

1.0 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. In August 2004, the California Resources Agency, California Department of Fish and Game (CDFG), and Resource Legacy Fund Foundation signed a memorandum of understanding launching the MLPA Initiative and implementation of the MLPA along the central coast. Among other actions, the MLPA Initiative established the MLPA Blue Ribbon Task Force, the Master Plan Science Advisory Team (SAT), a statewide stakeholder interest group, and an MLPA Initiative staff.

By December 2006 five key objectives were achieved by the MLPA Initiative: (1) a draft master plan framework was developed, (2) alternative proposals were developed for MPAs along the central coast and submitted to CDFG, (3) draft recommendations were made for long-term funding sources for MPA implementation and management, (4) draft recommendations were developed for increasing coordination and cooperation among state and federal agencies with the authority to manage marine resources, and (5) a recommended executive order to ensure implementation of the master plan by 2011 was submitted to the California Resources Agency (Memorandum of Understanding, August 2004). A draft master plan was developed (CDFG 2005a) and the stakeholder process for regional MPA planning in the central coast study region was completed in 2005-2006. In April 2007 the California Fish and Game Commission approved a set of central coast MPAs, and their associated regulations became effective in September 2007.

A second memorandum of understanding, effective January 1, 2007, continues the public-private partnership for planning marine protected areas (MPAs) in the north central coast study region. The MLPA North Central Coast Regional Stakeholder Group (NCCRSG) was convened in 2007 to begin evaluating existing MPAs and planning potential new MPAs for the area extending from Alder Creek, five miles north of Point Arena in Mendocino County, to Pigeon Point in San Mateo County. This *Regional Profile for the North Central Coast Study Region* provides background information on the biological, oceanographic, socioeconomic, and governance setting for the north central coast study region; it 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, in their evaluation of existing MPAs within the study region, and in developing alternative proposals for changes to existing MPAs. The information is provided in the form of text summaries, tables, selected maps (with links to other computer-accessible maps), and technical appendices. The regional stakeholders and SAT have provided additional information to augment this profile through a joint fact-finding process.

The regional profile helps to provide the context to develop alternatives that will meet the goals and objectives of the MLPA. The 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.

The best readily available data are being compiled for use in the north central coast study region MPA planning process. This regional profile provides an overview of some of that data. All 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 viewable through an Internet Map Service site (www.marinemap.org/mlpa). Appendix I provides a list of the currently available spatial data layers.

2.0 Description of the MLPA North Central Coast Study Region

The MLPA North Central Coast Study Region covers state waters extending from a line due west from Alder Creek, five miles north of Point Arena, to a line extending due west of Pigeon Point, and includes state waters around the Farallon Islands, but does not include San Francisco Bay (see [Map 1](#)). The shoreward boundary was drawn at the beach for creeks and rivers, at the extent of tidal reach and estuarine vegetation in lagoons and estuaries, and at the Golden Gate Bridge (to exclude San Francisco Bay). Lagoons (such as Abbots Lagoon) that are mostly or entirely closed to tidal inundation and dominated by brackish-freshwater species are not included in the MLPA North Central Coast Study Region.

To facilitate the display of information the region has been divided up into 6 sub-regions as follows:

1. Alder Creek/Point Arena to Horseshoe Point
2. Horseshoe Point to Bodega Head
3. Bodega Head to Double Point
4. Double Point to Point San Pedro
5. Point San Pedro to Pigeon Point
6. Farallon Islands

The coastline covers a straight-line distance of 146 miles (mi), but it is actually much longer due to the undulations of the coastline (over 363 mi). In general, state waters extend from the high tide line to 3 nautical mi (nmi) seaward. However, state waters also include an area of 94.3 square miles around the Farallon Islands, which are located 28 miles offshore of the San Francisco Bay.

The study region encompasses approximately 763.5 square miles and extends from the shoreline (mean high tide) to a maximum depth of approximately 382 ft (63.7 fm) off the Farallon Islands. The study region includes a broad array of habitats from intertidal to hard and soft bottom habitats on the continental shelf. The edge of the continental shelf where it transitions downward to become the continental slope is called the shelf-slope break, which occurs at approximately 200m; the continental slope is generally outside of the study region as the maximum depth in the region is 116m (380 feet, 63.4 fathoms). The continental shelf varies in width along the study region from 3.6 mi at its narrowest location to 27.2 mi at its widest location (where it extends beyond state waters) along the 100m contour. There are no submarine canyons in state waters in the region; however, there are some large canyons well offshore in federal waters. While much of the marine seafloor in the region is soft (sand or mud) bottom there are also rocky reefs, pinnacles, and rocky outcrops. Preliminary mapping of hard and soft bottom habitats in the entire study region is underway.

The north central coast study region is part of the California Current Large Marine Ecosystem (LME), one of only 4 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 very productive ecosystem fueled by nutrient-rich upwelling which supports blooms of phytoplankton that form the foundation for a

food web that includes many species of invertebrates, fish, marine mammals and seabirds. The north central coast study region is in the central part of the California Current LME and includes the most persistent upwelling center at Point Arena, the outflow of the largest estuary on the West Coast (San Francisco Bay), as well as the highly productive and biologically rich Gulf of the Farallones. This region has some of the highest numbers of species of fish, seabirds, and mammals in the North Pacific Ocean (PICES 2005; NOAA 2004).

A major upwelling center occurs at Point Arena, with cold nutrient rich waters carried south along the entire Sonoma coast, deflected offshore at Point Reyes and out into the Gulf of Farallones. During the upwelling season, the waters are rich in nutrients that fuel highly productive and diverse ecosystems, with large numbers of top predators that are dependent on this seasonal abundance of prey resources. The nutrient rich upwelled waters fuel a productive pelagic foodweb that includes phytoplankton, krill, coastal pelagic species (anchovies, sardines, squid, etc), fish, seabirds, marine mammals, and sharks. High local productivity also attracts many migratory species. During non-upwelling seasons and El Niño years, the nutrients that flow out from San Francisco Bay become more important (NOAA 2004). Relative to other parts of the state, this study region is very important to many species of top predators that are key players in the coastal and open ocean food webs. There are specific areas in the region important as foraging and breeding grounds for populations of some top predators (Karl et al 2001; Yen et al 2004).

The ecology of the study region has been relatively well characterized in several publicly available summary documents (Airame et al 2003; NOAA 2003; Karl et al. 2001) as well as numerous scientific studies. The following is general overview of important geographic and ecological features of the region, generally described from north to south. More specific information is provided in habitat descriptions (section 3.0) and subregional summaries (section 9.0).

Point Arena at the north end of the study region is a rocky peninsula with a lighthouse on an elevated coastal plain in Mendocino County. Just north of Point Arena, the Garcia River empties into the ocean from a small estuary. The Gualala River enters the ocean about 18.6 miles south of Point Arena and forms a coastal lagoon behind a sandbar.

