California Marine Life Protection Act Initiative

Draft Regional Profile of the North Coast Study Region

(Alder Creek to the California-Oregon Border)

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Draft

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How to Use this Document

This is the first draft of the *Regional Profile of the North Coast Study Region (Alder Creek to the California-Oregon Border)*, authored by the staff and advisors of the California Marine Life Protection Act Initiative. The purpose of this document is to provide an overview of the features and characteristics of the study region, to better inform the design of marine protected areas (MPAs) for the region. The intention of MLPA Initiative staff is that, after receiving input from stakeholders and scientific advisors, they will produce a revised version in early 2010.

Acronyms and Abbreviations

In a document of this type, it is natural that a large number of abbreviations and acronyms will be used. In all cases where an acronym is used for the first time, the name or phrase it stands for is spelled out. For reference, a complete list of acronyms and abbreviations has been placed inside the back cover, where it is easy to find. Note, though, that this list does not cover every acronym for institutions which have authored documents that are cited in the text. In those cases, the references appear at the end of each chapter, where they are sorted alphabetically by acronym. The full name of the institution is spelled out in at least the first reference.

Maps and Geographical Aids

As a companion to this profile, two atlases are being published in a single, separate volume. That book, the *MLPA North Coast Study Region Atlas*, contains large-format maps in two thematic atlases: the *Coastal Management & Human Uses Atlas* and the *Habitat & Species Atlas.* This profile will make several reference to those atlases.

MLPA Initiative staff have compiled and developed spatial data layers and have conducted geographic information system (GIS) analyses to support the planning process. The atlases that accompany this regional profile include maps of only selected spatial data layers. Additional spatial data layers for the study region are available through the online tool, MarineMap (http://northcoast.marinemap.org/marinemap/.). Data layers available at the date of printing are listed in Appendix A of this Profile.

How to Learn More

At the end of each chapter there is a list of references for that chapter. In all, over 350 works were consulted in the draft document's creation, and readers may want to consult these works. In the case of many academic papers, a trip to a good library is necessary. Increasingly, though, valuable documents are to be found online; we have supplied a URL in every case where we were able to identify an online source for a document. If you wish to follow the links to online sources, you may want to obtain an electronic copy of this profile, in which the URLs are highlighted in blue and are live, clickable links.

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Executive Summary

The Marine Life Protection Act Initiative is a public-private partnership designed to help the State of California implement the Marine Life Protection Act (MLPA) using the best readily available science, as well as the advice and assistance of scientists, resource managers, experts, and members of the public. The MLPA requires the state to redesign existing state marine protected areas (MPAs), and to establish a cohesive network of MPAs to protect, among other things, marine life, habitats, ecosystems and natural heritage, as well as to improve recreational, educational and study opportunities provided by marine ecosystems.

A regional approach is being used to redesign MPAs in state waters along California's 1100-mile coast. Implementation of the MLPA will occur in five study regions: the central coast, the north central coast, the south coast, the north coast, and San Francisco Bay. As part of the MLPA Initiative, a master plan was created to provide a framework to guide the planning process within individual study regions. The central coast study region (Pigeon Point in San Mateo County to Point Conception in Santa Barbara County) was the first study region for which the MLPA planning process was completed; the California Fish and Game Commission adopted 29 central coast MPAs in April 2007. The north central coast study region (Alder Creek to Pigeon Point) was the second study region for which the MLPA planning process was completed, and the California Fish and Game Commission adopted 28 north central coast MPAs in August 2009. Planning has also concluded for the south coast study region (Point Conception to the California-Mexico border), and MPA proposals are under review with the California Fish and Game Commission. The north coast study region (California-Oregon to Alder Creek near Point Arena in Mendocino County) is the fourth study region for which the MLPA Initiative planning process has been started. After the north coast process, the MLPA Initiative will address the San Francisco Bay study region (from Golden Gate Bridge to the Carquinez Bridge).

Marine protected areas within the MLPA North Coast Study Region will be evaluated and redesigned with input from the public, a regional stakeholder group, a science advisory team, a blue ribbon task force, the California Department of Fish and Game (DFG), the California Department of Parks and Recreation, and other interested parties. This document, the *Draft Regional Profile of the MLPA North Coast Study Region*, is intended to support the MPA planning process by providing background information and data on the ecological, socioeconomic, and governance characteristics of the north coast study region, among other topics. This profile will assist stakeholders and decision-makers in evaluating existing MPAs in the study region and developing alternative proposals for MPAs which meet the goals of the MLPA and which form a component of the statewide MPA network.

Regional Overview

The MLPA North Coast Study Region spans a straight-line distance of approximately 225 statute miles of the California coastline (with about 640 statute miles of actual shoreline) from the California-Oregon to Alder Creek near Point Arena in Mendocino County. Encompassing 1,023 square miles of coastal waters, the study region extends from the shoreline (mean high tide) to a maximum depth of approximately 1,667 feet. The population, broad range of interests, sensitive marine ecosystem, and the unique conditions of the California Current Large Marine Ecosystem (LME) combine to create a complex setting. Some of the unique features of the study region include:

- a complex system of oceanographic currents including the California Current LME; one of only 4 temperate upwelling systems in the world;
- diverse habitats ranging from rocky coasts and sandy beaches to soft- and hard-bottom deep habitat and some of the least developed coastal areas in the state;

- kelp forests dominated by bull kelp and associated species assemblages;
- nearly 20 estuaries and lagoons that are greater than 0.5 mi^2, and high biodiversity of fish, birds, invertebrates, and marine mammals;
- the Smith River, the largest river system in California that flows freely along its entire course;
- Castle Rock, an offshore rock supporting the largest population of Common Murres in California;
- Humboldt Bay, the second largest estuary in California and home to approximately 40% of the known eelgrass in the state;
- Cape Mendocino, location of the Mendocino Triple Junction and one of the most seismically active regions in the contiguous United States;
- the Eel River, the third largest watershed in California with the highest recorded average sediment yield per drainage area of any river of its size or larger in the contiguous United States;
- productive commercial and recreational fisheries, targeting a wide diversity of species that help support economies of coastal communities;
- opportunities for a range of non-consumptive activities, such as diving, surfing, kayaking, beach-going, swimming, and shore and boat-based wildlife viewing.

Ecological Setting

The MLPA North Coast Study Region is characterized by high productivity, high biodiversity, diverse habitat types, and unique oceanographic conditions. Nearly all of the habitats listed in the MLPA or recommended by the science advisory team for representation within MPAs, with the exception of seamounts (which do not occur within state waters) are found within the study region. For most of these habitats, there are some mapped data available for use in the planning process.

Key ecological considerations within the study region, including habitat types and ecologically distinctive areas, include:

- Most of the study region is relatively shallow (less than 100 meters), although some areas, such as basins and canyons, are much deeper.
- Intertidal zones include sandy beaches, rocky shores, tidal flats, coastal marsh, and manmade structures.
- Estuaries, with associated open water, soft bottom, coastal marsh, tidal mud flats, and eelgrass beds, exist throughout the study region. Two types of estuaries are present in the north coast: those permanently or semi-permanently open to the ocean and those seasonally separated from the ocean by sand bars. While there are some large estuaries (Humboldt Bay and Eel River estuaries) in the study region, most are small and are periodically closed to tidal influence. Some of the species that depend on these estuaries seasonally or at some point in their life history include staghorn sculpin, surfperch, sharks, and several species of smelt.
- Eelgrass (*Zostera sp*.) beds are found throughout the study region in estuaries (e.g. Humboldt Bay and Eel River estuaries). Eelgrass has also been reported from other locations, such as near the mouths of the Ten Mile River, Noyo River, and Albion River. Surfgrass (*Phyllospadix sp*.) is also found in the study region and is associated with open ocean habitat.

- Bull Kelp (*Nereocystis luetkeana*) dominates the study region with dense canopies that support diverse marine life. Kelp beds have been mapped at a fine-scale resolution in six annual surveys (1989, 1999, 2002, 2003, 2004, and 2005) and are generally found off of rocky headlands in the southern portion of the study region.
- Hard-bottom habitats (rocky reefs) are less common than soft-bottom habitats in the study region at all depth zones based on course-scale mapping. The species composition for hard substrate varies with depth zone. Kelp forests are associated with shallow rock bottoms, while deep-sea corals and sponges are found in deep rock habitat.
- Sandy and soft-bottom habitats are more common than hard-bottom habitats at all depth zones. These habitats do not have the relief or structural complexity of hard-bottom habitats, but do host a number of unique species adapted to the dynamic environment and low-relief physical characteristics. Invertebrates and bottom-dwelling fish are the most common species found in soft substrate.
- Underwater pinnacles are submerged rocky cones or outcrops that can be important areas where fish and other species aggregate. Underwater pinnacles likely exist in the north coast study region; however, they are not well mapped.
- Four submarine canyons exist in state waters within the study region and are found along the Lost Coast between Cape Mendocino and Pt. Delgada. Canyons provide important habitat for deep-water communities and young rockfish, and provide foraging areas for seabirds and marine mammals.
- Numerous rocks and islets located within the north coast study region provide important foraging and nesting sites for marine birds and are used as hallout sites by pinnipeds. In addition, the north coast study region contains offshore reefs, isolated offshore rocks, and two larger nearshore islands.
- Oceanography in the study region is complex, with the southward-flowing California current and northward flowing Davidson current dominating the flow of coastal waters. Upwelling plays a major role in the study region, especially during late spring and early summer, with a prominent center at Cape Mendocino. Additionally, freshwater inputs from large coastal rivers affect local ecosystems, especially in the northern portion of the study region.

The diverse habitats of the north coast study region host a wide array of species that may be considered in the MLPA Initiative process. This document describes some of the species that have relevance to MPA planning, including:

- Depressed or overfished species, which include species of abalone, salmon, rockfish, and steelhead;
- Species targeted by commercial and/or recreational fisheries, which are an important component of the study region's economy;
- Special-status species that are protected under either state or federal law, including a number of pinnipeds, cetaceans, seabirds, and fish.

Land-Sea Interactions

Ecological linkages between the marine and terrestrial environments include:

- Fish that live offshore but move to estuaries, bays, and other more sheltered habitats to reproduce. Plainfin midshipman, staghorn sculpin, and leopard sharks are among the species that depend on the marine and coastal habitats for their life histories.

- Anadromous fish that migrate between the ocean and coastal rivers in their life history for spawning, rearing, and dying. Steelhead trout and coho salmon are two examples of anadromous fish found in the region.
- Shorebirds and waterfowl that inhabit coastal lagoons, estuaries, and salt marshes (estuaries and bays of the study region form part of the Pacific Flyway, one of the four principal bird migration routes in North America).
- Marine mammals, including California sea lions, northern elephant seals, and harbor seals, which use coastal rocks, sandy beaches, tidal flats, and estuaries as haulout sites and for rookery sites.
- Coastal and estuarine vegetation and nutrients, which are carried to the open ocean, provide temporary food and shelter to species including juvenile fish.

Terrestrial activities can have significant impacts on coastal water quality and habitat condition. Some of the most important water quality issues to consider include:

- Point sources of pollution that empty into the coastal environment at specific locations and may cause localized impacts. Examples of point sources of pollution in the study region are wastewater treatment facilities, industrial discharge sites, and stormwater discharge;
- Nonpoint source pollution, which is the leading cause of degraded water quality and eutrophication in the study region, is difficult to identify because it is derived from diffuse locations. Major sources of nonpoint source pollution are agriculture, forestry operations, urban areas, hydromodification, and ports and associated vessels;
- Impaired rivers and waterbodies that have been identified under Section 303(d) of the federal Clean Water Act and have a total maximum daily load (TMDL) for pollutants;
- Recognized water quality management areas including state water quality protection areas (SWQPAs), areas of special biological significance (ASBSs), and California critical coastal areas (CCAs);
- Coastal energy involves development, extraction, and transportation of energy-related resources in coastal waters, as well as offshore. Projects include coastal power plants and hydrokinetic energy.

Socioeconomic Setting

The three counties of the MLPA North Coast Study Region are part of a unique economic setting that includes industries and economic sectors that are dependent on marine resources. Commercial and recreational fisheries, kelp and aquaculture leases, as well as tourism and non-consumptive uses marine resources all contribute to the coastal economies of Del Norte, Humboldt and Mendocino counties.

- Overall, the north coast study region has a smaller population than previous MLPA study regions. Data on top industries, as well as specialized information on top ocean-related industries are provided for each county in the study region. Population projections are also provided for each county.

- Significant commercial fisheries occur within the study region. Two port complexes (Eureka and Fort Bragg) include several ports that span the three counties of the study region. Major ports include Crescent City, Trinidad, Eureka, King Salmon, Fields Landing, Shelter Cove, Fort Bragg and Albion. Numbers of commercial fishermen and vessels for all three counties have declined from 1999 through 2008. Dungeness crab was the largest commercial fishery

in the region by landings over the past decade, followed by Urchin and Chinook Salmon. The Dungeness fishery was also the most profitable commercial fishery over the same period.

- Both harvest of kelp and aquaculture occur in the study region. Though, none of the administrative kelp beds in the region are currently open to commercial take, harvest of edible seaweeds does occur. Some harvested species include *Postelisa palmeformis*,which was harvested more than any other seaweed from 2002 to 2008, as well as *Laminaria* spp. and *Porphyra* spp. Mendocino county experienced the highest rate of harvest for all species of edible seaweeds during the same period. Aquaculture occurs in the study region within Humboldt Bay.
- Recreational fishing is important within the study region, and estimated annual recreational take is presented by species. Major recreational finfish fisheries in the region from 2005 - 2008 include black rockfish, redtail surfperch, Chinook salmon and lingcod. A recreational fishery for red abalone occurs in the study region, and is unique north of San Francisco Bay. The highest proportion of recreational catch is landed via private boat and commercial passenger fishing vessel (CPFV) for most recreational fisheries, with notable exclusions being the surfperch, smelt, greenling, and red abalone recreational fisheries. Various boat based and shore based fishing modes are described. Angling effort is summarized by mode, with the highest annual angler effort belonging to beach-and-bank-based modes.
- Coastal tourism is an important driver of local economies and Mendocino and Humboldt Counties lead the study region in travel spending. The most visited coastal state park in the region in 2007/2008 was Mendocino Headlands. Samoa dunes recreation area in Humboldt County was the most visited Bureau of Land Management public land adjacent to the coast in 2008/2009.
- Non-consumptive uses of coastal environments, including beach-going, swimming, surfing, sailing, kayaking, diving, wildlife viewing, photography, and other activities that do not involve the take or extraction of marine resources, also occur in within the north coast study region.
- Native American coastal communities and associated resource uses are significant within the study region. Major Native American communities in the region include Tolowa, Yurok, Wiyot, Mattole, Sinkyone, and Yuki peoples, in addition to others. Historic and contemporary significance of consumptive and non-consumptive uses of the marine environment is further described and important to consider in MPA planning.

Academic Institutions, Research, Public Outreach and Education

There are several institutions conducting research and monitoring of north coast marine ecosystems and resources. These include educational institutions (such as Humboldt State University) as well as government agencies and non-governmental organizations. Information on ongoing scientific research in the region and associated institutions, organizations and agencies is presented, as are those involved in public outreach.

Jurisdiction and Management

Federal, state and local government bodies, as well as Native American tribes, have various overlapping jurisdictions within the study region, which are herein discussed. Consideration of these managing agencies is important to consider in both MPA planning, as well as long-term management.

Existing MPAs and Coastal Protected Areas

Several state marine protected areas, as well as a number of fishery closures and other coastal protected areas exist within the north coast study region:

- There are five existing MPAs in the north coast study region, located in the southern portion of the study region. Punta Gorda State Marine Reserve (SMR) in Humboldt County is the only state marine reserve on the north coast of California and is the largest MPA currently established MPA in the study region at 2.07 square miles.
- Marine managed areas in the study region include the federally managed Redwood National Park (which has a boundary that extends 0.4 km offshore) as well as two types of fishery closures: rockfish conservations areas (RCAs) and essential fish habitat (EFH) areas.
- There are several terrestrial protected areas that occur in coastal watersheds of the north coast study region, which are further outlined and described,
- Marine protected areas in Oregon may provide additional connectivity with the California network of MPAs, and additional protection for some species

Conclusion

The MLPA North Coast Study Region's diverse marine habitats, communities and dynamic oceanographic setting create an assemblage of resources that is unique within the state. Bathymetric features, from submarine canyons to underwater pinnacles and offshore rocks provide essential substrate for assemblages of organisms that contribute to the region's biodiversity. Abundant marine resources support recreational and commercial activities that are important to the various coastal communities, including those of Native American peoples, in the three counties of the study region. Additionally, the coastal environment provides an exceptional background for the various academic and non-academic research and monitoring entities in Northern California. The unique nature of marine resources on the north coast has been a driving factor in the establishment of five existing marine protected areas within the region. This document summarizes key information relating to the study region in order that these state MPAs may be efficiently redesigned to better protect California's marine heritage in accordance with the Marine Life Protection Act.

1 Introduction

The Marine Life Protection Act (MLPA) was signed into law in 1999. The MLPA mandates the redesign of a statewide system of marine protected areas (MPAs) that function, to the extent possible, as a network. Central to the MLPA are six goals intended to guide the development of MPAs within California's state waters. The six goals of the MLPA are:

- Goal 1: To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.
- Goal 2: To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.
- Goal 3: To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.
- Goal 4: To protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value.
- Goal 5: To ensure that California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.
- Goal 6: To ensure that the MPAs are designed and managed, to the extent possible, as a component of a statewide network.

Note that the order in which these goals appear does not imply any ranking of importance or priority.

After several unsuccessful attempts to implement the MLPA, the California Natural Resources Agency, the California Department of Fish and Game (DFG), and Resources Legacy Fund Foundation signed a memorandum of understanding launching the MLPA Initiative in August of 2004, which began the implementation of the MLPA along California's Central Coast. Among other actions, the MLPA Initiative established the MLPA Blue Ribbon Task Force, MLPA Master Plan Science Advisory Team (SAT), a statewide stakeholder interest group, and MLPA Initiative staff.

A regional stakeholder group was convened for the MLPA Central Coast Study Region (Pigeon Point in San Mateo County to Point Conception in Santa Barbara County) in June of 2005. By March of 2006, several alternative proposals for MPA design had been generated by the MLPA Central Coast Regional Stakeholder Group and reviewed by the MLPA Blue Ribbon Task Force, which forwarded a preferred alternative proposal to DFG. DFG then forwarded a recommendation to the California Fish and Game Commission. After over a year of ensuing public comments and deliberations, the California Fish and Game Commission unanimously adopted a preferred alternative proposal for MPAs in the central coast in April of 2007. These MPAs were ultimately implemented in September of 2007.

A second memorandum of understanding, effective January 1, 2007, continued the public-private partnership for planning MPAs in the second MLPA study region along California's north central coast (Alder Creek, just north of Point Arena in Mendocino County, to Pigeon Point). The MLPA North Central Coast Regional Stakeholder Group was convened in May of 2007 and worked for nearly a year to generate three alternative proposals for MPAs on the north central coast by April of 2008. In June of 2008, the MLPA Blue Ribbon Task Force forwarded these three stakeholder-generated proposals, as well as an "Integrated Preferred Alternative" to the California Fish and Game Commission for consideration in the regulatory process. After over a year of ensuing public

comments and deliberations, in August 2009 the California Fish and Game Commission adopted a preferred alternative proposal for MPAs in the north central coast in August of 2009.

In December of 2007, California Secretary for Natural Resources Mike Chrisman announced the order in which the remaining portions of the California coastline would be considered under the Marine Life Protection Act, with the goal of completing the planning process by 2011. Secretary Chrisman announced that the MLPA Initiative would move to the MLPA South Coast Study Region (Point Conception to the California-Mexico border, including offshore islands and rocks within state waters) in 2008, followed by the North Coast Study Region (California-Oregon border to Alder Creek), and finally the San Francisco Bay study region (from the Golden Gate Bridge to the Carquinez Bridge). In February of 2008, the California Fish and Game Commission formally adopted a working version of the *California Marine Life Protection Act Master Plan for Marine Protected Areas* (DFG 2008), which includes guidelines for developing MPAs.

A third memorandum of understanding, effective July 2008, was signed for the third phase of the MLPA Initiative, which would begin with California's south coast. The MLPA South Coast Regional Stakeholder Group was convened in October of 2008 and worked for a year to generate three alternative proposals for MPAs on the south coast, which were considered by the MLPA Blue Ribbon Task Force in October and November of 2009. In November, the MLPA Blue Ribbon Task Force created an integrated preferred alternative MPA proposal, which was forwarded to the California Fish and Game Commission for consideration, along with the three proposals generated by the MLPA South Coast Regional Stakeholder Group.

MPA planning within the MLPA North Coast Study Region (California-Oregon border to Alder Creek) represents the next step in the MLPA Initiative. This regional profile includes background information on the biological, oceanographic, socioeconomic, and governance setting for the MLPA North Coast Study Region and is intended to provide basic regional information to support stakeholders and policy makers in their understanding of the marine resources and heritage of the region so that they may effectively reexamine and redesign MPAs in accordance with the Marine Life Protection Act. This information is provided in the form of text summaries, tables, maps displaying spatial information, and technical appendices. The MLPA Master Plan Science Advisory Team (SAT) and knowledgeable members of the public will provide additional information to augment this profile.

The best readily available data are being compiled for use in the north coast study region MPA planning process. This regional profile provides an overview of some of that data. Additional data in a spatial geographic information system (GIS) format are being housed in the California Marine Geodatabase at the University of California, Santa Barbara and are viewable using the online tool MarineMap (http://northcoast.marinemap.org/marinemap/). Appendix A provides a list of the data layers that are available for MPA planning.

References for Chapter 1

(DFG 2008) California Department of Fish and Game. 2008 *California Marine Life Protection Act Master Plan for Marine Protected Areas*. Approved by the California Fish and Game Commission in February 2008.

2 Overview of the MLPA North Coast Study Region

The MLPA North Coast Study Region covers state waters extending from the California-Oregon border to Alder Creek near Point Arena in Mendocino County. The study region also includes state waters surrounding offshore islands and offshore rocks such as Castle Rock, Green Rock, Reading Rock, and Pewetole Island. In general, state waters extend three nautical miles offshore. The shoreward boundary of the study region is drawn at mean high tide in most locations and at the extent of tidal influence and estuarine vegetation in estuaries and lagoons. Lagoons that are mostly or entirely closed to tidal inundation and dominated by brackish-freshwater species are not included in the MLPA North Coast Study Region.

The study region coastline covers an alongshore, straight-line distance of 225 statute miles. (Unless otherwise noted, all distance measurements in this document are measured in statute miles (mi) and all area measurements are measured in square statute miles (mi^2). The actual shoreline length is much longer due to undulations in the coastline and covers a distance of approximately 640 miles, according to the linear shoreline data of the National Oceanic and Atmospheric Administration's Environmental Sensitivity Index (NOAA ESI). The waters of the study region encompass 1,023 square miles and are offshore of some of the least developed coastal areas in the state. Flood plains of stream drainages are devoted mainly to agriculture and are primarily composed of pasturelands (Monroe et al. 1976). Offshore waters within the study region contain a number of channels, basins, and canyons, which extend to a maximum depth of 1,667 feet. A diverse array of habitats exists within the study region, ranging from rocky, sandy, and estuarine intertidal areas to deep hard and soft habitats on the continental shelf and slope.

The north coast study region is part of the California Current Large Marine Ecosystem (LME), one of only four temperate upwelling systems in the world. The California Current LME is considered globally important for biodiversity because of its high productivity and the large numbers of species it supports (World Wildlife Fund 2000). The California Current LME extends from Vancouver Island to Baja California and is a highly productive ecosystem fueled by upwelling, which richly supplies surface waters with nutrients; these nutrients support blooms of phytoplankton which in turn form the foundation for a food web that includes thousands of species of invertebrates, fish, marine mammals and seabirds.

The California Current LME in the north coast study region is characterized by strong seasonal variability. Spring and early summer favor upwelling and are characterized by strong winds from the north and northwest. High nutrient concentrations, low oxygen concentrations, low water temperatures, and moderately high salinities are found in the nearshore waters during upwelling periods. During late summer and early fall, the California Current moves closer to shore and brings lower nutrient concentrations, high temperatures, and moderate salinities to the nearshore environment. During the winter months, strong south and southwest winds favor downwelling (the Davidson Current). Unlike upwelling periods, downwelling periods decrease biological productivity. During El Niño years, enhanced southwest winds cause more intense coastal downwelling (Strub et al. 1991; Barnhart et al. 1992; Largier et al. 1993).

The following paragraphs provide a general overview of important geographic and ecological features of the region, generally described from north to south. More specific information is provided in the habitat descriptions in chapter 3.

The Del Norte coast at the north end of the study region is characterized by a relatively narrow shelf and a rocky coastline. The Smith River, the largest river system in California that flows freely along its entire course, meets the ocean five miles south of the Oregon border (Quinones and Mulligan 2005). Castle Rock (also referred to as Castle Island) is located 0.5 miles offshore from Crescent

City in Del Norte County. The coastal rock covers approximately 14 acres and rises steeply 335 feet above sea level. Castle Rock is an important refuge for marine mammals and nesting birds. It is the second largest nesting seabird colony south of Alaska (after the Farallon Islands), and it has the largest population of Common Murres in California (Jacques 2007). The Klamath River, another major river system in Del Norte County, enters the ocean 14 miles south of Crescent City.

Humboldt Bay, located in Humboldt County, is the second largest estuary in California and the only deep water port between San Francisco, California and Coos Bay, Oregon. Humboldt Bay is approximately 14 miles long and 4.5 miles wide at its widest point and is characterized by eelgrass beds, tidal flats, salt marshes, and extensive mud flats interlaced with drainage channels. Approximately 40% of the known eelgrass in the state occurs in Humboldt Bay (Schlosser et al. 2009). The largest commercial fishery in the bay is growing and harvesting oysters (Barnhart et al. 1992). More than 60% of the oysters sold in California are grown in Humboldt Bay (Schlosser et al. 2009). At least 110 species of fish have been reported from Humboldt Bay, including many commercially important species that spawn within the bay and several species of salmonids that spawn in the tributaries (Gotshall 1980; Barnhart et al. 1992). At least six fish species listed as threatened or endangered inhabit Humboldt Bay and its tributaries, including Coho salmon, Chinook salmon, steelhead, longfin smelt, and the tidewater goby (Emmett et al. 1991; Moyle et al. 1995; DFG 2009). Humboldt Bay also acts as an important nursery ground to invertebrates and fish (Barnhart et al. 1992) and provides important habitat for marine mammals. The estuary also is an important unit in the Pacific Flyway and supports numerous migrating waterfowl and shorebird species.

Cape Mendocino is located in southern Humboldt County and has been described as a transition zone between distinctive wind regimes north and south of Cape Mendocino. To the south, the dominant upwelling season occurs earlier and lasts longer. To the north, the upwelling season occurs later and is shorter, but the storm season lasts longer and exhibits the strongest wind forcing on the California coast (Largier et al. 1993). Cape Mendocino is the westernmost point on the coast of California, and it is one of the most seismically active regions in the contiguous United States. Offshore from Cape Mendocino is the Mendocino Triple Junction, a geologic feature occurring where three tectonic plates come together (Pacific Plate, North American Plate, and Gorda Plate). The San Andreas Fault runs south from the junction, separating the Pacific Plate from the North American Plate (USGS 2007).

The Mendocino coast is characterized by a narrow shelf and rocky cliffs. The Eel River, the third largest watershed in California, has the highest recorded average sediment yield per drainage area of any river of its size or larger in the contiguous United States. The Mediterranean climate and heavy annual precipitation of the area are conducive to the production of high sediment yields; the mass movement of sediment is accelerated by human influences on surface erosion through grazing, timber harvesting, and road building (Wolman et al. 1990). The continental shelf near the Eel River is flat and featureless due to sediments deposited by the Eel River to the south and the Mad River to the north (Goff et al. 1999). The Eel River is one of California’s most important spawning streams for listed Coho salmon, Chinook salmon, coastal cutthroat trout, and steelhead. The estuary also supports a variety of commercially important species, such as Dungeness crab, surf smelt (mostly juveniles), northern anchovy, Pacific herring, and several flatfish species (Monroe et al. 1974, Emmett et al. 1991).

Although the study region boundary ends at the political border between the states of California and Oregon, neighboring MPAs in southern Oregon could potentially provide habitat for species frequenting the waters of both states, and could supply recruits to MPAs established in the north coast study region. There are four existing MPAs in Oregon state waters from the state border to the Cape Arago area. All four are smaller than the SAT’s preferred size guidelines, and three of them

only provide protection to the intertidal zone. In addition to the existing MPAs, Oregon is currently undergoing an MPA development process to implement a new set of marine reserves.

The north coast study region abuts three coastal California counties: Del Norte, Humboldt, and Mendocino. Unlike the other MLPA study regions, the north coast study region does not support large numbers of people or extensive development. The marine resources of the region support commercial and recreational fisheries, including oysters, flatfish, rockfish, albacore, crab, and salmon. A variety of non-consumptive activities also are supported within the study region including swimming, diving, surfing, beach-going, kayaking, and a number of shore- and ship-based wildlife viewing activities.

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3 Ecological Setting

The MLPA North Coast Study Region includes unique ecosystems and encompasses habitats and species that are important for regional marine biodiversity, sustainable resource use and natural heritage. Diversity in floral and faunal assemblages reflects the variety of habitats in the region. This regional profile has drawn from many sources of information describing these characteristics, which can serve as further references. Online data resources and interactive maps are available that may serve as additional references. For example, Humboldt State University maintains the North Coast Marine Information system, which is available online at http://www.humboldt.edu/~ncalmis/database.html#link. This database compiles scientific papers pertaining specifically to the north coast region. Additionally, Reef Check California recently released an interactive map service where a database of information regarding both species and habitat can be viewed. This tool is available online at http://ned.reefcheck.org. Additional information regarding other research programs and online information can be found in chapter 6 of this document.

3.1 Marine Habitats and Communities

This section describes the diverse marine habitats that occur within the MLPA north coast study region. The MLPA specifically mentions the following habitats in reference to their inclusion in California's system of MPAs: intertidal zones, rocky reefs, sandy or soft ocean bottoms, kelp forests, submarine canyons, seagrass beds, underwater pinnacles, and seamounts. In the earlier stages of the MLPA Initiative process, the MLPA Master Plan Science Advisory Team (SAT) recommended further consideration of specific depth zones, estuaries, upwelling areas, retention areas, and freshwater plumes from coastal rivers, and different geologic substrata as additional habitats for MPA siting (DFG 2008a). These habitats, as identified within the MLPA and by the SAT, vary in their abundance along the California coastline. One habitat identified in the MLPA, seamounts, does not occur within state waters. Other habitats, such as pinnacles, are not well mapped. This document provides the best readily available information about each of these habitats, so that they can be considered in MPA planning. The MLPA requires that MPAs—specifically state marine reserves (SMRs)—in each of California's two biogeographic regions encompass a representative variety of marine habitats and communities across a range of depths and environmental conditions (section 2857(c) of the MLPA).

The SAT considers habitats present in the north coast study region and compares them to those outlined in the MLPA as well as previous study regions. The SAT then estimates the relative abundance and geographic distribution of habitats, and provides guidance for MPA design based on the specific attributes of the study region. Currently, the SAT is developing a list of key and unique habitats for the north coast study region, and has produced a description of and further information on those key habitats, including several habitats not considered in previous MLPA study regions. Additional guidelines for consideration of marine habitats in MPA planning will be developed by the SAT.

Regional habitats are described below and spatial data on the distribution of most habitats has been provided, to the extent possible given readily available information, and is available in the *Habitat and Species Atlas*. Table 3.1-1 provides a summary of the amount of each habitat in the study region, the biogeographic region, and California state waters (California-Oregon border to the U.S.-Mexico border, excluding San Francisco Bay). This summary shows the relative abundance of different habitats within the study region, as well as the contribution of the study region to the total amount of each habitat in the biogeographic region and state. Note that coastal habitats change over time due to human manipulation, erosion, currents, climate change, and rising sea level and Table 3.1-1 provides data on the current distribution of habitats.

During the north coast study region process, the SAT considers biogeographic patterns and will identify any smaller biogeographic subregions, referred to as bioregions, for the purpose of evaluating MPA proposals. Identification of the bioregions is based on a number of factors, including underlying geology, oceanographic patterns, and species distributions.

Table 3.1-1: Habitats within the north coast study region, biogeographic region, and state

Habitat	Amount in Study Region	% of Study Region	Amount in Biogeographic region	% of Biogeographic region Area	Amount in State Waters	% of State Waters Area	GIS Data Source / Comments
Total Area (mi^2)	1026.5	N/A	2891.0		5549.7		GIS analysis
Total Shoreline (Length, mi)	366	N/A	1604.3		2826.5		NOAA ESI[a]
Shoreline[b] Habitats (Length, mi)							
Intertidal: Rocky Shores	88	24.0%	620.6	38.7%	944.0	33.4%	NOAA ESI
Intertidal: Sandy Beaches	131	35.8%	787.0	49.1%	1293.5	45.8%	NOAA ESI
Intertidal: Coastal Marsh	80	21.9%	246.0	15.3%	320.3	11.3%	NOAA ESI
Intertidal: Tidal Flats	51	13.9%	239.9	15.0%	280.3	9.9%	NOAA ESI
Hard- and Soft-bottom Habitats[c] and Canyon (Area, mi^2)							
Total Hard- and Soft-Bottom Canyon Habitat	7.59	<1%	3824.8		6947.0		Moss Landing Marine Labs
Rocky Habitat 0-30 meters	12.68	1.2%	155.9	5.4%	209.1	3.8%	CSUMB, Fugro Pelagos
Rocky Habitat 30-100 meters	4.67	<1%	121.3	4.2%	233.7	4.2%	CSUMB, Fugro Pelagos
Rocky Habitat 100-200 meters	.24	<1%	18.4	<1%	139.3	2.5%	CSUMB, Fugro Pelagos
Rocky Habitat >200 meters	0	0%	21.5	<1%	144.2	2.6%	CSUMB, Fugro Pelagos
Total Rocky Habitat (all depths)	17.59	1.7%	317.0	11.0%	726.2	13.1%	CSUMB, Fugro Pelagos
Soft Bottom Habitat 0-30 meters	215.65	21.0%	1299.7	45.0%	2023.3	36.5%	CSUMB, Fugro Pelagos
Soft Bottom Habitat 30-100 meters	151.97	14.8%	1876.1	64.9	3033.7	54.7	CSUMB, Fugro Pelagos
Soft Bottom Habitat 100-200 meters	9.79	<1%	181.6	6.3%	385.4	6.9%	CSUMB, Fugro Pelagos
Soft Bottom Habitat >200 meters	0	0%	145.5	5.0%	593.7	10.7%	CSUMB, Fugro Pelagos
Total Soft Bottom Habitat (all depths)	377.42	36.8%	3502.9	121.2	6036.1	108.8%	CSUMB, Fugro Pelagos
Unknown Bottom Habitat 0-30 meters	268.71	26.17%	N/A	N/A	N/A	N/A	CSUMB, Fugro Pelagos
Unknown Bottom Habitat 30-100 meters	297.79	29.01%	N/A	N/A	N/A	N/A	CSUMB, Fugro Pelagos

Habitat	Amount in Study Region	% of Study Region	Amount in Biogeographic region	% of Biogeographic region Area	Amount in State Waters	% of State Waters Area	GIS Data Source / Comments
Unknown Bottom Habitat 100-200 meters	59.93	5.84%	N/A	N/A	N/A	N/A	CSUMB, Fugro Pelagos
Unknown Bottom Habitat >200 meters	4.71	<1%	N/A	N/A	N/A	N/A	CSUMB, Fugro Pelagos
Total Unknown Bottom Habitat (all depths)	631.14	61.48%	N/A	N/A	N/A	N/A	CSUMB, Fugro Pelagos
Estuarine and Nearshore Habitats (Area, mi^2)							
Kelp 2005 [d]	.08	<1%	10.6	<1%	42.2	<1%	DFG 2005 aerial survey
Kelp 2004	.60	<1%	14.3	<1%	45.5	<1%	DFG 2004 aerial survey
Kelp 2003	.16	<1%	14.4	<1%	49.3	<1%	DFG 2003 aerial survey
Kelp 2002	.40	<1%	19.5	<1%	36.6	<1%	DFG 2002 aerial survey
Kelp 1999	1.49	<1%	8.6	<1%	23.0	<1%	DFG 1999 aerial survey
Kelp 1989	2.30	<1%	31.4	1.1%	53.6	1.0%	CFG 1989 aerial survey
Estuary	38.96	3.8%	93.4	3.2%	148.5	2.7%	National Wetlands Inventory
Seagrass: Eelgrass	6.06	<1%	17.9	<1%	41.7	<1%	DFG

Notes: The data presented here are preliminary; comprehensive fine-scale data will be presented in the revised version of this report.

[a] *National Oceanographic and Atmospheric Administration's Environmental Sensitivity Index*

[b] *Shoreline percentages may add up to more than 100% since more than one type can be present in a given location.*

[c] *Data for hard- and soft-bottom habitats is preliminary and contains portions of the study region that are unmapped, which are characterized as "unknown" in this table. Fine scale data for the study region have been collected and will be available in the revised regional profile.*

[d] *2006 Kelp data not collected. 2008 Kelp data will be available soon.*

3.1.1 Depth Categories

Based on information about the depth distributions of fish in California (Allen et al. 2006), the SAT has recommended considering habitats as they are represented in the depth zones identified in Table 3.1-2

Table 3.1-2: Depth zones identified by the MLPA Master Plan Science Advisory Team

Meters (m)	Fathoms (fm)	Feet (ft)
intertidal	intertidal	intertidal
intertidal to 30 m	intertidal to 16 fm	intertidal to 98 ft
30 m to 100 m	16 fm to 55 fm	98 ft to 328 ft

Meters (m)	Fathoms (fm)	Feet (ft)
100 m to 200 m	55 fm to 109 fm	328 ft to 656 ft
greater than 200 m	greater than 109 fm	greater than 656 ft

Note: All depth figures above and throughout this document have been converted from the SAT guidelines, which are provided in meters. The above numbers have been converted from meters and are rounded to the nearest whole number. For reference, 1.00 m = 0.55 fm = 3.28 ft.

The intertidal zone includes habitats such as sandy beaches, rocky shores, tidal flats, and coastal marsh that are subject to periodic tidal inundation. The 0-30-meter depth zone is considered the euphotic zone where light penetrates to support photosynthetic activity. Below 30 meters, light penetration diminishes and different assemblages of species occur. The depth zone from 100-200 meters is the approximate depth of the shelf-slope break, which is an area of high diversity characterized by both shelf and slope assemblages. At 200 meters and below, the continental slope drops down to the abyssal plain where deep-sea communities occur.

Several of the habitats mentioned in the MLPA occur in only one depth zone, while others may occur in several depth zones. The areas of each subtidal depth range within the study region are provided in Table 3.1-3 and are based on DFG (2008) delineation of depth zones using Geophysical Data System 91meter resolution data. Most of the north coast study region is less than 100 meters in depth.

Table 3.1-3: Depth zones as percent of north coast study region

Depth Zone	Area (mi^2)	Percentage of Study Region
Intertidal to 200 m (0-16 fm)	497.04	48.42%
30 to 100 m (16-55 fm)	454.43	44.27%
100 to 200 m (55 to 109 fm)	69.96	6.81%
200 m and deeper (109 fm and deeper)	4.71	0.46%

3.1.2 Intertidal Zones

The shoreline represents a transition zone between the marine and terrestrial environments and includes many important intertidal ecosystems and communities. Intertidal zones that have been mapped as linear features along the coastline include rocky shores, sandy beaches, tidal flats, coastal marsh along the shores of estuaries and lagoons, and man-made structures such as jetties and seawalls (refer to *Habitat and Species Atlas* for maps). Table 3.1-4 is a summary of the linear length and percentage of total shoreline (approximately 366 miles as measured following the contours of the coastline) for each shore type in the study region based on data from NOAA ESI. The study region is dominated by sandy beaches, followed by salt marshes, sheltered tidal flats, and exposed wave-cut platforms in bedrock, in that order.

Table 3.1-4: Summary of the amount of shoreline habitats in north coast study region

Shore Type	Length in Study Region (mi)	Percentage of Total Shoreline in Study Region
Exposed rocky cliffs	26.37	7.2%
Wave cut rocky platforms	1.54	<1.0%
Exposed wave-cut platforms in bedrock	58.59	16.0%

Shore Type	Length in Study Region (mi)	Percentage of Total Shoreline in Study Region
Sheltered rocky shores	1.80	<1.0%
Fine to medium grained sand beaches	92.67	25.3%
Coarse-grained sand to granule beaches	28.44	7.8%
Mixed sand and gravel beaches	21.73	5.9%
Gravel beaches	13.29	3.6%
Salt marshes	80.20	21.9%
Exposed tidal flats	14.48	4.0%
Sheltered tidal flats	68.23	18.6%
Sheltered man-made structures	6.34	1.7%
Exposed seawall (man-made)	0.05	<1.0%
Riprap (man-made)	21.10	5.8%
Total shoreline length in study region [a]	366.07	100.0%

[a] *Due to overlap of features, totals for each shore habitat type do not sum to the actual shoreline length in the study region*

Rocky Shores

Rocky shore habitats and their associated ecological assemblages make up just under one quarter of the shoreline of the north coast study region (not including man-made hardened shore). Rocky shores are relatively common throughout the study region and include headlands and points such as Point Saint George, Patrick's Point, Trinidad Head, Cape Mendocino, Punta Gorda, and Mendocino headlands, as well as much of the coast at Fort Bragg. Exposed wave-cut platforms are the most common rocky shore type in the study region and are described below.

Rocky intertidal communities, from the splash zone to the lower intertidal, vary in composition and structure with tidal height and wave exposure (Ricketts et al. 1985) and with underlying geology (Foster et al. 1988). Beds of mussels (*Mytilus* spp.), surfgrass (*Phyllospadix* spp.), and algal assemblages from turfs (*Endocladia muricata*, etc.) to low canopies of leathery kelps (*Pterygophora californica, Postelsia palmaeformis*) are distributed in patches throughout the rocky shoreline of the north coast study region. The structure created by these beds, turfs and canopies provides suitable settlement substrate for many larval and juvenile intertidal organisms. Such structure is sometimes referred to as "biogenic habitat".

