activities. Sportfishing is an important recreational activity throughout central California, while southern California is considered a focal point for marine sportfishing in the eastern Pacific (USDOI/MMS 1996). These activities are detailed in BLM (1980) and NOAA (1986).

More than 165 fish species have been noted in the recreational catch for southern California, however, only a few of the species made up most of the catch. Recreational fishermen target several pelagic, reef-associated, and demersal fishes; details are provided in USDOI/MMS (1996). Additional information on recreational fisheries in southern California is summarized in Cross and Allen (1993).

About 4 million recreational fishing participants took more than 4.8 million trips and caught more than 18 million fish within the Pacific region in 2004 (NMFS 2005). Ninety-one percent of the trips were made in California, followed by 5% in Oregon, and 4% in Washington. The most commonly caught nonbait species (in numbers of fish) were barred sand bass (*Paralabrax nebulifer*), Pacific bonito, kelp bass (*Paralabrax clathratus*), black rockfish (*Sebastes melanops*), coho salmon, and Pacific barracuda (*Sphyraena argentea*). By weight, the largest harvests were chinook salmon, coho salmon, black rockfish, barred sand bass, Pacific barracuda, and albacore (*Thunnus alalunga*) (NMFS 2005).

The fish species most commonly taken by recreational anglers in federally managed waters were barred sand bass, Pacific sanddab (*Citharichtys sordidus*), kelp bass, California scorpionfish (*Scorpaena guttata*), and chinook salmon. Of the fish caught by recreational anglers in the Pacific region, 82% of the marine catch came primarily from in-state coastal waters, and 10% came from trips that fished primarily in inland waters (NMFS 2005).

TABLE 4.4.23-4 Reported Total Landing Weights and Total Landing Values for Major Ports in the Pacific Region in 2004

Rank among All U.S. Commercial Fishing Ports	Port	State	Total Landing Weight (millions kg)	Total Landing Value ($ millions)
9	Astoria	OR	61.6	19.9
11	Newport	OR	50.4	29.6
16	Los Angeles	CA	41.8	16.3
17	Westport	WA	41.4	20.5
18	Port Hueneme-Oxnard-Ventura	CA	31.8	17.7
21	Moss Landing	CA	25.2	6.9
31	Ilwaco-chinook	WA	14.1	12.0
33	Coos Bay-Charleston	OR	13.5	25.2
36	Bellingham	WA	10.7	21.9
38	Eureka	CA	8.8	13.1
45	Crescent City	CA	7.7	20.1
57	San Francisco Area	CA	4.7	12.9
58	Shelton	WA	4.7	27.3
66	Santa Barbara	CA	3.6	6.5
67	Seattle	WA	3.5	8.0
70	Bay Center-South Bend	WA	3.3	15.2
72	Blaine	WA	3.2	5.6
75	Fort Bragg	CA	2.9	7.2
76	Brookings	OR	2.8	8.6
79	Anacortes-La Conner	WA	2.4	6.1
82	Neah Bay	WA	2.2	4.9
83	Monterey	CA	1.7	1.9
84	Tillamook	OR	1.7	3.8
85	Tacoma	WA	1.5	4.2
89	Port Orford	OR	1.4	4.8
91	San Diego	CA	1.0	4.0
92	Port Angeles	WA	1.0	2.8
93	La Push	WA	1.0	3.7
94	Olympia	WA	0.9	6.3
95	Everett	WA	0.9	1.5
96	Port Townsend	WA	0.8	2.9

Source: NMFS (2005).