The Sonoma coast is characterized by a relatively narrow shelf, cold upwelled waters, a steep rocky coastline, and nearshore rocky reefs. The Russian River, which drains a very large watershed in Sonoma and Mendocino counties, meets the ocean at Jenner where a coastal lagoon forms behind a sandbar and a freshwater tidal plume extends from the coast during the wet season.

Bodega Head is a granitic peninsula, with coastal dune systems around the headland, located south of the Russian River. Bodega Harbor is a protected harbor southeast of Bodega Head and is an important regional port, with open water and mudflat habitats. There are several large bays or estuaries in the northern half of the study region including Bodega Bay, Tomales Bay, Estero Americano, Estero San Antonio, Drakes Estero and Estero de Limantour, and Bolinas Lagoon. These estuarine areas are located on the Pacific Flyway and support numerous

migrating waterfowl and shorebird species. The unique shallow water eelgrass beds and wetlands in large and small estuaries are nursery grounds for many invertebrates and fish.

The Marin coastline is characterized by a broader shelf and steep rocky cliffs. Point Reyes is a large peninsula that extends offshore and greatly influences local ocean circulation patterns. There are several large coastal protected areas including Point Reyes National Seashore and the Golden Gate National Recreation Area. This area includes two UNESCO Ramsar sites: Bolinas Lagoon and Tomales Bay. The nearshore waters of the Marin coastline include large concentrations of marine mammals, seabirds, and sea turtles. Point Reyes, in particular, is important for leatherback sea turtles.

San Francisco Bay is not part of the planning region; however the mouth of San Francisco Bay and the area seaward of the Golden Gate Bridge is included. All of the rivers of California's Central Valley (including the Sacramento, American, and San Joaquin rivers) and the rivers surrounding the San Francisco Bay Area drain to the sea under the Golden Gate Bridge. The large freshwater tidal plume that extends seaward for miles beyond the Golden Gate on ebb tides is very unique feature of the region. This plume reaches its greatest extent on ebb tides during the rainy winter season. During the winter the plume tends to flow north along the coast while during the summer it tends to flow south and further offshore. There are several major international ports within San Francisco Bay from which commercial shipping, fishing, recreational, and passenger vessels travel through the study region.

The Gulf of the Farallones includes one of the broadest sections of continental shelf on the West Coast of the U.S. (NOAA 2004). The entire area of the Gulf of Farallones is influenced by coastal upwelling and the San Francisco Bay tidal plume. The broad shelf is mostly sandy, relatively shallow (<120m), and provides important habitat and forage area for seabirds, marine mammals sea turtles, invertebrates, and fish. The waters around the Farallon islands are nutrient-rich and support high productivity and many species of top predators, including one of the world's largest congregation of white sharks. Gray whales, humpback whales and blue whales feed in the area. The Farallon Islands are located 28 miles west of San Francisco on the edge of the shelf-slope break and are a biological area of importance for breeding seabirds and marine mammals. Only seven rocky islands on Farallon ridge emerge from the ocean: Southeast Farallon, West End, Middle Farallon, North Farallon Island, the Isle of St. James, and two unnamed rocks. There are 12 species of seabirds that breed on the islands, the largest concentration of breeding seabirds in the lower 48 states. The area supports the largest California concentration of harbor seals.

South of the mouth of San Francisco Bay, the coastlines of San Francisco and San Mateo counties are characterized by cliffs, sandy beaches, and small coastal streams. Half Moon Bay/Pillar Point is an important regional port for commercial and recreational fisheries. Pescadero Marsh is one of the larger coastal lagoons along this stretch of coast.

The study region abuts five coastal California counties: San Mateo, San Francisco, Marin, Sonoma, and Mendocino. The coasts surrounding San Francisco Bay and the San Mateo coast support the largest concentration of human population in the study region. The marine resources of the region support commercial and recreational fisheries and many non-

consumptive economic activities such as coastal tourism and recreation. Important ports in the region include Bodega Harbor and Half Moon Bay/Pillar Point Harbor. The port of San Francisco is not in the study region; however, vessels that harbor there fish in and transit the region. The marine resources of the region support commercial and recreational fisheries and many non-consumptive economic activities such as coastal tourism and recreation.

3.0 Ecological Setting

The study region includes a wide variety of ecosystems, habitats and species that are important for regional marine biodiversity, sustainable resource use, and natural heritage. While only overlapping with the southern half of the study region, the characterization of natural history and biodiversity in the Monterey Bay National Marine Sanctuary (MBNMS) is applicable to the study region. MBNMS has been characterized as having high biodiversity, with 26 species of marine mammals, 94 species of seabirds, 345 species of fishes, 4 species of sea turtles, 31 phyla (thousands of species) of invertebrates and more than 450 species of marine algae (NOAA 2004). The Gulf of Farallones National Marine Sanctuary (GFNMS) is home to 36 species of marine mammals, 54 species of breeding birds, and 25 threatened or endangered species (NOAA 2006).

The biodiversity of this marine region was one of the driving factors in the designation of the Farallones National Wildlife Refuge in 1909, the Point Reyes National Marine Seashore in 1962, the Golden Gate National Recreation Area (GGNRA) in 1972, the Gulf of Farallones National Marine Sanctuary (GFNMS) in 1981, the UNESCO Golden Gate Biosphere Reserve in 1988, the Cordell Bank National Marine Sanctuary (CBNMS) in 1989, and the Monterey Bay National Marine Sanctuary in 1992.

The study region has been relatively well studied. The profile drew from existing studies and several key sources should be used to complement and expand upon the information in this regional profile. The following is a partial list of documents that broadly characterize the region's ecology and summarize some scientific research from a variety of original sources:

- NOAA, 2004. *The Monterey Bay National Marine Sanctuary Site Characterization* (available online at <http://bonita.mbnms.nos.noaa.gov/sitechar/>).
- Airamé, S., S. Gaines, and C. Caldow. 2003. *Ecological Linkages: Marine and estuarine ecosystems of central and northern California*. NOAA, National Ocean Service. Silver Spring, MD. 172p. (available online at http://biogeo.nos.noaa.gov/products/canms_cd/data/pdfs/ELR.pdf).
- NOAA, 2004. *A Biogeographic Assessment of North-Central California: To Support the Joint Management Plan Review for Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries* (2004) (available online at http://biogeo.nos.noaa.gov/products/canms_cd/).
- Karl, Herman A, John L. Chin, Edward Ueber, Peter H. Stauffer, and James W. Hendley II (eds.) 2001. *Beyond the Golden Gate—Oceanography, Geology, Biology, and Environmental Issues in the Gulf of the Farallones*. Reston, VA; U.S. Geological Survey: Denver, CO: USGS Information Services. (available online at <http://pubs.usgs.gov/circ/c1198/>)
- Evens, Jules G. 1993. *The Natural History of the Point Reyes Peninsula*. Point Reyes, California: Point Reyes National Seashore Association.
- National Park Service Inventory and Monitoring Website for the San Francisco Bay Network of Parks at <http://www.nature.nps.gov/im/units/sfan/>