In addition, intertidal boulders, platforms and cliffs, as well as tidepools, are home to many species of snails, barnacles, anemones, crabs, sea stars, and fishes. Also, rocky shores in the north coast study region provide important rookery/haulout sites for pinnipeds, including harbor seals, California sea lions and Steller sea lions.

The following rocky shore types have been mapped in the north coast study region by NOAA for the Environmental Sensitivity Index program (2006) (Table 3.1-4).

Exposed rocky cliff: Steep intertidal zone (greater than 30 degrees slope) with little width and little sediment accumulation. Strong vertical zonation of intertidal communities. Over one quarter of the rocky shore in the study region is this type.

Wave-cut rocky platform: Includes flat rocky bench of variable width with irregular surface and tidepools. Shore may be backed by scarp or bluff with sediments or boulders at base. Some

sediment accumulation in pools or crevices. May support rich tidepool and intertidal communities. Over half of the rocky shore in the study region is wave-cut platform.

Sheltered rocky shore: Bedrock shores of variable slope (cliffs to ledges) sheltered from wave exposure. These make up roughly two percent of the rocky shore in the study region

Sandy Beaches

Over one third of the shoreline within the north coast study region is sandy beach. Sandy beach communities are structured in large part by grain size, slope of the beach, and wave energy. Fine-to medium-grained sand beaches are the most common type in the study area, while gravel beaches are the least common type (Table 3.1-4).

Beaches are dynamic systems, changing with wind and wave action. Generally, sand is eroded from beaches in the winter and redeposited in the summer, resulting in annual changes in beach slope and width. Seasonal fluctuations in sand abundance are affected by the development of hardened shores and sand-retention structures.

Beach sand and the wracks of decaying seaweed and other detritus support a variety of invertebrate animals. Snails, bivalves, crustaceans, insects, spiders, isopods, amphipods and polychaetes are among the organisms that inhabit sandy beaches, and several of these provide nourishment for larger vertebrate animals, including coastal populations of the Western Snowy Plover. Many other species, including pinniped mammals, use sandy beaches for resting and rearing young.

Beach types in the north coast study region have been mapped as linear shoreline features and classified based on grain size:

Fine to medium-grained sand beach: Flat, wide and hard-packed beach that experiences significant seasonal changes in width and slope. Upper beach fauna scarce; lower beach fauna include sand crabs. These beaches make up roughly one quarter of the study region.

Coarse-grained sand beach: Moderate to steep beach of variable width with soft sediments; may be backed by dunes or cliffs; fauna scarce. Often located near river mouths and estuaries, this beach type makes up 7.8% of the study region.

Mixed sand and gravel beach: Moderately sloping beach with a mix of sand and gravel; may be zones of pure sand, pebbles or cobbles. Sand fraction may get transported offshore in winter. More stable substrata support algae, mussels and barnacles. These beaches make up 5.9% of the study region.

Gravel Beach: Beaches composed of sediments ranging from pebbles to boulders; often steep with wave-built berms. Attached algae, mussels and barnacles are present on lower stable substrata. This beach type makes up 3.6% of the study region.

Coastal Marsh and Tidal Flats

Coastal marshes support high levels of productivity and provide habitat for many species. Marshes also regulate the amount of fresh water, nutrient and sediment inputs into the estuaries and play an important role in filtration for estuarine water quality. The positions of marshes throughout the north coast study region along estuarine margins make them essential for stabilizing shorelines and storing floodwaters during coastal storms. Vegetation patterns and dominant species in coastal brackish marshes vary with salinity regime, which is defined by precipitation patterns and changes in freshwater inputs.

Tidal flats occur in the study region associated with coastal rivers as well as bays and estuaries, including the Smith River mouth, Mad River, Humboldt Bay, the Eel River estuary, and the Mattole River mouth. These areas provide essential foraging grounds for migratory bird species in their abundance of invertebrates, including clams, snails, crabs, worms and the burrowing ghost shrimp (*Neotrypaea californiensis*), as well as eelgrass (*Zostera* spp.). Eelgrass also provides substrate for juvenile fish species (e.g. *Sebastes* spp.) and Dungeness crab (*Cancer magister*), among other species.

The following shoreline types have been mapped as linear features of the coastline:

Salt marshes: Includes intertidal areas with emergent salt marsh vegetation. The width of marsh varies from a narrow fringe to extensive areas and provides important habitat for a variety of species. Salt marshes occur throughout study region, Mad River Slough (in north Humboldt Bay) being a prominent example of this shoreline type.

Exposed tidal flats: Includes intertidal flats composed of sand and mud. The presence of some wave exposure generally results in a higher presence of sand than in sheltered tidal flats; occurs in bays and lower sections of rivers. Sediments in tidal flats are generally water-saturated with the presence of infaunal community that attracts foraging shorebirds. Used as roosting sites for birds. The Entrance Bay portion of Humboldt Bay and the lower Eel River Estuary are examples of this shoreline type.

Sheltered tidal flats: Includes intertidal flats comprised of silt and clay (e.g. mudflats). Present in calm water habitats that are sheltered from wave exposure and frequently bordered by salt marsh. Soft sediments support large populations of worms, clams and snails; important foraging area for shorebirds. Extensive mudflats occur in north and south Humboldt Bay, as well as the Eel River Estuary.

Hardened (man-made) Shorelines

Jetties, seawalls and other man-made structures make up just over five percent of the shoreline in the north coast study region. Shorelines around major ports and harbors, especially Crescent City harbor, Humboldt Bay, and the Noyo River mouth, tend to be dominated by man-made shorelines.

3.1.3 Estuaries and Lagoons

Estuaries form at the mouths of rivers and streams where freshwater and saltwater meet. Specific characteristics of estuaries vary based on salinity. This salinity may change seasonally and over longer timeframes depending on freshwater inputs and creation or removal of barriers between the estuary and the open coast. Two kinds of estuaries exist within the north coast study region: bodies of water that are permanently or semi-permanently open to the ocean and bodies of water that are seasonally separated from the sea by sand bars. The latter of these types, known as “bar-built estuaries,” generally have a low level of freshwater inputs and are referred to as “lagoons” in this document. Estuaries in the north coast study region contain open water and soft-bottom habitats, coastal marsh and tidal flats (described in section 3.1.2), and eelgrass beds in some estuaries (described in section 3.1.4).

Within estuaries and lagoons, the shoreward boundary of the north coast study region was determined by evaluating the extent and presence of mapped salt marsh or brackish vegetation, presence of saltwater species, the known extent of tidal influence, and jurisdictional boundaries. Data sources include: the NOAA Environmental Sensitivity Index (NOAA-ESI), the National Wetlands Inventory, Digital Globe 1.0 m satellite color imagery, and expert knowledge from DFG biologists. This information was used to determine which estuaries and lagoons were included in the

north coast study region for consideration within the MLPA Initiative process. In general, lagoons and estuaries that are open, at least periodically, and are characterized by estuarine vegetation and tidal influence were included in the study region. Lagoons that are rarely open and characterized by more freshwater species were not included. Small coastal streams and rivers that empty directly into the Pacific Ocean also were not included within the study region.

A number of estuaries and lagoons occur along the approximately 225-mile coastline of the north coast study region. The study region contains at least a portion of 22 estuaries and lagoons in the north coast study region, 16 of which are greater than 0.5 square miles in area. Humboldt Bay is the largest estuary in the north coast study region and second largest estuary in California. Other relatively large estuaries or lagoons include the Eel River estuary, Lake Earl, Big Lagoon, and the Klamath River estuary. The estuaries that are greater than 0.5 square miles are described in more detail below. Some of the estuaries and lagoons are seasonally closed to tidal influence by sand bars. For example, in northern Humboldt County, pocket beaches and partially closed lagoons and estuaries are commonly interspersed between steep, rocky headlands and mountain slopes and meadows (Kraus et al. 2002). There is one particularly large stretch of the coastline along the north coast study region does not contain any estuaries or lagoons greater than 0.5 square miles, which is the approximately 65 mile stretch of coast between the Mattole River and Ten Mile River estuaries. Other notable gaps without an estuary or lagoon greater than 0.5 square miles include at least 15 miles of coastline both north and south of the Klamath River estuary, and between the Navarro River and Alder Creek estuaries. The aerial extent of estuaries in the entire north coast study region totals 43.0 square miles. The maps of coastal estuaries represent a composite from multiple sources, including the National Wetlands Inventory, California Natural Diversity Database, NOAA-ESI, and topographic maps.

Estuaries and lagoons are productive coastal ecosystems that play a key role as nursery habitat for many coastal invertebrates and fishes and serve as roosting and foraging sites for shorebirds and seabirds. Estuarine areas in northern California experience relatively high levels of annual rainfall and large freshwater inputs (e.g. Klamath River, Mad River, Eel River), and therefore generally include freshwater and anadromous species. The most abundant marine species in northern California estuaries are northern anchovy and threespine stickleback, and north coast estuaries may be dominated seasonally by anadromous or otherwise euryhaline species, such as salmon and trout, smelt species, cods, and herrings (Emmett et al. 1991; Allen et al. 2006). Other species that spend most of their lives in northern California estuaries include bay pipefish, Pacific staghorn sculpin, and several goby species. Marine migrant species that utilize estuaries seasonally, or for part of their life cycle, include pelagic species, particularly Pacific herring, silversides (jacksmelt and topsmelt), and shiner perch, as well as more benthic starry flounder and English sole (Emmett et al. 1991; Allen et al. 2006). Some estuaries also host species of concern other than salmonids, such as the federally endangered tidewater goby and longfin smelt.

Coastal bays and estuaries in the region, particularly Humboldt Bay, are an important part of the Pacific Flyway and host thousands of shorebirds and waterfowl on their migrations (Monroe et al. 1975; Barnhart et al. 1992; Colwell 1994; Moore et al. 2004). For example, Western Snowy Plover use many north coast locations as breeding and wintering sites, including near the mouths of the Smith River, Stone Lagoon, Big Lagoon, Little River (Clam Beach), Mad River, Humboldt Bay, Eel River, and Ten Mile River (MacKerricker Beach) (USFWS 2007a). At least six species of marine mammals, including harbor seal, California sea lion, Stellar sea lion, common dolphin, bottle-nosed dolphin, and harbor porpoise, are also known to inhabit north coast estuaries or ocean waters near the mouths at least seasonally (Monroe et al. 1975, Barnhart et al. 1992)

Since estuarine areas provide important habitat linkages between marine, aquatic and terrestrial habitats, their condition is closely tied to the condition of the surrounding watershed. Estuaries provide critical ecosystem services such as filtering sediments and nutrients from the watershed,

stabilizing shorelines, and providing flood and storm protection. Further information on the condition of northern California watersheds is included in section 4.2. Estuaries also are utilized for many recreational activities such as fishing, boating, kayaking, wildlife viewing, and interpretation/education activities (further information can be found in sections 5.6 and 5.8).

Following is a brief description of some of the major estuaries and lagoons within the study region (from north to south):

Smith River Estuary (including Tillas Slough): The Smith River is the northernmost river along the California coast and the largest undammed, free-flowing river that empties directly into the Pacific Ocean (Waldvogel 2006). The Smith River estuary supports at least 28 fish species, including listed salmonid species (Coho, Chinook, chum, steelhead, and coastal cutthroat trout), green sturgeon, and the federally endangered tidewater goby; the estuary also serves as a nursery area for Dungeness crabs (Monroe et al. 1975; McCain et al. 1995). Over 30 species of shorebirds, seven species of wading birds, and at least 24 species of waterfowl are known to use the Smith River and Lake Earl estuaries (Monroe et al. 1975, LeValley et al. 2004). Several marine mammals, including harbor seals, California sea lions, and Stellar sea lions, sometimes inhabit the estuary but occur more commonly in ocean waters near the estuary mouth (Monroe et al. 1975). As with many other river estuaries in California, the Smith River estuary has been reduced greatly in terms of size and available habitat from historical levels, largely attributed to increased sedimentation due to activities such as logging and construction, as well as drainage and diking (Monroe et al. 1975). Current restoration work in the coastal area of the Smith River, which aims to create habitat for salmonids in particular, is underway (the Smith River Estuary Restoration Project).

Lake Earl: Lake Earl, which includes Lake Talawa (Tolowa) because the two water bodies are often connected, is the largest coastal lagoon (not a lake as the name implies) in California, and was originally part of the Smith River drainage. Lake Earl is located about 2 miles north of Crescent City and 11 miles south of the California-Oregon border. All of Lake Earl and most of Lake Talawa is managed by the DFG as the Lake Earl Wildlife Area (LEWA); the other portion of Lake Talawa not owned by the DFG is leased from the California State Lands Commission, while lands along the western border of the Lake Earl Wildlife Area are owned by the California Department of Parks and Recreation (State Parks). Water level and quality depend on breaching of the barrier beach, which occurs both naturally and manually. For example, Lake Earl breached naturally at a water depth of approximately 10 feet in May, 2005, and at 9.5 feet in May, 2006 (Kraus et al. 2008). Artificial breaching has occurred for at least 75 years to some extent at several times a year during the fall and winter months to lower water levels, increase lands available for livestock grazing, and prevent flooding of neighboring private property. Water depths typically fluctuate from four to five feet during the summer to over ten feet during the winter prior to mechanical breaching (Tetra Tech 2000). Manual breaching may occur anytime between late fall and mid-February. Lake Earl supports at least 15 fish species, including several listed salmonid species (Coho, steelhead, coastal cutthroat trout) and the largest known population of the federally endangered tidewater goby (Monroe et al. 1975; DFG 2004). Green sturgeon also has been reported from Lake Earl (Monroe et al. 1975; Moyle et al. 1989). After artificial breaching events, documented common marine species that enter the lagoon include primarily shiner surfperch, Pacific herring, starry flounder, and sculpins (ARS 2009). Lake Earl is also an important area for waterfowl and shorebirds, including special-status species, including California Brown Pelican, Western Snowy Plover and Bald Eagle, as well as the federally threatened Oregon silverspot butterfly (DFG 2004b).

Klamath River Estuary: The estuary near the mouth of the Klamath River is located about 19 miles south of Crescent City. The estuary includes the lower Klamath River floodplain and associated wetland complexes. The Klamath River is the second largest river by volume in California. The Klamath River estuary is extremely important to many anadromous fishes, some of which are listed species, including Coho salmon, Chinook salmon, steelhead, coastal cutthroat trout, eulachon, and

both green and white sturgeon (Emmett et al. 1991; Moyle et al. 1995; Borgeld et al. 2006). Longfin smelt also are reported to inhabit the Klamath River estuary (DFG 2009b). The estuary supports a variety of other commercially important marine species, such as Dungeness crabs, Pacific herring, surf smelt, northern anchovy, and several flatfish species (Emmett et al. 1991). Harbor seals, Stellar sea lions and, to a lesser extent, California sea lions, sometimes inhabit the estuary but more commonly occur in the ocean waters near the mouth. The Klamath River estuary is also important to a variety of shorebirds and waterfowl. Several thousand birds are present during peak population periods from August through May (LeValley et al. 2004). The Klamath River is identified as an impaired water body because of nutrient enrichment, temperature, and pollutant concerns (CCC 2006).

Redwood Creek Estuary: The Redwood Creek estuary is located in northern Humboldt County about eight miles south of the Humboldt-Del Norte County border, near the town of Orick. The mouth is open to the ocean most of the year, but typically closes at the end of the summer when rainfall and river flow are low (Kraus et al. 2008). The majority of the lower Redwood Creek is located within the Redwood National and State Parks. The estuary supports many fish species, including four listed species of salmonids (Coho, Chinook, steelhead, and coastal cutthroat trout), starry flounder, surfperch, and tidewater goby (LeValley et al. 2004; Borgeld et al. 2006). Harbor seals and, to a lesser extent, California sea lions, sometimes inhabit the estuary but occur more commonly in the ocean waters near the mouth. Both shorebirds and waterfowl also use adjacent wet pasture areas, (LeValley et al. 2004). Redwood Creek is identified as an impaired water body in California due to excess sediment load and elevated water temperatures (CCC 2006).

Stone Lagoon: Stone Lagoon is located along Highway 101 and is part of the Humboldt Lagoons State Park along with three other lagoons including Freshwater Lagoon, Dry Lagoon, and Big Lagoon. All four lagoons are isolated from the Pacific Ocean by sand barriers, except that Stone Lagoon and Big Lagoon breach naturally and are marine-influenced typically for a portion of the year. The barrier dune that forms at the mouth of Stone Lagoon is reported to breach naturally every several years, while Big Lagoon breaches naturally nearly annually and persists longer due to its greater drainage area fed by more streams. Both Stone Lagoon and Big Lagoon are susceptible to breach during or near the end of the rainy season, between October and April (Kraus et al. 2002). Only one perennial stream (McDonald Creek) drains into Stone Lagoon. The lagoon supports several listed salmonid species and is listed as critical habitat for the tidewater goby (USFWS 2008). This area also supports significant numbers of waterfowl and other water-associated birds from fall to spring (LeValley et al. 2004).

Big Lagoon: Big Lagoon is a large lagoon located in northern Humboldt County, encompassing about 2.5 square miles in area. Highway 101 runs through the lagoon. Big Lagoon breaches naturally, nearly on an annual basis (Kraus et al. 2002). When the sandbar is closed, the lagoon is fed mostly by Maple Creek which is the main tributary. Big Lagoon and its tributaries support four listed salmonid species, including Coho, Chinook, steelhead, and coastal cutthroat trout (LeValley et al. 2004). The lagoon also is listed as critical habitat for the tidewater goby (USFWS 2008). Sago pondweed and Wigeon grass form dense submergent stands in some areas. In addition, Big Lagoon attracts thousands of waterfowl, shorebirds, and many other water-associated bids according to a 1990-1991 survey, which documented more than 360,000 annual bird-days use (LeValley et al. 2004).

Little River Estuary: Little River is a small coastal drainage that enters the Pacific Ocean about 6 miles north of the Mad River. The Little River estuary supports runs of several listed salmonids, including Coho, Chinook, steelhead, and coastal cutthroat trout. Seasonal flooding of the pasturelands also provides habitat for moderate numbers of waterfowl and shorebirds (LeValley et al. 2004). Western Snowy Plovers regularly nest at Clam Beach, which is located immediately south

and connected to Little River estuary (Colwell et al. 2005). Harbor seals sometimes inhabit the estuary but occur more commonly in the ocean waters near the mouth.

Mad River Estuary: The Mad River enters the Pacific Ocean just north of Arcata and approximately 13 miles north of the entrance to Humboldt Bay. The Mad River estuary supports listed salmonid species (Coho, Chinook, and steelhead) and shellfish harvesting. In addition, expansive pasturelands lying to the south of the river provide significant habitat for many water-associated birds when shallow flooding occurs during the rainy season. These pasturelands are contiguous with similar habitats near Mad River Slough and Humboldt Bay and attract thousands of waterfowl and shorebirds. They also are important hunting areas for egrets, herons, and the listed Peregrine Falcon (LeValley et al. 2004). The mouth of the Mad River is also an important haulout site for harbor seals (Neumann and Schmahl 1999). The Mad River is identified as an impaired water body (CCC 2006).

Humboldt Bay: Humboldt Bay is a marine embayment located along the central coast of Humboldt County. Humboldt Bay is the second-largest estuary in California, after San Francisco Bay, and consists of Arcata (North) Bay at its north end, Central Bay, and South Bay. The Humboldt Bay National Wildlife Refuge is located in South Bay. The bay encompasses an area of nearly 30 square miles and contains a number of diverse habitats, including tidal flats, salt marsh, and eelgrass beds. Approximately 40% of the known eelgrass in the state occurs in Humboldt Bay (Schlosser et al. 2009). Eelgrass beds in South Bay are denser than those of Arcata Bay (Barnhart et al. 1992; Tennant 2006), contain 78%-95% of the total eelgrass biomass in the bay (Harding and Butler 1979), and are recognized as one of the most important locations of eelgrass growth on the entire U.S. west coast (Phillips 1984).

Humboldt Bay is the most economically productive port in the north coast study region, and also is the largest port between San Francisco Bay and Coos Bay in Oregon. In 2000, Humboldt Bay was listed as one of 150 U.S. ports that handled more than one million tons of cargo (USCOP 2004). The largest commercial fishery in the bay is growing and harvesting oysters (Barnhart et al. 1992). More than 60% of the oysters sold in California are grown in Humboldt Bay (Schlosser et al. 2009). At least 110 species of fish have been reported from Humboldt Bay, including many commercially important species that spawn within the bay and several species of salmonids that spawn in the tributaries (Gotshall 1980; Barnhart et al. 1992). At least six fish species listed as threatened or endangered inhabit Humboldt Bay and its tributaries, including Coho salmon, Chinook salmon, steelhead, longfin smelt, and the tidewater goby (Emmett et al. 1991; Moyle et al. 1995; DFG 2009b). Humboldt Bay also serves as an important nursery area for a variety of fish and invertebrate species, including English sole, Pacific herring, lingcod, Dungeness crab, rock crabs, some surfperches, and some rockfishes (Barnhart et al. 1992). Other large fish species, such as bat rays and green sturgeon, can reach high abundances within Humboldt Bay, particularly during the summer months (Moyle et al. 1995; Gray et al. 1997). The bay also supports recreationally important bivalve species, particularly in South Bay, including gaper clams, Washington calms, and littleneck clams. DFG annual creel census surveys conducted from 1975 to 1989 reported annual effort and catch estimates as high as 6,639 diggers extracting 188,000 clams in 1982 (Collier 1992). A resumption of that study in 2008 showed sport clamming effort has decreased to an estimated 1,300 diggers extracting a total of 31,189 clams (Brooke McVeigh, DFG, personal communication).

The coastal areas of Humboldt Bay and Eel River (located approximately five miles south of Humboldt Bay) together are recognized as a site of International Importance for shorebirds by the Western Hemisphere Shorebird Reserve Network. Humboldt Bay supports anywhere from 20,000 to 80,000 shorebirds, depending on the season (Colwell 1994). Breeding Western Snowy Plover are concentrated at a few locations around Humboldt Bay (Colwell et al. 2005). The bay serves as an important wintering site for approximately 24 species of waterfowl, as well (LeValley et al. 2004). Threatened or endangered bird species utilizing the Humboldt Bay ecosystem include Marbled

Murrelet and Western Snowy Plover. Humboldt Bay also is the most important location in California for staging Pacific Black Brant (*Branta bernicla nigricans*) which feeds on eelgrass almost exclusively (Moore et al. 2004; Moore and Black 2006). Introduced populations of Canada Goose also have become established in the Humboldt Bay area in recent years (LeValley et al. 2004).

Harbor seal is the most common marine mammal in Humboldt Bay, and the bay serves as an important haulout and pupping area seasonally. Breeding populations of harbor seals typically reach their peak in late spring and pupping occurs mainly in South Bay (Sullivan 1980; Barnhart et al. 1992). Two other marine mammals, the harbor porpoise and California sea lion, also use the bay and nearshore habitats (Monroe et al. 1973; USFWS and HBNWRC 2009).

Eel River Estuary: The Eel River estuary enters the Pacific Ocean in southern Humboldt County approximately 10 miles south of Humboldt Bay. The Eel River estuary is the second largest estuary or lagoon in the study region, encompassing an area of approximately 5 square miles. The estuary includes several types of habitats, including tidal flats, salt marsh, and eelgrass beds. Much of what once was extensive salt marsh and other intertidal habitat has been converted to farmland by dike construction; however, these areas still function as wetlands when flooded by winter rains. Native eelgrass populations are found within the estuary, and the invasive dwarf eelgrass was reported in the Eel River estuary (McNulty Slough) in 2008 (Kirsten Ramey, DFG, personal communication). The Eel River is one of California's most important spawning streams for listed Coho salmon, Chinook salmon, coastal cutthroat trout, and steelhead. Green sturgeon and longfin smelt also are known to inhabit the estuary (Monroe et al. 1974; Emmett et al. 1991; Moyle et al. 1995; DFG 2009). The estuary also supports a variety of commercially important species, such as Dungeness crab, surf smelt (mostly juveniles), northern anchovy, Pacific herring, and several flatfish species (Monroe et al. 1974; Emmett et al. 1991). The lower estuary consists of a mosaic of bays, tidal flats, sloughs, marshes, and seasonal wetlands and is rich in marine life, including invertebrate species, which provide rich feeding grounds for shorebirds. Census results from 1967 to 1970 (expressed as average total annual bird–use days) are: waterfowl (1,351,960), shorebirds (1,023,825), wading birds (39,420), and other water-associated birds (274,845). Monroe et al. (1974) reported at least 31 species of shorebirds, five species of wading birds, as well as a number of waterfowl species and pelagic and coastal birds in the area. Listed species include Western Snowy Plover, Bald Eagle, Peregrine Falcon, Aleutian Cackling Goose, and tidewater goby. The Eel River estuary is listed as critical habitat for the tidewater goby (USFWS 2008). At least six species of marine mammals are known to visit the estuary, including the harbor seal, Stellar sea lion, California sea lion, common dolphin, bottle-nosed dolphin, and harbor porpoise (Monroe et al. 1974). The Eel River is identified as an impaired water body due to a number of concerns, such as illegal waste disposal and timber harvesting (CCC 2006).

Mattole River Estuary: The Mattole River estuary is located near the town of Petrolia, approximately 40 miles south of Eureka and 15 miles south of Humboldt Bay. It is similar to the nearby Bear River estuary in two ways: virtually all of the lower river is privately owned, and agriculture and logging are the most common land use practices (Monroe et al. 1976; Mattole Restoration Council 1995). Also similar to the Bear River estuary, wetland types are limited and the estuary lacks submerged vegetation. The Mattole River estuary usually is closed by a sandbar a few months of almost every year. The estuary supports several fish species, including three species of listed salmonids (Coho, Chinook, and steelhead) and euryhaline species such as starry flounder. Recreational sport fishing is important in the lower river portion, particularly to local residents. Dungeness crab may also use the estuary although temporary seasonal sandbar closings may restrict their entry. The estuary also supports large numbers of shorebirds (sandpipers, dunlin, Willet, Western Snowy Plover, yellowlegs, godwits, and Killdeer), small numbers of waterfowl, and several species of wading birds such as Great Blue Heron. Other coastal birds that frequent the estuary include kingfishers, grebes, cormorants, loons, pelicans, and a variety of other coastal and pelagic species (Monroe et al. 1976). Several marine mammals, including the California sea lion,

Stellar sea lion, harbor seal, and common dolphin, are common in the adjacent offshore waters but are not known to visit the estuary regularly. The Mattole River is identified as an impaired water body due to excess sediment load and elevated water temperatures (CCC 2006).

Ten Mile River Estuary: The Ten Mile River flows into the Pacific Ocean approximately eight miles north of Fort Bragg and just north of MacKerricher State Park. The neighboring beach, Ten Mile/MacKerricher Beach, is one of the longest stretches of dunes in California, extending from the river mouth south for approximately 4.5 miles. The majority of the watershed is privately owned. The estuary supports three species of listed salmonids (Coho, steelhead, and Chinook, at least occasionally), Pacific lamprey, and surfperch species. Eelgrass has been reported in the Ten Mile River estuary, but is not as well mapped as at other locations such as Humboldt Bay. The estuary is listed as critical habitat for the tidewater goby (USFWS 2008). In addition, Ten Mile River estuary also supports Bald Eagle and nesting sites for Western Snowy Plover and Common Merganser (LeValley et al. 2004).

Noyo River Estuary: The Noyo River estuary is located in northern Mendocino County, entering the Pacific Ocean approximately 2 miles south of Fort Bragg. Eelgrass beds have been reported in the Noyo River estuary, although they are not as well mapped as at other locations such as Humboldt Bay. The Noyo River estuary supports three species of listed salmonids (Coho, steelhead, and Chinook, at least occasionally). The estuary serves as an important nesting location for seabirds, such as cormorant species. The Noyo River is identified as an impaired water body due to habitat alteration and excess sediment and debris (CCC 2006).

Big River Estuary: Big River empties into the Pacific just south of the Mendocino Headlands, approximately 10 miles south of Fort Bragg. The Big River estuary is the largest estuary in Mendocino County, encompassing an area of 0.24 square miles. Unlike some of the other estuaries in Mendocino County, the mouth of the Big River remains connected to the ocean year round. The entire estuary, including extensive mudflats and marsh habitat, covers 1,500 acres and is one of the largest relatively undisturbed estuaries along the California coast (Warrick and Wilcox 1981; LeValley et al. 2004). The Big River estuary provides suitable habitat for eelgrass populations, particularly along the margins of shallow channels. For example, Warrick and Wilcox (1981) reported eelgrass beds from up to 4.8 km (3 mi) upriver. The estuary supports several anadromous species, including three species of listed salmonids (Coho, steelhead, and Chinook at least occasionally) and eulachon. Other commercially important species occurring in the Big River estuary include Dungeness crab, Pacific herring, surfperch species, and several flatfish species (Warrick and Wilcox 1981). The estuary also provides habitat for geese, ducks, and Bald Eagle (LeValley et al. 2004). The Big River is identified as an impaired water body due to concerns related to sedimentation and temperature (CCC 2006).

Albion River Estuary: The Albion River flows into the Pacific Ocean south of Mendocino and approximately eight miles south of Fort Bragg. The river mouth is connected to the ocean year round and inhabited by primarily two listed salmonid species (Coho and steelhead) and commercially important species, such as Dungeness crab, starry flounder, and surfperches. Eelgrass beds flank both sides of the channel. Harbor seals frequent the estuary, geese and ducks winter there, and Great Blue Herons nest along the river (LeValley et al. 2004). The Albion River is identified as an impaired water body due mostly to excess sediment (CCC 2006).

Navarro River Estuary: The Navarro River enters the Pacific Ocean approximately 3 miles south of Albion and 10 miles south of Mendocino. The Navarro River has the largest watershed in Mendocino County, including the Anderson Valley. The estuary supports several listed salmonid species (Coho and steelhead), surfperch species, Dungeness crab, and starry flounder. Shorebirds forage at the river mouth, migratory waterfowl use the estuary as a wintering location, and egrets are permanent

residents along the river (LeValley et al. 2004). The Navarro River is identified as an impaired water body due to sediment and elevated temperature concerns (CCC 2006).

3.1.4 Seagrass Beds

Seagrass habitats are extremely productive ecosystems that support an abundant and biologically diverse assemblage of aquatic animals, many of which are commercially important (Williams and Heck 2001). The most common type of seagrass in estuaries and sheltered coastal bays in California is *Zostera marina* or eelgrass (Abbott and Hollenberg 1976). A second species of eelgrass was recently discovered in Humboldt Bay and the Eel River estuary, the non-native dwarf eelgrass (*Z. japonica*), which has shorter and narrower leaves than *Z. marina*. Eelgrass is a marine flowering plant that often forms dense beds. Attributed mostly to their structural complexity and high productivity, eelgrass beds provide refuge, foraging, breeding, or nursery areas for a variety of invertebrates, fish, and birds (Phillips 1984). The long leaves and extensive root system also create a stable environment by reducing water flow and trapping particles, which consequently enhance sediment deposition, improve overall water quality and increase recruitment of young fish and invertebrates (Fonseca et al. 1982; Hemminga and Duarte 2000; Koch et al. 2006).

Native eelgrass beds (*Z. marina*) are known to be located mostly in bays and estuaries throughout the north coast (e.g. Humboldt Bay). Eelgrass has been reported from other locations, such as near the mouths of Ten Mile River, Noyo River, Big River, and Albion River in Mendocino County (Warrick and Wilcox 1981; LeValley et al 2004); however, the eelgrass in these areas is not as well mapped as eelgrass populations in Humboldt Bay and the Eel River estuary. Dwarf eelgrass (*Z. japonica*) was first discovered in Humboldt Bay in 2002 on Indian Island, which is located in the central part of the bay (Frimodig et al. 2009). Dwarf eelgrass is considered to be an invasive species in California waters due mostly to potential negative ecological effects and competition with native eelgrass. Eradication efforts began in 2003 with the removal of 284 square miles of dwarf eelgrass (Schlosser and Eicher 2007). Since then, annual efforts by the Humboldt Bay Cooperative Eelgrass Project have successfully reduced dwarf eelgrass in Humboldt Bay with less than 5 square miles requiring removal in 2008 (Schlosser et al., unpublished data). Despite continued monitoring and successful control efforts, a new population of dwarf eelgrass was discovered in the Eel River estuary in 2008.

The most common type of seagrass along the open coast of California is surfgrass (*Phyllospadix* spp.), also a flowering plant, which forms beds that fringe nearly all of the rocky coastline at the zero-tide level down to several meters below the zero-tide level. Surfgrass serves as an important habitat for a variety of fish and invertebrates, as well as algae (Stewart and Myers 1980), however it is not well mapped in the north coast study region.

3.1.5 Kelp Forests

Kelp forests are an important component of California's marine ecosystems that provide shelter for both juvenile and adult species of fish, offer vertical and horizontal substrate for a variety of marine organisms, and account for a large portion of the primary productivity in the nearshore communities. Biological diversity in kelp forests is high and many fishes and invertebrates depend on the health and robustness of the kelp forest (Foster and Scheil 1985). For example, juveniles of many nearshore rockfish species occur in the midwater or upper kelp canopy (Allen et al. 2006). Juveniles and adults of many nearshore rockfish species, as well as cabezon, greenlings, lingcod, and many other species, associate with bottom habitats in kelp forests (Allen et al. 2006). This habitat is also an economically valuable living marine resource, which supports both commercial and recreational fishing, diving, and kelp harvesting. Harvested kelp is a source of food (for both human consumption and for aquaculture feed), and is used for pharmaceuticals, fertilizer products and other industrial applications (DFG 2001a). Kelp harvesting is allowed within the north coast study region and

regulated by the DFG. Section 5.3 contains more information on commercial kelp harvest within the study region.

In California, there are two primary canopy-forming kelp, giant kelp, *Macrocystis sp. (*hereafter called *giant kelp*), and bull kelp, *Nereocystis luetkeana* (hereafter *bull kelp*). These two groups have geographic limitations, giant kelp spanning both the northern and southern hemispheres in temperate waters, and bull kelp primarily found in the northern hemisphere in temperate to cold waters (North 1971). These two species exist together along the central California coastline in separate or mixed stands (Foster and Scheil 1985). North of Santa Cruz, bull kelp becomes the dominant canopy forming kelp. Beneath the canopy are understory kelp and, on the bottom substrate, more encrusting or shrub-like algae. The kelp forests within the north coast study region are dominated by bull kelp (surface canopy), *Pterygophora californica* and *Laminaria setchellii* (understory), and foliose algae beneath (Foster and Scheil 1985).

Bull kelp is found on bedrocks, boulders, and reefs and can live at depths of 10 to 70 ft. (Vadas 1972). Bull kelp beds are persistent over time but exhibit marked seasonal and annual changes in the extent of the canopy, primarily due to winter storm activity and changing oceanographic conditions such as El Niño events (Ebeling et al. 1985; Harrold et al. 1988; Zimmerman and Robertson 1985). Bull kelp distribution also can be affected and controlled by several other factors both biotic and abiotic. Physical factors which influence bull kelp distribution include bottom light intensity, nutrients, wave action, shifting sediments, the character of the substrate (rocky, sandy, silty, course-grained), water temperature, water motion and salinity (Dayton 1985). Several factors may influence the distribution and productivity of bull kelp and identifying the individual factors influencing a bull kelp bed are often difficult. For example, higher water temperatures decrease the amount of nutrients available in the water column for uptake (DFG 2001b). Biological factors which influence *Nereocystis* distribution include grazing, disease and competition (Dayton 1985). Human impacts to bull kelp beds have not been as thoroughly documented as giant kelp beds (DFG 2001b). These impacts may be caused by thermal pollution, sediment or agricultural runoff, industrial waste. Direct impacts to kelp beds may occur through commercial or recreational fishing in or directly adjacent to the beds, and commercial kelp harvest (DFG 2001b)

Bull kelp has a typical life span of one year. Spores are released in the late fall and gametophytes develop during the winter months (Foreman 1984). By early spring the young sporophytes (a mature plant) typically appear (Vadas 1972). Bull kelp sporophytes are slow-growing for the first three to four weeks and then accelerate rapidly to canopy height by midsummer (DFG 2001b; Springer et al. 2006). Bull kelp typically dies by early winter with the onset of the winter storms.

Aerial surveys are used by the DFG to assess the state's kelp resource. The surveys have been performed annually and along the entire coastline; first in 1999, and then on an annual basis from 2002 through the present. However, the data from two survey years (2006 and 2007) are not available (See Table 3.1-5). One other survey used in this report was performed in 1989 by Ecoscan, a private organization. All surveys measured the extent of the kelp bed's surface canopy by using infrared photography and translating those images into GIS maps. These numbers are expressed in square miles and include beds of both giant kelp and bull kelp. Total kelp canopy coverage in the waters in the north coast study region has ranged from a low of 0.08 square miles (0.19 sq km) in 2005 to a high of 2.76 square miles (7.14 sq km) in 2008 (Table 3.1.5.1). These numbers reflect a similar trend occurring along the entire coast of California, with kelp persistence shrinking and growing over the same period. The majority of the kelp surveyed is found from the Fort Bragg area to the southern end of the study region.

Table 3.1-5: Kelp canopy coverage within the north coast study region

Survey Year	Canopy Coverage (mi^2)
1989	2.30
1999	1.57
2002	0.40
2003	0.16
2004	0.60
2005	0.08
2006	No data north of Pigeon Point
2007	Data collected but not yet processed
2008 [a]	2.76

[a] *A small portion of the coastline between Slaughterhouse Gulch (Mendocino County) and Jack Peters Gulch (Mendocino County) was not captured during the 2008 survey.*

3.1.6 Hard Bottom and Rocky Reefs

Rocky reef provides important habitat for a wide range of species in the north coast study region. Organisms ranging from subtidal kelps (e.g. *Nereocystis* sp., *Pterygophora* sp. and *Laminaria* sp.) to sea lions (Family *Otariidae*) rely on rocky reef as essential substrate for everything from attachment to prey acquisition. Additionally, many commercially fished species (for example, *Sebastes* spp.) are known to congregate around subtidal, rocky substrate. Examples of rocky reef include Saint George's Reef in Del Norte County, the nearshore subtidal ranging from Wedding rock to Camel rock in Humboldt County, the nearshore subtidal ranging from Cleone to the Noyo river mouth and the nearshore subtidal area off Point Cabrillo in Mendocino County.

The diverse assemblages of organisms associated with rocky reef and hard bottom vary with depth zone and, for this reason, the SAT considers hard bottom habitats in each depth zone to be distinct habitats (DFG 2005). For example, rocky reefs provide hard substratum to which kelp and other algae attach in the nearshore (<100 feet depth), while hard substratum in deeper water provides attachment substrate for many species of deepwater invertebrates. In addition to attached organisms, the structural complexity of rocky reefs provides habitat and protection for mobile invertebrates and fishes (Carr 1991).

Currently, coarse-scale data are available that show the extent of rocky substrate within the study region (refer to *Habitat and Species Atlas*). Although a significant portion of the available, coarse-scale substrate data fall into the “Unknown Substratum” category, fine-scale data have been collected for the north coast study region and will be available in late 2009. Table 3.1-6 shows the extent of rocky substrata in the north coast study region based on preliminary data. Rocky substrata are much less common than soft substrata on the north coast at all depth zones, covering only 1.71% of the study region based on coarse-scale data (when fine-scale data becomes available, it is likely to show a higher percentage). The majority of rocky substrata on the north coast occur shallower than 30 m, and none is found deeper than 200 m.

Table 3.1-6: Approximate amount of hard- and soft-bottom habitats by depth zone

Depth Zone	Hard Substrata (mi^2) (% of depth zone area)	Soft Substrata (mi^2) (% of depth zone area)	Unknown Substrata (mi^2) (% of depth zone area)
0-30 meters	12.68 (1.23%)	215.65 (21.00%)	268.71 (26.17%)

Depth Zone	Hard Substrata (mi^2) (% of depth zone area)	Soft Substrata (mi^2) (% of depth zone area)	Unknown Substrata (mi^2) (% of depth zone area)
30-100 meters	4.67 (0.45%)	151.97 (14.80%)	297.79 (29.01%)
100-200 meters	0.24 (0.02%)	9.79 (0.95%)	59.93 (5.84%)
>200 meters	0.00 (0.00%)	0.00 (0.00%)	4.71 (0.46%)
Total	17.59 (1.71%)	377.41 (36.77%)	631.14 (61.48%)

Note: This table is based on coarse-scale data. Fine-scale data, when it becomes available, will probably provide lower numbers in the "Unknown Substrata" category.

3.1.7 Sandy and Soft Bottoms

Nearshore and offshore soft-bottom environments range from flat expanses to slopes and basin areas. Somewhat less diverse in species assemblages than rocky reefs, soft-bottom habitats also lack the complex, three-dimensional structure of hard-bottom substrata. Despite their seemingly featureless physical characteristics, however, soft-bottom habitats can vary depending on the compositional sediment type. Soft-bottom habitats also can be highly dynamic in nature as sediments shift due to wave action, bottom currents and geological processes. Sandy and soft bottoms provide essential habitat for important commercially fished species such as Pacific halibut (*Hyppoglossus stenolepis*) and Dungeness crab (*Cancer magister*).

Preliminary mapping (which classifies a large portion of substrate as unknown) indicate that soft-bottom habitats are much more common than hard-bottom habitats at all depth zones, the former covering 36.77% of the north coast study region (Table 3.1-6; refer to the *Habitat and Species Atlas*). A majority of soft substrata occur shallower than 100 meters, and no soft substrata exist deeper than 200 meters within the study area. As with hard-bottom habitats, soft-bottom habitats in different depth zones are considered separate habitats (DFG 2005).

3.1.8 Underwater Pinnacles

Pinnacles are defined within the *California Master Plan for Marine Protected Areas* as a habitat to be considered during the MLPA process. Pinnacles are vertical rocky features that are tens of meters in diameter and height, with a cone-shaped geometry. Pinnacles can be distinguished from large boulders by their geologic origin. Pinnacles are generally a product of in-place erosional processes acting on rocky outcrops, while boulders are the result of erosional processes in other locations and the resulting movement of large rocks (G. Greene, Moss Landing Marine Laboratory, pers. comm.). Pinnacles are probably located in state waters in the north coast study region, but they are not well mapped. Pinnacles can be important bathymetric features that attract fish and invertebrates (Jorgensen et al. 2006; Carr 1991). Because they are not well mapped, pinnacles in the north coast study region are not distinguished from other hard-bottom habitats on substrata maps. (See the MLPA Initiative's separate *Habitat & Species Atlas*.)