- NOAA, 2006. *Gulf of the Farallones National Marine Sanctuary Draft Management Plan*. Prepared as part of the Joint Management Plan Review. October. [http://sanctuaries.noaa.gov/jointplan/drafts/gf_mp.html]
- Rintoul, C., B. Langabeer-Schlagenhauf, K.D. Hyrenbach, K.H. Morgan, and W.J. Sydeman. *Atlas of California Current Marine Birds and Mammals: Version 1*. Unpublished Report. PRBO Conservation Science, Petaluma, California. [http://www.prbo.org/cms/docs/marine/CCS_Seabird_Mammal_Atlas.pdf]
- CDFG, 2001. *California's Living Marine Resources: A Status Report* (ANR Publication #SG01-11) California Department of Fish and Game. [<http://anrcatalog.ucdavis.edu>]

3.1 Ecosystems and Habitats

The MLPA requires that MPAs in each bioregion, with specific reference to state marine reserves, encompass a representative variety of marine habitats and communities across a range of depths and environmental conditions (section 2857(c) of the MLPA). The MLPA specifically mentions the following habitats in reference to their inclusion in a system of MPAs: rocky reefs, intertidal zones, sandy or soft ocean bottoms, underwater pinnacles, seamounts, kelp forests, submarine canyons, and seagrass beds. In addition, the Science Advisory Team (SAT) recommended considering specific depth zones, estuaries, upwelling areas, retention areas, and freshwater plumes from coastal rivers as additional habitats for MPA siting (CDFG 2005a). Of these habitats, seamounts are not found in state waters at all; submarine canyons and soft and hard bottom habitats greater than 200m depth are not found in state waters in the north central coast study region; pinnacles exist in the study region, but have not been mapped.

The SAT identified two different types of kelp forests that occur in the state, *Macrocystis pyrifera* and *Nereocystis lutkeana*, as separate habitats for the purposes of MPA siting, since each type of kelp forest hosts distinguishable assemblages of organisms. The kelp forests in the north central coast study region are dominated by bull kelp. The SAT also identified underlying geology (e.g. granitic versus sandstone or shale substrata) as important in structuring the composition of communities on rocky reefs and rocky intertidal zones. The SAT assembled for the north central coast study region also identified estuaries and the intertidal and subtidal (bottom and water column) around the Farallon Islands as unique habitats to the region.

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 (maps [2a](#), [2b](#), [2c](#), [2d](#), [2e](#), [2f](#), [3a](#), [3b](#), [3c](#), [3d](#), [3e](#), [3f](#), and [4a](#), [4b](#)). Table 1 provides a summary of the amount of each habitat in the study region, the bioregion (Point Conception to Oregon border), and the state (Mexico border to Oregon border, excluding San Francisco Bay). San Francisco Bay was excluded from the bioregional and statewide analysis as it represents a distinctive large estuary (the largest on the West Coast) that is not directly comparable to smaller estuaries on the open coast and the inclusion of San Francisco Bay significantly complicates the analysis of shoreline and estuarine amounts. This summary shows the relative rarity of different habitats within the study region, as well as the contribution of the study region towards total amount of each habitat in the bioregion and state.

Table 1: Approximate Amount of Each Habitat in North Central Coast Study Region, Bioregion, and Statewide in State Waters

Habitat	Amount in Study Region	% of Study Region Area	Amount in Bioregion	% of Bioregion Area	Amount in State waters	% of State waters area	GIS Data Source / Comments
Total Area (area, mi²)	763.0		2891.0		5549.7		
Shoreline¹ (Length, mi)							
Total Shoreline Length	367.6		1604.3		2826.5		NOAA-ESI 2002, 2006 / Does not include SF Bay
Intertidal: Rocky shores	169.5	45.9%	620.6	38.7%	944.0	33.4%	NOAA-ESI 2002 / Does not include SF Bay
Intertidal: Sandy beaches	188.3	51.0%	787.0	49.1%	1293.5	45.8%	NOAA-ESI 2002, 2006 / Does not include SF Bay
Intertidal: Coastal marsh	51.8	14.0%	246.0	15.3%	320.3	11.3%	NOAA-ESI 2002, 2006 / Does not include SF Bay
Intertidal: Tidal Flats	60.6	16.4%	239.9	15.0%	280.3	9.9%	NOAA-ESI 2002, 2006 / Does not include SF Bay
Hard and Soft Bottom Habitats and Canyon (Area, mi²)							
Total Hard and Soft Bottom and Canyon Habitat	762.6		3824.8		6947.0		Total area includes all subtidal habitats from Greene et al 2004
Rocky Habitat 0-30m	37.0	4.8%	155.9	5.4%	209.1	3.8%	Kvitek et al 2007; Greene et al 2004
Rocky Habitat 30-100m	48.4	6.3%	121.3	4.2%	233.7	4.2%	Kvitek et al 2007; Greene et al 2004
Rocky Habitat 100-200m	0.0	0.0%	18.4	0.6%	139.3	2.5%	Kvitek et al 2007; Greene et al 2004
Rocky Habitat >200m	0.0	0.0%	21.5	0.7%	144.2	2.6%	Kvitek et al 2007; Greene et al 2004
Total Rocky Habitat (all depths)	85.4	11.2%	317.0	11.0%	726.2	13.1%	Kvitek et al 2007; Greene et al 2004
Soft Bottom Habitat 0-30m	221.9	29.1%	1299.7	45.0%	2023.3	36.5%	Kvitek et al 2007; Greene et al 2004
Soft Bottom	338.4	44.4%	1876.1	64.9%	3033.7	54.7%	Kvitek et al 2007;