3.1.9 Submarine Canyons

Submarine canyons are submerged steep-sided valleys that cut through the continental slope and occasionally extend close to shore. They have high bathymetric complexity, support unique deep-water communities, and affect local and regional circulation patterns. Submarine canyon habitats receive sediment and detritus from adjacent shallow areas and act as conduits of nutrients and sediment to deeper offshore habitats (Drexler et al. 2006; Mullenbach and Nittrouer 2006; Vetter and Dayton 1998). Canyons provide habitat for young rockfish and flatfish that settle in nearshore waters

to grow and move offshore as adults. Canyons also attract concentrations of prey species and provide important foraging opportunities for seabirds and marine mammals (Yen et al. 2004).

Four submarine canyons extend into state waters in the north coast study region. All four are located along the Lost Coast, between Cape Mendocino and Point Delgada. From north to south, the canyons are Mendocino Canyon, Mattole Canyon, Spanish Canyon, and Delgada Canyon. Although these canyons have not been extensively studied, the nearby Eel Canyon (located approximately six miles offshore of the Eel River mouth, outside of state waters) has been shown to serve an important role in the offshore transport of terrestrially-derived sediments (Mullenbach and Nittrouer 2006).

3.1.10 Offshore Rocks and Islands

Statewide, over 20,000 islands, rocks, and exposed reefs and pinnacles are included in the California Coastal National Monument, managed by the Bureau of Land Management (BLM). The monument was designated by presidential proclamation in January of 2000 and extends along the entire California coast (1,100 mi). The monument extends above the mean high tide line and was designed to protect the biological and geological values of offshore rocks and islets and the important forage and breeding grounds of associated marine birds and mammals.

In the north coast study region, mainland rocky shores frequently have associated nearshore rocks rising from just below mean high water to tens of feet above sea level. These numerous rocks and islets provide important foraging and nesting sites for marine birds and are used as haulout sites by pinnipeds. Some of the larger islets include Sugarloaf Island near Cape Mendocino, Green Rock and Flatiron Rock near Trinidad Head, False Klamath Rock north of the Klamath River mouth, and Hunter Rock near the Smith River mouth. All of these islets support multi-species seabird colonies.

In addition to many nearshore rocks and islets, the north coast study region contains two offshore reefs, one isolated offshore rock, and two larger nearshore islands. Blunts Reef, located approximately three miles northwest of Cape Mendocino, and Saint George Reef, extending from two to six miles northwest of Point Saint George, both consist of a series of wash rocks and islets rising just above sea level. These reefs are historic hazards to navigation, and the largest islet in Saint George Reef contains a lighthouse six miles offshore. Both reefs provide foraging and resting opportunities for marine birds and mammals, and Saint George Reef in particular contains numerous pinniped haulout sites and a seabird nesting colony. Reading Rock, located eight kilometers west of Gold Bluffs Beach in Redwood National Park, is an isolated offshore rock rising approximately three meters above sea level. Seven species of seabirds use the rock as a nesting site.

Two larger nearshore islands provide haulout and nesting sites for a large number of marine birds and mammals. Prince Island is located near the mouth of the Smith River and harbors nine species of nesting seabirds. Castle Rock is located approximately one kilometer offshore of Crescent City and provides nesting habitat for eleven species of marine birds, as well as haulout locations for numerous pinniped species. Castle Rock is designated as a National Wildlife Refuge, and is closed to the public. The island is the second-largest nesting seabird colony south of Alaska, after Southeast Farallon Island (located in the north central coast study region).

3.1.11 Oceanographic Habitats

Oceanographic patterns create pelagic habitats that differ from one another with respect to temperature, salinity, chlorophyll content, contaminant loads and planktonic biological assemblages. Oceanographic patterns also strongly influence growth, fecundity and survivorship of many species, and well as dispersal and recruitment patterns of sedentary species that have planktonic phases.

Oceanographic conditions such as currents, water masses and temperature strongly influence marine biodiversity. Variations in oceanographic factors determine areas of productivity where krill, squid, anchovy, seabirds and marine mammals congregate in the pelagic ecosystem (Forney 2000; Yen et al. 2004). Features such as eddies, upwelling plumes, currents, recirculation cells and river outflow plumes can be associated with high marine biodiversity, and transport patterns created by these features can significantly affect recruitment patterns of fish and invertebrates in intertidal nearshore communities (Farrell et al. 1991; Wing et al. 1995; Mace and Morgan 2006). The importance of these processes and their predictability over time is creating a greater emphasis on identifying oceanographic features and mapping their extent and temporal persistence.

Oceanography of the Study Region: The study region is characterized by a three-season oceanographic regime: the upwelling season, the relaxation season and the storm season (Largier et al. 1993). From April through July, the region is dominated by strong upwelling episodes of 3-10 days, during which persistent northwest winds drive surface waters offshore and equatorward, while deeper waters move onshore and poleward. The relaxation season, from August through November, is characterized by light winds and calm seas, with occasional upwelling events and early winter storms. The storm season lasts through winter and early spring and brings strong winds, large waves, and increased northward flow along the coast.

Two large-scale currents dominate the alongshore oceanographic conditions of northern California. The California Current is made up of southward-flowing surface waters and extends more than a hundred miles offshore, while the subsurface Davidson Current flows northward and remains closer to shore. During the winter, the California Current tends to “move” offshore, allowing the Davidson Current to dominate in the nearshore surface waters. At these times, free-floating drifters released in San Francisco Bay have been recorded as far north as Shelter Cove in as few as five days (Largier, J.L., pers. comm.).

Upwelling Centers and Upwelling Shadows: Within the California/Davidson Currents system, smaller processes are responsible for much of the oceanographic variability we see. Cape Mendocino and Point Arena are important upwelling centers, deflecting southward flowing currents far offshore in upwelling jets and bringing cold, nutrient-rich bottom waters to the surface. At Cape Mendocino, the water flows create a moderately persistent offshore eddy, which may create a barrier (albeit a permeable one) to larvae dispersing between areas north and south of the Cape (Magnell et al. 1990; Pullen and Allen 2001).

Downwind of major headlands, upwelling is absent and water recirculates in what are called upwelling shadows, which could also play important roles in nearshore oceanography (Graham and Largier 1997). Upwelling shadows retain planktonic organisms, creating increased foraging opportunities and the potential for increased invertebrate recruitment in those areas (Largier 2004). Although upwelling shadows in the North Coast Study Region have been poorly studied, they are likely to exist south of Crescent City and in the vicinity of Shelter Cove. Additionally, there are probably weak upwelling shadows in the lee of smaller headlands in the study region, such as Trinidad Head and the Mendocino Headlands (Largier, J.L., pers. comm.).

Climate Influences: Two large-scale atmospheric processes also influence the oceanography of the North Coast Study Region. El Niño-Southern Oscillation events (ENSO) and Pacific Decadal Oscillations (PDO) create variable oceanographic conditions worldwide. In northern California, ENSO events generally reduce upwelling of cold, nutrient-rich waters, increase onshore and northward flows, and increase sea surface temperatures. ENSO events occur every several years, and generally result in declines of zooplankton and reductions in productivity that can affect fish, seabird and marine mammal populations. Pacific Decadal Oscillations occur over much longer timescales (20-30 years) and have large-scale impacts on zooplankton and fish productivity throughout the North Pacific. These two events, coupled with the future potential impacts of climate

change, lend a large amount of uncertainty and variability to the oceanographic regime in the North Coast Study Region.

River Runoff: Numerous rivers and streams meet the ocean in the North Coast Study Region, including the Smith, Klamath, Eel, Mattole, and Navarro Rivers. The heaviest freshwater input occurs north of Cape Mendocino, though numerous small streams and seasonal creeks exist throughout the study region. The larger rivers, such as the Eel and Klamath, not only add large amounts of fresh water to the ecosystem, but also deposit sediment into the nearshore environment. The Eel River has an especially high sediment load, depositing up to 30 million tons of mud and sand in the nearshore environment each year, though much of this is transported to deeper waters through submarine canyons (Nittrouer 1999; Sommerfield and Nittrouer 1999). River plumes in the study region typically flow northward in the winter, adding sediment to nearshore habitats primarily north of Cape Mendocino.

3.2 Important Regional Species

This section briefly describes some of the important species in the study region. These include species currently described as depleted or overfished, fished species of interest, and species that receive special protections due to their legal status as protected, threatened, or endangered species. During the course of the north coast study region process, the SAT will develop a regional list of species likely to benefit from MPAs, which will be publicly available as a separate document.

3.2.1 Depleted and Overfished Species

This section describes depleted and overfished species that occur within the south coast study region. When describing these species, several definitions of "depleted" and "overfished" may be considered.

The MLPA refers to the term “depleted” in reference to marine life populations under “Program Goals” in Fish and Game Code (FGC) §2853(b)(2). However, additional definitions of this term exist. The federal Marine Mammal Protection Act (MMPA) has defined “depleted” as follows: “….a species or population stock is below its optimum sustainable population; … or a species or population stock is listed as an endangered species or a threatened species under the federal Endangered Species Act (ESA)” (16 USC §1362(1)). The equivalent term “depressed” is found in the Marine Life Management Act (FGC §90-99.5) which includes the following definition of a “depressed” fishery: “….the condition of a marine fishery that exhibits declining fish population abundance levels below those consistent with maximum sustainable yield” (FGC, §90.7). Similarly, the Pacific Fishery Management Council defines “overfished” as “Any stock or stock complex whose size is sufficiently small that a change in management practices is required to achieve an appropriate level and rate of rebuilding.” (PFMC 2008).

It should be noted that many species have not yet had their populations assessed. General information on what is known about the status of harvested species can be found at www.dfg.ca.gov/mrd/status/ (DFG 2001a; DFG 2004a). In addition, information on species managed by the Pacific Fishery Management Council can be found at http://www.pcouncil.org/groundfish/gfcurmgmt.html.

Several species that may be considered to be "depleted or overfished" under the definitions provided above are described below.

Groundfish (rockfishes, flatfishes, etc): The federal Pacific Coast Groundfish Fishery Management Plan, implemented by the Pacific Fishery Management Council in 1982, includes more

than 90 species of bottom-dwelling marine fishes. Species and species groups managed under the Pacific Coast Groundfish Fishery Management Plan include all rockfishes (about 60 species), sablefish, thornyheads, lingcod, Dover sole and other flatfishes (not including California or Pacific halibut), Pacific whiting, and some sharks and rays. For federally managed fisheries, any stock assessed to be between 25% and 40% of unfished biomass is managed under “precautionary zone” management, where harvest rates are reduced to slow the depletion rate. Species currently managed under precautionary zone measures include cabezon, petrale sole and sablefish.

The Pacific Fishery Management Council adopted new rebuilding analyses for seven rockfish species (*Sebastes* spp.) that are, or were previously, designated as “overfished” (less than 25% of their unexploited spawning population size remains). All seven of these species are known to occur in the north coast study region, but only five of these commonly occur: bocaccio, canary, widow, darkblotched and yelloweye rockfishes which have ranges that extend to Alaska. Juvenile bocaccio tend to settle in kelp beds after their pelagic larval stage and move to deeper rocky reefs (60-1550 feet) as adults. Most bocaccio were caught at depths of 250-750 feet. Juvenile canary rockfish also tend to stay closer to the surface before moving to deeper benthic habitats as adults. Canary rockfish are most abundant around depths of 500 feet, but go as deep as 900 feet. Widow rockfish juveniles stay near the surface after their pelagic larval stage, and move to deeper waters as adults. Most widow rockfish were caught at depths of 450 to 750 feet but have been found as deep as 1050 feet. Adult widow rockfish of the same size class tend to move together from area to area, and show seasonal movement among adjacent grounds. Yelloweye rockfishes primarily inhabit high-relief rocky habitats in depths 60 to 1,200 feet. These species of rockfish take years to reach reproductive maturity. The rebuilding process for most “overfished” rockfish species to reach healthy population levels is expected to require many years or even decades (DFG 2001a).

The commercial fishery for these species is generally regulated by a combination of allowable fishing depths, trip limits, and gear restrictions. The recreational fishery for these species is regulated using bag limits, seasons, area closures, and depth restrictions. Both the commercial and recreational fishery regulations can be adjusted in-season to prevent catches from exceeding harvest levels.

Yelloweye, and other “overfished” federal groundfish species, are protected with very low harvest limits (bycatch only), which constrains fishing opportunities for other species found in association with the “overfished” species. Depth-based Rockfish Conservation Areas, implemented in 2003, continue to be used to protect species of concern by closing the primary depth range of the overfished species to groundfish fishing. The Rockfish Conservation Area closures are expected to remain in place until “overfished” stocks are rebuilt or a new management approach is adopted.

The Nearshore Fishery Management Plan identified MPAs as a management strategy appropriate for nearshore fish stocks, but deferred implementation of any new MPAs for meeting Nearshore Fishery Management Plan objectives to the MLPA process. The 19 species covered by the Nearshore Fishery Management Plan are: black rockfish, black-and-yellow rockfish, blue rockfish, brown rockfish, cabezon, calico rockfish, California scorpionfish (not found within study region), California sheephead (Not found in the study region), China rockfish, copper rockfish, gopher rockfish, grass rockfish, kelp greenling, rock greenling, kelp rockfish, monkeyface eel, olive rockfish, quillback rockfish, and treefish. Many of these species have not undergone formal stock assessments.

Salmon: The majority of salmon caught off the coast of California are Central Valley Chinook (fall and late fall runs). There are also small numbers of Sacramento River winter Chinook (endangered), Central Valley spring Chinook (threatened), California coastal Chinook (threatened), Klamath Basin Chinook (fall and spring run), and northern Chinook stocks from Oregon and Washington caught in California's fisheries. Generally, the closer the fishery is to the mouth of the Klamath River, the

higher the contact rate (the fraction of the population brought to the boat) with Klamath Basin stocks. Contact with Oregon and Washington salmon stocks generally increases as you move north.

In 2008, approximately 66,200 Sacramento River fall Chinook adults returned to spawn in the Sacramento River Basin. This is the lowest return of Sacramento River fall Chinook on record and is well below the annual conservation objective of 122,000-180,000 adult spawners required by the PFMC's Salmon Fishery Management Plan.

Since Sacramento River fall Chinook salmon contribute significantly (generally 80 to 90 percent) to California's ocean sport and commercial fisheries, as well as to Oregon's fisheries south of Cape Falcon (60 to 80 percent), the PFMC, National Marine Fisheries Service and Fish and Game Commisson have severely constrained ocean salmon fisheries in California and much of Oregon to protect Sacramento River fall Chinook.

In April 2009, the Pacific Fishery Management Council (PFMC), the National Marine Fisheries Service, and the California Fish and Game Commission adopted a limited recreational ocean salmon season in the Klamath Management Zone (Humbug Mountain, Oregon to Horse Mountain, California). The area open to recreational salmon fishing will also include Humboldt Bay. The fishery was open from August 29 for all salmon except coho, and continued through September 7, 2009. The minimum size limit was 24 inches total length, with a two fish per day bag limit. Recreational ocean salmon fishing south of Horse Mountain is closed to protect Sacramento River fall Chinook. In 2010, the area south of Horse Mountain is scheduled to open for recreational salmon fishing on Saturday, April 3. There is a possibility the season will be closed by emergency action from Pacific Fishery Management Council and California Fish and Game Commission in March 2010. Additionally, PFMC and the National Marine Fisheries Service adopted a closure of all commercial ocean salmon fishing in California waters through April 30, 2010. For additional salmon management information, please visit the PFMC Web site at http://www.pcouncil.org/salmon/salcurr.html.

Further information on salmonids in the study region is provided below in sections 3.2.2 and 3.2.3.

Abalone: Seven species of abalone (*Haliotis* spp.) are found in California: red, white, black, green, pink, pinto, and flat. DFG applies the term “deplete” to five species of abalone. However of the five depleted species, only the black abalone occurs in the north coast region and has recently been listed as an endangered species. The California Legislature closed the commercial and recreational abalone fishery south of San Francisco Bay in 1997 due to a decline in the populations and the progression of disease (DFG 2008b).

The California Fish and Game Commission adopted the Abalone Recovery and Management Plan (ARMP) in December 2005. The ARMP outlines restoration strategies for depleted abalone stocks in central and southern California and describes the management approach to be used for northern California red abalone and eventually for other recovered abalone stocks. Further information regarding the recreational red abalone fishery is provided in section 3.2.2 below. Abalone data and survey information provided below comes from the ARMP and the Fisheries Forum Annual Report for 2008.

Black Abalone: This species is found from Oregon to southern Baja California. Black abalone habitats include rocky intertidal areas (to depths of 20 feet in southern California), often within the high energy surf zone. Adult black abalone congregate on rocks and in tidepools (DFG 2001a). Black abalone is listed as a species of concern by the National Marine Fisheries Service (NOAA Fisheries). A black abalone status review report was drafted and a final version will be out in the spring of 2008. Black abalone populations in southern California remain severely depressed since the closure of the fishery in 1993. However recent evidence shows some recruitment and potential

recovery at San Nicolas and Santa Cruz Islands. Current restoration research efforts focused on finding a genetically based resistance to Withering Syndrome, a disease that has devastated once abundant black abalone populations, and successful captive propagation of the species for recovery out-planting. For more information on abalone, go to DFG's Marine Region website: http://www.dfg.ca.gov/marine/armp/index.asp .

3.2.2 Fished Species of Interest

Commercial and recreational fisheries are an important component to California's economy. Below, some of the species that make up these fisheries in the north coast study region are discussed. More information on commercial and recreational fisheries can be found in 5.4 and 5.6 respectively.

Fish

Nearshore Finfish: DFG uses the term "finfish" to define fish that are aquatic vertebrates of the super class Pisces, breathing by gills throughout life, and having limbs in the form of fins. The California Nearshore Fishery Management Plan guides the management of 19 nearshore finfish species: rockfishes (black, black and yellow, blue, brown, calico, China, copper, gopher, grass, kelp, olive, quillback, and treefish), and cabezon, California scorpionfish, kelp and rock greenlings, California sheephead, and monkey-face prickleback. Some of these species occur coast-wide, while others are rare or do not occur in northern California (*e.g.,* California sheephead, California scorpionfish, calico rockfish and treefish). Collectively, these species are relatively long-lived, slow-growing fish that take several years to reach maturity and spawn. Most of the species were seldom harvested commercially until the development of the live-fish fishery during the early 1990s. Seventeen of these 19 species are also included in the federal Pacific Coast Groundfish Fishery Management Plan (DFG 2008a).

A restricted access program began in 2003 for the commercial nearshore fishery that affected the take of 10 specific nearshore species. The shallow nearshore group consists of: black-and-yellow, China, gopher, grass, and kelp rockfishes, kelp and rock greenlings, California scorpionfish, California sheephead, and cabezon. A total statewide participant capacity goal of 61 permits was specified for these 10 species though, as of 2007, 186 permits remain with 155 of the permits actively fished (annual landings of permit species exceeded 100 pounds). A restrictive permit program also began for eight species of deeper nearshore rockfishes: black, blue, brown, calico, copper, olive, quillback, and treefish rockfishes. The number of permits for these species decreased from 292 in 2003 to 239 permits in 2007 with 105 of the permits actively fished (annual landings of permit species exceeded 100 pounds).

Black rockfish: Black rockfish (*Sebastes melanops*), also known as blacksnapper and black bass, range from Amchitka Island, Alaska to Santa Monica Bay in southern California, but are uncommon south of Santa Cruz. They frequently occur in loose schools 10 to 20 feet above shallow (to 120feet) rocky reefs, but may also be observed as individuals resting on rocky bottom, or schooling in midwater over deeper (to 240 feet) reefs. They may attain a maximum length of 25.5 inches in California, although individuals over 20 inches are rarely observed today. Average size observed in commercial and recreational fisheries now is 14 to 15 inches in northern California. Black rockfish are an important recreational species, particularly in northern California and are a minor to moderate component of nearshore commercial fishery, with increasing importance from the San Francisco area northward. The Eureka area accounts for 80 to 90 percent of all commercial landings in the "black rockfish" market category (which may contain other species, most commonly blue rockfish) (DFG 2001a).

Monkeyface prickleback: The monkeyface prickleback (*Cebidichthys violaceus*) is a nearshore fish that makes up a relatively minor component of the recreational and commercial catch. The

monkeyface prickleback ranges along the Pacific coast from San Quentin Bay, Baja California, Mexico to central Oregon. It is most common off central California from San Luis Obispo County to Sonoma County, and is uncommon south of Point Conception. They normally occur in the intertidal zone with a depth range extending from the high intertidal to a reported depth of 80 feet. Typical habitat for monkeyface prickleback includes rocky intertidal areas with ample crevices, boulders, and algal cover, including high and low tide pools, jetties and breakwaters, and shallow subtidal areas, particularly rocky reefs and kelp beds. A specialized recreational fishery by shore anglers fishing in rocky intertidal and shallow subtidal habitat exists for this species. The most common fishing method is “poke poling,” which normally consists of fishing with a long bamboo pole, a short piece of wire, and a baited hook placed in front of or in holes or crevices in rocks. Skin and scuba divers also spear them (DFG 2001a).

Kelp and rock Greenling: Kelp greenling is a member of the family Hexagrammidae, which includes rock greenling, *Hexagrammos lagocephalus*, and lingcod. They are abundant from the Aleutian Islands, Alaska, to central California but are occasionally seen as far south as La Jolla, in southern California. Kelp and rock greenling inhabit kelp beds and rocky reefs but are also known to frequent sandy bottom areas; they are found subtidally to a depth of 150 feet (46 meters).

Kelp and rock greenling are highly sought after by recreational anglers and support a minor commercial fishery. Shore-based recreational anglers take them from central to northern California, but they are more frequently targeted in the northern-most sections of the state. Between 1980 and 2006, shore angling accounted for 62 percent of all sport caught kelp greenling in California. Current catch data from 2004 through 2006 show a continuation of low catch levels. Significant restrictions in regulations have occurred since the late 1990s which likely account for much of the observed decline. Due to a lack of life history data there are currently no estimates of abundance for kelp greenling in California. The recreational kelp and rock greenling fishery is managed under the rockfish, cabezon and greenling (RCG) complex which includes sizes, bag, depth and season restrictions (DFG 2008a).

Lingcod: The lingcod (*Ophiodon elongatus*) is the largest member of the Hexagrammidae family. Lingcod are found only off the West Coast of North America. They are distributed in nearshore waters from northern Baja California to the Shumagin Islands along the Alaskan Peninsula. Their center of abundance is off British Columbia, and they become less common toward the southern end of their range. Lingcod lack a swimbladder and thus will rest on the bottom or actively swim in the water column. They are found over a wide range of substrates at depths from 10 to 1,300 feet, but most occur in rocky areas from 30 to 330 feet. Typically, larger lingcod occupy rocky habitats; larger animals are found on deeper banks and reefs, whereas smaller animals live in shallower waters. Adult lingcod are strongly residential, tending to remain near the reefs or rocky areas where they live. Juveniles tend to disperse and travel over a wider range than adults.

The character of lingcod fisheries has changed greatly in the past 30 years. In the 1970s, about 85 percent of the commercially landed lingcod were caught with trawls; however, hook-and-line gear now account for half of the commercial landings. There has also been a shift in the lingcod fishery away from commercial and towards recreational catches. Recreational landings as a percentage of total lingcod landings increased from 20 percent in the 1970s to about 50 percent in the late 1990s. The recreational fishery is regulated using seasonal and depth closures and a 24 inch minimum size with a two-fish limit (DFG 2001a).

Vermilion rockfish: Vermilion rockfish (*Sebastes miniatus*), are found from the San Benito Islands, Baja California, to Prince William Sound, Alaska, and occur over rocky bottoms from the shallow subtidal to 1,400 feet. Vermilion rockfish generally remain on the same reef system on which they settle during their first year. Tagging studies have shown no movement of fish at liberty for one to three years. Vermilion rockfish are extremely long-lived. The slow growth and long juvenile period

make vermilion rockfish very susceptible to overfishing. In the north coast study region, vermilion rockfish support a relatively minor commercial fishery and are targeted by recreational anglers. Vermilion rockfish co-occur with other overfished groundfish species and therefore the sport fishery is managed using bag limits and seasonal and depth closures under the rockfish, cabezon and greenling species (RCG) complex (DFG 2001a).

Ocean salmon: Of the five species of Pacific salmon found on the West Coast, Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) are most frequently encountered off California. The PFMC began in 1992 to severely curtail the ocean harvest of coho salmon in California due to the depressed condition of most coastal stocks. Following the federal listing of California coho stocks in 1996 and 1997, the National Marine Fisheries Service (NMFS) extended the protective measures to a complete prohibition of coho retention off California.

Chinook are the largest of the salmon species and support both recreational and commercial fisheries, although the commercial fishery is currently closed in California waters through April 30, 2010. Chinook spend two to five years at sea before returning to spawn in their natal streams. The small percentage of chinook that mature at age two are predominately males and are commonly referred to as “grilse,” or “jacks.” The older age classes of chinook are composed of about equal proportions of males and females. Recovery of coded wire tags in ocean salmon fisheries has provided a better understanding of the temporal and spatial distribution of various Chinook stocks, particularly those from the Central Valley and Klamath Basin. For example, although Central Valley fall Chinook are distributed primarily off of California and Oregon, they are also frequently recovered off Washington and British Colombia. Klamath River fall Chinook are more narrowly distributed primarily between Cape Falcon, Oregon and Point Sur, California.

During the 1990s, a fishing technique known as mooching gained popularity among salmon sport anglers in California. Mooching is generally used when salmon are feeding on forage fish such as anchovies or herring in fairly shallow nearshore areas. When trolling, the hook generally sets itself as the salmon attacks the moving prey whereas during mooching, line is fed out to the salmon when it strikes to encourage the salmon to swallow the bait and hook. Ocean fisheries can have a significant impact on the average age of spawning Chinook because ocean-fishing gear often selects for larger, older fish. Ocean harvests of Chinook must be constrained to meet the spawning escapement goal of the Klamath River fall chinook and to provide for the federally reserved fishing rights of the Yurok and Hoopa Valley Indian tribes. For up-to-date information on the status of salmon stocks and current regulations please visit the PFMC web site at http://www.pcouncil.org/salmon/salcurr.html.

California halibut: Adult California halibut (*Paralichthys californicus*) range from the Quillayute River, Washington, to Almejas Bay, Baja California. California halibut inhabit soft-bottom habitats in coastal waters generally less than 300 feet deep, with greatest abundance at depths of less than 100 ft. Adults spawn throughout the year with peak spawning in winter and spring. Newly settled and larger juvenile halibut are frequently taken in un-vegetated shallow-water embayments and infrequently on the open coast, suggesting that embayments are important nursery habitats.

In northern California, California halibut are targeted primarily by recreational anglers by hook-and-line. While California halibut can be caught from shore, most are caught from boats. Currently the recreational fishery is managed using size and bag limits. Over the past century abundance appears to have been cyclic, which may be due to a number of fishery dependent and fishery-independent factors. However, protection of bay and estuarine habitats, upon which juvenile halibut depend, is important to insure the health of this resource (DFG 2004a).

Pacific Herring: Pacific herring (*Clupea pallasi*) are found throughout the coastal zone (waters of the Continental Shelf) from northern Baja California on the North American coast around the rim of

the North Pacific Basin and Korea on the Asian coast. In California, herring are found offshore during the spring and summer months foraging in the open ocean. Beginning as early as October and continuing as late as April, schools of adult herring migrate inshore to bays and estuaries to spawn. Known spawning areas in California include San Diego Bay, San Luis River, Morro Bay, Elkhorn Slough, San Francisco Bay, Tomales Bay, Bodega Bay, Russian River, Noyo River, Shelter Cove, Humboldt Bay, and Crescent City Harbor.

Pacific herring in California have been commercially harvested primarily for their roe, with small amounts of whole herring marketed for human consumption, aquarium food and bait. The sac-roe fishery is limited to California's four largest herring spawning areas: San Francisco Bay, Tomales Bay, Humboldt Bay, and Crescent City Harbor. Herring abundance fluctuates greatly due to large variations in spawning, which may be tied to multiple events including changing ocean conditions (i.e. low primary productivity, increased temperature and decreased upwelling), potential displacement by sardine populations, and increased predation and reduced recruitment. Historically, Humboldt Bay supported a small, but successful fishery for many years. However, with the observed decline in the spawning population, fishing effort has declined (DFG 2008a).

True smelts: The true smelts of the family *Osmeridae* are small fishes found in cold coastal, estuarine, and freshwater habitats in the Northern Hemisphere. Seven of the 12 species of true smelts occur in California, but only 2 species (Surf and night smelt) support both commercial and recreational fisheries. Surf smelt *(Hypomesus pretiosus)* are the most widely distributed smelt in California but are only common north of San Francisco Bay. They are schooling, plankton-feeding fish that can reach 10 inches in length. Females typically grow the largest and live the longest (up to five years), while males rarely live longer than three years. The standard A-frame dip net used to catch this smelt is based on one used by Native Americans in the aboriginal fishery. About 95 percent of all commercial landings are taken with this gear, the other five percent are captured using purse seines, trawls, or beach seines. The fact that surf smelt *(Hypomesus pretiosus)* spawn on selected beaches at predictable times of the day and year has made them a favorite sport fish The sport fishery primarily uses techniques and A-frame nets similar to the commercial fishery. Beach seines ("jump nets") up to 20 feet long (with mesh sizes of at least 7/8 inch) are also legal in the sport fishery, as are cast nets (Hawaiian throw nets). The sport catch limit for smelt is 25 pounds per day, a regulation that has been in place for many years (DFG 2001a).

Night smelt *(Spirinchus starksi)* range in distribution from Point Arguello in central California to Alaska. Like surf smelt, night smelt are schooling, plankton-feeding fish that are important prey for other fishes as well as marine mammals and birds. They rarely exceed six inches in length or three years in age. Night smelt are also taken in large numbers, both in the commercial and sport fisheries, in much the same ways as surf smelt. Although night smelt are smaller in size and spawn only at night, they represent over 50 percent of the total commercial smelt landings (DFG 2001a).

Surfperch: The surfperch family (*Embioticidae*) contains a colorful set of fish that are sought-after primarily by recreational anglers (Appendix C). As a group surfperch was the second most popular species group in terms of the number of fish landed (kept and/or released) by recreational anglers fishing ocean waters statewide in 2006. Surfperch also support a comparatively minor hook-and-line commercial fishery. The redtail surfperch (*Amphistichus rhodoterus*) is the primary species taken by recreational beach anglers in northern California. Redtail surfperch are found along sandy beaches and near sources of food and cover such as piers and jetties. Several species of surfperch prefer similar habitat while others prefer rocky reefs or kelp beds. Surfperch are usually found in 60 feet or less with some species occurring as deep as 240 feet. Surfperch stay near the shoreline in relatively shallow water making them vulnerable to coastal development and pollution (DFG 2008a).

Nearshore Sharks: Nearshore sharks and rays (Class *Chondrichthyes*) occur in the nearshore zone and utilize bays and estuaries as nursery sites. These species tend to grow slowly, live many

years, and have low reproductive rates. In the Eastern Pacific, Pacific angel sharks (*Squatina californica*) are found from southeastern Alaska to the Gulf of California and from Ecuador to Chile. Pacific angel sharks are bottom-dwelling species found at depths of three to over 600 feet. They are often found in sandy, soft bottoms between rocky reefs. According to tagging studies, Pacific angel sharks stay in the same vicinity as tagged, though angel sharks tagged at the islands did tend to move around the islands. Pacific angel sharks eat mostly queenfish, blacksmith and market squid. The Pacific angel shark fishery is regulated with gear restrictions and minimum size limit (DFG 2001a).

Sport and commercial fishermen take nearshore sharks and rays throughout California (Appendix B and Appendix C), except for the shovelnose guitarfish, which is rare north of Monterey Bay. Take of many shark, skate and ray species occurs as bycatch, so some species are possibly taken and discarded in trawl and other fisheries because of their low value. Although not targeted by sport or commercial fishermen, the spiny dogfish probably makes up a significant amount of the bycatch in some fisheries (DFG 2002). Bat rays are taken by sport and commercial fishermen, then discarded. Leopard sharks are primarily found in bays, estuaries, and shallow nearshore waters where they are easily taken by sport fishermen. Declines in the Pacific angel shark, thresher shark, spiny dogfish and soupfin shark fisheries were observed prior to effective management by DFG (DFG 2001b). Threats other than targeted fishery and bycatch include loss of nursery habitat and illegal take of pups for marine aquaria trade.

Invertebrates

Red abalone: The red abalone (*Haliotis rufescens*) range extends from Oregon into Baja California, Mexico. Red abalone is the largest abalone in the world with a record maximum shell length of 12.3 inches. Red abalones inhabit intertidal and shallow subtidal areas in northern and central California; however, they are exclusively subtidal in southern California. There is a clear distinction between juvenile and adult red abalone habitat, an indication that migration occurs as the abalone grow. Abalones live as long as 30 years. Red abalone generally reach sexual maturity at a shell length of five inches, but may become mature as small as 1.6 inches for females and 3.3 inches for males. Age at sexual maturity varies among species, ranging from 1 to 5 years.

A successful red abalone sport only fishery continues to the north of San Francisco county, where SCUBA has always been prohibited and commercial take was only allowed for a three year period during WWII. The red abalone season is open from April through June, and August through November. Red abalone populations in northern California have supported a viable recreational fishery for decades. While legal-sized adults (7 in.) are still relatively abundant, population and fishery data analyzed in 2001 revealed four trends that are of concern: concentration of fishery effort and increased take, evidence of poor recruitment, declines in deep-water stocks, and local depletion (DFG 2001a).

Red Sea Urchin: The red sea urchin (*Strongylocentrotus franciscanus*) is an echinoderm (along with sea stars) that feeds primarily on algae, including kelp (Strathmann 1971). They are found from Baja California, Mexico to Alaska in relatively shallow water (low-tide line to 300 feet). Red sea urchins prefer rocky habitat near kelp and seaweeds (MarineBio 2008). Sea urchins can dramatically reduce kelp abundance creating urchin barrens (Tegner and Dayton 1991). Red sea urchins are harvested for their roe, which is sold mostly as an export product. Statewide landings of red sea urchins in 2008 were 10.3 million pounds, with 2.6 million pounds landed in Fort Brag. The statewide catch has remained in a relatively narrow range from 10.3 to 14.0 million pounds since 2002 (Appendix III). There is a small amount of recreational take of sea urchins from tide pool areas (DFG 2001a).

Dungeness crab: Dungeness crab, *Cancer magister*, range from the eastern Aleutian Islands, Alaska, to around Santa Barbara (Santa Barbara County); however, the species is considered rare south of Point Conception (Santa Barbara County). Dungeness crab prefer sandy and sand-mud bottoms but may be found on almost any bottom type. They may range from the intertidal zone to a depth of at least 750 ft, but are not abundant beyond 300 ft.

The Dungeness crab population off California, as demonstrated by tagging experiments, consists of five sub-populations, located in Avila-Morro Bay, Monterey, San Francisco, Fort Bragg, and Eureka-Crescent City. Only the latter three are commercially important. DFG surveys indicate that the San Francisco and Fort Bragg sub-populations combined are smaller than the sub-population extending from Eureka into Oregon. Little or no intermixing of the sub-populations occurs. Tagging studies have also demonstrated random movement by both sexes. At times, an inshore or offshore migration may be observed, but most movement is restricted to less than 10 miles. Movement of up to 100 miles has been noted for individual males, but female movement appears to be much more limited.

The commercial fishery for Dungeness crab occurs from Avila (San Luis Obispo County) to the California-Oregon border, with commercial and recreational seasons beginning in late fall and ending in early summer. Northern California fishing grounds extend from Fort Bragg to the California-Oregon border, with the prime area located between Eureka and Crescent City. Almost all of California's commercial Dungeness crab catch is landed in the trap fishery.

There is limited sport take of Dungeness crab in central and northern California. The total annual recreational harvest is unknown, but it is believed to be less than 1% of the commercial take. The recreational fishery is managed through seasonal and area closures, gear restrictions, size limits, and a limit on the number of crabs that may be possessed. Either sex may be taken in the recreational fishery. In northern California the size limit is 5.75 in. across the widest part of the carapace and the bag/possession limit is 10 crabs (DFG 2004a).

Clams: There are primarily three types of clams (razor, gaper, and Washington) that are targeted by recreational clammers in the north coast study region. The Pacific razor clam (*Siliqua patula*) ranges from western Alaska to Pismo Beach, California, and is generally found on flat or gently sloping sandy beaches with a moderate to heavy surf. Razor clam shells are long and thin, with fragile, shiny valves. Razor clams attain their maximum rate of growth during their first year of life. The growth rate remains high through the second or third year, after which it slows markedly. The largest razor clam on record in California was a seven-inch specimen taken from Clam Beach in 1979. Beaches in Del Norte and Humboldt counties are some of the best places in California to take razor clams. Clam Beach and Crescent City both support similar fisheries where beds are divided into north and south beaches with alternate year closures in effect. In both areas, the northern beach was more heavily fished and more productive than the southern beach for many years. The El Niño events of the past two decades have had large storms associated with them and this may have had some impact on northern California razor clam populations. The razor clam population in the Crescent City area is recovering, but the Clam Beach population is still much diminished from former levels. The recreational daily bag limit is 10 per person. (DFG 2001a)

Gaper clams are found from Alaska to Scammon's Lagoon, Baja California. Both the Pacific (*Tresus nuttalli*) and fat gaper (*Tresus capax*) live in fine sand or firm sandy-mud bottoms in bays, estuaries, and more sheltered outer coast areas. They are found from the intertidal zone to depths of at least 150 feet. The Pacific gaper is the most commonly taken gaper clam in California. A closely related species, the fat gaper, is the predominant gaper clam taken in Humboldt Bay, where it is very common in the intertidal zone. Gaper clams live to a maximum age of 17 years and can attain a length of 10 inches with a weight of approximately five pounds. The fishery for the gaper clams, the Pacific gaper (*Tresus nuttalli*) and the fat gaper (*Tresus capax*), is almost exclusively sport, however,

the Fish and Game Code allows these clams to be harvested commercially in Humboldt Bay. The Pacific and fat gaper support a significant sport fishery that takes place in intertidal areas of bays with sand and mud bottoms. Humboldt Bay is the largest gaper clam fishery in the state where a take of 25 clams per day is allowed. (DFG 2001a)

The range of the Washington clam is from Humboldt Bay, California, to San Quentin Bay, Baja California. This species lives at depths of 12 to 18 inches in mud, sandy mud or sand of bays, lagoons and estuaries. Two principal species of Washington clam are harvested in California. The Washington clam (*Saxidomus nuttalli*) is the principal species sought, and the best yielding localities include Humboldt Bay. The second popular Washington clam, the butter clam (*Saxidomus giganteus*), formerly known as the smooth Washington clam, is seldom taken south of Humboldt Bay. In only one California locality, near Fields Landing in Humboldt Bay, is this clam common enough to support a minor fishery. Sport clammers in Humboldt Bay are permitted to take 50 Washington clams in combination with no more than 25 gaper clams. (DFG 2001a)

Plant species: A variety of marine algae provide habitats and food for invertebrates, fishes, and marine mammals in the south coast study region. Further information in the ecology of giant kelp can be found in section 3.1.5. More information on the harvest of kelp can be found in section 5.5.1.

3.2.3 Special-Status Species

Some species within the north coast study region have been designated with a special status under either state or federal law. Both the California state and federal Endangered Species Acts provide for special protections for a variety of fish, marine mammals, birds, and plants. In addition, marine mammals are protected under the Marine Mammal Protection Act, and migratory seabirds and shorebirds are protected under the Migratory Bird Treaty Act.

In addition, DFG maintains a list of taxa they are interested in tracking, regardless of the legal or protection status of each taxon. These “species at risk” or “special-status species” are those taxa considered to be of greatest conservation need. DFG also designated certain vertebrate species as “Species of Special Concern” because declining population levels, limited ranges, and/or continuing threats have made them vulnerable to extinction. Not all “Species of Special Concern” have declined equally; some species may be just starting to decline, while others may have already reached the point where they meet the criteria for listing as a “Threatened” or “Endangered” species under the state and/or federal Endangered Species Acts.

A complete listing of state listed endangered or threatened species can be found at http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf (animals) and http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEPlants.pdf (plants).

A complete listing of federally listed endangered or threatened species can be found at http://www.fws.gov/endangered/wildlife.html.

The section below includes descriptions of several special-status species that exist within the north coast study region. Comprehensive lists covering all species with special status in the state can be found at http://www.dfg.ca.g ov/wildlife/nongame/list.html.

Plants

Humboldt Bay Owl’s Clover: The coastal marshes of Humboldt Bay and Eel River estuary provide essential habitat for the Humboldt Bay owl's clover (*Castilleja ambigua* ssp. *humboldtiensis*). Within the north coast study region, this species is known to occur in Mendocino and Humboldt counties.

Although it can occur in high densities in appropriate habitat, coastal development (especially around Humboldt Bay) has resulted in severe habitat loss for this subspecies (Pickart 2001)

Lyngbye's Sedge: Lyngbye's sedge (*Carex lyngbyei*) grows rhizomatously into dense monotypic stands (McBain and Thrush 2004). It can be found in brackish or freshwater marshes and swamps from 0-33 feet elevation. In the north coast study region, Lyngbye's sedge is present in Del Norte, Humboldt and Mendocino counties.

Point Reyes Bird's Beak: Point Reyes bird's beak (*Cordylanthus maritimus* ssp*. palustris*) is present in the north coast study region in salt marshes around Humboldt Bay and Eel River estuary. Through its action as a hemiparasite, *C. maritimus* has been demonstrated to ameliorate salt stress in the soil, resulting in increased species richness in salt marsh communities where it is present (Grewell 2008). Point Reyes bird's beak's increasingly fragmented habitat has been largely reduced by development around Humboldt Bay (Pickart 2001).

Fish

Salmonids: A number of anadromous salmonids (*Oncorhynchus* spp.) occur in the north coast study region, though several are considered to be species in jeopardy (Moyle 2002). For example, pink salmon (*Oncorhynchus gorbuscha*) have been extirpated from the state. The remaining five salmon species have at least some populations listed as threatened or endangered, including Chinook, Coho, chum, steelhead, and cutthroat trout.

Chinook salmon (*Oncorhynchus tshawytscha*) in California exhibit a wide array of life history patterns that allow them to take advantage of the diverse and variable riverine and ocean environments. At least seventeen distinct runs of Chinook salmon are recognized in California. These runs have been classified into six major groups, or Evolutionarily Significant Units (ESUs). The California coastal ESU includes naturally spawned coastal spring and fall Chinook salmon between Redwood Creek, Humboldt County and the Russian River, Sonoma County, and is listed as federally threatened. The Southern Oregon and Northern California Coastal Chinook salmon ESU includes fall-run Chinook salmon in coastal streams from Cape Blanco in Oregon south to the Klamath River. Southern Oregon and Northern California Coastal Chinook salmon were proposed for federal listing in 1999, but listing was determined to be not warranted. Large populations of spring-run Chinook salmon used to occur in at least 20 streams in the Klamath-Trinity drainage, but they have been reduced to largely five locations (Smith River, Redwood Creek, Mad River, Mattole River, and Eel River), and there is no evidence of recent spawning in these locations (Moyle et al. 1995).

Coho salmon (*Oncorhynchus kisutch*), are distributed throughout the north pacific and are the most common species encountered offshore of California after Chinook. Coho enter fresh water from September through January in order to spawn. Generally, coho salmon spawn in smaller streams than do Chinook salmon. One year after hatching, smolts begin migrating downstream to the ocean in late March or early April. In some years emigration can begin prior to March and can persist into July. The amount of time coho salmon spend in estuarine environments is variable, and the time spent there is less in the southern portion of their range. Upon entering the ocean, the immature salmon remain inshore, congregating in schools as they move north along the continental shelf. Most remain in the ocean for two years; however, some return to spawn after the first year. Data on ocean distribution of California coho salmon are sparse, but it is believed that the coho salmon scatter and join schools from Oregon and possibly Washington.

In August, 2002 the California Fish and Game Commission issued a finding that coho salmon warranted listing as a threatened species from the Oregon border south to Punta Gorda and as an endangered species from Punta Gorda south to San Francisco including the Bay. The Central

California Coast ESU includes naturally spawning populations in streams between Punta Gorda, Humboldt County, and the San Lorenzo River, Santa Cruz County, and is listed as federally endangered. There is also a Southern Oregon/Northern California ESU, including populations between Cape Blanco, Oregon, and Punta Gorda, which is listed as federally threatened (DFG 2004c).

Other salmonids include chum salmon, coastal cutthroat trout, and steelhead. No fisheries exist in California for Chum salmon (*Oncorhynchus keta*) due to limited stocks (Barrow and Heisdorf 2001).

The coastal cutthroat trout (*Oncorhynchus clarki* spp. *clarki*) is one of the three native cutthroat subspecies in California. In California, the native range of the coastal cutthroat begins near the Eel River drainage and includes drainages north to Oregon and beyond into Alaska. Many of the populations are anadromous, “sea-run” cutthroat. Others are freshwater residents and some travel between the brackish estuaries and the freshwater tributaries. Steelhead (*Oncorhynchus mykiss*) are caught recreationally in streams and rivers from the Central Valley basin north to the California-Oregon border. Steelhead are anadromous and thus spend most of their lives in the ocean, returning to freshwater to spawn. Unlike most Pacific salmon, steelhead do not necessarily die after spawning and repeated spawning is common. A recent estimate of annual statewide abundance of summer-run steelhead is about 2,000 adults (McEwan 2001). The Northern California ESU is listed as federally threatened; it includes naturally spawning populations residing below impassable barriers in coastal basins from Redwood Creek, Humboldt County to the Gualala River, Mendocino County.

Additional information regarding salmonids is provided above in sections 3.2.1 and 3.2.2.

Tidewater Goby: The tidewater goby (*Eucyclogobius newberryi*) is a small, short-lived fish species restricted to relatively shallow, brackish estuarine waters along the California coastline from Tillas Slough, Del Norte County, to Cockleburr Canyon in San Diego County (USFWS 2007b). The tidewater goby was listed as federally endangered under the Endangered Species Act (ESA) in 1994, due mostly to its disappearance from nearly half of its historic locations and the unstable status of remaining populations (USFWS 1994, 2005). However, a 5-year review conducted by the U.S. Fish and Wildlife Service in 2007 recommended changing the listing to threatened (USFWS 2007). Tidewater gobies feed on small benthic invertebrates, such as ostracods and amphipods, and appear to have a generally annual life cycle (Swift et al. 1989). They reproduce throughout the year resulting in constant variability in local abundance, which makes accurate population estimates difficult. Distribution and health of tidewater goby populations is affected by habitat loss or degradation because they rely on estuarine habitats throughout their entire life cycle, as well as competition and predation by native and exotic species (USFWS 2007b). Critical habitat for tidewater goby in the north coast study region includes Lake Earl/Lake Talawa, Stone Lagoon, Big Lagoon, Humboldt Bay, Eel River estuary, Ten Mile River, Virgin Creek, and Pudding Creek (USFWS 2008).

Green Sturgeon: The green sturgeon (*Acipenser medirostris*) spends most of its life in the ocean, spawns at between 15 and 20 years, and is not well studied. Limited feeding data suggest that sturgeon feed mainly on benthic invertebrates, including shrimp, mollusks, and amphipods, as well as small fish (Moyle et al. 1992). They are reported to spawn only in the Sacramento, Klamath, and Trinity rivers (Kohlhorst 2001), although green sturgeon have been reported from a number of other locations such as the Smith River estuary and Lake Earl (Monroe et al. 1975).

The southern Distinct Population Segment (DPS) of the green sturgeon, which includes all spawning populations south of the Eel River, is listed as federally threatened. The Pacific-northern DPS (including coastal spawning populations from the Eel River north to the Klamath and Rogue rivers) is federally listed as a species of species of concern. Most of the threats to green sturgeon, including

reduced flow, increased sediment, reduction in dissolved oxygen concentration, impassible barriers, and harvest, affect this species during the portion of its lifecycle spent in rivers (NOAA 2005).

Longfin Smelt: The longfin smelt (*Spirinchus thaleichthys*) is listed as threatened under the California Endangered Species Act (CESA) and its status is currently unresolved at the federal level. Longfin smelt was once one of the most abundant species in San Francisco Bay and Humboldt Bay; however, populations have declined in most locations and may be attributed primarily to factors such as water diversion and varying water flows (Allen et al. 2006; Rosenfield and Baxter 2007). Longfin smelt is a short-lived, anadromous species that feeds exclusively on zooplankton, typically spawns in freshwater rivers between January and March, and spends most of its adult life in nearshore coastal environments from Alaska to San Francisco Bay. There is little information on the abundance of longfin smelt in California, especially north of San Francisco Bay; however, they are reported to inhabit several areas in the north coast study region including the Klamath River estuary, Humboldt Bay, and the Eel River estuary (DFG 2009b).

Eulachon: The eulachon (*Thaleichthys pacificus*) is another smelt species that occurs in California, though its numbers have declined in recent years and it is listed as a state species of special concern. Eulachon is known for its high content of an oil that is used for food and candles. Until the mid-1970s, eulachon supported a fairly consistent river sport dipnet fishery, as well as a dipnet fishery by Native Americans. The commercial catch in California has apparently never been large (maximum reported landings are 3,000 pounds in 1987), but eulachon are important commercially in British Columbia. They are a very important food for predatory marine animals, including salmon, halibut, cod and sturgeon (Sweetnam et al. 2001).

Eulachon spend most of their lives in the ocean but return to the lower reaches of coastal streams to spawn, usually no farther south than the Klamath River and Humboldt Bay tributaries (Allen 2006). In recent years, eulachon numbers have declined drastically and they are now rare or absent from the Mad River and Redwood Creek and scarce in the Klamath River. However, the eulachon and its fishery have been little studied in the past, so it is unknown if the fish are at a low point in a natural population cycle or if they have been reduced by human-related factors (Sweetnam et al. 2001).

Birds

Brant: Brant (*Branta bernicla*) winter and stage along the entire coastline of California. Brant are food specialists during non-breeding season, eating eelgrass (*Zostera* spp.) almost exclusively. Winter and spring distributions of Brant are closely tied with those of eelgrass. Within the north coast study region, relatively high numbers of wintering and staging Brant occur in Humboldt Bay, where eelgrass is plentiful. Within Humboldt Bay, numbers of staging Brant are higher than might be expected based solely on eelgrass abundance due to distance from other staging areas. The more extensive eelgrass beds in South Bay support higher numbers of staging Brant than Arcata Bay. As Brant rely on eelgrass, the health and distribution of the population is affected by destruction of eelgrass habitat by human activity, including dredging, oyster mariculture, pollution and coastal development. Brant may also be displaced from healthy eelgrass habitats by human recreation activities, including boating, hunting and shellfish harvesting (Davis and Deuel 2008; Moore et al. 2004).

Western Snowy Plover: The Pacific population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*) occurs throughout the north coast study region, and its breeding range extends from Baja California to southern Washington. Western Snowy Plover are found on beaches, estuarine sand and mud flats, and in man-made salt ponds and feed on invertebrates in the wet sand and surf-cast kelp, and occasionally on insects from low-growing plants. Nesting occurs above the high tide line on coastal beaches, sand spits, dunes, and in lagoons and estuaries with appropriate habitat, during the breeding season (March–September). During a breeding-season

range-wide survey in June 2002, an estimated 1,501 individuals were found; most were in California (Fancher et al. 2002). Human harassment and direct destruction of nest sites and breeding habitat, expanding predator populations, and introduced species contributed to the decline of and continue to threaten the Western Snowy Plover. In the north coast study region, Western Snowy Plover are known to nest at the following locations: Gold Bluffs Beach, Big Lagoon, Clam Beach, the south spit of Humboldt Bay, the Eel River Wildlife Area, Centerville Beach and the Eel River gravel bars in Humboldt County; Ten Mile River beach and Virgin Creek in Mendocino County (USFWS 2009).

Tufted Puffin: The Tufted Puffin (*Fratercula cirrhata*) breeds along the coast of the northern Pacific Ocean from Japan to central or southern California on offshore rocks and on occasion, mainland cliffs. Tufted Puffin breed April – September and occur mostly offshore on the outer continental slope and shelf during this time. Tufted Puffin occur throughout pelagic waters in their range during the non-breeding season (McChesney and Carter 2008). The Tufted Puffin, once found from the Oregon border to the Channel Islands, is now distributed from the Oregon border (where there are now only a few sites) to the Farallon Islands, and a single possible site in the Channel Islands. Historic breeding locations in north coast study region included Castle Rock in Del Norte county and Green and Flatiron Rocks (off Trinidad) in Humboldt County. Current breeding range has been studied little, but surveys from 1989 – 1991 estimated 276 breeding puffins in 13 colonies, 57% of which occurred north of Cape Mendocino (Carter et al. 1992). Principle breeding sites identified within the study region were Prince Island and Castle Rock in Del Norte County, Green Rock in Humboldt County and Goat Island and Fish Rock in Mendocino county. Possible reasons for the reduction of the Tufted Puffin's breeding range include oil spills and human alteration of breeding habitat (especially at the Farallon Islands and Castle Rock). Other possibilities include climate change and reduction in prey availability (McChesney and Carter 2008).

Pinnipeds

At least four species of pinniped occur within the north coast study region. Steller sea lion, northern elephant seal, and California sea lion are historically known to migrate along the coast of northern California (Griswold 1985). In addition to these, harbor seal is common along the coast and in bays throughout the study region. While populations of northern elephant seals, California sea lions and harbor seals have increased steadily during the second half of the 1900s, Steller sea lion populations are on the decline (Steward 1997; NOAA 2009).

California Sea Lion: California sea lions (*Zalophus californianus*) are found from British Columbia to Mexico, but is not as common on the north coast as it is south of San Francisco Bay (Daugherty 1979). See Habitat Atlas for haulout sites in the north coast study region.

Steller Sea Lion: The Steller sea lion (*Eumetopias jubatus*) is the only pinniped in the north coast study region on DFG's list of Special Animals (DFG 2009a). Steller sea lion in California are part of the eastern distinct population segment (DPS), which extends from southeast Alaska and British Columbia to California. Sugarloaf Island and Cape Mendocino on the north coast are known to provide essential habitat to eastern DPS as rookery locales (NOAA 2009). Steller sea lions also are known to visit several north coast locations, such as Klamath River mouth, Trinidad Head and Smith River estuary (Monroe et al. 1975) (also refer to Habitat Atlas for known haulout sites in the study region). Steller sea lion populations are known to fluctuate with abundances of Pacific herring (*Clupeidae*) (Sigler and Csepp 2007).

Pacific Harbor Seal: Pacific harbor seals **(***Phoca vitulina richardsi*) range from the Bering Sea south to Monterey County (Daugherty 1979) and are common in nearshore areas and bays throughout the study region (refer to Habitat Atlas for haulout sites on the north coast). Habitat use has been documented within the study region at the Klamath River mouth, where seals were found to utilize the river primarily as a refuge (Holzwarth 2001).

Northern Elephant Seal: The Northern elephant seal (*Mirounga angustirostris*) is the largest of all seals, ranging from Alaska to Baja California. Although the California population has steadily recovered since 1980 (when protective legislation was passed), it is fairly uncommon in the study region (refer to Habitat Atlas).

Cetaceans

Historic records show that humpback whales, fin whales, sei whales, blue whales, sperm whales, gray whales, right whales and Baird's beaked whales were hunted within the north coast study region (see Clapham et al. 2006). Additionally, killer whales are sometimes seen from shore in coastal towns and harbor porpoises frequent the nearshore within the north coast study region. See Table 3.2-1 for a list of these cetaceans and their scientific names. Gut contents indicate that sardines (*Clupeidae*) and krill (*Euphausiacea*) are a major food source for humpback whales, whose numbers have declined dramatically from pre-exploitation levels (Clapham et al. 2006). Also, humpback whale populations in the north Pacific have been found to fluctuate with Pacific herring, which serve as a food source for the whales (Sigler and Csepp 2007).

Table 3.2-1: Some cetacean species of the north coast study region

Common Name	Scientific Name
Gray whale	*Eschrichtus robustus*
Humpback whale	*Megaptera novaeangliae*
Blue whale	*Balaenoptera musculus*
Fin whale	*Balaenoptera physalus*
Sperm whale	*Physeter macrocephalus*
Baird's beaked whale	*Berardius bairdii*
Killer whale	*Orcinus orca*
Sei whale	*Balaenoptera borealis*
Right whale	*Eubalaena glacialis*
Harbor porpoise	*Phocoena phocoena*

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4 Land-Sea Interactions

Important land-sea interactions occur across variable time scales and wide geographic ranges. The type and intensity of land-sea interactions significantly varies among the coastal region depending on a unique combination of factors. Abiotic factors include climate, geomorphology, ocean currents, and while biotic factors include land use and other activities. Studying associations between watersheds and coastal waters from multiple perspectives and beneficial uses—biological, ecological, human, etc.—helps managers understand how modification of these linkages may impact the effectiveness of an MPA or MPA network in meeting its objectives. These complex interactions at the land-sea interface can be beneficial (e.g., critical riverine and estuarine nursery habitats for coastal marine and anadromous species) or detrimental (e.g., point and nonpoint sources of pollution) (Stoms et al. 2005).

Many associations exist between coastal watersheds and coastal and marine waters. Episodic and seasonal factors influence terrestrial input to marine environments. In the north coast study region, nutrient loading from terrestrial sources can be significant at local scales especially during high flow periods. Substantial net export from rivers and estuaries to the ocean usually occurs during the rainy season and primarily during storm events (Coastal Reserves Working Group, 2005).

Four main classes of land-sea interaction should be considered when examining the effects of land use on the marine ecosystems of California's north coast:

- watershed processes and the export of sediment and materials of terrestrial origin to estuaries and the ocean (particularly nutrients, persistent toxic chemicals, and pathogens)
- sediment input from coastal erosion, landslides, and disposal
- use of land and streams by marine-dependent species (e.g., steelhead migrations, harbor seal haulouts, sea bird rookeries)
- socioeconomic interactions between land and sea at the coastal margin where degraded water and sediment quality (e.g., leading to beach closures or seasonal bans) may affect ecotourism and management of environments

These four classes of land-sea interactions specifically affect nearshore and estuarine dependent species and habitats as well as marine species that spend some portion of their life cycle on land or freshwater (Coastal Reserves Working Group, 2005).

Understanding land-sea interactions may provide important input to the design of MPAs, and help MPA managers prevent future degradation of protected areas. Impacts on coastal watersheds (i.e. a stream or estuary) have repercussions for the entire coastal ecosystem. Estuaries and bays are particularly vulnerable to development, pollution, and introduction of invasive species.

The following sections discuss the importance of these watershed-coastal water associations, the effect of land use and watershed modification on rivers and coastal waters, and important regional programs related to coastal water quality.

4.1 Ecological Linkages

Watersheds and coastal waters have many complex ecological linkages and associations. Watersheds carry nutrients, sediments and fresh water to bays, estuaries and the ocean. In northern California, urban and agricultural areas have significantly changed the nature of many watersheds. Many rivers and streams, for example the Smith River, have been affected by dike construction, which affects transport of sediment, nutrients and pollution to coastal environments. Numerous

smaller streams and rivers flow into small estuaries, in which mixing and dilution occur. Many of the estuaries, embayments, coastal lagoons, and remaining wetlands have high importance relative to their small size and the number of resident migrating species (see section 3.1.3). Studies have shown that some species, including flatfish, rely on intricate associations between estuarine and coastal environments during different life stages (Brown 2006).

Some examples of critical ecological associations along the north coast study region are described below for selected marine species.

- **Marine fish** such as sole, sablefish, hake, and rockfish, live as adults on the continental shelf and slope or in submarine canyons. They produce pelagic larvae that recruit to estuaries, bays, kelp forests, rock outcrops and cobble fields. Eelgrass beds are important for spawning and juvenile habitat for certain species, such as shiner perch and barred sand bass (Valle et al. 1999; Allen et al. 1995; Hart 1973). The structure of eelgrass beds provides protection from predation for juvenile invertebrates and fishes. Bat rays, leopard and smoothhound sharks, plainfin midshipman, staghorn sculpin, several surf perch, jacksmelt, and topsmelt mate and bear their young in estuarine habitats.
- **Anadromous fish** produce eggs and juveniles in fresh water. The juveniles then pass through estuarine environments to mature at sea and return through the estuaries as adults to migrate upstream in coastal rivers to reproduce. Rivers within the north coast study region, such as the Eel River and Klamath River, once supported large numbers of anadromous species. However, due to degradation of watersheds and freshwater ecosystems and the presence of barriers to fish passage, stocks of native anadromous fish, such as steelhead trout, Coho and Chinook salmon, Pacific lamprey and sturgeon, are limited in northern California.
- **Shorebirds and waterfowl**, such as Black-bellied Plover, Marbled Godwit, Long-billed Curlew, Ruddy Duck, Brant, and Canada Goose, in addition to special-status species such as Western Snowy Plover inhabit coastal lagoons, estuaries, and salt marshes as well as areas near sandy beaches. Large numbers of shorebirds and diving ducks are attracted to eelgrass beds, where they feed on the eelgrass, fish, and invertebrate eggs and young. Many bird species use salt marshes, shallow intertidal flats, and lagoons during their annual migrations. The estuaries, bays and sandy beaches of coastal California form part of the Pacific Flyway, one of the four principal bird migration routes in North America.
- **Marine mammals**, such as California sea lions, Stellar sea lions, northern elephant seals, and harbor seals, have many haulout sites, as well as a few rookeries, on secluded rocks and sand beaches, tidal flats, and estuaries in the region.
- **Coastal and estuarine vegetation** include plants such as macroalgal mats, Humboldt cordgrass (*Spartina densiflora*), pickleweed (*Salicornia virginica*) and eelgrass (*Zostera marina*). Macroalgal mats composed primarily of *Ulva* and *Enteromorpha* spp., may be carried on tides or currents to the open ocean, where they provide shelter and food for numerous organisms, notably juvenile fishes. Eventually, these mats may wash up on shore, where they supply nutrients to sandy beach and rocky intertidal communities.

Understanding associations between watersheds and coastal waters may help to inform MPA planning for resource protection and recreation and other uses, as well as take into account land use impacts and existing water quality conditions.

4.2 Coastal Watersheds and Land Use

For the purpose of the MLPA Initiative, watersheds are described using a classification system developed by the California Department of Water Resources, which identifies surface waters by hydrologic units, areas, and subareas. Specifically, hydrologic units are defined as surface drainage divides, which include the total watershed area, both water-bearing and non-water-bearing formations, and two or more small contiguous watersheds with similar hydrologic characteristics draining from one mountain body (RWQCB 2007). The north coast study region extends for over 640 miles along the Californian coast, includes 1,023 square miles of ocean, and drains over 10,000 square miles from the 19 hydrologic units or major watersheds.

A variety of land uses can have negative impacts on adjacent coastal and estuarine water, including urban and rural developments, agriculture, timberlands, commercial and industrial (Clark 1996). Impacts may result, but are not limited to nutrient loading and associated eutrophication, runoff, siltation, habitat loss, and decrease in fish populations. However, other land uses, such as open space, can serve as a buffer and reduce terrestrial impacts on nearby water bodies. The California Environmental Quality Act (CEQA) is the state law that requires state and local agencies to identify and reduce, if feasible, the significant, negative environmental impacts of land use decisions.

4.3 Coastal Water Quality

Coastal water quality information is important in MPA planning to ensure that the state of an area's water quality can be considered in MPA siting. *The Water Quality Control Plan for Ocean Waters of California* (California Ocean Plan) was prepared by the State Water Resources Control Board (SWRCB) in 1972. It is regularly updated and was most recently reviewed in 2009. This plan establishes water quality standards for ocean waters, and the requirements and management of waste discharge to the ocean. The California Ocean Plan also identifies specific beneficial uses, water quality objectives, effluent limitations, monitoring program requirements, and regulation of Areas of Special Biological Significance (ASBS), which are a subset of the recently formed state water quality protection areas (SWRCB and CEPA 2009). Additional water quality regulations can be found in the following locations: the SWRCB Thermal Plan; California's Porter-Cologne Water Quality Act; the Federal Clean Water Act; the Federal Marine Protection, Research and Sanctuaries Act; the Coastal Zone Management Act; and the California Toxics Rule. Taken together these regulations establish water quality standards for all coastal, bay, lagoon and estuarine waters in the State of California.

Included under the umbrella of the SWRCB are nine regional boards throughout the state, each of which monitors a separate SWRCB region. The North Coast Regional Water Quality Control Board (RWQCB) manages Region 1, which is constituted by the North Coast Basin and the Klamath River Basin. This regional board extends from the California-Oregon border to the mouth of Tomales Bay (Marin County), which is south of the north coast study region boundary.

Each RWQCB has a unique "water quality control plan" (or "basin plan"), which contains three main types of information. First, each plan lists all of the water bodies in the region and the beneficial uses designated for those water bodies (e.g., recreation, wildlife, spawning, etc.). Second, each plan defines the water quality that must be maintained to support those beneficial uses. Last, each basin plan contains an implementation plan that describes the various regional programs, projects, and other actions that are necessary to achieve the water quality standards established in the plan. Beneficial uses along with the numeric or narrative objectives established to protect those uses jointly constitute federal water quality standards. These implementation plans include a description of nonpoint source programs, such as the Water Discharge Program implementation and municipal wastewater management, as well as regional surveillance and monitoring programs and models,

such as the Toxic Substances Monitoring Program. For more information on the basin plans in the north coast, visit the RWQCB's website at http://www.waterboards.ca.gov/plans_policies.

4.3.1 Point Sources

There are specific locations (point sources) where industrial pollution enters coastal waters; these are generally regulated by state or federal agencies. These point sources include municipal wastewater treatment and disposal systems and industrial sites, such as desalination plants, power plants, aquaculture sites, and research marine laboratories. In the north coast study region, there are 7 municipal wastewater treatment plants, 1 power plant, and 3 other permitted pollution discharge sites whose effluents include marine lab waste seawater, sawmill wastewater, and fish offal from a fish cleaning station (Table 4.3-1).

Table 4.3-1: Pollutant point sources

Point source	Effluent
Municipal Wastewater Treatment Facilities	
City of Crescent City Publicly Owned Treatment Works	Treated sanitary wastewater
National Park Service Requa Waste Water Facility	Treated sanitary wastewater
City of Arcata Waste Water Treatment Plant	Treated sanitary wastewater
City of Eureka Elk River Waste Water Treatment Plant	Treated sanitary wastewater
Shelter Cove Publicly Owned Treatment Works	Treated sanitary wastewater
Fort Bragg Waste Water Treatment Plant	Treated sanitary wastewater
Mendocino City Community Services District	Treated sanitary wastewater
Industrial-Power Plants	
Humboldt Bay Power Plant	Cooling water
Other Industrial Permitted Discharge Sites	
California State University Humboldt Marine Lab	Marine lab waste seawater
Sierra Pacific Industries Arcata Division Sawmill	Industrial wastewater
Humboldt Recreation District Fish Cleaning Station	Fish offal

Source: State Water Resources Control Board 2009.

Stormwater Discharge

Outfalls for untreated stormwater are another kind of point source within the study region. Stormwater discharge at outfalls can affect water quality as the discharge from outfalls may contain a variety of pollutants, such as bacteria, trash and heavy metals from runoff. These outfalls exist throughout the study region. For example, in the city of Eureka, there are 17 storm drain outfalls located on Humboldt Bay and the surrounding sloughs (Eureka 2005). While stormwater outfalls are considered a point source, they are closely related to non-point source pollution discussed in the following section.

4.3.2 Nonpoint Sources

Nonpoint source pollution is the leading cause of degraded water bodies in northern California and across the country (SWRCB 2004). Unlike point sources, nonpoint source pollution is difficult to control and address because it derives from many diffuse sources. In the north coast study region,

nonpoint source pollution occurs during rain events where runoff moves over the land, picks up and transports pollutants, and deposits them into surface waters (e.g., estuaries, coastal waters, the ocean). Among many other substances, common nonpoint source pollutants are sediment, pesticides, fertilizers, trash, salt, oils, heavy metals, grease, bacteria and nutrients (SWRCB 2000). There are five major categories of nonpoint source pollution: 1) agriculture, 2) forestry operations, 3) urban, 4) hydrologic modification, and 5) marinas and recreational activities (RWQCB 2005). Each of these sources is described below.

Agriculture

The agriculture industry is an essential part of California's economy. The primary crops in the study region are nursery plants, milk and milk products, livestock, fruits, nuts and vegetables. The nonpoint source pollution typically associated with agriculture includes nutrients, animal waste, sediments, and pesticides that enter receiving waters by direct runoff to surface waters or seepage into ground water. These pollutants may degrade aquatic habitats by causing eutrophication, turbidity, temperature increases, toxicity, and decreased oxygen (SWRCB 2008). Agricultural activities are regulated by state and regional water boards through point source and nonpoint source programs (RWQCB 2007). To help address water quality issues related to agriculture, the regional water boards work with local governments to promote the incorporation of Best Management Practices. Best Management Practices along with small grants are part of an incentive approach to encourage growers to reduce runoff and conserve water.

Forestry Operations

Forestry operations are extensive in the study region and may cause erosion, thus increasing sediment concentrations in receiving waters. Other impacts of forestry operations may include increasing water temperatures because of removal of overstory riparian shade, depleting dissolved oxygen because of organic debris, and increasing concentrations of organic and inorganic chemicals because of harvesting, fertilizers, and pesticides (SWRCB 2008). Forestry operations in the north coast study region occur mostly in the form of commercial logging and timberland use conversions (RWQCB 2005). Geologic instability and high precipitation rates concentrated over a few months of the year create naturally high erodibility. When combined with forestry operations, the resulting sedimentation and temperature changes in rivers, streams, and creeks may have detrimental effects on Coho salmon and steelhead trout populations (RWQCB 2007; Young 2000). Many of the coastal streams in the north coast study region are impaired by sedimentation or temperature (e.g. Mattole, Eel, Mad, and Ten Mile rivers).

Urban Areas

Unlike the other regions in the state, the north coast study region is largely undeveloped. Where urbanization occurs, the modification to the land surface caused by that development affects runoff magnitude and type of runoff pollutants (Booth and Jackson 1997). Urban areas include buildings, roads, parking lots, and other residential, industrial or commercial paved surfaces. Replacement of natural land cover with impervious surfaces increases stream channel erosion, flooding, water contamination, sedimentation, and degradation of aquatic habitat (Center for Watershed Protection 2003). This may result in increased runoff as well as higher concentrations of harmful pollutants within runoff. The pollutants commonly found in the study region's urban runoff are sediment, nutrients, plastics, viruses, pathogenic bacteria, heavy metals, pesticides and petroleum hydrocarbons (SWRCB 2008). Smaller municipalities and road construction also generate urban nonpoint source pollution.

Hydrologic Modification

Floodplains collect water traveling down the watershed and reduce flows. As a result, water and pollutants have the opportunity to settle out and/or infiltrate into the soil (Booth and Jackson 1997). They serve as natural buffers by removing suspended solids and contaminants from the water. In urban settings, where the flood control services of floodplains are lost, hydrologic modifications are used in lieu of the natural feature. In general, hydrologic modifications are designed to control water flow (RWQCB 2007). A number of activities fall within the category of hydrologic modifications, such as alteration of stream and river channels, installation of dams and water impoundments, and dredging (SWRCB 2000).

While hydrologic modifications are intended to address urban flood control, they can lead to degraded water quality (SWRCB 2000). Hydrologic modification can reduce the quality of aquatic habitats by altering temperature and sediment transport (SWRCB 2008).

Ports, Harbors, Marinas and Associated Vessels

Marinas and other embayments, along with associated vessels, can have adverse impacts on water quality, as most pollutants are directly discharged into the water (SWRCB 2008). In the north coast study region, recreational boating is an important activity with social and economic benefits, and pleasure boats make up 97% of the vessels in the study region (CADMV 2008, Rust and Potepan 1997). Boating-related activities also can cause water pollution from antifouling paint, sewage, spills, wastewater and trash (SWRCB 2008).

Antifouling paint used on boat hulls to reduce fouling growth contains harmful chemicals, such as copper and lead (EPA 1993; Carson et al. 2002). These chemicals can have adverse effects on aquatic species (e.g., mussels, sea urchins) by impeding growth, reproduction, spawning, eating and survival (Carson et al. 2002). Efforts are in place to transition boats over to non-metal antifouling paints.

Commercial vessels are another potential source of pollution. There are a number of different types of commercial craft, such as ferries, tugs, crew and supply boats, commercial fishing vessels, and boats for charter fishing and other excursions. In 2004, roughly 86 commercial vessels identified their home port within northern California (ARB 2004). The historical number of oil spills along the Pacific Coast is small, but the potential size and impact of such a spill on the marine environment can be significant (MBNMS 2006).

Ballast water from commercial vessels and cruise ships, which is regulated by the State Lands Commission, also may be a source of pollution as well as non-indigenous species. Non-indigenous species are organisms not native to an area, which can cause negative effects on the marine environment once established (Falkner et al. 2006). Some known non-indigenous species associated with ballast waters in California include the Zebra mussel, Chinese mitten crab, and European green crab (Falkner et al. 2006). The European green crab was first detected in Humboldt Bay in 1995. By 1998, large numbers were found in areas where their habitat and feeding preferences overlap those of native species, primarily Dungeness crab (Foss 2006). The green crab is a voracious predator and has been listed as one of the World’s 100 Worst Invasive Alien Species by the Invasive Species Specialist Group (Foss 2006).

4.3.3 Impaired Water Bodies in the North Coast Study Region

When a water body does not meet established water quality standards, it is placed on an impaired waters list mandated by §303(d) of the federal Clean Water Act. For this reason, this list is often called the 303(d) list, and waters on this list are referred to as “impaired” waters. States are required

to update this list every two years and work towards resolving problems associated with the listed water bodies. Typically, a total maximum daily load (TMDL) is developed for each impaired water body. A TMDL determines the total amount of the pollutant/stressor (e.g. pathogens, sediment, nutrients) that the water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources (EPA 2008). An implicit or explicit margin of safety also is factored into this analysis. The TMDL then allocates the allowable loading to all point and nonpoint sources to the water body and establishes an implementation plan to ensure that the allocations and water quality standards are achieved.

Based on the data from 2006, 34 water bodies in the north coast study region are designated as impaired. Illustrative examples of the water bodies in the north coast study region for which TMDLs have been established include the following:

Eel River: Seven impaired bodies of water are associated with the Eel River Hydrologic Unit(HU), including the Eel River Delta and the Middle Fork, South Fork, and North Fork Hydrologic Areas (HA). The Eel River flows from southeastern Mendocino County through southern Humboldt County to the Eel River Delta 10 miles south of Humboldt Bay (SWRCB 2006). Its watershed provides habitat for fish and wildlife, including threatened or endangered salmonids, and humans make municipal, agricultural, and recreational uses of it. The Eel River has a TMDL listing for temperature and sedimentation and siltation (SWRCB 2006). The temperature impairment stems from channelization, removal of riparian vegetation, habitat modification, and from unspecified nonpoint sources. A number of factors contribute to the sedimentation/siltation impairment, including construction, land development, range grazing of riparian and upland habitats, silviculture, logging road construction and maintenance, and unspecified nonpoint sources (SWRCB 2006; CCC 2006).

Redwood Creek: The mouth of Redwood Creek is located about 8 miles south of the Humboldt-Del Norte County border and is listed as a TMDL site for temperature. Timber harvesting, road building, grazing, and the construction of levees in the lower 3.5 miles of the creek are contributing factors to the temperature impairment. Redwood Creek supports an anadromous fishery, and the estuary is important for juvenile salmonid rearing. Declines in salmonid population in Redwood Creek have been attributed to the elevated water temperatures (SWRCB 2006; CCC 2006).

Klamath River: Seven impaired bodies of water are associated with the Klamath River Hydrologic Unit, including portions of the Lower and Middle Hydrologic Areas. The Klamath River is the second-largest river by volume in California and is listed as a TMDL site primarily for nutrients, organic enrichment, and temperature. The nutrients and organic enrichment impairments are attributed to agricultural, municipal, and industrial land uses as well as a number of other point and nonpoint sources. The temperature impairment stems from habitat modification, including upstream impoundment and the removal of riparian vegetation, and unspecified nonpoint sources (SWRCB 2006; CCC 2006).

Table 4.3-2 shows impaired water bodies in region 1 that fall within or drain into the study region. Other information provided includes: pollutants/stressors and general source of impairment. More information on these water bodies is available at http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/303dlists2006/epa/r1_06_303d_regtmdls.pdf.

Table 4.3-2: Impaired water bodies in SRWCB Region 1

Name	Pollutant/Stressor	Source
Mattole River (Mattole River HA)	Temperature	RG, S, road const., HM, RRV, Natural, NPS
Clam Beach	Indicator bacteria	Unknown

Name	Pollutant/Stressor	Source
Eel River Delta (Lower Eel River HA)	Sed./Silt., Temp.	RG, S, NPS, RRV
Eel River (Middle Fork HA)	Temperature	RRV, NPS
Eel River (Middle Main HA)	Sed./Silt., Temp.	RG, S, Harv., Rest., Logging road Const., land development, Hydro., HM, RRV, Erosion, UI, D/F wetlands, channel erosion
Eel River (North Fork HA)	Temperature	HM, RRV, SMD, NPS
Eel River (South Fork HA)	Temperature	Hydro., FRM, RRV, Erosion, NPS
Eel River (Upper Main HA)	Sed./Silt., Temp.	Agri., S, Harv., Rest., Logging Road Const., Land Development, RRV, SMD, Erosion, HM, D/F wetlands, NPS, Channelization
Lake Pillsbury (Eel River HU)	Mercury	Inactive mining, Natural, NPS
Elk River	Sed./Silt.	S, Harv., Rest., Logging road const., RRV, SMD, Erosion, Natural, NPS
Freshwater Creek	Sed./Silt.	S, Harv., Rest., Logging road const., RRV, SMD, Erosion, Natural, NPS
Humboldt Bay	DTE, PCB	Unknown
Jacoby Creek watershed	Sediment	S, Road const., Land development, urban runoff, Hydro., Channelization, RRV, SMD, D/F wetlands, Erosion, Natural, NPS
Butte Valley HA	Nutrients, Temp.	NPS
Tule Lake and Mt Dome HAS (Lost River HA)	Nutrients	Agri., SCP, Water Diversions, HM, RRV, D/F wetlands, Natural, NPS
Klamath Glen HAS (Lower Klamath River HA)	Nutrients, Organic Enrichment/LDO, Sed./Silt., Temp.	PS, Agri., ICP, SCP, RG, Animal Feeding, UI, FRM, out-of-state source, HM, RRV, Erosion, Hydro., Dam Const., Water Diversions
Iron Gate Dam to Scott River (Middle Klamath HA)	Nutrients, Organic Enrichment/LDO, Temp.	NPS, out-of-state, Hydro., UI, FRM, HM, RRV
Oregon to Iron Gate (Middle Klamath HA)	Nutrients, Organic Enrichment/LDO, Temp.	PS, Agri., SCP, Natural, NPS, ICP, RG, UI, FRM, out-of-state, Hydro.
Scott River to Trinity River (Middle Klamath HA)	Nutrients, Organic Enrichment/LDO, Temp.	PS, Agri., Natural, NPS, out-of-state, UI, FRM, Hydro., Channelization, Dam Const., Water Diversions, HM, RRV, SMD, D/F wetlands
Tule Lake and Lower Klamath Lake NWR	pH (high)	NPS, Internal Nutrient Cycling
Luffenholtz Beach	Indicator bacteria	Unknown
Mad River	Sed./Silt., Temp., Turbidity	S,RE, NPS, UI, FRM, HM, RRV
Albion River	Temperature	Unknown
Big River	Temperature	HM, RRV, SMD, NPS, D/F wetlands, Erosion
Navarro River HA	Temperature	Agri., RE, FRM, Water Diversions, RRV, SMD, D/F wetlands, NPS
Noyo River	Temperature	Unknown
Pudding Creek (Noyo River HA)	Temperature	Unknown
Ten Mile River	Temperature	HM, RRV, SMD, NPS
Moonstone County Park	Indicator bacteria	Unknown
Redwood Creek	Temperature	Logging Road Const., RRV, SMD, Erosion, Natural, NPS
Trinidad State Beach	Indicator bacteria	Unknown

Name	Pollutant/Stressor	Source
Trinity Lake (was Claire Engle Lake)	Mercury	Unknown
Trinity River (South Fork HA)	Temperature	RG, Water Diversions, HM, RRV, SMD
Trinity River (East Fork, Upper HA)	Mercury	Unknown

Source: State Water Resources Control Board, 2006.

Note: Agri.= Agriculture, D/F wetlands= Drainage/Filling of Wetlands, DTE= Dioxin Toxic Equivalents, FRM= Flow Regulation/Modification, HA = Hydrologic Area, Harv.= Harvesting, HM= Habitat Modification, Hydro.= Hydromodification, HU = Hydrologic Unit, ICP= Irrigated Crop Production, LDO= Low Dissolved Oxygen, Natural= Natural Source, NPS= Nonpoint Source, PCB= Polychlorinated biphenyls, PS= Point Source, RE= Resource Extraction, Rest.= Restoration, RG= Range Grazing, Road Const.= Road Construction, RRV= Removal of Riparian Vegetation, S= Silviculture, SCP= Specialty Crop Production, Sed./Silt.= Sedimentation/Siltation, SMD= Streambank Modification/Destabilization, Temp.= Temperature, UI= Upstream Impoundment, Unknown = Unknown Source.

4.3.4 Existing Water Quality Protection Designations

A number of different water quality designations exist in California. These designations include: state water quality protection areas, Areas of Special Biological Significance, and critical coastal areas.

State water quality protection areas (SWQPAs) are “designated to protect marine species or biological communities from an undesirable alteration in natural water quality…” (Public Resources Code Section 36700[f]). SWQPAs are one of six categories of managed areas described in the Marine Managed Areas Improvement Act. (The other categories under the Marine Managed Areas Improvement Act include the following: state marine reserve, state marine park, state marine conservation area, state marine cultural preservation area, and state marine recreational management area.) The SWRCB designates SWQPAs, under which waste discharge is prohibited. At this time, all SWQPAs are also Areas of Special Biological Significance (ASBSs). ASBSs were established through the California Ocean Plan and are considered a subset of the SWQPAs (SWRCB and CEPA 2009). Individuals may nominate areas for designation as an ASBS. Areas proposed for ASBS designation should have the potential to benefit from protection beyond that offered by standard waste discharge restrictions and other measures.

There are four existing ASBSs in the study region (Table 4.3-3, see also the *Coastal Management & Human Uses Atlas*), totaling 137.19 square miles in area (SWRCB and CEPA 2009).

Table 4.3-3: Areas of special biological significance (ASBS)

ASBS Site	Area (mi^2)	SWQPA ID Number
Jughandle Cove	0.32	1
Trinidad Head	0.46	6
King Range	39.15	7
Redwood National Park	97.26	8

Source: SWRCB and CEPA 2009 (The Ocean Plan).

Note: All the ASBS sites listed are also SWQPAs.

California critical coastal areas (CCAs), designated by the California Coastal Commission, significantly overlap with SWQPAs. These CCAs serve the dual goals of “improving degraded water quality, and providing extra protection from nonpoint source pollution to marine areas with recognized high resource value” (CCC 2002). Fourteen areas in the north coast study region have been designated as CCAs (Table 4.3-4) (CCAs not also designated as SWQPAs are notated by *

following the name). This list of CCAs includes “impaired water bodies” identified in the section 303(d) list, as well as marine managed areas, wildlife refuges, waterfront parks, and beaches and ASBSs.

Table 4.3-4: Critical coastal areas (CCAs)

Critical Coastal Area Name	CCA ID Number
Klamath River	1
Redwood Creek	2
Redwood National and State Park	3
Kelp Beds at Trinidad Head	4
Mad River*	5
Eel River*	6
Mattole River*	7
King Range National Conservation Area	8
Noyo River*	10
Pygmy Forest Ecological Staircase	11
Big River*	12
Albion River*	13
Navarro River*	14
Garcia River*	15

Source: CCC 2002 and 2006.

*Note: * indicates which CCAs not designated as SWQPA.*

4.4 Coastal Energy Projects

Coastal energy projects may have effects on the marine ecology of the study region by impacting water quality, oceanographic patterns, habitat suitability, and other environmental conditions. (Cada et al. 2007; Ferry-Graham et al. 2008) Some of these energy projects are briefly described below and may be considered in MPA planning.