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Habitat	Amount in Study Region	% of Study Region Area	Amount in Bioregion	% of Bioregion Area	Amount in State waters	% of State waters area	GIS Data Source / Comments
Habitat 30-100m							Greene et al 2004
Soft Bottom Habitat 100-200m	5.5	0.7%	181.6	6.3%	385.4	6.9%	Kvitek et al 2007; Greene et al 2004
Soft Bottom Habitat >200m	0.0	0.0%	145.5	5.0%	593.7	10.7%	Kvitek et al 2007; Greene et al 2004
Total Soft Bottom Habitat (all depths)	565.8	74.2%	3502.9	121.2%	6036.1	108.8%	Kvitek et al 2007; Greene et al 2004
Unknown ³ Bottom Habitat 0-30 m	110.1	14.4%	N/A	N/A	N/A	N/A	Kvitek et al 2007; Greene et al 2004
Unknown ³ Bottom Habitat 30-100 m	1.4	0.2%	N/A	N/A	N/A	N/A	Kvitek et al 2007; Greene et al 2004
Unknown ³ Bottom Habitat 100-200 m	0.0	0.0%	N/A	N/A	N/A	N/A	Kvitek et al 2007; Greene et al 2004
Unknown ³ Bottom Habitat >200 m	0.0	0.0%	N/A	N/A	N/A	N/A	Kvitek et al 2007; Greene et al 2004
Canyon 0-30m	0.0	0.0%	0.7	< 0.1%	1.7	< 0.1%	Greene et al 2004
Canyon 30-100m	0.0	0.0%	6.4	0.2%	11.3	0.2%	Greene et al 2004
Canyon 100-200m	0.0	0.0%	11.5	0.4%	20.1	0.4%	Greene et al 2004
Canyon >200m	0.0	0.0%	62.1	2.1%	90.4	1.6%	Greene et al 2004
Total Canyon (all depths)	0.0	0.0%	80.6	2.8%	123.4	2.2%	Greene et al 2004
Underwater Pinnacles	NA		NA		NA		Data not available
Estuarine and Nearshore Habitats (Area, mi²)							
Kelp 2005	0.9	0.1%	10.6	0.4%	42.2	0.8%	CDFG 2005 aerial survey
Kelp 2004	1.4	0.2%	14.3	0.5%	45.5	0.8%	CDFG 2004 aerial survey
Kelp 2003	1.2	0.2%	14.4	0.5%	49.3	0.9%	CDFG 2003 aerial survey
Kelp 2002	1.7	0.2%	19.5	0.7%	36.6	0.7%	CDFG 2002 aerial survey
Kelp 1999	2.5	0.3%	8.6	0.3%	23.0	0.4%	CDFG 1999 aerial

Habitat	Amount in Study Region	% of Study Region Area	Amount in Bioregion	% of Bioregion Area	Amount in State waters	% of State waters area	GIS Data Source / Comments
							survey
Kelp 1989	3.4	0.4%	31.4	1.1%	53.6	1.0%	CDFG 1989 aerial survey
Average Kelp Estuary	1.8	0.2%	16.5	0.6%	41.7	0.8%	
	19.5	2.5%	93.4	3.2%	148.5	2.7%	National Wetlands Inventory; California Natural Diversity Database; NOAA-ESI 2002; USGS Topos
Seagrass: Surfgrass (Length, mi, % of shoreline)	68.8	18.6%	NA		NA		Tenera/Minerals Management Service
Seagrass: Eelgrass	6.0	0.8%	17.9	0.6%	41.7	0.8%	Morro Bay National Estuary Program; Elkhorn Slough Foundation; CDFG Tomales Bay data; Humboldt GIS Atlas, Drakes Estero and Estero de Limantour data sources.
Oceanographic Habitats							
Upwelling center ²	1 major center at Point Arena		5 major centers		5 major centers		NOAA Coastwatch Sea Surface Temperature
Retention area	One retention area south of Point Reyes at Drakes Bay		NA		NA		Wing et al 1998, Largier 2004
Freshwater plume	Coastal river mouths and mouth of SF Bay		NA		NA		

Notes: 1. Shoreline percentages may add up to more than 100% since more than one type can be present in a given location; San Francisco Bay was not included in the shoreline analysis. 2. Major upwelling centers in the state include: Cape Mendocino, Point Arena, Davenport, Point Sur, Point Conception. 3. Note that a portion of shallow habitats in the north central coast are not mapped and have thus been classified as "unknown"

3.1.1 Depth Categories

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

Table 2: Depth Zones Identified by the SAT

Meters	Fathoms	Feet
Intertidal	Intertidal	Intertidal
Intertidal to 30 m	Intertidal to 16 fm	Intertidal to 98 feet
30 m to 100 m	16 fm to 55 fm	98 feet to 328 feet
100 m to 200 m	55 fm to 109 fm	328 feet to 656 feet
200 m and deeper	109 fm and deeper	656 feet and deeper

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 meters = 0.55 fathoms = 3.28 feet.

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

Several of the seven habitats mentioned in the MLPA occur in only one depth zone, while others may occur in several depth zones. The area of each subtidal depth range within the study region are provided in Table 3, based on CDFG 2005a delineation of depth zones using Geophysical Data System 91m resolution data. The vast majority of the study region is at depths less than 100m; deeper water habitats are rare in state waters.

Table 3: Depth Zone as Percent of North Central Coast Study Region

Depth Zone	Area (mi ²)	Percentage of Study Region
Intertidal to 30 m (0 to 16 fm)	300.9	37.9%
30 to 100 m (16 to 55 fm)	455.1	59.6%
100 to 200 m (55 to 109 fm)	5.0	0.7%
200 m and deeper (109 fm and deeper)	0.0	0.0%

Note: 0.3% of the study region is unclassified.

The continental shelf in the study region is relatively wide, especially offshore of the San Francisco Bay and gets narrower to the northern part of the study region. Deep water habitats

(>100m) are very rare in the study region. A few small areas deeper than 100m (55 fm, 328 feet) occur off Point Arena and the Farallon Islands.

3.1.2 Intertidal Zones

The shoreline represents a transition zone between the marine and terrestrial environments and includes many important ecosystems and communities, most of which are intertidal. Intertidal zones that have been mapped as linear features along the coastline include sandy beaches, rocky shores, tidal flats, coastal marsh along the shores of estuaries and lagoons, and man-made structures such as jetties and seawalls (see Maps [2a](#), [2b](#), [2c](#), [2d](#), [2e](#), [2f](#)).

Rocky shores: Rocky shore habitats and their associated ecological assemblages are found throughout the study region. 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; Foster et al 1988). Intertidal boulders, platforms, and cliffs, as well as tidepools, are home to many species of algae, barnacles, anemones, snails, mussels, crabs, sea stars, and fishes. Boulders may serve as haulout sites for some pinnipeds, such as those at Point Reyes Headland used by California sea lions. Mussel beds (*Mytilus* spp.), sea palm (*Postelsia palmaeformis*), algal beds (*Endocladia muricata* and many other species), and surfgrass (*Phyllospadix* spp.) are patchily distributed along rocky shores but support high biodiversity. Many birds, including the Black Oyster Catcher, which is a Species of Special Concern, use rocky shores. In addition to the tidal height and steepness, the underlying geology of a rocky coast can affect the ecological communities present (Foster et al., 1988). The following rocky shore types have been mapped in the north central coast study region by NOAA for the Environmental Sensitivity Index (ESI) program (2006) (Table 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; barnacles, mussels, limpets, sea stars, anemones, crabs, and macroalgae abundant.
- **Exposed rocky cliff with talus boulder base/boulder rubble:** Same as above but with boulders at base of cliff.
- **Exposed 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 and crevices. May support rich tidepool and intertidal communities with algae, barnacles, snails, mussels, sea stars, crabs, and polychaetes.
- **Sheltered rocky shore:** Bedrock shores of variable slope (cliffs to ledges) that are sheltered from wave exposure. The intertidal community may include algae, mussels, barnacles, anemones, sea stars, snails, and crabs. Sheltered rocky shores are rare in north central California (Table 4); however, they are found inside bays and estuaries, particularly along the shores of Tomales Bay.

Extensive stretches of rocky shore are found along the Sonoma and Marin coasts and around the Farallon Islands. Smaller stretches of rocky shores are interspersed with large sandy

beaches along the San Francisco and San Mateo coasts. Throughout the study region, exposed wave-cut rocky platforms are the most common rocky shoreline type, while rocky cliff with talus boulder base and boulder rubble are among the least common types.

Sandy Beaches: Significant expanses of continuous sandy shores areas occur along the San Francisco and San Mateo coasts, with shorter stretches of sandy beaches and pocket beaches along the Sonoma and Marin coastlines. Sandy beach communities are structured in large part by grain size, slope of the beach, and wave energy. Beaches are dynamic systems that change with wind and waves; generally sand is eroded from beaches in the winter and redeposited in the summer resulting in annual changes in beach slope and width. Barrier beaches and sand spits form at the mouths of larger rivers. Small pocket beaches occur where rocky cliffs are eroded along exposed coasts. Rivers deposit sediments and create barrier beaches and sandspits, such as those at the mouths of the Garcia, Gualala, and Russian Rivers and Bolinas and Limantour estuaries.

A variety of invertebrates live in the sand and in wracks of decaying seaweed and other detritus on the sand surface. There are numerous species of shorebirds, such as sanderlings, marbled godwits, and willets that feed at the waters edge. Western snowy plovers and California least terns nest on sandy beaches and coastal dunes. Pinnipeds haul out on isolated beaches and sand spits, including gravel to fine to medium grained beaches. Sand dollars, worms, clams, crabs, surfperches, flatfishes, and other fishes live in the surf zone. Beach types in the north central coast have been mapped as linear shoreline features and classified based on grain size:

- **Gravel beach:** Beaches composed of sediments ranging from pebbles to boulders; often steep with wave-built berms. Attached algae, mussels, and barnacles on lower stable substrata.
- **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.
- **Coarse-grained sand beach:** Moderate-to-steep beach of variable width with soft sediments, typically at river mouths; may be backed by dunes or cliffs; fauna scarce.
- **Fine to medium-grained sand beach:** Flat, wide, and hard-packed beach; significant seasonal changes in width and slope. Upper beach fauna scarce; lower beach fauna include sand crabs.

Fine to medium-grained sand beaches are the most common type in the north central coast of California, while gravel and coarse-grained beaches are relatively uncommon.

Tidal Flats and Coastal Marsh: Tidal flats and marshes occur primarily around the edges of bays and estuaries (e.g. Bolinas Lagoon, Drakes Estero, Estero de Limantour, Tomales Bay, Estero Americano, and Estero San Antonio). Tidal flats are sandy or muddy expanses that are exposed at low tides and provide important foraging ground for shorebirds due to the

abundance of invertebrates such as clams, snails, crabs, and worms. High densities of sandpipers, willets, yellowlegs, and avocets can be found on tidal flats at low tide. Herons and egrets forage at the water's edge. Brants and Brown Pelicans also utilize these areas. Tidal sand bars serve as haulout and colony sites for harbor seals. At high tide, tidal flats become important foraging habitat for estuarine fish (e.g. sculpins, sanddabs, halibut, and leopard sharks). 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 estuarine water quality. The position of marshes along estuarine margins and their dense stands of persistent plants also make them essential for stabilizing shorelines and for storing floodwaters during coastal storms. Vegetation patterns and dominant species in coastal brackish marshes vary with the salinity regime which is defined by precipitation patterns and changes in freshwater inputs. The following shoreline types have been mapped as linear features of the coastline:

- **Salt and brackish marshes:** Includes intertidal areas with emergent vegetation, either salt marsh or brackish marsh. The width of marsh varies from a narrow fringe to extensive areas and provides important habitat for a variety of species.
- **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 site for birds and haulout site for marine mammals.
- **Sheltered tidal flats:** Includes intertidal flats comprised of silt and clay (e.g. mudflats). Present in calm water habitats and sheltered from wave exposure; frequently bordered by marsh. Soft sediments support large populations of worms, clams, and snails; important foraging area for migrating shorebirds.

Table 4 is a summary of the linear length and percentage of total shoreline (363.3 mi as measured by the shoreline segments) for each shore type (including man-made seawall and riprap) in the study region based on data from NOAA -ESI (2006). Rocky shores and sandy beaches dominate the shoreline; marsh and tidal flat habitats are found only in sheltered bays and estuaries.

Table 4: Summary of the Amount of Shoreline Habitats in Study Region

Shore Type	Length in Study Region (mi)	Percentage of Total Shoreline in Study Region¹
Exposed rocky cliffs	40.9	11.1%
Exposed rocky cliffs with boulder talus base	2.4	0.6%
Exposed wave cut rocky platforms	106.8	29.0%
Sheltered rocky shores	17.6	4.8%
Boulder rubble	1.9	0.5%
Gravel beaches	29.1	7.9%
Mixed sand and gravel beaches	48.8	13.2%

Shore Type	Length in Study Region (mi)	Percentage of Total Shoreline in Study Region¹
Coarse-grained sand to granule beaches	24.1	6.5%
Fine to medium grained sand beaches	86.9	23.5%
Salt and brackish water marshes	52.6	14.3%
Freshwater marshes	0.5	0.1%
Exposed tidal flats	9.1	2.5%
Sheltered tidal flats	51.7	14.0%
Riprap (man-made)	12.5	3.4%
Sheltered riprap (man-made)	3.2	0.9%
Exposed seawall (man-made)	1.1	0.3%
Sheltered man-made structures (man-made)	1.2	0.3%
Total shoreline length in study region	367.6	

Notes: 1. Many areas of the shoreline have more than one shoreline type present, so percentages have been calculated using total length of shoreline (not sum of lengths of all types)

3.1.3 Estuaries and Lagoons

Estuaries form at the mouths of rivers and streams where freshwater and saltwater meet; the salinity in estuaries and lagoons varies seasonally and over longer timeframes when the river mouths get closed by sand spits or other barriers. Lagoons (which are used here to refer to bar-built estuaries) are coastal water bodies that are seasonally closed off from the sea by sand bars and generally have low freshwater inputs. California’s estuaries contain open water and soft-bottom habitats, as well as habitats described elsewhere, such as coastal marsh, tidal flats, and eelgrass beds.