Electric Generating Plants

Many large coastal power plants (at least 50 megawatts of generating capacity) use a once-through cooling system that withdraws water from nearby open water source such as a bay, estuary, or ocean (Ferry-Graham et al. 2008). California coastal power plants are permitted to withdraw and discharge approximately 16,700 million gallons of cooling water per day. Generating electricity involves burning fuel in a boiler to turn water into superheated steam. The spent steam is condensed back into water, often using ocean water to absorb the heat. The heated ocean water is then discharged back to the ocean up to 20 degrees warmer than when it was withdrawn. This withdrawal and discharge of cooling water has an impact on ocean organisms and habitats. For instance, drawing water from coastal waters can lead to impingement and entrainment. Impingement means aquatic organisms are trapped against or within components of the cooling system. Entrainment means aquatic organisms are drawn through the cooling system. Impingement usually affects larger organisms such as fish that are trapped within or against the cooling water system structures and either die of starvation or exhaustion (Ferry-Graham et al. 2008). Entrainment usually kills smaller organisms in early life stages by exposing them to water temperature increases, mechanical damage, and/or toxic stress. For a large power plant, the adverse effects to marine life caused by

entrainment can stretch up to dozens of miles along the coast. Owners of coastal power plants are upgrading their facilities to use systems other than once-through cooling or are experimenting with deterrents to reduce the number of marine organisms in their water intake systems (Ferry-Graham et al. 2008).

In 2006, Pacific Gas and Electric Company filed an Application for Certification with the California Energy Commission to construct and operate the Humboldt Bay Repowering Plant (HBRP) which would replace the existing 50-year-old plant (California Energy Commission 2008). The existing plant comprises two units that have a combined generating capacity of 105 megawatts (MW). The HBRP will utilize a reciprocating engine-generator (air radiator cooling system in a closed loop system similar to an automobile cooling system) with a generating capacity of 163 MW. The newer technology will only use an average of 2,400 gallons of water per day for cooling or other industrial purposes; this is a fraction of the water required for traditional combined-cycle turbine design (California Energy Commission 2008). The new plant will provide a 33% increase in efficiency and reduce the use of ocean water for cooling by almost 2 billion gallons per month over the existing plant. In 2008, the application was approved and the HBRP is scheduled to be operational as early as 2010 (California Energy Commission 2008).

Hydrokinetic Energy

Hydrokinetic technologies produce renewable electricity by harnessing the energy that results from the motion of a body of water (kinetic energy). There are a number of types of water resources from which it is possible to generate electricity from kinetic energy. Capturing the energy contained in near and off-shore waves is thought to have the greatest energy production potential. In the Pacific Northwest alone, wave energy could produce 40-70 kilowatts per meter of western coastline (Bedard 2005). The technologies developed to generate energy from waves and currents, called hydrokinetic energy conversion devices, are generally categorized as either wave energy converters (WEC) or rotating devices. Both categories utilize buoy and/or turbine technologies (Bedard 2005).

While the generation of electricity by hydrokinetic devices does not produce harmful air emissions, further research is necessary to determine what other types of environmental impacts may result from trapping the energy in waves and currents. Some of the concerns associated with a full-scale array of hydrokinetic devices include fish strike or impingement, sediment disruption, noise, and the potential to hinder movements of aquatic species (Cada et al. 2007).

Currently, preliminary permits have been issued for the development of hydrokinetic technologies in the north coast study region: Humboldt WaveConnect Pilot Project, and Green Wave Mendocino Wave Park. For the Humboldt WaveConnect Pilot Project, Pacific Gas and Electric has convened a Humboldt Working Group made up of diverse local community, environmental and fishing interests along with the state and federal agencies involved. The company has selected a site for the approximately five-megawatt pilot and is currently working on selecting the three or four wave energy devices to be installed; completing the engineering design; conducting impact analyses; gathering baseline environmental information; preparing an adaptive management and monitoring plan; and submitting all environmental and regulatory permit applications required for the pilot project. The ocean site is an area one-half nautical mile wide and two nautical miles long, where the wave energy converters would be located. From these converters, cables would run to shore to connect to the electric grid. Green Wave Energy Solutions LLC has laid claim to a 17 mi^2 section of ocean off the Mendocino County coast in hopes of eventually testing the feasibility of wave power. The Green Wave Mendocino Wave Park project is still in the preliminary stages of development (PFMC 2009).

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5 Socioeconomic Setting

California's marine and coastal environments form part of the state's identity and support important economies that depend on healthy ocean resources. Socioeconomic conditions affect coastal livelihoods, human activities and patterns of marine resource use. A brief overview of coastal counties, ocean economy, demographics, and resource use in the study region is provided as regional context for MPA planning.

Information provided in this section has been collected from a variety of sources. Data from the U.S. Census Bureau, California Department of Finance, California Employment Development Department, the National Ocean Economics Program, and Dean Runyan Associates were compiled for each county and are discussed below. Furthermore, information has been collected from public documents (general plans, resolutions, etc) related to marine uses from coastal public entities (counties, cities, special districts, parks).

For each county, general economic data on top industries and specialized information on top ocean-related industries is provided. Information describing the overall economy came from the California Employment Development Department. The California Employment Development Department reports on industry sectors identified in the North American Industry Classification System. The specialized information on the ocean-related economy came from the National Ocean Economics Program, which also is based on the North American Industry Classification System. The industry sectors referenced by the two types of information were not necessarily the same because the sectors central to the ocean economy may not have a proportional impact on the overall economy.

The National Ocean Economics Program's Ocean Sector and Industry Data provide information for industries, which depend on and derive their source from the ocean and shoreline. These data are referenced below for up to five ocean industry sectors (as available, and defined by the National Ocean Economics Program), and include the number of establishments, number of people employed, wages paid, and gross state product. The ocean industry sectors include:

1. Coastal Construction (marine construction).

2. Living Resources (fishing, fish hatcheries and aquaculture, seafood markets and seafood processing).

3. Offshore Minerals (limestone, sand and gravel; oil and gas exploration and production)

4. Tourism and Recreation (amusement and recreation services, boat dealers, eating and drinking places, hotels and lodging places, marine, recreational vehicle parks and campgrounds, scenic water tours, sporting good retailers, zoos and aquaria).

5. Transportation (deep-sea freight transportation, marine passenger transportation, marine transportation services, search and navigation equipment, and warehousing).

Please note that recreational fishing is included in the Tourism and Recreation category and not in the Living Resources category. The grouping of these categories was determined by the National Ocean Economics Program and cannot be adjusted for the purposes of this planning process.

Additionally, it is important to look at major coastal cities within the study region when considering socioeconomic factors, as important community-level characteristics may be missed if only county statistics are considered. Therefore, as a means of characterizing the coastal cities' populations and

economic conditions, statistics regarding unemployment rate, income level and percentage of population below the poverty level are provided for each county.

5.1 Coastal Counties

There are three counties in the north coast study region. They are briefly discussed below, ordered from north to south. It should be noted that individuals residing outside of these three counties may utilize marine resources within the north coast study region. Detailed economic data are not provided for areas outside of these three coastal counties, though it should be recognized that the socioeconomic influence of resources within the north coast have broader effects.

5.1.1 Del Norte County

Del Norte County, at 2000 mi^2 in area, is the smallest county in the north coast study region (Census 2009). Del Norte is also the region's least populous county (see section 5.1.4 for population projections). The county's largest coastal community is Crescent City (see Table 5.1-1).

The service industry, which includes tourism, is the largest industry in Del Norte's general economy, employing 7,570 people in October 2009 (EDD 2009). Travel-related spending in 2007 accounted for $101.9 million in sales in Del Norte County (Dean Runyan Inc. 2009).

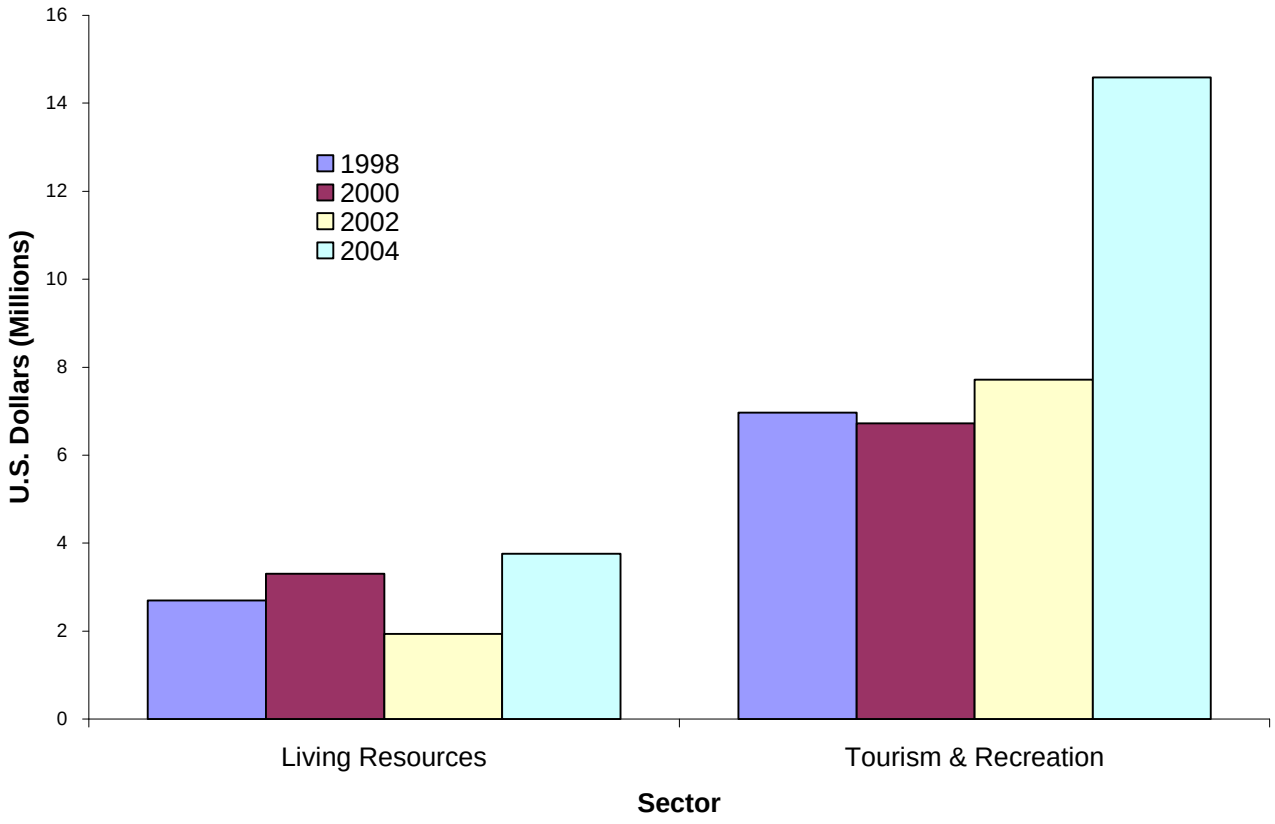
In addition, economic information was gathered for the ocean-related sectors found in the study region. These sectors, which depend upon ocean resources, include construction, living resources, minerals, ship and boat building, tourism and recreation, and transportation. Wages by sector provide an economic comparison of how important each sector is in any given county. Note that not all sectors are represented in the counties. In Del Norte County, tourism and recreation and living resources are the two sectors that contribute most to the ocean economy, with tourism and recreation providing the highest economic contribution (see Figure 5.1-1).

Table 5.1-1: Del Norte County: Coastal cities, populations and economic characteristics

City	Total Population (2008 Estimate)	Unemployment Rate (2000)	Per Capita Income (1999)	Median Household Income (1999)	Percent Below Poverty (1999)
Crescent City	7,852	6.5%	$12,833	$20,133	34.6%

Source: U.S. Census Bureau 2009

Figure 5.1-1: Del Norte County ocean economy wages by sector (1998-2004, even years)



Source: National Ocean Economics Program 2009

Note: Living Resources and Tourism & Recreation were the only sectors with available data

5.1.2 Humboldt County

Humboldt County is the largest county by area in the study region, at approximately 3,509 mi^2. It also has the highest population of all the counties in the region, at 132,755 people (CDF 2009). The largest coastal communities in Humboldt County are Trinidad and Eureka, Eureka being the larger (refer to Table 5.1-2).

Humboldt County's service-providing industry, which employs 40,300 as of October 2009, is the largest industry in Humboldt's general economy (EDD 2009). The travel industry accounted for $294 million in sales generated by visitor spending in 2007 (Dean Runyan, Inc. 2009).

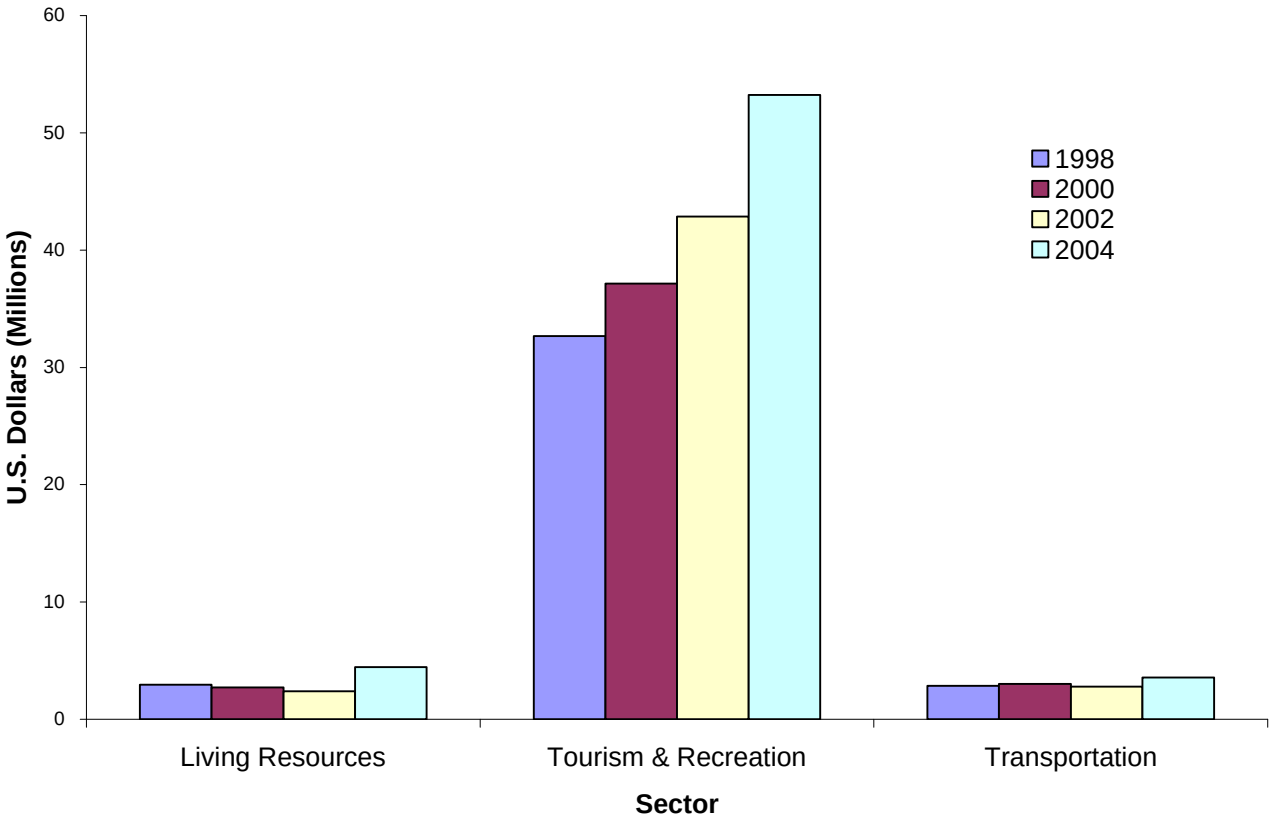
The tourism and recreation sector of Humboldt County's ocean-based economy has increased from 1998 to 2004, generating over $50 million in wages in 2004. Tourism and recreation contributed substantially more to Humboldt's ocean-based economy than either living resources or transportation, the latter two sectors contributing less than $5 million in wages over the same seven year period (see Figure 5.1-2).

Table 5.1-2: Humboldt County: Coastal cities, populations and economic characteristics

City	Total Population (2008 Estimate)	Unemployment Rate (2000)	Per Capita Income (1999)	Median Household Income (1999)	Percent Below Poverty (1999)
Eureka	25,300	5.5%	$16,174	$25,849	12.4%
Trinidad	310	3.7%	$28,050	$40,000	8.8%

Source: U.S. Census Bureau 2009

Figure 5.1-2: Humboldt County ocean economy wages by sector (1998-2004, even years)



Source: National Ocean Economics Program 2009

Note: Living Resources, Tourism & Recreation and Transportation were the only sectors with available data

5.1.3 Mendocino County

Mendocino County encompasses 3,510 square miles, making it the second in size among the three counties in the north coast study region (Census 2009). However, only the portion of Mendocino County north of Alder Creek near Point Arena lies within the study region. The largest coastal communities in this county are Fort Bragg and Point Arena (see Table 5.1-3).

Employment in Mendocino's general economy is highest in the service providing industry, which employs 24,180 people as of October 2009 (EDD 2009). The travel industry specifically accounted for $326.1 million in visitor spending in 2007 (Dean Runyan, Inc. 2009).

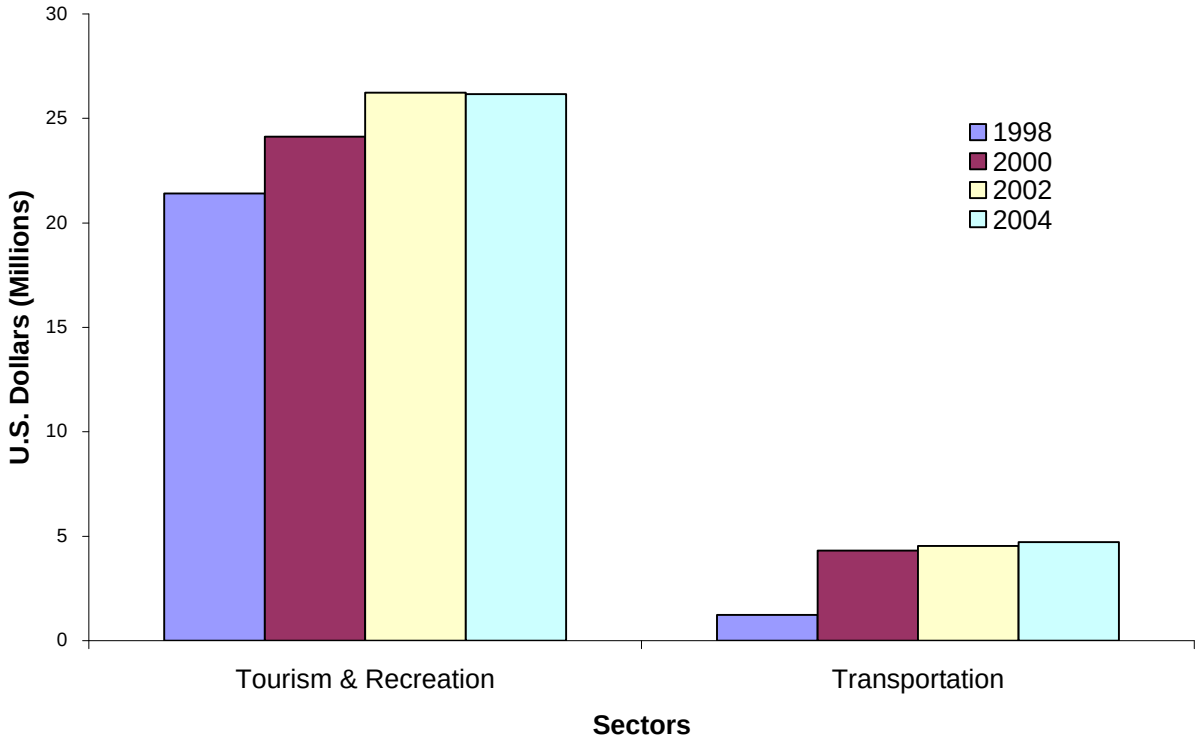
The ocean-based economy in Mendocino County consists primarily of two sectors: tourism and recreation, and transportation. The tourism and recreation sector has accounted for over $25 million in wages annually from 2002-2004 (see Figure 5.1-3). Comparatively, the transportation sector of the ocean-based economy in Mendocino County accounted for under $5 million annually from 2000-2004.

Table 5.1-3: Mendocino County: Coastal cities, populations, and economic characteristics

City	Total Population (2008 Estimate)	Unemployment Rate (2000)	Per Capita Income (1999)	Median Household Income (1999)	Percent Below Poverty (1999)
Fort Bragg	6,604	5.3%	$15,832	$28,539	20.4%
Point Arena	460	2.1%	$12,591	$27,083	26.0%

Source: U.S. Census Bureau 2009

Figure 5.1-3: Mendocino county ocean economy wages by sector (1998-2004, even years)



Source: National Ocean Economics Program 2009

Note: Tourism & Recreation and Transportation were the only sectors with available data

5.1.4 Population Projections

Although 76% of California's total population lives in coastal counties (Kildow and Colgan 2005), the portion of northern California including and inland from the north coast study region does not follow that pattern. Rather, major cities like Redding are situated inland. The result is a relatively rural

coastline. However, two of the three north coast counties' major population centers are on the coast (Crescent city in Del Norte and Eureka in Humboldt). Mendocino's major city, Ukiah is situated inland (CDF 2009).

Population trends in coastal counties may result in increasing pressure on and impacts to coastal and marine resources and habitats. Based on a demographic model that incorporates fertility, migration, and survival rates, population projections indicate that Del Norte County will have the highest percent change in population over the next fifty years. Mendocino County follows Del Norte with almost half the percent change in population (see Table 5.1-4). Humboldt County, with the highest population, is expected to experience the lowest percent population change of the three counties in the north coast study region.

Table 5.1-4: Population, population change and density

Coastal County	Total population 2000	Projected population 2010	Population change (2000-2010)	Projected population 2050	Population change (2000-2050)	Population density in 2000 (people/mi^2)
Del Norte	27,680	30,983	11.9%	56,218	103.1%	29
Humboldt	126,839	134,785	6.3%	152,333	20.1%	36
Mendocino	86,736	93,166	7.4%	134,358	54.9%	25

Sources: Population density: Census 2009; all other: CDF 2007

5.2 Native American Coastal Communities

Native American tribal people, also referred to as Indigenous Peoples, have inhabited the north coast of California for over 12,000 years, and rely on the coast and ocean for a variety of important uses, such as spiritual, ceremonial, cultural, training, travel, subsistence, harvesting, and gathering (Rocha, pers. comm. 2009; Erlandson et al. 2007; Anderson 2006). As an intrinsic part of the ecosystem, Indigenous Peoples strive to steward the environment in a sustainable manner based on their traditional ecological and cultural knowledge (Anderson 2006; Eglash 2002; Heizer and Elsasser 1980). In the north coast study region, there are a number of tribes located adjacent to the coast. Tolowa, Yurok, Wiyot, Mattole, Sinkyone, Yuki and Pomo have ancestral territories directly adjacent to the coast. Other tribal groups such as Hoopa and Karuk have coastal interests but not a direct land link to the coast (NAHC 2009; Wiki, pers. comm. 2009).

At the time of the first European contacts in the north coast study region, Indigenous Peoples lived in numerous and well-populated coastal and inland villages. These areas provided abundant food and resources. The ocean and its many marine resources have always been an important part the Native American way of life on the north coast. Despite historic events and policies that sought to remove, colonize, or assimilate Indigenous Peoples, many of the Tribes of the north coast study region continue to reside in or near their homelands, remain culturally intact, and continue many aspects of the traditional lifeways (Rocha, pers. comm. 2009). This has led to culturally, politically and socially strong Tribal organizations that are very much connected to place, although they vary in capacity, membership, land status, government, and structure. Unlike other parts of the California coastline, many tribes own land along the ocean.

5.2.1 Native American Resource Use

Some Native American people have indicated that they are an intrinsic part of the ecosystem, as expressed in their interactions with the land, the ocean, and the various resources and animals

(Eglash 2002). Traditional ecological knowledge has enabled Indigenous Peoples to live off the land for thousands of years, with minimal environmental consequences (Anderson 2006; Heizer and Elsasser 1980). There are many cultural uses of the coast and ocean waters by Indigenous Peoples in California that can be consumptive and non-consumptive. Consumptive uses may be subsistence or ceremonially based, for example. Non-consumptive examples may include use of the viewshed[1] from a particular place for spiritual purposes, and resources needed in creating regalia used for ceremony. Thus, these cultural uses are not recreational or commercial, although commercial fishing does occur. Additionally, specific areas are identified for certain resources and/or uses by a given family, Tribe or group of Tribes, and some maintain that they have aboriginal rights in these areas. Therefore, some Native American people assert that restrictions for these uses cannot be designated in those cultural use areas, often referred to as Traditional Cultural Properties (Rocha, pers. comm. 2009).

Indigenous Peoples depend upon the rich diversity of marine and coastal plant resources as part of their daily lives. Important marine resources include salmon, clams and abalone (as both food sources and for the shells, which are used in ceremonial regalia), mussels, seaweed, eels, crab, rockfish, steelhead, surf fish, candle fish (or eulachon) and sea salt (Young, pers. comm. 2009; Hostler, pers. comm. 2009; Dowd and Dowd, pers. comm. 2009). Subsistence fishing for crab, salmon, surf fish (smelt), mussels and clams occurs regularly from the rocky beaches. Non-plant or animal materials with cultural significance found in the coastal zone include steatite and chert, which are used to make items such as bowls and arrow points, respectively (Verwayen 2007) Historic value is another important consideration. For example, certain areas along the coast are also highly valued for their historic significance, such as submerged buried grounds (Erlandson et al. 2007). These past and present uses are relevant in marine planning, as decisions may affect these traditions.

5.3 Commercial Fisheries

The California Department of Fish and Game (DFG) collects landings data for all commercial fisheries landed at California ports. Landing receipts that report poundage and ex-vessel value (price paid to fisherman) by species and species groups, are submitted to DFG by fish dealers and receivers. The data provided in this section was extracted from the Commercial Fisheries Information System (CFIS), which houses California's commercial landings data. Data are available electronically from this database from 1969 to the present. For purposes of this section, data from the past 10 years were extracted from the CFIS database. Historic data preceding the CFIS database is available on DFG's website at http://www.dfg.ca.gov/mrd/status/index.html.

Species included in analysis: All fish and invertebrate species caught in ocean waters in the study region (i.e., out to three miles) were included in the landings data analysis. Humboldt Bay is within the study region, so the herring fishery is included in the analyses for these ports, but freshwater species were excluded.

Gear Types: A variety of gear types are deployed by commercial fishermen. Some of the gear types utilized in the north coast study region include: trolling gear, pots/traps, long lines, hook-and-line, and hand picking using hookah gear. Trolling, a method of fishing where a line with one or more hooks is towed through the water column by a vessel underway or making way, is utilized in the salmon fishery as well as in the California halibut fishery. Pots, also known as traps, are utilized in

[1] A viewshed is an area of land, water, or other environmental that is visible to the human eye from a fixed vantage point.

both the crab fishery and in the hagfish and sablefish fisheries, and are set on the sea floor and retrieved. Pots used in the Dungeness crab fishery have a device that destructs the pot if the gear is lost. The nearshore finfish and rockfish fishery utilize hook and line (rod and reel) as well as stick gear (described as a vertical longline or set-line). The red sea urchin fishermen dive for urchins using compressed air systems ("hookah") with collection done by hand. Gill nets are also utilized in Humboldt Bay and Crescent City Harbor for the Pacific herring fishery; the ends of the nets are anchored, and a weighted lead line is used to keep the net on the bottom. The use of trawl gear, seine nets, and gill nets other than in the Humboldt Bay and Crescent City Harbor herring fisheries is prohibited inside state waters. However, these gears are used outside of state waters to target species groups like pink shrimp and federal groundfish, which are then landed in ports of the study region.

5.3.1 Port Complexes

For reporting purposes, DFG organizes California ports geographically into nine port complexes along the entire state. California commercial landings from ports within each complex are combined for some tables in public reports to maintain reporting confidentiality. Other tables in public reports may list landings by individual ports provided there is more than one dealer in a port. The north coast study region encompasses two port complexes: Eureka and Fort Bragg. However, the Eureka port complex is reported here by county: Del Norte and Humboldt counties. Also, Point Arena and Anchor Bay, which are the two southernmost ports in the Fort Bragg port complex, are not within the study region. All ports within the study region where landings have occurred are listed by county in Table 5.3-1 with their average weight and value for the last 10 years (1999-2008), at both the county and port complex level.

During the 1999-2008 period, average annual landings in the north coast study region totaled over 13 million pounds with an average annual ex-vessel value of over $24 million (Table 5.3-1). Important ports in the study region in terms of both volume and value are Crescent City, Trinidad, Eureka, King Salmon, Fields Landing, Shelter Cove, Fort Bragg and Albion. The number of fishermen per port complex from 1999 through 2008 can be viewed in Figure 5.3-1 through Figure 5.3-4 and are displayed by port complex and fishery in Appendix B). A 2006 federal socioeconomic study that considered the needs of fishing communities conducted by PFMC and NMFS has listed some ports in the study region as "most vulnerable" and "vulnerable" with high levels of dependence on commercial fishing and low levels of resilience (PFMC & NMFS 2006). Details about fishing communities classified as "most vulnerable" or "vulnerable" are provided in the Fishing Communities section below.

Table 5.3-1: Average annual commercial landings and revenue by county, 1999-2008

Port Complex	Coastal County	Average Annual Landings (lb)	Average Annual Ex-vessel Revenue
Eureka	Del Norte	5,732,041	$11,398,116
Eureka	Humboldt	4,261,690	$7,667,705
Fort Bragg	Mendocino	3,162,283	$5,119,412
	All County Totals	13,156,015	$24,185,233

Note: Dollar values are adjusted for inflation (in 2008 dollars). 2008 data are preliminary (August 25, 2009).

Fishing Communities

A brief profile of each port complex grouping is given below.

Eureka Port Complex

The Eureka port complex includes two counties, Del Norte and Humboldt, and various ports from the California-Oregon border to Shelter Cove (approximately 35 miles south of Cape Mendocino). These components of the Eureka port complex are described below.

Del Norte County – In 2008, there were 117 commercial vessels, 122 commercial fishermen, and 21 processors that reported landings from fisheries in the study region (CFIS, August 2009). The study region's top ten fisheries (see Appendix B.1 for the list of species included in each market category) in these ports during 2008, in order of importance (total value landed), were Dungeness crab, deeper nearshore, coonstripe shrimp, salmon, shallow nearshore, lingcod, skates/rays/sharks, smelt, surfperch, hagfish, and rock crab (note that pink shrimp and trawl fisheries (e.g. slope rockfish) occur outside of state waters and therefore outside the study region. However, these fisheries are still considered economically important to this port complex. There was a single year of box crab landings (2001) that ranked in the top ten fisheries. However, the box crab fishery has not been a primary contributor to the county fisheries over the last ten years. The total value of all landings in 2008 was over six million dollars, with nearly three million pounds landed. In a 2006 federal socioeconomic study to consider the needs of fishing communities, the County of Del Norte was classified as "vulnerable" with high levels of dependence on commercial fishing and low levels of resilience (PFMC & NMFS 2006). The town of Crescent City, located within Del Norte County, was classified as "vulnerable" utilizing the same criteria (PFMC & NMFS 2006).

Humboldt County - In 2008, there were 122 commercial vessels, 137 commercial fishermen, and 43 processors that reported landings from fisheries in the study region (CFIS, August 2009). The study region's top ten fisheries (see Appendix B.1 for the list of species included in each market category) landed in these ports during 2008, in order of importance (total value landed), were Dungeness crab, hagfish, salmon, smelt, deeper nearshore, surfperch, shallow nearshore, lingcod, herring, and rock crab (note that highly migratory (e.g. tuna) and trawl fisheries (e.g. slope rockfish) occur outside of state waters and therefore outside the study region. However, these fisheries are still considered economically important to this port complex). The total value of all landings in 2008 was almost six million dollars, with over three million pounds landed. In a 2006 federal socioeconomic study to consider the needs of fishing communities, the County of Humboldt was classified as "most vulnerable" with high levels of dependence on commercial fishing and low levels of resilience (PFMC & NMFS 2006). The town of Eureka, located within Humboldt County, was classified as "vulnerable" utilizing the same criteria (PFMC & NMFS 2006).

Northern Fort Bragg Port Complex

The Fort Bragg Port Complex includes ports from Westport to Point Arena. However, the ports of Port Arena and Anchor Bay are not within the bounds of the study region. They were included in the Regional Profile for the MLPA north central coast study region. While some landings in these two ports may have been caught within the study region, they have not been included in this section. The remaining ports of the Fort Bragg Port Complex are referred to here as the Northern Fort Bragg Port Complex. In 2008, there were 83 commercial vessels, 89 commercial fishermen, and 26 processors that reported landings in the Northern Fort Bragg Port Complex (CFIS, August 2009). The top ten fisheries (see Appendix B.1 for the list of species included in each market category) landed in these ports from 1999-2008, in order of importance (total value landed), were: Dungeness crab, salmon, red urchin, deeper nearshore, coonstripe shrimp, shallow nearshore, smelt, hagfish, lingcod, and skates/rays/sharks (Note that pink shrimp and trawl fisheries occur outside of state waters and therefore outside the study region, although these fisheries are still considered

economically important to this port complex). Two fisheries ranked in the top ten on average but are not listed above. The jumbo squid fishery occurred in the port complex and landings increased over the past three years (2006-2008) to over $25 thousand in 2007. The spot prawn fishery occurred in a single year (2001) with nearly $24 thousand in value. However, they have not been consistent contributors to the port complex and may be considered pulse fisheries. The total value of all landings in 2008 was over three million dollars, with almost three million pounds landed. In a 2006 federal socioeconomic study to consider the needs of fishing communities, the County of Mendocino was classified as “most vulnerable” with high levels of dependence on commercial fishing and low levels of resilience (PFMC & NMFS 2006). The town of Fort Bragg, located within Mendocino County, was classified as “vulnerable” utilizing the same criteria (PFMC & NMFS 2006).

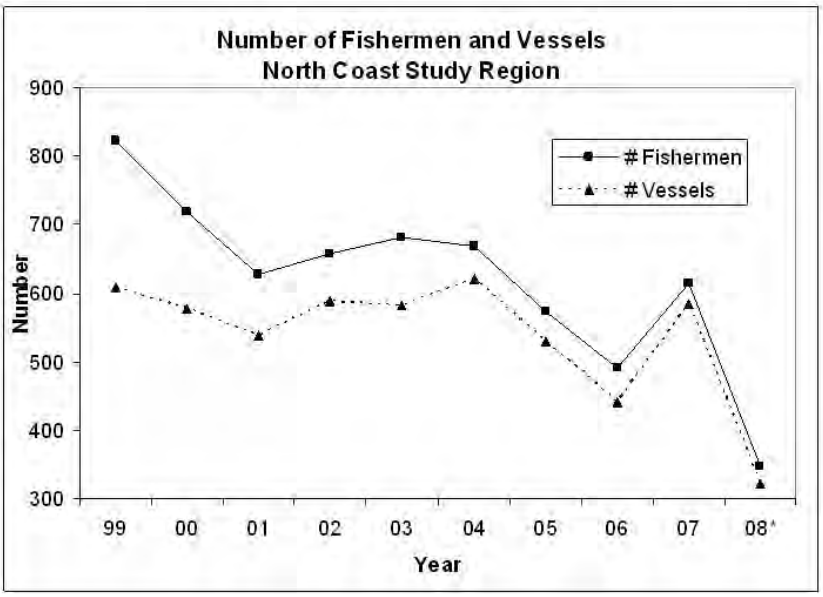
Further Information on Fishing Communities

The *Final Groundfish Essential Fish Habitat Environmental Impact Statement* produced in 2005 (NOAA Fisheries 2005) provides socioeconomic data for fishing communities along the West Coast (California, Oregon and Washington). The document focuses on West Coast fisheries managed federally. Ports included from the north coast study region are: Crescent City, Eureka, and Fort Bragg. Types of socioeconomic indicator data included are summarized within the Environmental Impact Statement in *Socioeconomic Table 4-1: Summary of Criteria for Evaluating Socioeconomic Consequences of the Alternatives*. Components of the socioeconomic environment are: federally managed fisheries, processors and buyers, consumers, safety, management and enforcement, communities, non-market values, and non-fishing values. The table summarizes types of analyses and variables used to assess impact. Additional socioeconomic tables and figures are provided in Appendix E of the environmental impact statement. Links to these sections can be found at http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/NEPA-Documents/EFH-Final-EIS.cfm.

Fishermen and Vessels

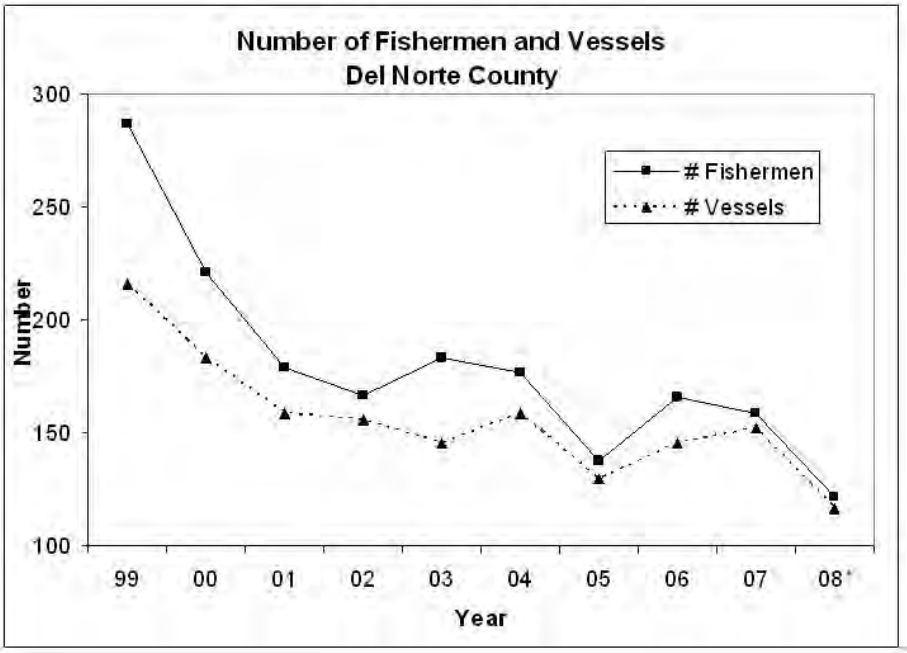
The overall number of commercial fishermen and vessels in the study region has declined for the period from 1999 through 2008 (). The total number of fishermen and vessels by port complex can be viewed in Figure 5.3-2 through Figure 5.3-4. The number of fishermen, by port complex and fishery, can be viewed in Appendix B. The number of fishermen shown in Figure 5.3-2 through Figure 5.3-4, and in Appendix B may not reflect the number of core participants making landings in a port complex or fishery because the numbers reported reflect the total number of fishermen who made at least one landing from study region fisheries for each year.

Figure 5.3-1: Numbers of commercial fishermen and vessels for all ports, 1999-2008



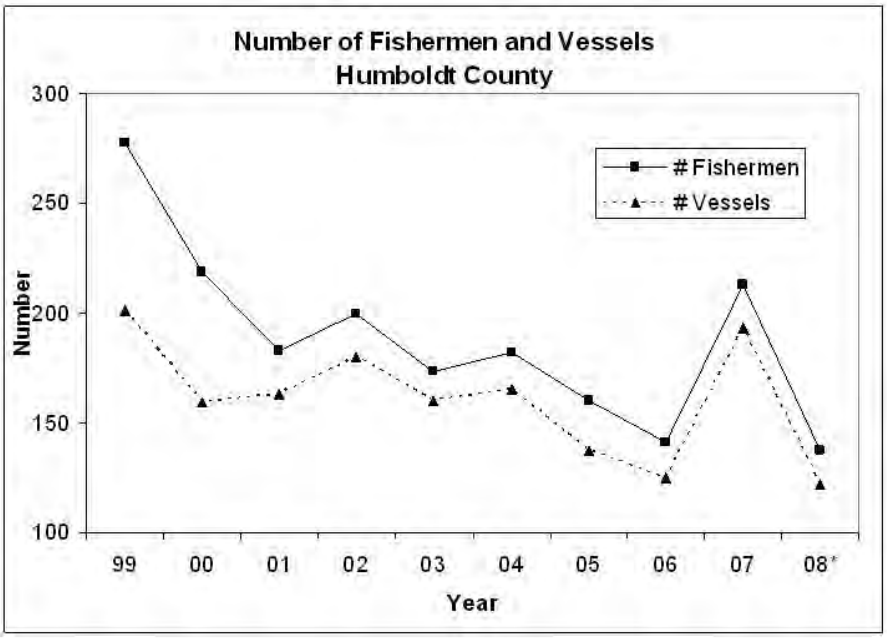
Source: Data were compiled from the Commercial Fishery Information System database (extraction date: August 25, 2009). 2008 data are preliminary.

Figure 5.3-2: Numbers of commercial fishermen and vessels for Del Norte County, 1999-2008



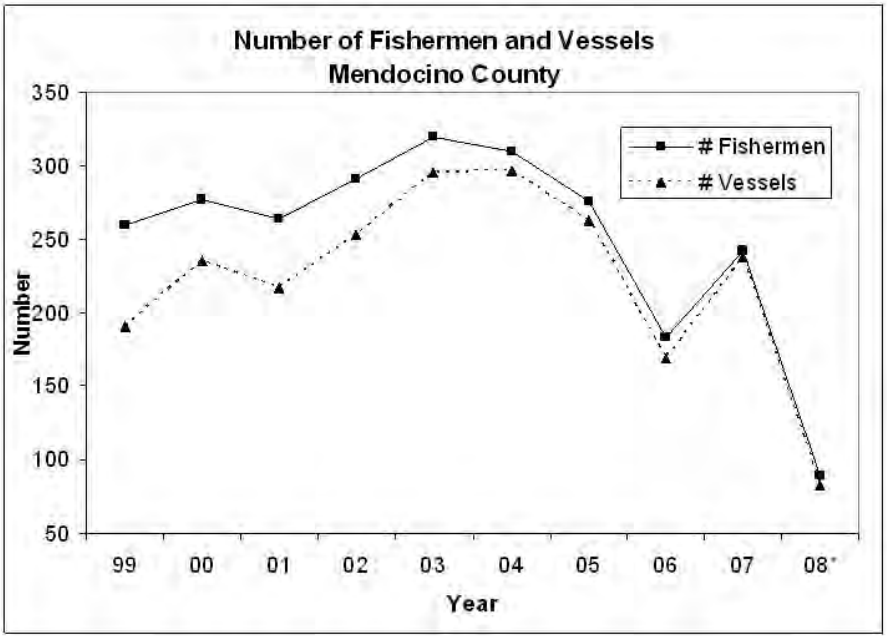
Source: Data were compiled from the Commercial Fishery Information System database (extraction date: August 25, 2009). 2008 data are preliminary.

Figure 5.3-3: Numbers of commercial fishermen and vessels for Humboldt County, 1999-2008



Source: Data were compiled from the Commercial Fishery Information System database (extraction date: August 25, 2009). 2008 data are preliminary.

Figure 5.3-4: Numbers of commercial fishermen and vessels for Mendocino County, 1999-2008



Source: Data were compiled from the Commercial Fishery Information System database (extraction date: August 25, 2009). 2008 data are preliminary.

5.3.2 Description of Commercial Fisheries

This section provides data on the commercial fisheries in the north coast study region. Average annual landings and value of commercial fisheries for the study region, and average annual landings by port complex for the years 1999-2008 are listed in Table 5.3-1. The top ten commercial fisheries by average annual landings compose 99.4% of the total average annual landings (Table 5.3-2) from 1999-2008.

Commercial catch is reported either by species or, in certain cases, “market categories.” Market categories include a variety of similar species, or species commonly sold as a generic category of fish. These numbers attest to the high value and diversity of fishery resources in the north central coast study region. Because market categories may contain multiple species, these numbers do not correspond exactly to the number of species landed. In addition, the landings totals could include species harvested outside of the study region’s boundaries, but landed in study region ports.

Table 5.3-2: Average annual landings (pounds) for principle commercial fisheries by county, 1999-2008

Species and Market Category	Del Norte	Humboldt	Mendocino	Average Annual Landings
Deeper Nearshore[a]	153,571	39,756	8,445	201,771
Dungeness Crab	5,314,046	3,508,692	544,241	9,366,979
Hagfish	7,075	188,924	9	196,008
Herring	4,065	23,254	0	27,319
Lingcod	21,782	7,807	9,814	39,403
Salmon, Chinook	47,968	81,938	825,570	955,476
Shallow Nearshore	13,152	3,743	38,603	55,497
Shrimp, Coonstripe[b]	62,886	455	39	63,380
Skates/Rays/Sharks[c]	22,413	2,671	106	25,190
Smelt[d]	59,240	335,453	5,099	399,792
Surfperch[e]	4,338	18,066	161	22,564
Urchin	3,177	4,779	1,680,318	1,688,274
Total (State waters)	5,713,713	4,215,538	3,112,405	13,041,653
Total (All waters)	12,372,012	16,182,151	7,174,504	35,728,667
Percent of total landings	16%	12%	9%	37%

Notes: 2008 data are preliminary.

[a] *Includes the following rockfish: black, brown, olive, copper, treefish, blue and quillback.*

[b] *Includes cabezon, monkeyface eel, the following rockfish: black-and-yellow, China, gopher, kelp, and grass.*

[c] *Includes all sharks and rays except white shark and big skate*

[d] *Includes jacksmelt, topsmelt, and true, surf and night smelt.*

[e] *Redtail surfperch.*

Table 5.3-3: Average annual ex-vessel revenue in dollars for 1999-2008 for principle commercial fisheries

Species and Market Category	Del Norte	Humboldt	Mendocino	Ex-vessel Revenue
Deeper Nearshore[a]	313,561	63,562	17,842	394,966
Dungeness Crab	10,421,572	7,023,624	1,200,463	18,645,659
Hagfish	2,377	98,561	3	100,225
Herring	1,808	9,650	0	11,459
Lingcod	43,300	13,326	18,600	75,225
Salmon, Chinook	164,226	249,011	2,239,955	2,653,193
Shallow Nearshore[b]	63,407	15,953	212,135	291,496
Shrimp, Coonstripe	290,665	1,906	146	292,717
Skates/Rays/Sharks[c]	34,885	2,259	143	37,287
Smelt[d]	21,526	119,256	2,091	142,873
Surfperch[e]	6,507	23,614	237	30,358
Urchin	2,129	4,664	1,388,166	1,394,959
Total (State waters)	$11,365,963	$7,625,386	$5,079,781	$24,070,417
Total (All waters)	$13,975,615	$13,104,261	$8,226,342	35,306,219
Percent of total landings	32%	22%	14%	68%

Notes: Reported ex-vessel revenue are adjusted for inflation (in 2008 dollars). 2008 data are preliminary.

[a] *Includes the following rockfish: black, brown, olive, copper, treefish, blue and quillback.*

[b] *Includes cabezon, monkeyface eel, the following rockfish: black-and-yellow, China, gopher, kelp, and grass.*

[c] *Includes all sharks and rays except white shark and big skate*

[d] *Includes jacksmelt, topsmelt, and true, surf and night smelt.*

[e] *Redtail surfperch.*

Table 5.3-4: Average annual landings and value for 1999-2008 for major commercial fisheries

Market Category Groupings	Del Norte	Humboldt	Mendocino	Average Annual Landings (lbs) for Study Region	Average Annual Value ($) for Study Region
Crab, Dungeness	5,314,046	3,508,692	544,513	9,367,251	18,646,340
Crab, Rock	800	4,595	374	5,769	10,301
Hagfish	7,075	188,924	9	196,941	100,941
Halibut, California	1	1,076	86	1,162	3,578
Herring	4,065	23,254	0	27,319	11,459
Lingcod	21,782	7,807	9,814	39,403	75,225
Nearshore, Deeper	153,571	39,756	8,445	201,771	394,966
Nearshore, Shallow	13,152	3,743	38,603	55,497	291,496
Octopus	101	30	355	486	395
Pelagic Finfish	508	8,211	14	8,733	2,743
Salmon, Chinook	47,968	81,938	825,570	955,476	2,653,193
Sea Cucumber	0	0	304	304	588
Shrimp, Coonstripe	62,886	455	39	63,380	292,717

Skates/Rays/Sharks	22,413	2,671	106	25,190	37,287
Smelt	59,240	335,453	5,099	399,792	142,873
Spot Prawn	0	76	259	335	3,469
Squid, Jumbo	0	8	23,217	23,225	5,624
Surfperch	4,338	18,066	161	22,564	30,358
Urchin, Red	3,177	4,779	1,680,318	1,688,274	1,394,959
Grand Total	5,715,123	4,229,534	3,137,286	13,156,015	24,185,233
Percent of total landings	43%	32%	24%		

Note: Market categories represented by these groupings can be found in Appendix B.

The commercial fisheries that are located in state waters of the north coast study region and/or are economically important to the fishing communities in the study region, and had landings in the years 1999 through 2008 are listed below (listed in descending order of average annual landings for all port complexes):

***Finfish Fisheries*:** Salmon, deeper nearshore, shallow nearshore, smelt, hagfish, lingcod, skates/says/sharks, surfperch, herring, pelagic finfish, and California halibut.

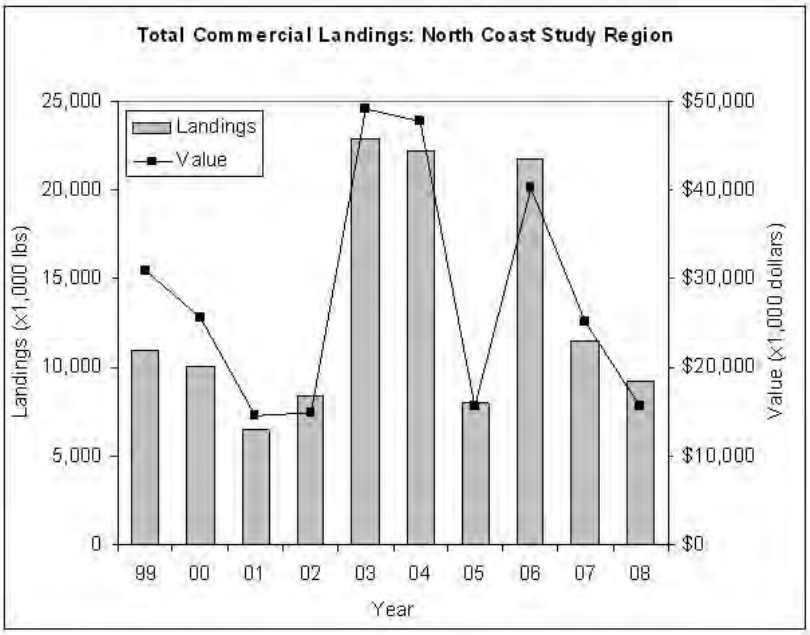
***Invertebrate Fisheries*:** Dungeness crab, red urchin, coonstripe shrimp, jumbo squid, crab and spot prawn.

5.3.3 Commercial Landings

In general, total landings and ex-vessel values by county for commercial fisheries primarily occurring in state waters are dependent on species availability and fishing regulations in the study region over the period 1999 though 2008 (Figure 5.3-5 through Figure 5.3-8). This is particularly true for the commercial salmon landings due to changes to fishery regulations. Commercial salmon regulations closed the area between the California-Oregon border and the Humboldt south jetty (Crescent City to Eureka) in 2006 and the complete closure to all ocean salmon fishing in 2008. Jumbo squid landings increased from 2006 through 2008 and may be affected by oceanic conditions. There were two years (2000 and 2008) with landings of box crab, which may be attempts to discover new fishery opportunities.

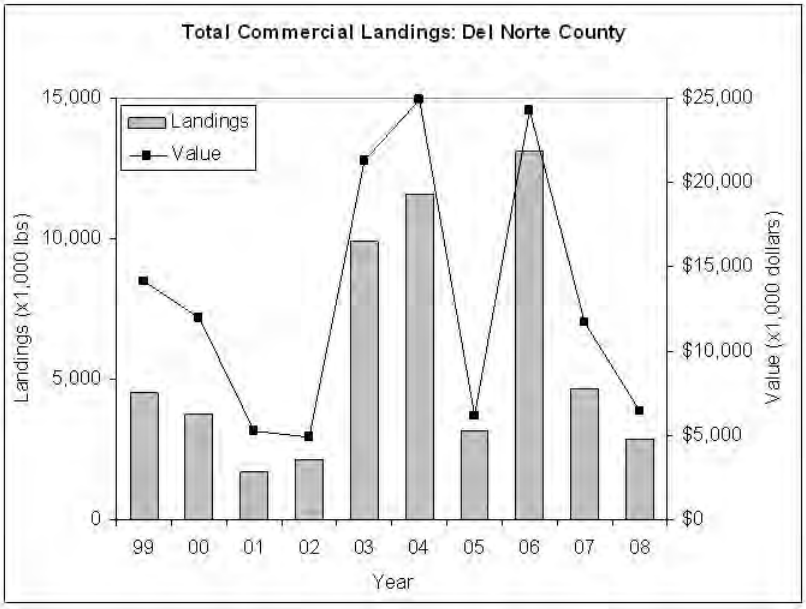
A critical component of commercial fisheries related to establishing or modifying MPAs is the area in which each fishery occurs. More specifically, the relative effort occurring in specific areas, and the relative ex-vessel revenue derived from these areas, are key components to MPA planning. Landing receipts collected by DFG require that catch locations for all market categories be included. These data are reported by coded 10-minute blocks. However, these data are usually filled in by the processors, rather than by the fishermen, and contain inaccuracies. Data regarding areas of stated importance for commercial fisheries was gathered by Ecotrust in 2009 in an attempt to provide better information on the spatial distribution of fisheries, and is available to stakeholders in the MLPA Initiative south coast process for use in MPA planning.

Figure 5.3-5: Total state waters landings and values for all ports, 1999-2008



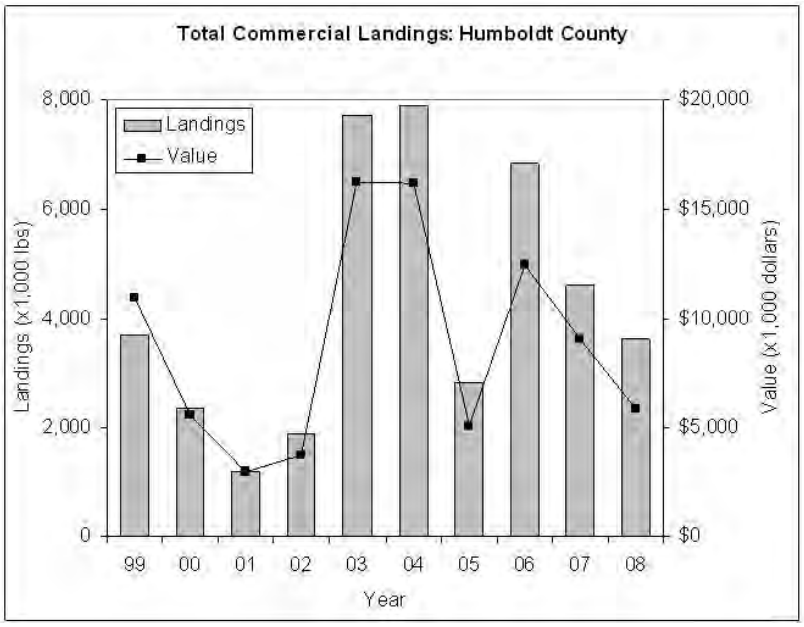
*Source: Data were provided from the Commercial Fishery Information System (CFIS) database (extraction date: 25 August 2009). *Data for 2008 are preliminary. Note: Values were adjusted for inflation (in 2008 dollars).*

Figure 5.3-6: Total state waters landings and values for Del Norte County, 1999-2008



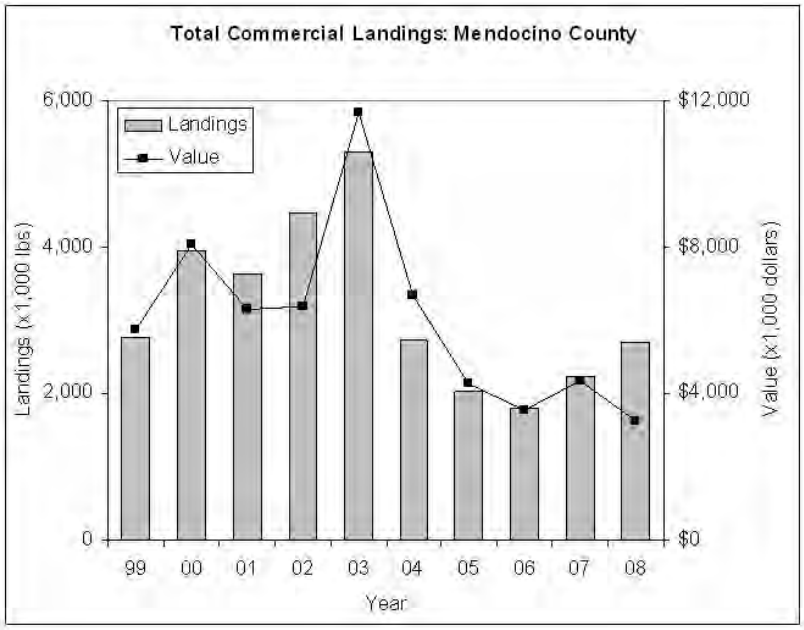
*Source: Data were provided from the Commercial Fishery Information System (CFIS) database (extraction date: 25 August 2009). *Data for 2008 are preliminary. Note: Values were adjusted for inflation (in 2008 dollars).*

Figure 5.3-7: Total state waters landings and values for Humboldt County, 1999-2008



*Source: Data were provided from the Commercial Fishery Information System (CFIS) database (extraction date: 25 August 2009). *Data for 2008 are preliminary. Note: Values were adjusted for inflation (in 2008 dollars).*

Figure 5.3-8: Total state waters landings and values for Mendocino County, 1999-2008



*Source: Data were provided from the Commercial Fishery Information System (CFIS) database (extraction date: 25 August 2009). *Data for 2008 are preliminary. Note: Values were adjusted for inflation (in 2008 dollars).*

5.4 Kelp Harvesting and Aquaculture Leases

Aquaculture leases and harvestable kelp bed leases should be considered in MPA planning, especially in the establishment of state marine reserves or state marine parks that do not allow for

commercial take. While aquaculture does occur in the study region, none of the administrative kelp beds in the region are currently being leased for commercial take. Harvesting for edible algae can occur throughout the coastline, and is not subject to the kelp bed leasing requirements, which regulate the commercial harvest of bull kelp for industrial purposes.

5.4.1 Synopsis of Kelp Bed Lease Status, Kelp Harvest Regulations, and Algae Harvest

Administrative kelp bed areas in California waters are numbered from north to south (see Title 14 California Code of Regulations Section 165.5 (j)(1)), are defined by compass bearings from known landmarks, and applicable commercial regulations pertain to the harvest of giant kelp or bull kelp only, with bull kelp being the primary form of kelp available to harvesters in the study region. The entire coastline is numbered although not all areas contain kelp beds. The administrative kelp beds are classified as closed, leasable, leased (to the state), or open. Closed beds may not be harvested. Leased beds provide the exclusive privilege of harvesting to the lessee. Open beds may be harvested by anyone with a kelp-harvesting license. Leased beds maybe harvested to be used in a variety of industrial products including fertilizer or alginate extraction. However, past beds in the study region were leased to abalone farmers who harvested the kelp as feed for their abalone. Bull kelp harvested for human consumption fall under a different set of regulations and is described below.

There are 12 administratively numbered kelp beds within the north coast study region; all of these are closed to the leasing and harvesting of bull kelp with the exception of three beds (See Table 5.4-1. These three beds are identified as kelp beds 308, 309, and 312. Bed number 308 is located between the middle of Ten-mile River to Point Delgada, just north of Fort Bragg. Bed number 309 runs from Point Delgada to Point Mendocino, between Fort Bragg and Eureka. Bed number 312 is found from the middle of the Klamath River to the California-Oregon border. These three beds can only be harvested if a harvester enters into a lease with the DFG. Without a lease agreement, kelp cannot be harvested from these beds and the beds are effectively considered closed. Currently no one holds a lease for any of these beds, and therefore kelp harvesting does not occur within the study region outside of the edible kelp industry described below.

Table 5.4-1: Administrative kelp beds available to leasing

Bed Number	Leasing Status as of Oct. 2008
301	CLOSED
302	CLOSED
303	CLOSED
304	CLOSED
305	CLOSED
306	CLOSED
307	CLOSED
308	LEASE ONLY
309	LEASE ONLY
310	CLOSED
311	CLOSED
312	LEASE ONLY

5.4.2 Edible Algae Harvest

Members of the genera, *Porphyra, Laminaria, Monostroma, Postelsia*, and other aquatic plants are classified as edible seaweeds by the DFG, as long as the algae is utilized as human food. The holder of an edible seaweed harvester's license may take up to 4,000 pounds of *Nereocystis* annually for human consumption. Edible seaweed license holders are not restricted to the kelp leasing laws above, so they may harvest bull kelp wherever it is found, granted they follow the weigh restriction described above. Regulations require that harvesters weigh and report the amount they harvest, and pay a royalty of $24.00 to the State of California for each ton of seaweed harvested. These plants may be harvested throughout the year and within all state waters. Currently there are few regulations pertaining to the harvest of these ecologically and economically important species. Nevertheless, the DFG encourages sustainable harvest techniques such as cutting only the blade portion of certain plants such as the *laminarians* (kombu) and *Postelsia palmaeformis* (sea palm), and rotating harvest to allow adequate time for re-growth of previously harvested areas.

The edible algae industry in the north coast study region is a cottage industry harvesting a variety of algae for human consumption. Since 2002, sea palm was the most heavily harvested species in the study region, with algae workers collecting an average of nearly 8,300 lbs over a 7-year period. Other prominent harvest yields over the same period include kombu averaging 4,700 pounds, *Alaria margintina* (wakame) averaging just under 3,900 pounds, and *Porphyra spp*. (nori) averaging over 2,700 pounds from 2002 to 2008 (Table 5.3-2). During this same period there were a total of six companies and two individuals harvesting edible algae in the study region. In 2008, there were approximately five harvesters with edible seaweed licenses that operated in the study region. However, the latent capacity in the study region is 28 license holders, which is based on the number of inactive harvesters who hold a kelp harvesters license. Overall, Edible seaweed harvesters have averaged just over 25,000 pounds of edible seaweed/year in the past seven years. A majority of this harvest comes from coastal waters within Mendocino County. Interest in edible algae collection in both Humboldt and Del Norte Counties has been expanding since 2005 and 2007, respectively, although the harvest rates are less than those of Mendocino County (Table 5.3-3).

Table 5.4-2: Edible algae harvest (average pounds) by species, 2002 to 2008

Species	Common Name	Average Pounds Harvested
Alaria marginata	wakame	3,865
Fucus spp.	bladderwrack	981
Gigartina spp.	grapestone	328
Laminaria spp.	kombu	4,745
Nereocystis luetkeana	bullwhip kelp	959
Palmaria mollis	pacific dulse	141
Porphyra spp.	nori	2,749
Postelsia palmaeformis	sea palm	8,339
Ulva spp.	sea lettuce	11

Note: Only the most commonly harvested species are listed.

Table 5.4-3: Edible algae harvest (pounds) for all species by county

County	2002	2003	2004	2005	2006	2007	2008
Del Norte County (pounds harvested)	0	0	0	0	0	1,582	1,624
Humboldt County (pounds harvested)	0	0	0	709	3,487	3,315	2,923
Mendocino County (pounds harvested)	17,854	7,945	33,519	23,138	26,658	21,225	33,651
Total (pounds harvested)	17,854	7,945	33,519	23,847	30,145	26,122	38,198

There is a small but unknown amount of kelp harvest occurring within the study region by recreational fishermen. There is no closed season, closed hours, or minimum size limit, and the daily bag limit on all marine aquatic plants is 10 pounds wet weight. No eel grass (*Zostera* sp.), surf grass (*Phyllospadix* sp.), or sea palm (*Postelsia* sp.) may be cut or disturbed by recreational harvesters. In addition to this, an unknown amount of algae may be collected by tribal groups for subsistence use. This amount is expected to be small when compared to the commercial edible algae harvest described above.

5.4.3 Aquaculture Leases

Six operators currently hold leases for mariculture activities in the north coast study region. Activities are focused in Humboldt Bay, but only take place on a portion of the entire lease area. Unlike in many other areas of the state (such as Tomales Bay), leases in the north coast study region have been granted by private organizations rather than the California Department of Fish and Game. Coast Seafoods Company leases well over 1000 acres from the Humboldt Bay Harbor and Recreation District, easily making it the largest lessee. Other companies hold smaller leases ranging from approximately 10 to 350 acres.

Growers in the north coast study region cultivate a number of species, focusing on bivalves (oysters, clams, scallops, and mussels), and some growers also harvest seaweed. Cultivation techniques are similar to those used in other California growing regions and include longlines and rack-and-bag methods.

5.5 Recreational Fisheries

Recreational fisheries within the north coast study region are influenced by cold nutrient-rich oceanic waters as well as large river and estuarine systems. According to data collected by the DFG's California Recreational Fisheries Survey (CRFS), 76 finfish species were harvested within state waters by recreational anglers in the study region from 2005 to 2008.

Chinook salmon, rockfishes (*Sebastes* spp.), and lingcod, and Pacific halibut are all examples of important finfish targeted by coastal boat-based anglers throughout the study region (Table 5.5-1 and 5.4-2). Albacore tuna is also an important target, although catches occur primarily outside of state waters. Surfperches (*Embiotocidae* spp.), nearshore rockfishes, and greenlings are examples of fishes commonly targeted by shore-based angler (Table 5.4-1). Additionally, bays and estuaries, and river mouths are important fishing areas for targets such as California halibut and steelhead (rainbow trout). Steelhead may be caught in some estuarine areas of the study region, but is prohibited in ocean fisheries.

Also important to the recreational fishery in the north coast study region are the harvest of invertebrates such as red abalone (Table 5.4-3), Dungeness crab, rock scallops, various species of clams, and in some years, Humboldt squid. Invertebrates such as sandcrabs and clams are also harvested by recreational anglers for use as live bait.

Fishes and invertebrates in the north coast study region are targeted using a variety of methods, including but not limited to troll and hook-and-line fishing with live and dead baits and artificial lures, flies and jigs, spear fishing, poke-pole, crab traps, and hand capture.

Statistics on finfish catch and effort for recreational fishing modes are primarily available from DFG's California Recreational Fisheries Survey (CRFS) and additionally from fishing activity logbook data for CPFVs, the DFG Ocean Salmon Project (OSP) provides estimates of recreational take of ocean salmon, and DFG Steelhead Report Card data provides statistics on steelhead catch in inland waters. Catch and effort data on recreational invertebrate fisheries are more limited, and currently available from CPFV logbook records, and for abalone, from Abalone Report Card catch statistics. Additionally, some limited data is available for clamming from DFG creel surveys conducted in Humboldt Bay.

Table 5.5-1: Estimated average annual recreational finfish catch, 2005-2008

Type of fish	Shore catch	Boat catch	Total catch	Dominant species	Species harvested
rockfishes	8.43	174.25	182.68	black rockfish	22
surfperches	38.65	0.24	38.90	redtail surfperch	9
Chinook Salmon[a]		45.1	45.1	Chinook salmon	1
other	2.05	0.07	2.12	unidentified fish	8
Greenlings and lingcod	6.00	17.27	23.27	lingcod	4
anchovies	13.06	8.11	21.17	northern anchovy	1
silversides	4.47	0.36	4.82	jacksmelt	2
sculpins	1.30	3.37	4.67	cabezon	4
flatfishes	0.04	3.51	3.55	California halibut	10
tuna and mackerels	0.03	2.12	2.15	albacore	3
sharks and rays	0.13	0.13	0.26	bat ray	8
herrings	0.10		0.10	Pacific herring	1

Source: CRFS data extracted from the RecFIN database at http://www.recfin.org/forms/est2004.html. Query consists of sampler examined and angler reported dead fish (A+B1) catch by supergroup for trips occurring in inland and ocean waters within three miles of shore for Redwood and Wine Districts. Extraction date: July 15, 2009.

Note: All catch figures are fish x 1000 taken within the north coast study region.

[a] *Source: DFG Ocean Salmon Project. Chinook is the primary target species for ocean salmon anglers, especially since the retention of coho salmon has been prohibited since 1995. A few pink salmon (<50) are also caught by recreational anglers in odd years.*

Table 5.5-2: Recreational ocean catch (numbers of fish) for Chinook salmon by port, 2005 to 2008

Year	Crescent City	Eureka	Fort Bragg
2005	1,498	16,046	22,183
2006	756	15,647	13,993
2007	871	18,025	5,751
2008	closed	closed	6[a]

Source: PFMC 2008 Ocean Salmon SAFE Document.

[a] *Fort Bragg was only open from Feb 16 through March 31 in 2008(the PFMC closed the fishery via emergency action to protect depressed Sacramento fall Chinook stocks. No other ocean salmon fisheries were allowed in 2008.*

Table 5.5-3: Estimated sport abalone catch (numbers of abalone) by report card location

Site	2005	2006	2007	2008[a]	Annual Average
Elk	6,407	5,955	9,988	7,804	7,539
Navarro River	3,886	4,867	4,487	3,011	4,063
Salmon Creek	803	2,485	2,132	1,277	1,674
Albion Cove	9,223	11,909	8,050	4,478	8,415
Dark Gulch	2,633	4,660	3,861	3,721	3,719
Van Damme	11,645	14,446	16,414	16,492	14,749
Gordon Lane	2,014	3,003	3,339	2,207	2,641
Mendocino Headlands	7,139	11,547	15,191	9,539	10,854
Jack Peters Gulch	2,971	5,074	4,920	4,383	4,337
Russian Gulch	6,097	7,456	6,947	6,575	6,769
Caspar Cove	7,435	4,582	7,931	3,957	5,976
Jughandle	5,872	5,048	7,782	3,689	5,598
Mitchell Creek		595	1,923	3,248	1,441
Hare Creek	3,915	2,977	5,099	5,629	4,405
Todds Point	8,153	8,285	9,303	8,246	8,496
Georgia Pacific	6,111	6,032	6,768	8,293	6,801
Glass Beach	4,590	5,980	5,561	4,147	5,070
MacKerricher	3,915	3,883	4,905	3,926	4,157
Kibesillah	1,577	466	999	1,119	1,040
Westport	2,028	1,631	2,147	1,182	1,747
Abalone Point	3,520	2,563	4,189	4,746	3,755
Hardy Creek	1,464	1,398	1,163	1,813	1,460
Usal	239	78	268	173	190
Bear Harbor	535	155	611	221	381
Other Humboldt	943	181	567	126	454
Shelter Cove	3,717	3,029	4,413	4,320	3,870
Punta Gorda	422	673	1,476	1,230	950
Trinidad	253	285	373	189	275
Patrick's Pt	465	207	820	631	531

Site	2005	2006	2007	2008[a]	Annual Average
Other Del Norte	0	0	45	0	11
Crescent City	56	104	60	47	67
North Coast Area Total	108,030	119,556	141,731	116,418	121,434

Source: DFG Abalone Report Card catch statistics. Represents total catch estimates combined from report card and telephone survey. Data were portioned using catch ratios obtained from report card data.

[a] *2008 catch estimates are preliminary*

5.5.1 Modes of Fishing

The CRFS, which is the primary source of marine recreational fishery statistics in recent years, categorizes fishing activity by mode. A fishing mode is the method of access used to fish. The distribution of recreational fishing catch (see Table 5.5-4) and effort varies by mode of fishing and availability of access. The following are common modes of recreational fishing throughout the north coast study region:

- Boat-based modes
  - Commercial passenger fishing vessels (CPFVs)
  - Private and rental boats
- Shore-based modes
  - Beach and bank fishing
  - Fishing from man-made structures

Table 5.5-4: Percentage of finfish (numbers of fish) caught by fishing mode in state waters, 2005-2008

Common name	Man-made	Beach and bank	CPFV	Private boat
anchovies	61.7%	0.0%	0.3%	38.0%
cabezon	5.6%	13.1%	15.3%	66.0%
California halibut	0.0%	0.0%	11.7%	88.3%
kelp greenling	18.0%	48.3%	6.3%	27.4%
lingcod	2.1%	1.6%	30.4%	65.9%
monkeyface prickleback	19.0%	81.0%	0.0%	0.0%
other flatfishes	1.7%	0.0%	5.0%	93.3%
Pacific halibut	0.0%	0.0%	26.6%	73.4%
rock greenling	4.9%	86.9%	1.7%	6.5%
rockfishes	1.6%	3.1%	35.0%	60.4%
sharks and rays	33.0%	15.8%	2.4%	48.8%
silversides	84.1%	8.5%	0.0%	7.4%
smelts	0.4%	99.6%	0.0%	0.0%
surfperches	12.3%	87.0%	0.0%	0.6%

Source: CRFS data extracted from the RecFIN database at http://www.recfin.org/forms/est2004.html. Query based on sampler examine and angler reported dead fish (A+B1) catch by mode for fish by common name and supergroup for inland and marine waters less than 3 miles from shore in Redwood and Wine districts. Extraction date: October 28, 2009.

Boat-Based Modes

Commercial Passenger Fishing Vessels (CPFVs)

CPFVs, also called party boats, are crewed vessels that carry recreational anglers to ocean fishing locations for a fee. CPFVs are generally limited by travel time, and can be characterized by trip duration (extended day, half day) or target (bottomfishing, crab, or albacore for example). CPFVs in the study region operate out of ports in all three north coast counties of Del Norte, Humboldt, and Mendocino. There are approximately 20 CPFVs operating in recent years in the north coast study region, ranging in passenger capacity from four to 49 persons, with an average passenger load of 10 persons per trip (CFIS 2009). CPFVs in the study region fish in nearshore waters and bays of the mainland coast, as well as offshore. Most CPFVs cater to anglers using hook-and-line gear and trap (for Dungeness crab). However, a small proportion of vessels engage in consumptive diving trips.

Private and Rental Boats

Private boats are privately owned vessels, and rental boats are vessels that are rented without a crew. The private and rental boat category includes kayaks, skiffs, and large motor boats. Areas fished vary by vessel type and size, but are similar to those fished by CPFVs. Most fishing effort is by hook-and-line, but crabbing by trap and consumptive diving are also popular forms of fishing from private boats.

Kayaks

Kayak fishing activity is part of the private and rental boat fishery. Areas fished include nearshore coastal waters, bays, and tidally influenced river mouths. Finfish target species include bottomfishes, salmon, and halibut. Abalone and crab may also be targeted by kayakers freediving or hoopnetting. Important kayaking areas include Humboldt Bay and Trinidad.

Shore-Based Modes

Shore-based modes include all land-based fishing access, including beaches, rocky shores, and man-made structures. Shore trips include scuba and free dive trips where the point of access was shore based and no vessel was used.

Beach and Bank

The beach and bank mode consists of fishing that occurs from the natural shoreline. Types of fishing activity include angling, clamming and shore picking, pokepoling, and consumptive diving. Popular finfish targets in this region include redtail and other surfperch species, rockfishes, greenlings, and smelts. Salmonids and elasmobranches (sharks and rays) are also targeted from shore in estuaries and river mouths. Abalone and various species of clams are important invertebrate targets.

Shore access areas in ocean and estuarine waters can be limited in many locations throughout the north coast study region. Large stretches of the north coast study region have little to no shore access due to private land ownership and difficult or dangerous terrain. Shore access frequently occurs in the more populated areas of the study region (i.e.),Fort Bragg, Eureka and Crescent City areas). In many of the less populated areas, access may be locally abundant. However, these areas may not be as frequently used due to their remote location (i.e. Cape Mendocino, Shelter Cove, and Gold Bluffs Beach areas).

Pokepoling

Pokepole fishing involves the use of a fiberglass or bamboo pole with a baited hook attached to the terminal end. The pole is used to access fish in deep rocky crevices or thick kelp along the shore (or

man-made structures such as jetties). Monkeyface pricklebacks, cabezon, and nearshore rockfishes are frequently targeted.

Clamming

Clamming on the north coast occurs both within protected bays and open ocean beaches. Pacific razor clams (*Siliqua patula*) are prized north coast clams, dug using a specialized shovel from the low intertidal zone of surf-beaten sandy beaches. The most popular razor clam beaches are from Clam Beach County Park (McKinleyville, CA) to Moonstone Beach County Park (Westhaven, CA) in Humboldt County and Enderts Beach, South Beach and beaches north of Point St. George (Crescent City, CA) in Del Norte. Other open coast species of clam, such as cockles, are taken between Battery Point and Point St. George. A DFG razor clam creel census of Humboldt County beaches from 1971 to 1988 found highly variable annual effort and catch. Annual catch estimates ranged from zero to 116,392 clams and annual diggers estimates ranged from 147 to 12,671 people (Warner, unpublished). Preliminary results of a 2008 and 2009 resumption of that creel census indicate effort, catch, and catch per unit effort (CPUE) were in the lower end of historic ranges (McVeigh, pers. comm.).

A variety of bay clam species are harvested within Humboldt Bay and Crescent City Harbor by digging into mud or sand flats with rakes, shovels, or by hand. South Bay within Humboldt Bay has long been a popular sport clamming area with an abundance of recreationally important bivalves including fat and Pacific gaper clams (*Tresus capax* and *T. nuttallii*), Washington and California butterclams (*Saxidomus nuttallii* and S. *gigantea*), Pacific littleneck clams (*Leukoma staminea*), and Pacific geoduck clams (*Panopea abrupta*). According to a Department creel census survey conducted from 1975 to 1989, annual effort and catch estimates ranged from 6,639 diggers extracting 188,000 clams in 1982 to 2,440 diggers extracting 72,000 clams in 1989 (Collier, unpublished). A resumption of that study in 2008 showed annual sport clamming effort had decreased to an estimated 1300 diggers annually extracting a total of 31,000 clams (McVeigh, pers. comm.). Additionally, introduced Eastern softshell clams (*Mya arenaria*) are periodically harvested at unknown levels from coastal areas such as Little River and Humboldt Lagoons State Park in Humboldt County.

Consumptive Shore Diving

An important shore based fishery in the north coast study region is consumptive diving, especially free diving for red abalone. Spearfish targets include rockfish, lingcod, and cabezon. Divers may also target rock scallop and Dungeness crab by hand.

Man-made Structures

Man-made structures consist of piers, jetties and breakwaters, docks, and other fishable structures. If these structures are public, a fishing license is not required. Finfish are typically targeted with hook-and-line gear, but dip nets may be used to target small schooling fish. Traps or hoop nets may also be used to target crab. Consumptive diving also occurs from some structures, such as jetties. Popular finfish targets include rockfish, greenlings, other bottomfishes, and surfperch. Silversides (typically jacksmelt) and sharks are also targeted in bays and estuaries.

5.5.2 Recreational Fishing Effort

Effort is a measure of the time anglers spend fishing, and can be quantified by the number of trips taken by anglers. Recreational fishing effort differs seasonally and by mode in the north coast study region (Table 5.5-5). According to CRFS estimates and CPFV Logbook statistics, an average of over 195,000 marine angler trips were taken out of the counties of Mendocino, Humboldt, and Del Norte

in annually In recent years. 2008 saw a significant drop in effort, most likely due to the closed salmon season that year.

Table 5.5-5: Estimated annual angler trips in north coast marine waters by mode, 2005 to 2008

Mode	Average annual angler trips
CPFV	12,218
Beach and bank	63,457
Man-made	53,634
Private boats	66,585

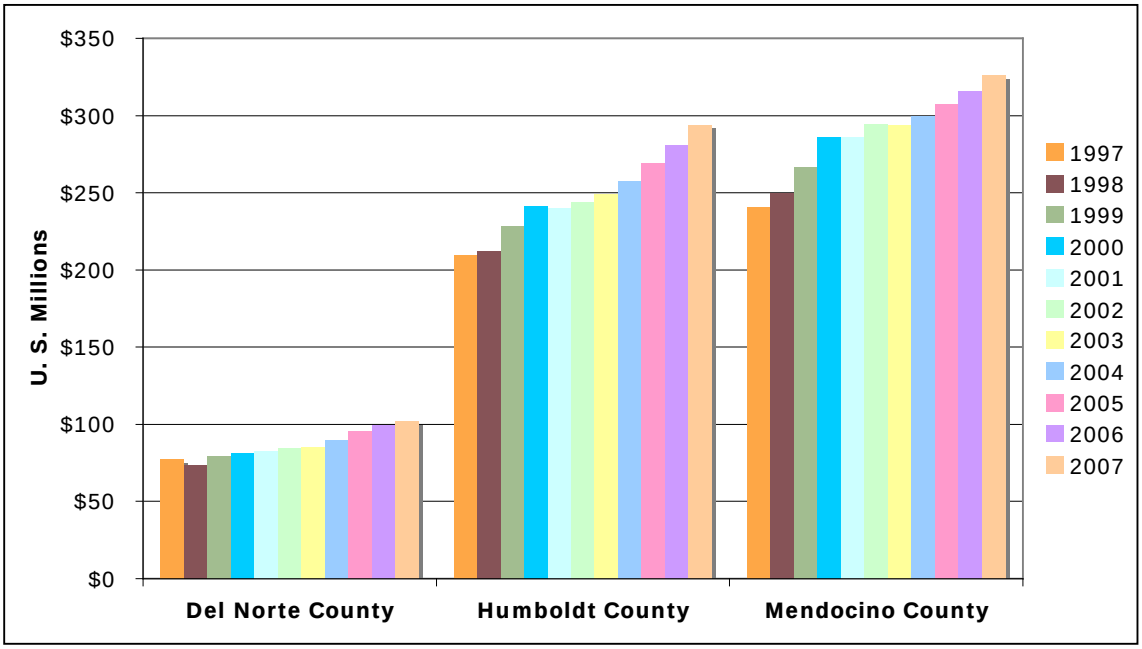
Sources: CPFV fishing activity logbooks submitted to DFG by CPFV operators were used for the estimates of CPFV effort; CRFS data extracted from the RecFIN database at http://www.recfin.org/forms/est2004.html for trips in all waters for Wine and Redwood Districts (extracted October 23, 2009) were used for effort in the other fishing modes.

5.6 Coastal Tourism

California receives millions of domestic and international visitors who spend billions of dollars in the state every year. In 2008, California received approximately 13.4 million international visitors (CTTC 2009). California also received approximately 338 million domestic visitors, with Californians traveling within the state accounting for 86% of all domestic visitors (D.K. Shifflet & Associates, Ltd. 2009). From 1998 to 2002, travel and tourism, taken together, were the third-largest employer in California and the fifth-largest contributor to the gross state product (Kildow and Colgan 2005; CLIA 2008). According to a report by Dean Runyan Associates (2009), tourists' total direct travel spending in California reached $96.7 billion, $18.3 billion by international travelers, in 2008. When adjusted for inflation, this amount represents a 3.9% decrease in travel spending from 2007. Travel spending also directly supported 924,000 California jobs in 2008. Travel spending generated the greatest number of jobs in accommodation and food service (533,000), and arts, entertainment and recreation (227,400).

Coastal tourism and recreation contributed $12.4 billion to California's gross state product in 2000 (Kildow and Colgan 2005). Visits to the beach and waterfront activities are the third most popular recreational activities in California after "sightseeing" and "theme and amusement parks" (CTTC 2006). Tourism and recreation contribute to the economy in the north coast study region (Figure 5.6-1). Within the study region, Mendocino County has the highest travel spending, generally increasing from $240 to $326 million between 1997 and 2007, followed closely by Humboldt County, which also showed increasing trends in spending. Travel spending in Del Norte County has remained more constant, and significantly below the travel spending in Mendocino and Humboldt counties, possibly due to smaller cities, fewer theme park-type attractions (ThemeParkCity 2009), the weather and remoteness of the area (see Figure 5.6-1).

Figure 5.6-1: Total travel spending by county, 1997-2007



Source: Dean Runyan Associates 2009.