Within estuaries and lagoons, the shoreward boundary of the north central coast study region was determined by evaluating the extent and presence of mapped salt marsh or brackish vegetation, the known extent of tidal influence, and in some cases the shoreward management boundary of the GFNMS. Information used in this analysis included the NOAA Environmental Sensitivity Index (NOAA-ESI) shoretype data, the National Wetlands Inventory data, and GFNMS boundaries. This determined which estuaries and lagoons were included in the study region and are considered part of CDFG’s Marine Region MLPA 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 (such as Abbott’s Lagoon) were not included. Coastal streams and small rivers that may form lagoons or estuaries at their mouth were not included, even though some of these streams may have migratory species such as steelhead, as the resources in these rivers are managed under inland regions of CDFG and are specifically excluded by definitions in MLPA and the Marine Managed Areas Improvement Act (MMAIA).

The north central coast study region includes at least part of the following estuary or lagoon areas:

- Garcia River estuary
- Gualala River estuary
- Russian River estuary
- Bodega Harbor (and estuary)
- Estero Americano
- Estero de San Antonio
- Tomales Bay and associated marshes
- Drakes Estero (and Estero Limantour)
- Bolinas Lagoon
- Rodeo Lagoon
- Pescadero Marsh

The study region includes some relatively large low-inflow estuaries such as Bodega Harbor, Drakes Estero, and Bolinas Lagoon. Smaller bar-built estuaries or lagoons are found at the mouths of coastal rivers and are characterized by closing off from the seas on a seasonal basis with sand bars (and opening seasonally or with human intervention). Some examples of bar-built estuaries include: the Garcia River estuary, Gualala estuary, Russian River estuary, Estero Americano, Estero de San Antonio, Olema Marsh, Livermore Marsh, Marshall Marsh, Estero de Limantour, Rodeo Lagoon, and Pescadero Marsh (maps [2a](#), [2b](#), [2c](#), [2d](#), [2e](#), [2f](#)). The aerial extent of estuaries in the north central coast study region totals 19.5 mi² or 2.5% of the region (Table 1). 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 very productive coastal ecosystems that play a key role as nursery habitat for many coastal invertebrates and fish. Coastal bays and estuaries in the region are an important part of the Pacific Flyway and host thousands of shorebirds and waterfowl on their migrations (Ramer, 1991). Anadromous species such as salmonids and lampreys must pass through estuaries on their migration pathways (Boesch and Turner, 1984). Steelhead trout in the north central coast spend a significant part of their juvenile phase in coastal estuaries (McEwan and Jackson, 1996). Since estuaries and lagoons are 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. Estuaries are also utilized for many recreational activities such as fishing, clamming, kayaking, and wildlife viewing.

Garcia River Estuary: Just north of Point Arena, the Garcia River Estuary forms behind a seasonal sandbar where the Garcia River meets the Pacific Ocean at Manchester State Beach. The Garcia River drains a mostly forested, 73,223 acre watershed where forestry, dairying, livestock grazing, and gravel mining takes place. The Garcia River is listed as an impaired body for temperature. The Garcia River Estuary hosts both steelhead and coho salmon and extends upriver to the confluence of Hathaway Creek.

Gualala River Estuary: There is a large sand bar at the mouth of the Gualala River that is generally closed with seasonal opening; a lagoon forms behind the sandbar much of the year. The Gualala River has small populations of coho salmon and steelhead and the estuary serves as nursery area and migration corridor for these species. Other species of fish found in the estuary include roach, coast range sculpin, prickly sculpin, starry flounder, and Pacific staghorn sculpin. The watershed for the estuary covers 298 square miles, and water quality has suffered due to impacts from upland forestry and agriculture (Klamt et al 2002) The Gualala River is listed as an impaired water body for temperature and sedimentation/siltation (http://www.ncwap.ca.gov/gualala/synth_report.html).

Russian River Estuary: The Russian River drains an area of 1485 square miles in Mendocino and Sonoma Counties. The Russian River Estuary is subject to frequent closure by the formation of a barrier beach across the estuary mouth in the spring, summer, and fall, and is categorized as a Type II system with salinity stratification following closure of the barrier beach. Tidal extent in the estuary can be up to 7.3 miles upriver and 800 feet wide. The closure of the estuary temporarily eliminates tidal exchange and creates ponding of the river, which results in a gradual increase of the water level in the estuary. The County of Sonoma removes the barrier in order to limit property damage by flooding. Twenty-four species of fish, eight species of crab, and five species of shrimp are found in the Russian River Estuary. This estuary also has a large harbor seal haulout. The Russian River watershed supports threatened populations of Steelhead, Chinook, and Coho salmon (Sonoma County Water Agency, 2005).

Bodega Harbor: Bodega Harbor is a moderately sized bay that forms behind the granitic Bodega Head (headland) and the sandspit that extends from Doran Beach. It is an important harbor for commercial and recreational fishing. Recreational shellfish gathering also occurs in the estuary. Habitats present in the bay include tidal mudflats, sandflats, and marsh as well as protected shallow subtidal waters and eelgrass beds. This area is a top birding spot in Sonoma County (<http://www.bml.ucdavis.edu/bmr/location.html>). The harbor has some water quality issues, including those associated with agricultural uses in the watershed and local municipal runoff and boatyards.

Estero Americano: Estero Americano is slightly larger shallow estuary that drains into Bodega Bay at the Sonoma-Marin County line and is located just north of Estero de San Antonio within the Gulf of the Farallones National Marine Sanctuary. The estuary is consistently 7 to 13 feet deep and has approximately 300 acres of open water and 400 acres of wetland habitat, which includes mudflats, seasonal brackish marsh, freshwater march, and eelgrass (University of Rhode Island 2007, Rodriguez 2004). Americano Creek is the sole tributary of the estero and drains a 49 square mile watershed which includes grazed pastureland, dense willow thickets, and coastal oak woodlands. This creek is dry for 4 to 6 months between late spring and fall (Rodriguez 2004). Estero Americano has documented water quality problems, including excess nutrients and sedimentation/siltation and is listed as a Critical Coastal Area and impaired water body. Some of the sources of water impairment include livestock grazing in the watershed, as well as hydromodification and erosion. When the mouth of the estuary is open, the estero experiences tidal influence for 4 miles upstream of Americano Creek, though a seasonal sandbar that restricts tidal flow forms during some years and periods of hypersalinity have been recorded. A large mudflat in the middle reach of the estuary periodically restricts flow between

the upper and lower estero. The estero supports a rich diversity of species including 71 species of water/marsh birds, 44 species of marine and freshwater fish, over 70 species of benthic invertebrates, and 30 species of epibenthic invertebrates as well as several special status species such as the northwestern pond turtle, steelhead, and the tidewater goby (Rodriguez 2004).

Estero de San Antonio: Estero de San Antonio is a small shallow estuary that drains into Tomales Bay and is part of the Gulf of Farallones National Marine Sanctuary. It has about 90 acres of open water and 200 acres of coastal marsh habitat and also includes mudflats and rocky shores. It has fairly constant shallow depths of 6-13 feet. The tidewater goby breeds in the shallow waters of this estuary (NOAA 2006) and Dungeness crabs use the estero's eelgrass beds as a nursery area (Rodriguez 2004). The 59 square mile Stemple Creek watershed drains into the estero and over time, changes in land use in this watershed have led to changes in the estuary. The estero is currently affected by sedimentation, poor water quality, and altered hydrology. It is a Critical Coastal Area and an impaired water body (nutrients, sediment, and low dissolved oxygen). While it was historically fully tidal, it is now seasonally closed (during late spring, summer, and fall) and has poor circulation and variable salinity (it can be hypersaline). It remains closed until late fall or early winter flood flows breach the sandbar at its mouth (Philip Williams Associates, 1993).

Tomales Bay: Tomales Bay, in western Marin County, is the largest embayment in the study region and it covers 11 square miles. The mouth of the bay is at the southern end of Bodega Bay and it extends in a southeasterly direction along the San Andreas Fault. The bay is long and narrow (12 miles long and less than 1 mile wide) and has an average depth of 20 feet. The mouth of the bay is open and tides, rather than wind, dominate current patterns in the bay. There are three mixing regimes within the bay: there is significant flushing from the mouth of the bay to Hog Island, sluggish mixing in mid-bay (Pelican Point to Sandy Point), and less exchange in the upper bay to the south (Smith et al. 1971 cited in Ghodrati 2004). The watershed area of the bay is approximately 216 square miles and includes four major drainages (Fischer et al. 1996). Tomales Bay is categorized as an impaired water body because of pathogens (Ghodrati 2004)

Tomales Bay has estuarine subtidal habitat, sheltered rocky shores, sheltered sand beaches, eelgrass beds, tidal flats, and coastal marsh. The Tomales Bay Biodiversity Partnership (tomalesbaylife.org) is conducting inventories of species and habitats in the bay. The bay is a top birding spot in Sonoma/Marin Counties; there are 163 species of birds known to occur there, with 122 species regularly or occasionally observed (Kelly and Stallcup, 2004). The bay is an important stop and overwintering ground on the Pacific Flyway and shelters up to 20,000 shorebirds and 20,000-25,000 waterfowl. Productivity in the bay has been linked to both terrestrial and upwelling-derived nutrients (Smith and Hollibaugh 1997). The bay is a nursery ground for many species of invertebrates and fish including Dungeness crab, smelt, Pacific herring, Northern anchovy, coho salmon, steelhead trout, California halibut and other flatfish (NOAA 1990). Gray whales feed in the bay and white sharks occur occasionally. Several species of elasmobranchs (including leopard sharks, bat rays, and smoothhound sharks) are found within Tomales Bay and migrate from the outer portion to the inner portion of the bay to feed according to tidal (Ackerman et al 2000) and diurnal (Matern et al 2000) cycles as well as

associated changes in temperature and salinity (Hopkins and Cech 2003, Miklos et al 2003). During the winter, these species leave Tomales Bay, presumably due to changes in temperature (Hopkins and Cech 2003) and salinity (Meloni et al 2002). There are 150 species of fish and 200 species of algae in the bay. The California freshwater shrimp, tidewater goby, Pacific herring, coho salmon, and steelhead trout are some endangered and threatened species found in the bay. Lagunitas Creek, which drains into the bay, has a relatively large returning coho salmon population. There are marine mammal haulouts on tidal flats and beaches in the bay (Tomales Bay Biodiversity Partnership, 2006; Tomales Bay Watershed Council 2003; Evens 1993).

The area below mean high tide in Tomales Bay is part of the Gulf of the Farallones National Marine Sanctuary. The Golden Gate National Recreation Area also has jurisdiction. Tomales Bay is also part of the Golden Gate Biosphere Reserve, and was designated in September 2002 as a "Wetland of International Significance (Ramsar Convention on Wetlands). Much of the western shoreline of Tomales Bay is protected as part of Point Reyes National Seashore and Tomales Bay State Park. There are 12 active oyster aquaculture leases in Tomales Bay, with the largest located at the mouth of Walker creek and in the southeast portion of the bay across from Teachers Beach. Tomales Bay has long been a popular and highly utilized location for recreational clamming. Clam Island and Seal Island, in the western end of the bay, have produced large annual catches of gaper clams and other clam species over the decades. California Department of Fish and Game biologists estimated that over 50,000 gaper clams were taken annually during the late 1980s, with catches reduced in recent years due to a combination of siltation on clam island and reduced public access due to discontinuation of the clam barge from Lawson's Landing on the northeast shore (T. Moore, pers. comm.). The bay is also utilized for other recreational activities such as kayaking, angling, and wildlife viewing. The shores of Tomales Bay were home to coast Miwok.

Drakes Estero: Drakes Estero is located in the Point Reyes National Seashore, just south of Point Reyes and adjacent to Estero de Limantour. The estuary covers approximately 2,270 acres during the highest tides, with the central estuary encompassing 1,300 acres. Drakes Estero is less than 6 feet deep in most places, though the central channel is 25 feet deep, and connects to Drakes Bay via a narrow, 21 foot deep inlet. The estuary is protected from wave action by sand spits at Drakes and Limantour beaches and receives freshwater from 6 perennial and 4 ephemeral streams that drain approximately 13.5 square miles of coastal scrub and grassland. The mudflats, sandflats, and eelgrass beds of the estuary support several native clam species and serve as important habitats for the larval and juvenile stages of lingcod, English sole, speckled sanddab, several species of nearshore rockfish, Dungeness crab, Pacific herring, and several shrimp species. Over 60 species of fish have been documented in the estero and over 100 species of shore and water birds have been observed in the winter, including special status birds such as Osprey, White Pelicans, Brown Pelicans, Peregrine Falcons, Black Brants, Western Snowy Plovers and Marbled Murrelets. Harbor seals inhabit the estuary year-round and use the estuary as a rookery. The estero is an important area for bird watching and kayaking, though some human activities (including recreation, cattle grazing, and oyster farming) have negative effects on the estuary, such as disturbances to water birds and seals and impairment of water quality (VanderVen 2005). Only one company has a mariculture lease in the estuary and this National Park Service land reservation of use and occupancy is

set to expire in 2012. Drakes Estero is the only Federal Marine Coastal Wilderness on the US west coast, south of Alaska, and is a Site of Regional Importance under the US Shorebird Conservation Plan, in addition to being located within the Point Reyes National Seashore (NPS 2006).