The north coast study region contains many state parks and state beaches that provide access to the coast and ocean resources. Mendocino Headlands State Park, the most visited coastal state park in the study region, received 1,121,973 visitors in 2007/2008 (see). Redwood National Park received 385,153 visitors in 2007 (National Park Service 2008). Redwood National Park and the following state parks, Prairie Creek Redwoods State Park, Del Norte Coast Redwoods State Park and Jedediah Smith Redwoods State Park (not included in Table 5.6-1 due to lack of ocean frontage), make up Redwood National and State Parks, and are managed as a single unit by the National Park Service and the California Department of Parks and Recreation. The Bureau of Land Management (BLM) also manages public lands adjacent to the coast in the study region. These managed coastal lands draw an increasing number of visitors every year, and include the South Spit Cooperative Management Area (65,000 in 2008/2009) and Samoa Dunes Recreation Area (190,000 in 2008/2009) near Eureka, the Lost Coast Headlands (8,000 in 2008/2009) and the King Range National Conservation Area (191,259 visits in 2007/2008) (RMIS 2009), also known as the “Lost Coast” due to the limited access to the area.

Table 5.6-1: Attendance at California state parks adjacent to the shore, fiscal year 2007-8

Park Name	County	Total Attendance
Mendocino Headlands State Park	Mendocino	1,121,973
MacKerricher State Park	Mendocino	947,441
Prairie Creek Redwoods State Park	Del Norte/Humboldt	231,223
Van Damme State Park	Mendocino	188,822
Westport-Union Landing State Beach	Mendocino	156,292
Humboldt Lagoons State Park	Humboldt	149,381
Navarro River Redwoods State Park	Mendocino	137,874
Jug Handle State Natural Reserve	Mendocino	136,261

Park Name	County	Total Attendance
Patrick's Point State Park	Humboldt	123,510
Del Norte Coast Redwoods State Park	Del Norte	115,196
Greenwood State Beach	Mendocino	83,174
Russian Gulch State Park	Mendocino	74,057
Manchester State Park	Mendocino	71,805
Schooner Gulch State Beach	Mendocino	45,127
Caspar Headlands State Beach	Mendocino	44,992
Trinidad State Beach	Humboldt	44,964
Caspar Headlands State Natural Reserve	Mendocino	36,226
Point Cabrillo Light Station	Mendocino	35,953
Pelican State Beach	Del Norte	30,257
Tolowa Dunes State Park	Del Norte	25,807
Little River State Beach	Humboldt	13,342
Sinkyone Wilderness State Park	Humboldt/Mendocino	11,591

Source: State Parks 2009

In addition to the state parks and beaches listed in Table 5.6-1, the north coast study region is also home to a number of county and city beaches; therefore, total beach attendance for the study region is greater than the numbers reported for state parks and beaches alone (Table 5.6-1).

5.7 Non-consumptive Uses

Americans flock to beaches and shores to partake in a variety of consumptive and non-consumptive recreational activities. Non-consumptive uses of the coastal environment include beach-going, swimming, surfing, sailing, kayaking, diving, wildlife viewing, photography, and other activities that do not involve the take or extraction of marine resources. As with consumptive uses, non-consumptive uses generate revenue and jobs for local communities. Non-consumptive users purchase boat trips for activities such as scuba diving or wildlife viewing, rent or buy equipment, and pay park fees. Restaurants, hotels, local retail shops and gas stations all benefit from coastal tourism. Additionally, the community as a whole benefits through tax revenue created by coastal tourism.

In 1999 and 2000, more than 43% of all Americans participated in some form of marine recreation (Leeworthy and Wiley 2001). In coming years, populations in the coastal zone are expected to grow and the total number of people participating in all forms of marine recreation is expected to increase with the largest increases expected for beach going activities (Leeworthy et al. 2005). Despite this expected increase in the total number of Americans participating in marine recreation, the percentage of all Americans engaged in marine recreation is expected to decrease (Leeworthy et al. 2005). California ranks second to only Florida in the number of participants in coastal recreation nationwide with nearly 18 million participants, most of whom participate in one of the 17 non-consumptive activities listed in Table 5.7-1 (Leeworthy 2001).

The National MPA Science Center and the Marine Biology Conservation Institute conducted a study entitled ‘The California Ocean Uses Atlas Project’. They are compiling comprehensive data on all types of human uses of the ocean. Their study has produced maps of human uses, including many non-consumptive uses such as boating, beach going, kayaking, and scuba diving, for Southern

California. Similar maps for the north coast study region are being developed and will be posted to the Atlas Project website: http://mpa.gov/science_analysis/atlas.html

Table 5.7-1: Participation in coastal recreation in California

Coastal Activity	Estimated Numbers Statewide
Visit Beaches	12,598,069
Visit Waterside Besides Beaches	1,500,965
Swimming	8,398,997
Snorkeling	706,998
Scuba Diving	288,023
Surfing	1,114,372
Wind Surfing	82,201
Motorboating	1,549,289
Sailing	1,087,755
Personal Watercraft Use	680,309
Canoeing	190,948
Kayaking	433,209
Rowing	280,265
Water-skiing	265,533
Bird Watching in Saltwater Surroundings	2,581,958
Viewing Other Wildlife in Saltwater Surroundings	2,551,711
Viewing or Photographing Scenery in Saltwater Surroundings	4,175,372

Source: Leeworthy 2001.

Note: Data includes civilian non-institutionalized population 16 years and older as sampled Sept. 1999. Extrapolated from a sample of 27,854 households.

5.7.1 Recreational Beach Use

The study region's approximately 225 miles of coastline provide not only intrinsic natural and aesthetic values, but also recreational opportunities for its users and great economic benefits to the local, regional, and state economies. Rural counties in California (including Del Norte and Humboldt counties in the study region) generate approximately $27 billion in travel spending and $1.6 billion in tax receipts. Approximately 357,400 jobs are generated as a result of rural tourism throughout California (CTTC 2008). In 1998, California's beaches statewide generated $14 billion in direct revenue ($73 billion including indirect and induced benefits), $2.6 billion in federal tax revenue, and 883,000 jobs (King 1999). A more recent study by Kildow and Colgan estimates that direct expenditures by beach goers in California average roughly $25 per person per day and total spending by beach goers in the state is approximately $3.75 billion (Kildow and Colgan 2005). Revenues at state parks adjacent to the coast in the study region from user fees and concessions reached over $2.7 million during the 2007/2008 fiscal year (Table 5.7-2) (CDPR 2009). The highest revenues were seen at MacKerricher State Park, Patrick's Point State Park and Prairie Creek Redwoods State Park, and MacKerricher and Prairie Creek Redwoods State Parks were two of the three most visited coastal parks in the study region (Table 5.6-1). These three parks account for over half of the total revenue earned by state parks adjacent to the coast in the study region.

Table 5.7-2: Department of Parks and Recreation revenue from coastal state parks, 2007-8

California State Park	County	Total Revenue (Fiscal Year 2007/2008)
MacKerricher State Park	Mendocino	$539,668
Patrick's Point State Park	Humboldt	$535,569
Prairie Creek Redwoods State Park	Del Norte/Humboldt	$413,746
Jedediah Smith Redwoods State Park	Del Norte	$334,288
Van Damme State Park	Mendocino	$331,488
Del Norte Coast Redwoods State Park	Del Norte	$239,813
Russian Gulch State Park	Mendocino	$163,675
Westport-Union Landing State Beach	Mendocino	$64,492
Manchester State Park	Mendocino	$43,095
Navarro River Redwoods State Park	Mendocino	$36,414
Sinkyone Wilderness State Park	Humboldt/Mendocino	$31,323
Humboldt Lagoons State Park	Humboldt	$4,099
Caspar Headlands State Beach	Mendocino	$0
Caspar Headlands State Natural Reserve	Mendocino	$0
Jug Handle State Natural Reserve	Mendocino	$0
Mendocino Headlands State Park	Mendocino	$0
Point Cabrillo Light Station	Mendocino	$0
Greenwood State Beach	Mendocino	$0
Schooner Gulch State Beach	Mendocino	$0
Little River State Beach	Humboldt	$0
Pelican State Beach	Del Norte	$0
Tolowa Dunes State Park	Del Norte	$0
Trinidad State Beach	Humboldt	$0

Source: California Department of Parks and Recreation 2009.

Note: Some state parks do not charge an entrance fee nor a parking fee. Therefore, there is no revenue listed for these parks. Some state parks are managed by an entity other than State Parks, and any revenue received by those entities is not included here.

California beaches are owned by the public, and as a result, one does not necessarily need to pay to visit the beach. Beach visitors may value the beach beyond their direct expenditures such as gas or parking fees. Using a conservative estimate of $15/visit for the value of a beach day and a conservative estimate of beach attendance of 150 million beach days annually, Kildow and Colgan (2005) estimate the non-market value of beach visits in California to be approximately $2.5 million annually. They also estimate that the total value of going to the beach, including market and non-market values, may exceed $5 billion annually.

The impact of California's beaches on the state and national economy continues to grow; in comparison to Delaware, which ranks just behind California in overall federal funding for shoreline preservation, California generates 20 times more economic activity per federal dollar (King 1999).

In addition to the state parks adjacent to shore, the counties and some of the cities in the north coast study region maintain one or more public beaches or coastal access points. The study region's miles

of state, county and city beaches offer many locations for non-consumptive recreational activities such as sailing, diving, sightseeing, hiking, surfing, kayaking, canoeing and whale watching.

Approximately 1.1 million surfers live in California, surfing at popular spots along the coast, including areas in the study region (NOAA 2000). Table 5.7-3 lists surf spots in the region. Surfing culture also supports a $7.48 billion dollar surf industry (in 2006) in the U.S. (SIMA 2007).

Table 5.7-3: Surfing spots in the north coast study region

County	Name of surfing location		
Del Norte	Crescent City South Beach		
Humboldt	Redwood Creek	Moonstone	Gale Point
	Trinidad State Beach	Bunkers	Deadman's
	Camel Rock	North Jetty	Third Reef
	Patrick's Point	Harbor Entrance	No Pass
Mendocino	Big River	Hare Creek	Moat Creek
	Blues	Manchester Beach	Point Arena Cove

Source: www.wannasurf.com 2009.

A detailed list of individual breaks in the north coast study region can be found at http://www.wannasurf.com/spot/North_America/USA/index.html

Kite surfing, or kite boarding, is also a rapidly growing sport in California. Kite surfers prefer many of the same beaches popular with surfers, though tend to be on the water when the weather is less ideal for surfers. South Beach in Crescent City is a popular location for kite surfers. Along with surfing and kite surfing, windsurfers can also be found in the study region. Humboldt Lagoons and Crescent City Harbor are popular spots for windsurfing. The study region's windy weather and sandy beaches also create popular kite flying locations for those visitors who prefer to stay dry.

The California Coastal Access Guide gives a brief description of the location, type of access and amenities at each public access coastal area along California's 1,100 miles of continent abutting the Pacific Ocean. There are many coastal destinations within the north coast study region, summarized in Table 5.7-4. For many coastal access points, the parking area abuts the beach it provide access to, but in other locations a path or stairway must be taken to reach the coast and these are noted in Table 5.7-4. Coastal access points are also shown in the *Habitat & Species Atlas* and the *Coastal Management & Human Uses Atlas*. Also in Table 5.7-4, fishing sites refer to locations that have a fishing pier, fish cleaning facility or are commonly used for fishing according to the *California Coastal Access Guide*.

Table 5.7-4: Facilities at beaches

County	# Campgrounds	# Stairways to Beach	# Paths to Beach	# Biking Trails	# Boating Facilities	# Fishing Sites
Del Norte	6	4	16	1	5	21
Humboldt	16	3	18	0	14	28
Mendocino	12	2	16	1	4	17

Source: California Coastal Commission, California Coastal Access Guide, 2003.

Tide pool visitation is another popular recreational activity within the study region. While tide pool visitation is a non-consumptive activity in theory, careless tide pool visitors or great numbers of visitors can cause damage and disturb the habitat during their visit by trampling or handling tide pool species (Ambrose and Smith 2004). Proper tide pool etiquette should be observed to avoid detrimental effects to the tide pool habitats and species.

Tidepool locations in the study region were taken from *California Coastal Access Guide,* by the California Coastal Commission, and from the California State Parks website. Table 5.7-5 does not represent an exhaustive list of tide-pooling sites in the study region.

Table 5.7-5: Tide pooling sites

County	Name of tide pooling location		
Del Norte	Enderts Beach	Wilson Creek Beach	Del Norte Coast Redwoods State Park
Humboldt	Patrick's Point State Park	Shelter Cove/Lost Coast Wilderness	
Mendocino	MacKerricher State Park	Glass Beach	

Watching wildlife from shore is a popular activity in the north coast study region. Pinnipeds, cetaceans, seabirds and shorebirds can be viewed from numerous locations. Pinniped rookeries and haulouts are shown in the *Habitat & Species Atlas*, which also gives seabird diversity and colony location information. Piers and many prominent points of land can be used to view whales and other cetaceans. Mendocino Headlands State Park and Pomo Bluffs Park in Fort Bragg, Crescent Beach Overlook and Klamath Overlook are popular locations for watching migrating whales. Estuaries in the study region are often locations used for viewing resident and migrating waterfowl, seabirds and shorebirds. Wildlife watching from shore includes fish too.

The north coast also has a number of lighthouses that draw tourists (Table 5.7-6). Most of the lighthouses in the study region are open to the public. Some of the lighthouses are more accessible than others. The Punta Gorda lighthouse has a three-and-a-half-mile trail leading to it from the nearest parking area. The lighthouses also offer good locations for wildlife viewing from shore.

Table 5.7-6: Lighthouses in the north coast study region

County	Lighthouse Name	Open to the Public
Del Norte	St. George Reef	No
Del Norte	Battery Point	Yes
Humboldt	Trinidad Head	No*
Humboldt	North Spit	No longer standing
Humboldt	Table Bluff	Yes
Humboldt	Cape Mendocino	No
Humboldt	Punta Gorda	Yes
Mendocino	Point Cabrillo	No

Source: Nelson and Nelson 1993.

** Tourists can visit a nearby replica of the Trinidad Head lighthouse.*

Northern California's coastal communities are also host to a variety of music and art festivals and events, harbor festivals, whale festivals and more throughout the year to draw tourists to their shores.

5.7.2 Boating

Boating is a popular and economically important activity in the north coast study region. In 2000, over four million people in California were involved in activities related to marine boating (Kildow and Colgan 2005). The contribution of boating to the gross state product was $11 billion in 1995, representing 1.2% of the state economy (Rust and Potepan 1997). There are numerous bays, estuaries and harbors in the study area that provide protected waters that are conducive to boating. Boats also participate in whale watching activities out of the harbors in the north coast study region.

The California Department of Boating and Waterways published a report titled "California Boating Facilities Needs Assessment" (CDBW 2002) as a survey and assessment of boating and boating facilities needs in California. The California Boating Facilities Needs Assessment breaks the state into regions, one of which encompasses the entire north coast study region. According to this study, the 25 most used waterways (including freshwater waterways) for residents from the study region included the marine waterways of the Pacific Ocean (i.e. ocean waters not defined by another name), Humboldt Bay, Trinidad Harbor and the Humboldt Lagoons. The Pacific Ocean was the most used waterway in the study region with 7.2% of all boaters in the region using this waterway.

Non-consumptive boat data is also collected as supplemental data from the DFG's CRFS program. The purpose of the CRFS is to estimate total marine recreational finfish catch and effort in California. CRFS staff conduct interviews of anglers returning to public launch ramps. Under the Primary Private Boat Survey, boaters are interviewed at primary launch ramps approximately eight days per month (Van Buskirk pers. comm. 2007). "Primary" launch ramps are defined as "those where the majority of the managed species, in any particular month, are landed" (PSMFC 2007). Supplemental data collected include the number of private and rental boats that are not recreationally fishing for finfish. Note that, the goal of the CRFS is to produce marine recreational fishery-based data to inform management of recreational fisheries and, therefore, may underestimate the number of non-consumptive boat users because it focuses on public launch ramps where the majority of managed species are landed rather than a random sampling of public launch ramps.

CRFS samplers intercepted a total of 2,967 private and rental boats within Del Norte, Humboldt and Mendocino counties. The most surveys took place in Humboldt County while the fewest took place in Mendocino County. Del Norte County had the highest rate of boats that had fished for finfish recreationally (80%), and Mendocino County had the lowest rate (52%). Humboldt County had the highest percentage of commercial fishing or non-finfish vessels at approximately 9%. Mendocino County had the highest percentage of vessels not fishing (25%), while Del Norte and Humboldt Counties had about the same percentage of vessels not fishing, approximately 10%. See Table 5.7-7 for a complete summary of the CRFS results for all counties in the study region.

Overall, the number of registered vessels has been slowly increasing in the study region, though there has been a decrease of registered vessels in Del Norte County. According to the California Department of Motor Vehicles, the study region had approximately 13,315 registered recreational vessels as of December 31, 2008, an increase of 1,531 since 1991 (Table 5.7-8).

Table 5.7-7: Activities using private and rental boats, 2007

	Del Norte		Humboldt		Mendocino	
	Vessels (#)	Within County (%)	Vessels (#)	Within County (%)	Vessels (#)	Within County (%)
Fished recreationally for finfish	679	79.69	1370	77.23	178	52.20
Intended to fish recreationally, but no gear in water	3	.35	12	.68	11	3.22
Recreational shellfish	57	6.69	58	3.27	63	18.48
Fished commercially	30	3.52	164	9.24	4	1.17
Total Vessels Fishing	769	90.26	1604	90.42	256	75.07
Recreational cruising	23	2.70	41	2.31	16	4.69
Burial at sea	0	-	0	-	0	-
Bird watching	0	-	0	-	0	-
Diving, non-consumptive	0	-	2	.11	0	-
Enforcement (public agency)	4	.47	1	.06	2	.59
Hunting, gun	0	-	0	-	0	-
Boat maintenance	22	2.58	61	3.44	10	2.93
Research (public agency)	4	.47	10	.56	0	-
Whale watching	0	-	0	-	0	-
Other commercial activity	1	.12	8	.45	0	-
Removing boat form slip, no trip	15	1.76	15	.84	38	11.14
Unidentified	14	1.64	32	1.80	19	5.57
Total Vessels Not Fishing	83	9.74	170	9.58	85	24.93
Total All Boats	852	100.0	1774	100.0	341	100.0

Note: Table shows private and rental boats surveyed by the California Recreational Fisheries Survey in 2007

Table 5.7-8: Registered vessels in 1991 and 2008

County	Total number of registered vessels, 1991	Total number of pleasure vessels, 1991	Total number of registered vessels, 2008	Total number of pleasure vessels, 2008
Del Norte	1,549	1,419	1,498	1,433
Humboldt	6,613	6,254	7,382	7,144
Mendocino	4,420	4,111	4,888	4,738

Source: CADMV 2009.

Number of registered vessels in the north coast study region as of December 31, 1991 and December 31, 2008.

Ports, marinas, public launch ramps and hoists in the study region are listed in Table 5.7-9 and Table 5.7-10. Piers, jetties and ports are also shown in the *Coastal Management & Human Uses Atlas*.

Table 5.7-9: Ports and marinas

Ports and Marinas	County
Crescent City Harbor	Del Norte
Trinidad Harbor	Humboldt
Woodley Island Marina	Humboldt
Eureka Mooring Basin	Humboldt
Noyo Harbor	Mendocino
Albion Flat	Mendocino

Table 5.7-10: Public boat launch or hoist locations

Public Boat Launch or Hoist Locations	County
Smith River Fishing Access	Del Norte
Salmon Harbor RV Resort	Del Norte
Crescent City Harbor	Del Norte
Chart Room Marina	Del Norte
Trinidad Harbor	Humboldt
Stone Lagoon	Humboldt
Freshwater Lagoon	Humboldt
Mad River Beach County Park	Humboldt
Arcata Boat Ramp (Arcata Marsh)	Humboldt
Woodley Island Marina (hoist)	Humboldt
Eureka Mooring Basin	Humboldt
North Spit	Humboldt
Humboldt Bay National Wildlife Refuge	Humboldt
King Salmon Resort (hoist)	Humboldt
Fields Landing County Boat Launch	Humboldt
Shelter Cove	Humboldt
MacKerricher State Park	Mendocino
Noyo Harbor District	Mendocino
Noyo Mooring Basin	Mendocino
Albion Flat	Mendocino
Schooners Landing Campground & Marina	Mendocino

Source: California Coastal Commission, California Coastal Access Guide, 2003

5.7.3 Scuba Diving and Kayaking

Scuba diving is a popular activity within the study region, especially along the Mendocino coast. About 20% of California's 1.5 million certified divers are "active," meaning they dove within the past 12 months and plan to dive within the next year. California, which contributes an estimated 12% total of the national revenue generated by recreational scuba diving, generates approximately $180 million annually in revenue from diving; equipment sales produce an additional $60 million (Hornsby 2005). Growth in the sector was estimated at 10-20% per year in the 1980s and 5-7% in the 1990s (Weinstein undated). Diving also fosters related business, such as underwater photography and art

galleries, and produces direct and indirect revenue via services and facilities serving the region. Many of the dive sites along the north coast study region are listed in Table 5.7-11. Some shore dive locations are shown on in the *Coastal Management & Human Uses Atlas*.

Table 5.7-11: Popular scuba diving sites

Scuba diving site	County	Scuba diving site	County
High Bluff Beach	Del Norte	Humboldt lagoons	Humboldt
Wilson Creek Beach	Del Norte	Prairie Creek Redwoods State Park beaches	Humboldt
Enderts Beach	Del Norte	Redwoods National Park – 40 miles of coast	Humboldt
Crescent Beach	Del Norte	Arena Rock	Mendocino
Crescent City Harbor	Del Norte	Nowhere Reef	Mendocino
Crescent City Beaches	Del Norte	Navarro River Beach	Mendocino
Battery Point Lighthouse	Del Norte	Bull Rock	Mendocino
Smith River/Tillas Slough	Del Norte	Albion River Flats	Mendocino
Pelican State Beach	Del Norte	Colby Reef	Mendocino
King Range National Conservation Area	Humboldt	Van Damme State Park	Mendocino
Mattole River/Mattole River Beach	Humboldt	Blow Hole	Mendocino
Mattole Road beaches	Humboldt	Jack Peters Gulch	Mendocino
Centerville Beach County Park	Humboldt	Russian Gulch State Park	Mendocino
Samoa Dunes Recreation Area/North Spit/North Jetty	Humboldt	The Pipeline	Mendocino
Mad River Beach County Park	Humboldt	The Bathrooms	Mendocino
Clam Beach County Park	Humboldt	Caspar Bay	Mendocino
Little River State Beach	Humboldt	Jug Handle State Reserve	Mendocino
Moonstone County Beach	Humboldt	Glass Beach	Mendocino
Trinidad State Beach	Humboldt	MacKerricker Beach State Park	Mendocino
Patrick's Point State Park	Humboldt	Usal Beach	Mendocino

Sources: Rosenburg 2000 and Osborn 2003.

More than one-half-million people participated in some form of kayaking in California in 1999, 2.5 million people participated in wildlife viewing, and more than 4 million people took photos at the beach (Leeworthy and Wiley 2001). Kayaking, whale watching and nature observation have all increased in popularity (Weinstein undated). The coast along Mendocino County is popular with both consumptive and non-consumptive sea kayakers. There are kayak rental shops throughout the study region. Some popular kayak trips and sites are listed below (Trails.com 2009). Locations are in Mendocino County unless otherwise noted.

- Shelter Cove to Bear Harbor (Humboldt County)
- Bear Harbor to Usal Beach
- Russian Gulch to Point Cabrillo
- Big River
- Mendocino (city) Coast

- Van Damme State Beach
- Albion to Dark Gulch
- Navarro River Estuary

5.8 Dredging and Vessel Traffic

5.8.1 Dredging

Dredging is an excavation activity used in coastal waterways and ports to keep them navigable by deepening channels (SWRCB 2003). It involves the physical removal of substrate, where large equipment gathers up bottom sediment and deposits the dredge spoils outside the waterway in deeper waters (EPA 2008). Dredging is also used to import sediment in beach nourishment projects. There are environmental consequences associated with dredging, which include: general disturbance to aquatic ecosystems, reduction in population and biodiversity of benthic communities, mortality of fish species, loss of spawning areas, and damage or loss of habitat (Newell et al. 1998). These impacts affect both the area where material is removed and the area where it is deposited. Humboldt Open Ocean Dredged Site (HOODS) was established in 1995 as a permanent ocean dredge material disposal site for Humboldt Bay and the north coast (National Dredging Team 1998). HOODS is located 3.5 miles offshore of Eureka, California; beyond the north coast study region. The impacts of dredge material removal and deposition can be minimized with proper management plans. Northern California has a regional dredging team that develops Dredge Material Management Plans, which include efforts to minimize ecological impacts (National Dredging Team 1998). In addition, dredge activities are regulated under the Clean Water Act Section 401 and under California SWRCB's Water Quality Order (SWRCB 2003).

5.8.2 Vessel Traffic

The busiest port complex in the north coast study region is the Humboldt Bay port complex. Humboldt Bay is the only deep-water shipping port between San Francisco, California and Coos Bay, Oregon. The Humboldt Bay port complex cargo consists of exports to Asia, trades with Canada, inbound domestic petroleum products, and inbound and outbound forest products (HBHRCD 2007). Between 1996 and 2005, Humboldt Bay handled an average of one million short tons of cargo per year. Currently, approximately 220 registered commercial vessels list the Humboldt Bay port complex as home port, and over 500 vessels from other west coast ports use the bay's facilities annually (HBHRCD 2007). The most recent major vessel accident off the California coast within the study region occurred in 1999 when the M/V Stuyvesant (a dredging vessel) spilled approximately 2,000 gallons of fuel oil near the entrance to Humboldt Bay (DFG 2007). In 1997, the vessel M/V Kure collided with a loading dock in Humboldt Bay, spilling several thousand gallons of bunker fuel oil into the bay (DFG 2008).

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6 Academic Institutions, Research, Public Outreach and Education

Academic and research institutions, government agencies, and non-governmental organizations in the north coast study region contribute to marine research, education and public outreach. Locations of research institutions and long-term monitoring sites are shown in the *Habitat & Species Atlas*.

6.1 Marine Research Institutions in the North Coast Study Region

Universities, colleges, government agencies and non-governmental organizations in northern California conduct research and monitoring in coastal and marine ecosystems of the north coast study region. Universities include Humboldt State University and several campuses of the College of the Redwoods. Telonicher Marine Institute is the focus of marine research at Humboldt State University. The Central and Northern California Coastal Ocean Observing System (CeNCOOS) is a collaborative network of research institutions and laboratories which are conducting research on a variety of topics, including water quality, fisheries management, climate change and predicting and mitigating coastal hazards in central and northern California. Several government agencies contribute to research in the north coast study region, including California Department of Fish and Game, California Sea Grant, NOAA National Marine Fisheries Service and U.S. Geological Survey. Non-governmental organizations also contribute to research in the north coast study region, including Reef Check, Marine Wildlife Care Center, Reef Environmental Education Foundation (REEF), Humboldt Baykeeper and the Northcoast Marine Mammal Center in Crescent City.

6.1.1 Scientific Research and Collecting

The scientific research within the north coast study region is diverse, ranging from intertidal ecology to studies of the pelagic zone and deep ocean (Table 6.2-1). A portion of the research in the north coast study region is conducted by and/or concentrated around marine laboratories and universities.

- Humboldt State University (HSU) is the home of research institutes and training in marine biology, fisheries and oceanography. The Northern California Institute of Marine Sciences, based at HSU, integrates research from biology, fisheries and oceanography departments. The Ocean Observing Group at HSU gathers real-time and historical data on water quality and climate.
- The Telonicher Marine Laboratory**,** established in 1965 and affiliated with HSU, fosters marine research and education in the northern California coast. The laboratory is located near Trinidad close to rocky shorelines, sandy beaches, mud flats, lagoons and estuaries, offshore kelp beds and submarine canyons. The laboratory has lecture rooms and labs for instruction and research on biological, chemical and geological oceanography, marine biological sciences, mariculture and fisheries. A culture room and a wet lab are used to grow algae and rear invertebrates and fish. The laboratory has specialized research equipment and a circulating seawater system to supply holding tanks and classrooms. The 90-foot R.V. Coral Sea, a 26-foot pontoon boat, and several smaller (12- to 24-foot) vessels support research and educational activities. (www.humboldt.edu/~marinelb/index.html)
- The California Cooperative Fish and Wildlife Research Unit, established in 1966, is one of 40 units established under the Federal Organic Act at universities throughout the United States. The Research Unit is a cooperative research and training program integrating resources from HSU, the California Department of Fish and Game, the United States Department of the Interior, U.S. Geological Survey, the Wildlife Management Institute and the United States Fish and Wildlife Service. One of the primary purposes of the Research Unit is to train

graduate students in fisheries and wildlife management through coursework and mentoring. Scientists and students associated with the cooperative research program conduct scientific research on wildlife, including fish, and their habitats and ecosystems. Current topics of investigation include ecology of salmon and steelhead, fish in coastal lagoons, distribution of oceanic birds and mammals, amphibian ecology, wetland ecology and physical and chemical processes in lakes and streams. (www.humboldt.edu/~cuca/index.html)

- The California State University Center for Integrative Coastal Observation, Research and Education (CICORE) was established in 2002 as an applied coastal research center distributed throughout California. CICORE is no longer funded but has been integrated into the Central and Northern California Ocean Observing System (CeNCOOS, see below). CICORE produced and archived data about marine and estuarine ecosystems in coastal California between the shore and 100 m depth between 2002 and 2005. The program used in-situ monitoring, optical remote sensing and high-resolution bathymetry to investigate a variety of questions about coasts and oceans. CICORE monitoring stations for temperature, salinity, dissolved oxygen, pH, turbidity and chlorophyll were located in Humboldt Bay in the northwest section of the Eureka waterfront and at the Trinidad Pier. Long-term monitoring initiated by CICORE continues through the Central and Northern California Ocean Observing System (CeNCOOS). (http://www.csc.noaa.gov/cots/accomp_reports/CICORE.pdf)
- The Central and Northern California Ocean Observing System (CeNCOOS) is a regional organization that coordinates ocean research in central and northern California, while implementing the national goals of the Integrated Ocean Observing System (IOOS). HSU is one of eight campuses of the California State University system that is participating in CeNCOOS. Research activities are concentrated within the U.S. Exclusive Economic Zone (from the coastline out to 200 nautical miles) from the California-Oregon border south to Point Conception and including bays and estuaries. CeNCOOS provides real-time links to ground observations, radar and satellite imagery, hydrologic prediction, precipitation maps, buoys, and wave predications. Water quality monitoring occurs in real time at Trinidad and Dock B. Climate monitoring stations are located at Trinidad Head, Samoa, and Woodley Island. (http://cencoos.humboldt.edu/)
- The Northern California Institute of Marine Sciences The Ocean Observing Group (CeNCOOS) at HSU gathers real-time data on water quality and climate. The group has archived relevant historical data from the region and produced a queryable database with information about eelgrass beds and fish abundance. Benthic and shoreline digital elevation maps of Humboldt Bay are also available. (www.calstate.edu/coast/coast_data_and_products/hsu_data.shtml)
- North Coast Marine Information System is a database of information about the northern California coast, developed by faculty from HSU. The system links to existing datasets and documents and provides an interface for mapping marine geographic information. (www.humboldt.edu/~ncalmis/database.html#link)
- The Multi-Agency Rocky Intertidal Network (MARINe) is a partnership of agencies, universities and private groups focused on monitoring rocky intertidal habitat. MARINe monitoring sites in the north coast study region are monitored by scientists affiliated with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) with support from a variety of sources, including Redwood National Park, The Nature Conservancy, the Minerals Management Service, and the Moore and Packard foundations (see below).
- PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) is a large-scale interdisciplinary marine research program based at four academic institutions on the U.S. west coast, including University of California, Santa Cruz (UCSC). PISCO-UCSC maintains an array of 11 intertidal monitoring sites in the north coast study region. The monitoring sites

were established between 1999 and 2004 and are part of a larger network extending from Southeast Alaska to Baja California Sur, Mexico. In the north coast study region, PISCO scientists survey intertidal biodiversity using point contacts, quadrats, band counts and tidal height topographic measurements. In addition, PISCO scientists survey intertidal community structure using photo quadrats, counts and size frequency surveys, transects, mobile invertebrate quadrat counts and recruitment studies. PISCO also conducts subtidal community surveys, oceanography monitoring and a variety of experiments to investigate large-scale, long-term ecological patterns and processes. (www.piscoweb.org)

Government agencies in the north coast study region sponsor, coordinate, collaborate and conduct scientific research.

- Redwood State and National Parks work with local researchers to study coastal and marine ecosystems in the park. Collaborators include faculty and graduate and senior students from HSU and other universities and colleges, local high school students, the MARINe intertidal monitoring program, and PISCO. Topics for research include water quality; intertidal and beach habitats; Chinook, steelhead, coastal cutthroat, and black rockfish nursery habitats; effects of seasonal trawling and hook and line fishing; shorebird and seabird colonies; and pinniped haulouts. The MARINe intertidal monitoring program monitors three sites in the park and PISCO has surveyed biodiversity at two sites. (www.nps.gov/redw/index.htm)
- Humboldt Bay National Wildlife Refuge collaborates with many partners to conduct research and monitoring in the refuge. Partners include other Fish and Wildlife Service offices, other state and federal agencies, the Wiyot Tribe, private landowners, the County and HSU faculty and students. Research priorities include study of seabirds and shorebirds, aquatic invertebrates, vegetation and invasive species. (www.fws.gov/humboldtbay/index.html)
- The National Marine Fisheries Service, Santa Cruz Lab (formerly Tiburon) conducted subtidal abundance surveys for juvenile rockfish in kelp beds in the north coast study region near the town of Albion in Mendocino County from 1983 to 2007. These surveys consisted of timed counts of all juvenile rockfish by divers along a 3 m transect. Divers also recorded additional information about adult fish and invertebrates observed during the surveys. (http://swfsc.noaa.gov
- The California Department of Fish and Game is initiating a program to inventory, monitor and assess the distribution and abundance of priority species, habitats and natural communities in California, bringing together many efforts to collect, compile and disseminate information to assist decision-makers in managing California's marine region. (http://www.dfg.ca.gov/regions/)
- The Cooperative Research and Assessment of Nearshore Ecosystems (CRANE) is a California statewide monitoring program developed by the California Department of Fish and Game in cooperation with other research scientists. The program was implemented in 2004 but has not continued at all sites. (http://www.dfg.ca.gov/regions/)
- The University of California Sea Grant Extension office based in Eureka, California, incorporates university-based and applied research into management and education and outreach programs on coastal, estuarine, marsh and marine resources. Sea Grant Extension has worked with an interagency team to prepare the Humboldt Bay Management Plan. Sea Grant Extension staff worked with colleagues from the Humboldt Bay Harbor, Recreation and Conservation District and the California Department of Fish and Game to assess biomass and density of native eelgrass in Humboldt Bay as part of the Humboldt Bay Management Plan. Sea Grant Extension initiated the Humboldt Bay and Eel River Estuary Subtidal and Intertidal Habitat Goals Project to integrate information about bay and estuarine habitats and

species and identify research needs for ecosystem-based management of the Humboldt-Eel River estuary. Sea Grant Extension staff surveyed juvenile rockfish and their habitats as well as invasive European green crabs. Staff also studied sea urchin nutrition and reproduction, primarily to contribute to management of aquaculture facilities.

- The Sea Grant Extension Marine Advisory program in northern California (Del Norte County) focuses on research and education about the salmon fishery. Sea Grant Extension completed extensive investigations of salmon, including (1) a 20-year study of Chinook salmon spawning escapement on Mill Creek, a tributary to the Smith River, California, (2) a survey of ocean sport salmon fishers in local rivers and (3) studies of potential economic impacts of salmon management on local industries, including the river guide industry and lily bulb industry in Del Norte, Curry and Humboldt Counties.
- The City of Arcata's Wastewater Treatment Facility, Marsh and Wildlife Sanctuary, established in 1949, is engaged in research activities to maximize treatment efficiency for the minimum cost. The facility partners with faculty and students at HSU to conduct research on wastewater treatment and effects of wastewater discharge. Through collaborative research with the university, the treatment facility has implemented innovations and technology to meet new and stricter water policies. Scientists also monitor environmental impacts of effluent discharged to habitats and species of Humboldt Bay. (http://www3.humboldt.edu/engineering/sites/www3.humboldt.edu.engineering/marsh/index.htm)
- Humboldt Bay Harbor, Recreation and Conservation District promotes commerce, fisheries, navigation, and recreational uses of the Humboldt Bay, and protects its natural resources. The Harbor District coordinates with other agencies (NOAA, US Army Corps of Engineers, Humboldt Bay Shellfish Technical Advisory Committee, California Sea Grant, among others) to gather and update information needed to manage natural resources and activities in Humboldt Bay. The Harbor District and collaborators developed a GIS database that includes physical and biological data from Humboldt Bay. (www.humboldtbay.org/gis/interactivemap.html)

A number of non-governmental organizations also contribute to research in the north coast study region.

- Reef Check California works with volunteer divers to survey nearshore reefs. The purpose of surveys is to assess relative abundance and size distribution of target species, including fish, invertebrates, and algae and evaluate changes over time. Reef Check works to conserve nearshore rocky reef ecosystems in California. Monitoring programs started in 2005. They educate and train volunteer divers to conduct surveys at 48 monitoring sites throughout the state. They have three monitoring sites in the north coast study region: Mendocino Headlands, Portuguese Beach, and Van Damme. All three sites are in Mendocino County near Mendocino Bay and maps can be found at http://www.reefcheck.org/PDFs/rcca2yr/RCCA_2yr_Report_App1.pdf. They monitor sites twice a year. Divers assess density of selected invertebrates, seaweed and substrate, and the density, size and identification of selected fish species along transects that are 30 meters long with a maximum depth of 18 meters.
- The Marine Wildlife Care Center, located on the HSU campus, was established in 1997 to care for oiled seabirds and participates in the Oiled Wildlife Care Network of emergency response centers in the north coast region from Point Arena to the California-Oregon border. The center was activated three times to care for oiled birds during emergencies in 1997, 1999 and 2006. The center is not equipped to care for oiled marine mammals, which must be transported to the Northcoast Marine Mammal Center in Crescent City. During non-

emergencies, the Marine Wildlife Care Center at HSU is used for classrooms and laboratories for the wildlife program. (mwcc@humboldt.edu)

- The Northcoast Marine Mammal Center, founded in 1983 and located in Crescent City, is a private non-profit organization for rescue and rehabilitation of marine mammals. The Center was constructed with support from an Offshore Oil Mitigation Grant. The center can accommodate or assist stranded, sick or injured seals, sea lions, dolphins, porpoises and whales. The center provides emergency response for injured wildlife as well as participates in collection of data on marine mammals. The center also works to educate the public about marine mammals and their role in ocean ecosystems. (www.northcoastmmc.org)

6.2 Public Education and Outreach

Local, state and federal agencies, colleges and private institutions throughout the north coast study region offer public outreach and education about coastal and marine ecosystems. Table 6.2-1 lists some key academic, research and education institutions in the north coast study region that focus on coastal or marine ecosystems, including:

- University and graduate education degrees/programs in marine science, management and conservation are available through several educational institutions including HSU and College of the Redwoods.
- Marine research institutions, such as the Telonicher Marine Institute at HSU, provide opportunities for hands-on learning in the marine environment for students, teachers and the public.
- State and federal agencies, including Redwood National and State Parks, provide opportunities for public education, K-12 education and teacher and volunteer docent training.
- Public education is offered through private institutes such as the Ocean World aquarium in Crescent City.

Some education and research institutions have developed educational opportunities for undergraduate and graduate students. In a few cases, the research institutions expand education programs to include K-12 students, teachers and community members.

- The College of Natural Resources and Sciences at HSU provides instruction and research opportunities for undergraduate and Masters students in marine science, including fields such as oceanography and invertebrate zoology.
- The Telonicher Marine Laboratory, affiliated with HSU, offers education to local schools and the public. The lab offers opportunities to explore beach and ocean ecosystems with a marine naturalist. The lab also maintains seven aquaria, two touch tanks and other displays to educate visitors about marine ecosystems of northern California. Visitors also can learn about marine habitats and species through slide presentations, microscope activities and tide pooling with a marine naturalist.
- The Albion Field Station, operated by Pacific Union College, is located in forested hills near the Pacific Ocean. The remote location provides opportunities for study of intertidal habitats, tide pools and estuaries. Current educational programs focus on art and ornithology. The station also provides opportunities for groups to engage in outdoor environmental education.
- Mendocino College in Ukiah offers courses in marine biology, marine mammal biology and field ecology for undergraduate students. The college operates the Point Arena Field Station, 50 miles southwest of Ukiah, as a field laboratory for science classes in marine biology, geology and meteorology. The field station supports research activities and student projects

in marine biology, oceanography, environmental chemistry, marine ecology and coastal geology.

- College of the Redwoods, based in Fort Bragg, offers a Certificate of Achievement and Associate of Science degree in Marine Science Technology.

Some local, state and federal agencies have developed education and outreach programs to increase public awareness about coast and ocean issues:

- The City of Arcata's Wastewater Treatment Facility, Marsh and Wildlife Sanctuary provides an innovative combination of services, including wastewater treatment, wildlife habitat, research, education and recreation. Over 15,000 visitors come to the facility each year to learn about how water becomes wastewater and is cleaned and how the treated water is integrated into the marsh. The facility provides free guided tours focused on biodiversity and ecology of the marsh. Docents, who may eventually lead tours, are trained in the fall and spring. Wetlands on Wheels (WOW) brings education about wetlands and the Arcata Marsh to local elementary students in third- and fourth-grade classes. Marsh Explorers is a summer science class for children cosponsored with the Humboldt State Natural History Museum. Girl Scouts and the Recreation Departments' Natural Resources Science Camp collaborate to teach young students about marsh diversity and ecology. The facility also sponsors a science fair prize for the best project related to wetlands at the annual Humboldt County Science Fair. The Wastewater Facility and Marsh sponsors community events including a monthly art exhibit featuring wildlife and landscape of Arcata Marsh.
- The Redwood State and National Parks offer facilities for standards-based education programs at Howland Hill Outdoor School near Crescent City and Wolf Creek Education Center near Orick. Educational programs feature field studies about wetland, stream, prairie and old-growth forest communities in the parks as well as tidepools in the vicinity of Crescent City. Programs at Wolf Creek Education Center focus on grades 4-6 and feature learning about old-growth forests, prairies and streams where salmon spawn and grow.
- The Humboldt Bay National Wildlife Refuge protects wetland, bay, dune habitats (including Lanphere and Ma-le'l Dunes) and associated species, including Black Brant, Common Murre, Aleutian Cackling Goose, Peregrine Falcon, Bald Eagle, California Brown Pelican, Humboldt Bay wallflower, and beach layia. Undergraduate and graduate students from HSU and College of the Redwoods conduct basic and applied research in the Humboldt Bay National Wildlife Refuge. The refuge also provides guidance for outdoor class activities and field trips to Salmon Creek and Hookton Slough. Castle Rock National Wildlife Refuge is about a half mile offshore from Crescent City and approximately eighty miles north of Humboldt Bay. Castle Rock is a roosting and nesting site for hundreds of thousands of seabirds and an important haul out for marine mammals.

Non-governmental organizations also contribute to education and outreach in the north coast study region.

- Humboldt Baykeeper, established in 2004, works to "safeguard…coastal resources for the health, enjoyment, and economic strength of the Humboldt Bay community through education, scientific research, and enforcement of laws to fight pollution." Scientists, students, fishermen, boaters and other concerned citizens are engaged with Humboldt Baykeeper in an effort to protect Humboldt Bay, its associated watersheds, and adjacent coastal waters. Humboldt Baykeeper works in Humboldt Bay and its tributaries as well as along the coast between Trinidad Harbor and the Eel River. Patrols of this area are conducted by motorboat, kayak, airplane, car and foot.

- Friends of the Dunes is a non-profit organization established in 1982 to promote community involvement in coastal conservation projects. The organization has been involved with education programs, guided walks and the restoration of coastal ecosystems. Friends of the Dunes serves as the land trust for the Humboldt Coastal Nature Center, a coastal dune property. The organization sponsors fall and spring field trip programs about biodiversity, ecology and conservation of Humboldt Bay and coastal dunes for local elementary students, grades 3-6. Friends of the Dunes coordinates a volunteer program to help restore the dune ecosystem by removing non-native invasive plants.

Public education is the primary focus of aquariums.

- Ocean World aquarium, originally Under Sea Gardens, was established in Crescent City in 1964. For the first twenty years, the aquarium consisted of a barge in Crescent City harbor that allowed visitors to descend below the sea's surface to view underwater life. In 1985, the barge was moved to dry land and was remodeled to include tanks holding over 500,000 gallons of seawater and displaying a diversity of sea life. Attractions include shark petting and an interactive tide pool.

Table 6.2-1: Academic, research and education institutions with a focus on coastal and marine ecosystems

Name	Address and Telephone	Website/Email
Albion Field Station Pacific Union College	P.O. Box 86 34100 Albion Street Albion, CA 95410 Phone: (707) 937-5440 Fax: (707) 937-3557	www.puc.edu/puc-life/albion/home Email: albion@puc.edu
California Department of Fish and Game	619 Second Street Eureka, CA 95501 Phone: (707) 445-6493 32330 North Harbor Drive Fort Bragg, CA 95437 Phone: (707) 964-9080 741 Cooper Avenue Crescent City, CA 95531 Phone: (707) 465-5241	www.dfg.ca.gov/
Center for Integrative Coastal Observation, Research, and Education (CICORE)	Humboldt State University 1 Harpst Street Arcata, CA 95521	http://www.csc.noaa.gov/cots/accomp_reports/CICORE.pdf
Central and Northern California Ocean Observing System (CeNCOOS)	Humboldt State University 1 Harpst Street Arcata, CA 95521	http://cencoos.humboldt.edu/

Name	Address and Telephone	Website/Email
City of Arcata's Wastewater Treatment Facility, Marsh and Wildlife Sanctuary	569 South G Street Arcata CA 95521	http://www3.humboldt.edu/engineering/sites/www3.humboldt.edu.engineering/marsh/index.htm
College of the Redwoods	1211 Del Mar Drive Fort Bragg, CA 95437 Phone: (707) 962-2600 Fax: (707) 961-0943	www.redwoods.edu
Friends of the Dunes	P.O. Box 186 Arcata, CA 95518 Phone: (707) 444-1397	http://www.friendsofthedunes.org/ Email: info@friendsofthedunes.org
Humboldt Bay Harbor, Recreation and Conservation District	P.O. Box 1030 601 Startare Drive Eureka CA 95502-1030 Phone: (707) 443-0801 Fax: (707) 443-0800	www.humboldtbay.org
Humboldt Bay National Wildlife Refuge	1020 Ranch Road Loleta, CA 95551 Phone: (707) 733-5406	www.fws.gov/humboldtbay/index.html
Humboldt Baykeeper	217 E Street Eureka, CA 95501 Phone: (707) 268-8897	www.humboldtbaykeeper.org/
Humboldt State University California Cooperative Fish & Wildlife Research Unit	1 Harpst Street Wildlife & Fisheries Bldg, Rm 212 Arcata, CA 95521 Phone: (707) 826-3268 Fax: (707) 826-3269	www.humboldt.edu/~cuca/index.html
Humboldt State University College of Natural Resources and Sciences	Department of Oceanography 1 Harpst Street Arcata, CA 95521	www.humboldt.edu/~ocn/
Humboldt State University Marine Wildlife Care Center Department of Wildlife	1 Harpst Street Arcata, CA 95521 Phone: (707) 826-3450	www.humboldt.edu/~mwcc Email: mwcc@humboldt.edu

Name	Address and Telephone	Website/Email
Humboldt State University North Coast Marine Information System	Steven J. Steinberg Institute for Spatial Analysis 1 Harpst Street Arcata, CA 95521 Phone: (707) 826-3202	www.humboldt.edu/~ncalmis/index.html
Humboldt State University Northern California Institute of Marine Sciences	1 Harpst St. Arcata, CA 95521	Email: gbc3@humboldt.edu (Greg Crawford)
Mendocino College Point Arena Field Station	1000 Hensley Creek Road Ukiah, CA 95482 Phone: (707) 468-3000	www.mendocino.edu
North Coast Marine Mammal Center	424 Howe Drive Crescent City, CA 95531 Phone: (707) 465-6265	www.northcoastmmc.org
Ocean (Under Sea) World	304 U.S. Highway 101 South Crescent City, CA 95531-4412 Phone: (707) 464-4900	www.oceanworldonline.com/new/
Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)	University of California, Santa Cruz Long Marine Laboratory 100 Shaffer Road Santa Cruz, CA 95060	www.piscoweb.org
Redwood State and National Parks	1111 Second Street Crescent City, CA 95531 Phone: (707) 464-6101 Fax: (707) 464-1812	www.nps.gov/redw/index.htm
Reef Check California	17575 Pacific Coast Highway, Suite B Pacific Palisades, CA 90272 Phone: (310)230-2371	www.ReefCheck.org
Southwest Fisheries Science Center	110 Shaffer Road Santa Cruz, CA 95060 Phone: (831) 420-3900 Fax: (831) 420-3980	http://swfsc.noaa.gov

Name	Address and Telephone	Website/Email
Telonicher Marine Laboratory	570 Ewing Street or P.O. Box 690 Trinidad, CA 95570 Phone: (707) 826.3671	www.humboldt.edu/~marinelb/index.html
University of California Sea Grant Extension	2 Commercial Street, Suite 4 Eureka, CA 95501 Phone: (707) 443-8369 Fax: (707) 445-3901	Email: scschlosser@ucdavis.edu (Susan Schlosser),; cedelnorte@ucdavis.edu (Jim Waldvogel)

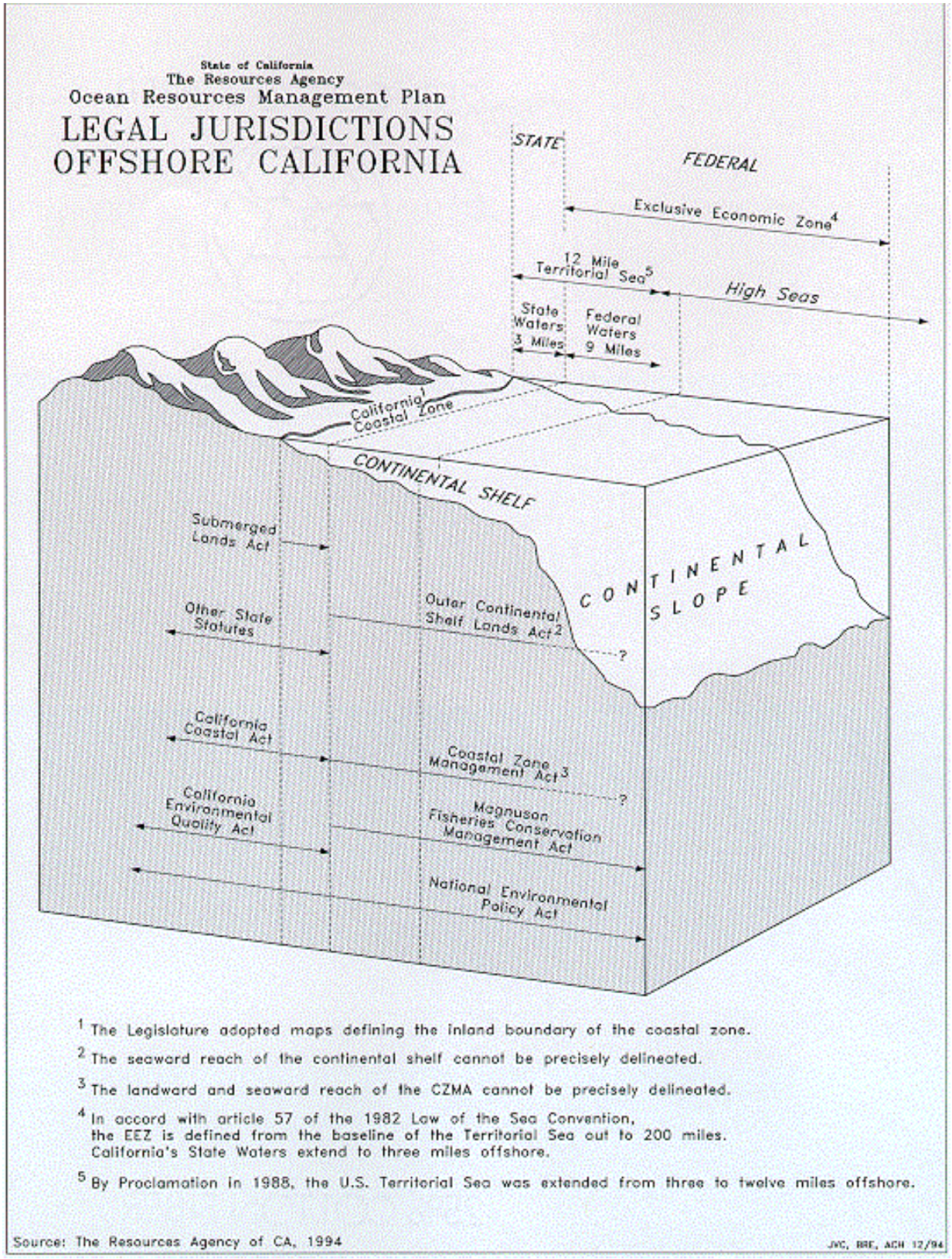
7 Jurisdiction and Management

7.1 Federal, State, Local and Native American Jurisdiction and Programs

No single agency has sole jurisdiction over the coastal and marine environment. Rather, jurisdiction varies spatially and by resource type. The main federal, tribal, state, and local entities are highlighted below with a brief description of their role and responsibility. Figure 7.1-1 illustrates the division of jurisdictions between state and federal agencies as it pertains to the coastal zone and ocean.

While the MLPA Initiative process will establish a network of MPAs in state waters, coordination and communication with many agencies (federal, state, local and Native American) is essential for successful MPA management. The next section lists some key agencies and a brief description of their respective mandates and missions.

Figure 7.1-1: Legal jurisdictions offshore California



Source: California Resources Agency 1997

7.1.1 Federal Agencies and Programs

The U.S. Department of Commerce has several agencies with responsibilities for ocean and coastal resources, some of which are described below:

The National Oceanic and Atmospheric Administration's (NOAA) mission is to understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet the nation's economic, social, and environmental needs (NOAA 2009a). NOAA offices and programs that have direct interest in MPA issues include the Office of Ocean and Coastal Resource Management (OCRM), the National Marine Fisheries Service (NOAA Fisheries), and the National Marine Sanctuary Program.

OCRM implements three statutes: the Coastal Zone Management Act, the Marine Protected Areas Presidential Executive Order, and the Coral Reef Conservation Act. OCRM provides national leadership, strategic direction and guidance to state and territory coastal programs and estuarine research reserves. OCRM is composed of six divisions that oversee ocean and coastal management at the federal level. One division is the **Marine Protected Areas Center**, which was established in 2000 under the Presidential Executive Order 13158 to facilitate the effective use of science, technology, training and information in the planning, management and evaluation of the nation's system of marine protected areas (MPAs). The National MPA Center works with the Department of the Interior and other agencies and stakeholders to develop a plan for an effective, integrated system of MPAs. Another division is the **Estuarine Reserves Division,** which oversees the National Estuarine Research Reserve System (NERRS), a partnership program between NOAA and the coastal states (NOAA 2009d).

NOAA Fisheries implements the Magnuson-Stevens Fishery Conservation and Management Act, the Marine Mammal Protection Act, and the Endangered Species Act. Its mission is stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems. NOAA Fisheries is responsible for the management, conservation and protection of living marine resources within the United States Exclusive Economic Zone. NOAA Fisheries also plays a supportive and advisory role in the management of living marine resources in coastal areas under state jurisdiction, provides scientific and policy leadership in the international arena and implements international conservation and management measures as appropriate.(NOAA 2009c).

The Pacific Fisheries Management Council is one of eight regional fishery management councils established by the Magnuson-Stevens Fishery Conservation and Management Act and is responsible for fisheries off the coasts of California, Oregon, and Washington (PFMC 2009).

The National Marine Sanctuary Program implements the National Marine Sanctuaries Act. Its mission is to serve as the trustee for the nation's system of marine protected areas, to conserve, protect, and enhance their biodiversity, ecological integrity and cultural legacy (NOAA 2009b).

The U.S. Department of the Interior also has several agencies with responsibilities for ocean and coastal resources, some of which are described below:

The U.S. Fish and Wildlife Service's mission is to work with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people (USFWS 2007). The US Fish and Wildlife Service implements and enforces more than a dozen federal statutes, including the Endangered Species Act, the Migratory Bird Treaty Act, the Marine Mammal Protection Act and the National Wildlife Refuge System. Within the North Coast Study Region there are two national wildlife refuges along the coast: Castle Rock NWR and Humboldt Bay NWR (USFWS 2009).

The National Park Service (NPS) aims to preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world (NPS 2009). Redwood national park is the only national park located adjacent to the north coast study region. It is located in northern Humboldt and southern Del Norte counties.

The Bureau of Land Management carries out a multitude of programs to manage and conserve a significant portion of public lands. One component of this work is the management of the National Landscape Conservation System, which includes the California Coastal National Monument. This monument consists of more than 20,000 small islands, rocks, pinnacles, and exposed reefs between Mexico and Oregon and extends from shore out to 12 nautical miles. Some of these features in the study region include:

- Castle Island/Castle Rock
- Reading Rock
- Wedding Rock
- Flatiron Rock
- Pilot Rock
- Blunts Reef

The BLM manages the resources above the mean high tide and the State of California manages the resources below. The primary purpose of the monument is to protect geologic and habitat values. There are visitor information centers within the North Coast Study Region in Trinidad and Pt Arena (BLM 2009).

The U.S. Geologic Survey provides reliable scientific information to describe the earth and aid in its understanding; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

The United States Coast Guard is a military, multi-mission, maritime service within the Department of Homeland Security and one of the nation's five armed services. Its core roles are to protect the public, the environment, and U.S. economic and security interests in any maritime region in which those interests may be at risk, including international waters and America's coasts, ports, and inland waterways (USCG 2008). Bases adjacent to the north coast study area are outlined in Table 7.1-1.

Table 7.1-1: Coast Guard stations

Name of Facility	County
Boating Station	Del Norte
Air Station Humboldt Bay	Humboldt
Station Humboldt Bay	Humboldt
Station Noyo River	Mendocino

The U.S. Environmental Protection Agency is an agency of the federal government and leads the nation's environmental science, research, education and assessment efforts. Its mission is to protect human health and the environment (EPA 2009).

The U.S. Army Corps of Engineers' mission is to provide vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risks from disasters (U.S. Army 2009). The Corps is a federal agency that regulates and permits construction and engineering projects for the public and the military.

7.1.2 State Agencies and Programs

The Natural Resources Agency works to restore, protect and manage the state's natural, historical and cultural resources for current and future generations using creative approaches and solutions based on science, collaboration and respect for all the communities and interests involved. The Natural Resources Agency oversees the policies and activities of 25 departments, boards, commissions and conservancies (CNRA 2007).

The California Department of Fish and Game (DFG) manages California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. This includes protection and maintenance of habitat in a sufficient amount and quality to ensure the survival of all species and natural communities. The department is also responsible for the diversified use of fish and wildlife including recreational, commercial, scientific and educational uses (DFG 2009).

The California Department of Parks and Recreation (State Parks) provides for the health, inspiration and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation. Responsible for almost one third of California's scenic coastline, California State Parks manages coastal wetlands, estuaries, beaches and dune systems, including over 280 miles of coastline (State Parks 2009). Table 7.1-2 provides a list of state parks adjacent to the north coast study region by county.

Table 7.1-2: California State Parks

Name of State Park, Beach, or Wildlife Area	Underwater Park	County
Pelican		Del Norte
Prairie Creek Redwoods		Del Norte
Tulowa Dunes		Del Norte
Lake Earl		Del Norte
Del Norte Coast Redwoods		Del Norte
Prairie Creek Redwoods		Humboldt
Humboldt Lagoons		Humboldt
Harry A. Merlo		Humboldt
Patrick's Point		Humboldt
Trinidad		Humboldt
Little River		Humboldt
Sinkyone Wilderness		Mendocino
Westport-Union Landing		Mendocino
MacKerricher	*	Mendocino
Caspar Headlands		Mendocino
Mendocino Headlands		Mendocino
Russian Gulch	*	Mendocino

Name of State Park, Beach, or Wildlife Area	Underwater Park	County
Pt. Cabrillo Light Station	*	Mendocino
Van Damme		Mendocino
Greenwood		Mendocino

The California Ocean Protection Council's (OPC) mission is to ensure that California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations. Responsibilities of the OPC include the coordination of ocean-related state agencies, including collection and sharing of scientific data, and to identify and recommend changes in state and federal law and policy (OPC 2008).

The California Environmental Protection Agency (Cal/EPA) aims to restore, protect and enhance the environment, to ensure public health, environmental quality and economic vitality. Cal/EPA is charged with developing, implementing and enforcing the state's environmental protection laws that ensure clean air, clean water, clean soil, safe pesticides and waste recycling and reduction. Cal/EPA oversees the policies and activities of 6 departments, boards and offices (Cal/EPA 2009).

The State Water Resources Control Board's (SWRCB) mission is to preserve, enhance and restore the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations. The joint authority of water allocation and water quality protection enables the State Board to provide comprehensive protection for California's waters (SWRCB 2009).

The California State Lands Commission (CSLC) aims to provide stewardship of the lands, waterways, and resources entrusted to its care through economic development, protection, preservation, and restoration. The Commission has jurisdiction and management control over certain public lands of the State. Additionally this commission has jurisdiction over oil and gas development, manages the removal of hazardous structures such as old piers, issues permits for dredging in harbors and waterways, issues leases for certain types of development, and has programs established for oil spill prevention (CSLC 2007).

The California Coastal Commission (CCC) aims to protect, conserve, restore and enhance environmental and human-based resources of the California coast and ocean for environmentally sustainable and prudent use by current and future generations. The Coastal Commission implements the California Coastal Act and is one of two designated coastal management agencies that administer the federal Coastal Zone Management Act (CZMA). The CZMA requires federal consistency with the California Coastal Act and can extend the Coastal Commission's jurisdiction out to 200 nautical miles from shore. The Coastal Commission, in partnership with coastal cities and counties, plans and regulates the use of land and water in the coastal zone. Development activities, which are broadly defined by the Coastal Act to include (among others) construction of buildings, divisions of land, and activities that change the intensity of use of land or public access to coastal waters, generally require a coastal permit from either the Coastal Commission or the local government. California's coastal management program is carried out through a partnership between state and local governments. Implementation of Coastal Act policies is accomplished primarily through the preparation of **local coastal programs (LCPs)** that are required to be completed by each of the 15 counties and 60 cities statewide located in whole or in part in the coastal zone. The Coastal Commission also has an oil spill prevention and response program, a statewide Coastal Act enforcement program, a Coastal Nonpoint Source Water Pollution Control Program, and a Coastal Access Program (CCC 2005). The establishment of MPAs may require a coastal development

permit if they would create certain conditions pertaining to public access, physical development, intensity of use, or others (CCC 2009).

The California State Coastal Conservancy (SCC) is a state agency that uses entrepreneurial techniques to purchase, protect, restore, and enhance coastal resources, and to provide access to the shore. The Conservancy works in partnership with local governments, other public agencies, nonprofit organizations, and private landowners (SCC 2008).

7.1.3 Local Government Programs

Coastal counties in the north coast study region manage and maintain public beaches and coastal parks. A list of these beaches and parks by county is as follows:

Del Norte County: Clifford Kamph Memorial Park

Humboldt County: Big Lagoon, Centerville Beach, Fields Landing Boat Ramp, Luffenholtz Beach, Mad River, Samoa Boat Ramp, Moonstone Beach

Mendocino County: None in study region

Local Coastal Programs (LCP)

The federal Coastal Zone Management Act passed in 1972 encouraged coastal states to develop policies to protect coastal resources. The California Coastal Act of 1976 established the Coastal Commission as a permanent coastal management and regulatory agency. The Coastal Commission retains permanent permit jurisdiction for proposed projects within a designated coastal zone, ranging from several hundred feet to several miles from the coast. However, local government may assume permit jurisdiction once the Coastal Commission approves its LCP. Each LCP includes a land-use plan that prescribes land-use classifications, types and densities of allowable development, goals and policies concerning development, and zoning and other ordinances and administrative procedures needed to implement the plan. After an LCP is approved, the Coastal Commission's permitting authority is delegated to the local county/city government. The Coastal Commission retains appeal authority over certain local government permit decisions. It also retains original permit jurisdiction over development on tidelands, submerged lands, and public trust lands. All amendments to approved LCPs must be submitted to the Commission for review and approval. Within the north coast study region, all three coastal counties have certified LCPs. In addition, the following cities within the north coast region have approved LCPs or Land Use Plans (LUPs) as of July 2009: Crescent City in Del Norte County, Arcata, Eureka and Trinidad in Humboldt County, and Ft. Bragg in Mendocino County.

7.1.4 Native American Jurisdiction and Treaty Rights

There are many different and distinct Tribal groups within the three counties of the north coast study region (NAHC 2009; BIA 2009). Within each Tribal group, there are a variety of ways in which the larger group is further segmented, each sub-set being unique, including, for example, identification by band, village, family, and/or house. Groups are interconnected by complex social and trade networks, as well as trails that extend north, south and inland. Some Tribal groups originally resided seasonally along the coast, while others had permanent villages there. Therefore, although a majority of coastal and marine resources are now used by those people residing predominately along the coast, there is significant use and meaning of marine resources for peoples many miles to the north, south, and inland that must also be recognized. It should be noted that some areas are

simultaneously identified by neighboring Tribes and that certain areas may be more distinctly identified as attributed to certain band(s), village(s), family(ies), and/or individual(s).

Federally-recognized Native American Tribes are recognized as separate and independent sovereign nations within the territorial boundaries of the United States by the Federal Government. Tribes promulgate and administer their own laws and operate under their own Constitutions. Moreover, tribal membership is determined by the governing tribal law and as such, being classified as "Indian" due to your acceptance to a roll of a federally-recognized Tribe means this classification is not racial, but rather citizenship-based, thus making it a political classification. Tribal governments may include a single or many members from varying Tribal groups. Tribes in California have varying types of lands identified as Indian Country[2], including Reservation, Rancheria, dependent Indian communities[3], and allotments. Currently, there are 109 federally-recognized Native American Tribes in California, 20 of which lie within the three coastal counties of the north coast study region (Rocha, pers. comm. 2009). In addition, there are several tribes petitioning for federal recognition. Federally-recognized Tribes in the north coast study region include (BIA 2009, Rocha, pers. comm. 2009):

Del Norte County

- Tolowa Tribe of the Smith River Rancheria
- Elk Valley Rancheria
- Yurok Tribe (majority of Reservation lands span Humboldt County)
- Resighini Rancheria

Humboldt County

- Big Lagoon Rancheria
- Blue Lake Rancheria
- Cher-Ae Heights Indian Community of the Trinidad Rancheria
- Bear River Band of the Rohnerville Rancheria
- Wiyot Tribe
- Hoopa Valley Tribe

Mendocino County

- Round Valley Indian Tribes of the Round Valley Reservation

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[2] Congress has defined the term "Indian Country" as including a) all land within the limits of any Indian reservation under the jurisdiction of the United States Government, . . . (b) all dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state, and (c) all Indian allotments . . . . Source: http://library.law.emory.edu/1circuit/july96/95-1944.01a.html

[3] "[D]ependent Indian communities" refers to a limited category of Indian lands that are neither reservations nor allotments (the other categories of Indian country set forth in Sec. 1151), and that satisfy two requirements -- first, they must have been set aside by the Federal Government for the use of the Indians as Indian land; second, they must be under federal superintendence. Source: http://www.citizensalliance.org/Major%20Issues/General%20Legal%20Issues/def_indian_country.htm

- Cahto Indian Tribe of the Laytonville Rancheria, California
- Sherwood Valley Rancheria of Pomo Indians of California
- Coyote Valley Band of Pomo Indians of California
- Pinoleville Rancheria of Pomo Indians of California
- Redwood Valley Rancheria of Pomo Indians of California
- Manchester Band of Pomo Indians of the Manchester-Point Arena Rancheria
- Hopland Band of Pomo Indians of the Hopland Rancheria
- Guidiville Rancheria
- Potter Valley Tribe

Each of these Tribes are distinct political entities and each have various areas they identify for subsistence, cultural, and ceremonial purposes, as well as to a lesser extent recreational and commercial uses of the coast and ocean waters within those lands they identify an ancestral, cultural, and/or Tribal connection. Each Tribe individually has a government-to-government relationship with the federal government. There are also federally-obligated Trust Responsibilities that are multi-faceted.

The California Fish and Game Code is not applicable within the boundaries of the reservation or rancheria for recognized members of Native American tribes, although the sale of bird, mammal, fish, or amphibia is still prohibited (Fish and Game Code §12300). Outside reservation or rancheria property, Native American citizens are subject to the Fish and Game Code.

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8 Existing MPAs, Coastal Protected Areas and Federally Managed Areas

The MLPA North Coast Study Region contains several areas that are currently afforded some degree of protection by existing state or federal regulations. These areas include existing state MPAs and fisheries management measures. Additionally, there are a number of terrestrial protected areas immediately adjacent to the study region (such as state beaches) as well as several areas located in the watersheds of coastal rivers (such as national forests).

8.1 Existing State Marine Protected Areas in the Study Region

The MLPA requires consideration of each study region's existing MPAs to assess the need for changing existing MPAs or adding new ones to fulfill the requirements of the act. The existing MPAs are evaluated during the MLPA Initiative evaluation process as "Proposal 0," and provide a reference point for newly proposed or modified existing MPAs. An MPA, according to California State law, is a discrete geographic area that has been designated by law, administrative action, or voter initiative to protect or conserve marine habitat and life. Estuarine protected areas are considered MPAs.

There are currently five MPAs in the north coast study region, all of which are smaller than the minimum size guidelines identified in the master plan for MPAs. The existing MPAs are described below from north to south and displayed in the *Coastal Management & Human Uses Atlas*.

Punta Gorda State Marine Reserve (SMR) is the only existing SMR in the NCSR. Located off Punta Gorda in Humboldt County, it encompasses the area from the 3-fathom depth contour to the 30-fathom depth contour between 40˚16.43' N and a line running from 40˚15.23'N to 40˚14.83'N. This area prohibits all commercial and recreational take. At approximately 2.07 square miles, it is the largest existing MPA in the NCSR.

MacKerricher State Marine Conservation Area (SMCA) is located along MacKerricher Beach north of Fort Bragg. It extends from the mean high tide line to the 3-fathom depth contour between a line from 39˚29.81'N to 39˚29.95'N and a line from 39˚27.62'N to 39˚27.55'N, covering an area of approximately 0.75 square miles. MacKerricher SMCA allows the recreational take of only red abalone, chiones, clams, cockles, rock scallops, native oysters, crabs, lobster, ghost shrimp, sea urchins, mussels, marine worms, and finfish; and the commercial take of only algae (except giant kelp and bull kelp), crabs, ghost shrimp, jackknife clams, sea urchins, squid, worms, and finfish. Take of all other species is prohibited.

Point Cabrillo SMCA is located at Point Cabrillo in Mendocino County. It extends from the mean high tide line to a distance of 1000 feet offshore and is bounded by a line from 39˚21.24'N to 39˚21.33'N and a line from 39˚20.57'N to 39˚20.66'N, covering approximately 0.21 square miles. Point Cabrillo SMCA allows the commercial take of only marine aquatic plants and finfish and prohibits all recreational take.

Russian Gulch SMCA and Van Damme SMCA are located along the Mendocino coast and are adjacent to terrestrial state parks of the same names. Both allow the recreational take of only red abalone, chiones, clams, cockles, rock scallops, native oysters, crabs, lobster, ghost shrimp, sea urchins, mussels, marine worms, and finfish; both allow the commercial take of only algae (except giant kelp and bull kelp), crabs, ghost shrimp, jackknife clams, sea urchins, worms and finfish. Russian Gulch SMCA extends from the mean high tide line to the three-fathom depth contour and is bounded by a line from 39˚19.86'N to 39˚19.85'N and a line at 39˚19.52'N, covering approximately

0.08 square miles. Van Damme SMCA extends from the mean high tide line to the 3-fathom depth contour and is bounded by a line from 39˚16.45'N to 39˚16.355'N and a line at 39˚16.27'N, covering approximately 0.02 square miles.

8.2 Federally Managed Areas and Fishery Closures

Several areas in state and federal waters along the north coast study region currently experience some degree of marine management. These areas are detailed below.

8.2.1 Federally Managed Areas

The boundary of Redwood National Park extends 0.4km offshore, encompassing a long stretch of state waters from Crescent Beach, just south of Crescent City, in the north to Humboldt Lagoons State Park in the south. These waters include several larger offshore rocks such as the Sister Rocks and the rocks near False Klamath Cove. The National Park Service does not impose fishing regulations in these waters other than those established by state or federal fishery management agencies.

8.2.2 Fishery Closures Within and Adjacent to the North Coast Study Region

Two main types of fishery closures exist within and adjacent to the NCSR. Rockfish conservation areas (RCAs) have been established along large portions of the west coast to minimize the incidental take of overfished rockfish that are likely to co-occur with healthy stocks of groundfish. Essential fish habitat (EFH) areas have also been established in areas along the west coast to prevent habitat damage by fishing gear in areas of important groundfish habitat. A third closure, the Klamath River Salmon Conservation Zone, prohibits the take of Pacific whiting in an area reaching approximately six nautical miles north and south of the Klamath River mouth and extending approximately twelve nautical miles from shore. This area was established to protect spawning runs of salmon as they congregate near the Klamath River mouth.

In the NCSR there are extensive RCAs that may vary seasonally and by gear type. The most up-to-date list of RCAs can be found at http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/. Currently, recreational fishing for rockfish in the NCSR is only allowed in waters shallower than 20 fathoms during certain months of the year; recreational rockfish fishing is prohibited in waters deeper than 20 fathoms at all times. North of 40˚10'N lat., recreational fishing for rockfish in waters shallower than 20 fathoms is allowed from May 15 to September 15, while in areas between that latitude and the southern boundary of the NCSR, recreational rockfish fishing is only allowed from May 15 to August 15. Commercial regulations specify that non-trawl fishing for rockfish in the same areas is prohibited from 20 to 100 fathoms in the northern area and from 30 to 150 fathoms in the southern area year-round.

Trawl gear is regulated along the west coast primarily through EFH areas that are intended to protect groundfish habitat from damage by trawl gear. Though most of these closures occur in federal waters, several closures extend into state waters, including Blunts Reef, Mendocino Ridge, Delgada Canyon, and Tolo Bank bottom trawl closure areas. These and other trawl closure areas in federal waters are closed to bottom trawl gear other than demersal seines. Additionally, an extensive area of habitat in federal waters is closed to all bottom trawl gear. A map of these essential fish habitat closures can be found at http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/Groundfish-EFH/upload/Map-Gfish-EFH-Close.pdf.

8.3 Terrestrial Protected Areas in Coastal Watersheds

A large number of terrestrial protected areas exist adjacent to the NCSR, ranging from state beaches to national forests in the watersheds of coastal rivers. These areas provide varying degrees of protection to coastal habitats, and are listed in Table 8.3-1 below. Agencies managing terrestrial protected areas may make good partners for research, monitoring, and enforcement.

Table 8.3-1 List of terrestrial protected areas

Type of Protected Area	Locations	# of Areas
National Park	Redwood	1
National Recreation Area	Smith River	1
National Wildlife Refuge	Castle Rock, Humboldt Bay	2
National Forest	Six Rivers, Klamath, Shasta-Trinity, Mendocino	4
National Wild and Scenic River	Smith River, Klamath River, Trinity River, Eel River	4
State Beach	Pelican, Trinidad, Little River, Westport-Union Landing, Caspar Headlands, Greenwood	6
State Park	Tolowa Dunes, Jedediah Smith Redwoods, Del Norte Coast Redwoods, Prairie Creek Redwoods, Humboldt Lagoons, Patrick's Point, Grizzly Creek Redwoods, Humboldt Redwoods, Richardson Grove, Sinkyone Wilderness, MacKerricher, Russian Gulch, Mendocino Headlands, Van Damme, Mendocino Woodlands, Navarro River Redwoods, Hendy Woods, Manchester	18
State Reserve	Azalea, Smithe Redwoods, Jug Handle, Caspar Headlands, Montgomery Woods, Mailliard Redwoods	6
State Recreation Area	Harry A. Merlo, Benbow Lake, Standish-Hickey, Admiral William Standley	4
State Historic Park	Fort Humboldt, Point Cabrillo Light Station	2
County Park	Florence Keller, Ruby Van Deventer, Clifford Kamph Memorial, Big Lagoon, Luffenholtz, Clam Beach, Mad River, Van Duzen, A.W. Way	9
Other	Arcata Marsh and Wildlife Sanctuary, Lake Earl State Wildlife Area	2

8.4 Marine Protected Areas in Oregon

Although the north coast study region is bounded on the north by the political border between California and Oregon, neighboring MPAs in southern Oregon could potentially provide protected habitat for species frequenting the waters of both states, and could supply larvae and juveniles to MPAs established in the NCSR. There are four existing MPAs in Oregon state waters from the state border to the Cape Arago area. All four are smaller than the preferred size guidelines in the master plan for MPAs, and three of them only provide protection within the intertidal zone.

Harris Beach Marine Garden is an area contained within another MPA, Brookings Research Reserve, only a few miles from the California border. The marine garden prohibits all take of marine invertebrates except single mussels taken for bait, while the research reserve prohibits the take of marine invertebrates except abalone, crabs, clams, mussels, piddocks, scallops and shrimp. These regulations only apply to the area between extreme high tide and extreme low tide.

Two other research reserves are located in the Cape Arago area near Coos Bay, Oregon. Gregory Point Research Reserve and Cape Arago Research Reserve both prohibit the take of all marine invertebrates, except for a section of the Cape Arago Reserve, which has the same regulations as the Brookings Reserve. Gregory Point's regulations apply only to subtidal areas, whereas Cape Arago's regulations apply only to the intertidal. There are a number of other marine gardens and research reserves along the Oregon coast, but they are much farther north, and so are not described here.

In addition to the existing MPAs, Oregon is currently undergoing an MPA development process to implement a new series of marine reserves. After several public workshops to determine the direction the state government should take, Oregon Sea Grant and the Oregon Ocean Policy Advisory Council developed reports to the governor intended to guide the marine reserve process. Additionally, members of the public were encouraged to submit MPA proposals; 20 proposed MPAs have been identified for further site-specific analyses (OPAC 2009). Five of the proposed MPAs are located south of Cape Arago, the closest being at Mack Arch Reef between Brookings and Gold Beach; there are two overlapping proposed MPAs in this area. The proposed MPAs are in the preliminary review process.

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9 Conclusion

The north coast study region is the fourth portion of the California coastline where existing MPAs will be assessed and redesigned as part of the California MLPA Initiative. Representing the northern-most portion of the state, the north coast study region is characterized by a unique combination of ecological, socioeconomic, and management conditions, which are summarized in this regional profile. Along with MPAs previously designed through the central coast, north central coast, and south coast processes, MPAs in the north coast will serve to complete the coastal portion of a statewide network of MPAs. The north coast study region serves as an important link to MPAs designed in the north central coast, which lies adjacent to the north central coast at Alder Creek, near Point Arena. Together with the central coast and north central coast study regions, the north coast study region comprises one of two biogeographic study regions in California. The north coast also serves as an important link to habitats and management measures north of California, in Oregon.

The northern portion of California includes some of the most remote locations in the state, with relatively undeveloped landscapes meeting the Pacific along a rugged coastline. Exposure to high-energy wind and seas shapes both the ecosystems and human use patterns in the north coast, which along with unique oceanographic patterns, species, and a range of both commercial and recreational fisheries help to form the unique character of the north coast. Some important features of the north coast outlined in this regional profile include:

- A mostly rocky coastline with many offshore rocks and pinnacles, including Prince Island and Castle Rock, as well smaller islets like Green Rock and Flatiron Rock.
- Several large offshore rocky reefs, including Blunts Reef and St. George Reef
- An upwelling-driven oceanographic environment, which provides for high productivity
- A high-energy wind and wave environment
- Several large rivers, including the Klamath, Eel, and Mattole rivers
- Numerous estuaries, the most significant of which is the Humboldt Bay estuary
- Kelp forests, dominated by bull kelp (*Nereocystis luetkeana*)
- High species-biodiversity, including salmon, red abalone, and many groundfish species
- Important commercial fisheries, including Dungeness crab and nearshore rockfish
- A range of recreational fisheries, including the abalone fishery, which only exists north of San Francisco Bay
- A diversity of Native American tribes, with significant knowledge of coastal environments and an important connection to coastal resources
- Important research and educational institutions, especially Humboldt State University in Eureka

This draft regional profile represents an effort to compile the best readily available information regarding the north coast study region, so that it may inform the redesign of MPAs. The information provided here serves as a supplement to additional knowledge and information provided by stakeholders as part of a joint fact-finding effort. Together, along with information drawn from a wide range of scientific literature, this local knowledge serves as a valuable foundation for the north coast MLPA Initiative process.

Common Name	Scientific Name	Federal Status	State Status	Other Status
steelhead - Klamath Mountains Province ESU summer run	Oncorhynchus mykiss irideus		SSC(QT)	
steelhead-northern California ESU	Oncorhynchus mykiss irideus	T	SSC(QT)	
Green sturgeon	Acipenser medirostris	SC (NMFS) - Candidate	SSC(QT)	
Cowcod	Sebastes levis	Overfished, SC (NMFS)		
Bocaccio	Sebastes paucispinis	Overfished, SC (NMFS)		
Canary rockfish	Sebastes pinniger	Overfished (NMFS)		
Darkblotched Rockfish	Sebastes crameri	Overfished (NMFS)		
Pacific Ocean Perch	Sebastes alutus	Overfished (NMFS)		
Widow rockfish	Sebastes entomelas	Overfished (NMFS)		
Yelloweye rockfish	Sebastes ruberrimus	Overfished (NMFS)		
Eulachon	Thaleichthys pacificus		SSC(WL)	
Bluefin tuna	Thunnus thynnus	SC		
Swordfish	Xiphias gladius	SC		
Garibaldi	Hypsypops rubicundus		P	
White shark	Carcharodon carcharias		P	IUCN, CITES, CMS
	Invertebrates			
Black abalone	Haliotis cracherodii	PE, SC (NMFS)	P	IUCN
Sandy beach tiger beetle	Cicindela hirticollis gravida	SC		

Plant Common Name	Scientific Name	Federal Status	State Status	Other Status
Northcoast sand verbena	Abronia umbellata ssp. breviflora	SC		

Sources for special status species list:
Original list from MBNMS
California ESA status: http://www.dfg.ca.gov/whdab/pdfs/TEAnimals.pdf
California Species of Special Concern http://www.dfg.ca.gov/wildlife/species/ssc/index.html
Federal ESA status: http://www.nmfs.noaa.gov/pr/species/esa.htm
Birds of Conservation Concern: http://migratorybirds.fws.gov/reports/bcc2002.pdf
California Natural Diversity Database http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPAnimals.pdf

D.2 Index of the Listing Codes Used In Table D-1

Federal Listing Codes

ESA: Endangered Species Act of 1973 listing codes

E.....Federally listed as endangered
T.....Federally listed as threatened
D .....Federally delisted
PE .....Proposed for federal listing as endangered
PT .....Proposed for federal listing as threatened
PD.....Proposed for federal de-listing
Candidate .....Candidate for federal listing as endangered or threatened
SC.....Species of concern
SC (NMFS) ...Species of concern by the National Marine Fisheries Service
SC (FWS) .....Species of concern by the US Fish and Wildlife Service
BCC (FWS)...Birds of Conservation Concern by US Fish and Wildlife Service

State Listing Codes

CESA: California Endangered Species Act listing codes

E.....State-listed as endangered
T.....State-listed as threatened
CE.....Candidate for state listing as endangered
CT.....Candidate for state listing as threatened
CD.....Considered for state delisting as endangered

SSC: Species of special concern listing codes

(QE) .....Qualify as endangered (fish list)
(QT) .....Qualify as threatened (fish list)
(WL).....Watch list
(FP).....First priority (bird list)
(SP).....Second priority (bird list)
(TP).....Third priority (bird list)

Other State listings

FP .....State fully protected animal list
P.....Protected species

Other Status Codes

MMPA .....Protected under the Marine Mammal Protection Act
IUCN .....Included in the World Conservation Union's Red List of Vulnerable Species
CITES .....Protected under the Convention of International Trade in Endangered Species of Fauna and Flora
CMS.....Protected by the Convention on Migratory Species