Estero de Limantour: Estero de Limantour is an extensive salt water and brackish marsh system located to the east of Drakes Estero that is popular for both birdwatching and kayaking (Point Reyes National Seashore 2004). The estero covers nearly one square mile of area and is separated from the ocean by a Limantour spit (USEPA 2002). Muddy Hollow Creek is one of the key tributaries to the estero, though dams constructed in the 1950s and 60s restrict the water and sediment that flows to the estuary (Collins and Ketcham 2005). Harbor seal haul out and pupping sites occur on the spit and tidal sandbars. Some of these dams are failing and impairing fish passage (Laura Hoberecht pers. comm.). The estero, which was characterized as an impaired water body for pathogens in 2002, is dominated by pickleweed and inhabited by federally protected coho salmon and steelhead trout (Point Reyes National Seashore 2004, USEPA 2002, Collins and Ketcham 2005).

Bolinas Lagoon: Bolinas Lagoon is a 1,100 acre lagoon just south of the Point Reyes National Seashore, 15 miles northwest of the entrance to San Francisco Bay, with a 16.7 square mile watershed that includes Pine Gulch creek. It was designated a Wetland of International Importance by RAMSAR in 1997, and is part of the Gulf of the Farallones National Marine Sanctuary, the Marin County Department of Parks and Recreation, and the Golden Gate National Recreation Area. Bolinas Lagoon empties into the ocean through a narrow channel at the north end of the sandspit at Stinson Beach. Habitats present in the lagoon include open water estuarine habitat, subtidal channels, eelgrass beds, mudflats and sandflats, saltmarsh and brackish marsh, and a flood shoal island. There are numerous species of shorebird and waterfowl that winter at the lagoon including the clapper and black rails, the saltmarsh common yellowthroat, and the California brown pelican, which are special status species (Rodriguez 2004). Harbor seals haul out on tidal flats in the lagoon. In recent years, sedimentation within Bolinas Lagoon has become an important issue. As the lagoon becomes shallower, available habitat for some species has decreased. Changes in the nature of Bolinas Lagoon have both natural (resulting from tectonic action) and human induced (such as local development) components. Within the Bolinas Lagoon watershed, some of the key changes include: logging, cord wood cutting, road building, grazing, and agriculture (Marin County Open Space District 2006). A restoration effort has been proposed in the lagoon in recent years and a feasibility study was conducted in 2002 (more information on this effort can be found at <http://www.spn.usace.army.mil/projects/bolinaslagoon> and <http://www.bolinaslagoon.org>).

Pescadero Marsh: Located 35 miles south of San Francisco and covering approximately 588 acres, Pescadero Marsh is the largest wetland between San Francisco Bay and Elkhorn Slough (Agriculture Water Quality Alliance 2006). The marsh is a seasonally bar-built estuary and into which both Pescadero and Butano creeks flow and drain 81 square miles of mostly wooded land. The estuary contains salty, brackish, and freshwater habitats that are important for salmonoids, including steelhead juveniles and smolts during late spring to early summer and adult steelhead in winter and early spring (ESA 2004). In addition to a large steelhead population, the lagoon has Coho salmon which have been stocked in the estuary in previous

years. The marsh also provides habitat for other special status species, including brackish water snails, red-legged frogs, the San Francisco garter snake, black and clapper rails, and tidewater gobies. Marine mammals and migratory waterfowl use the estuary as well. Much of the watershed is used for commercial forestry and 5% of the watershed is used for agricultural production and some urban development has occurred (Agriculture Water Quality Alliance 2006). Both Pescadero and Butano Creeks are listed as Critical Coastal Areas and impaired water bodies (for sediment). The estuary itself is included in the Pescadero Marsh Natural Preserve.

3.1.4 Seagrass Beds

Seagrass habitats are very productive and biologically diverse. The most common type of seagrass in estuaries and sheltered coastal bays in California is *Zostera marina*, or eelgrass (Abbott and Hollenberg 1976). It is a flowering plant, not an alga, and occurs in dense beds. It helps prevent erosion and maintain stability near shore by anchoring sediment with its spreading rhizomes and slowing water flow. Eelgrass beds provide foraging, breeding, or nursery areas for invertebrates, fish, and birds (Hoffman, 1986).

Eelgrass beds cover much of the mud bottoms of Tomales Bay, Drakes Estero, Estero de Limantour and the smaller esteros, including Estero Americano and Estero de San Antonio. Bolinas Lagoon had eelgrass beds historically, but does not currently. Eelgrass beds have been mped in Tomales Bay and Drakes Estero and cover less than 0.8% of the study region (Table 1). Total coverage of eelgrass beds is approximately 6.0 mi² (see Maps [2a](#), [2b](#), [2c](#), [2d](#), [2e](#), [2f](#)).

The most common type of seagrass along the open coast is surf grass (*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. The distribution of surfgrass along the north central coast study region has been mapped by the U.S. Minerals Management Service (1982) as linear segments that total 68.8 mi or 18.9% of the shoreline.

3.1.5 Kelp Forests

Kelp forests (also called kelp beds) within the study region are formed predominantly by canopy-forming bull kelp, *Nereocystis lutkeana* (Foster and Schiel 1985). Giant kelp (*Macrocystis pyrifera*) dominates most kelp forests south of Davenport (outside of this study region). North of Davenport, bull kelp becomes the dominant kelp. 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 (Ebling et al. 1985; Harrold et al. 1988; Zimmerman and Robertson 1985).

Kelp beds are found primarily along the northern half of the north central coast study region (Sonoma coastline) where hard substrata is available in the nearshore; kelp beds are small and rare in the southern half of the study region. Kelp reproduces by spores. Although these spores may be viable up to a mile away, experiments have shown that recruitment density rapidly declined with distance from the adult stand; significantly lower recruitment was observed as

little as 10 feet from adults (CDFG 2001). The kelp forests in the study region are well mapped at fine-scale resolution based aerial surveys in 1989, 1999, 2002, 2003, 2004, and 2005 by CDFG. Total kelp abundance in the study region over the 6 survey years has ranged from a high of 3.4 mi² in 1989 to a low of 0.9 mi² in 2005.

Kelp forests are one of the most productive marine habitats along the coast of California and provide habitat and nursery areas for many species of fishes and invertebrates (Foster and Schiel 1985). Studies have shown that distribution and abundance of kelp beds and successional processes are affected by climatic and oceanographic changes, as well as by grazer abundances and fishing (Pearse and Hines 1979; Tegner et al 1997; Tegner and Dayton 2000). Grazers, such as urchins, can play a large role in the abundance and distribution of kelp and their populations can be directly affected by both predation by animals such as sea otters, and by urchin fishing (Tegner & Dayton 2000). Kelp beds are important habitat and feeding grounds for many species. 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). Sea otters, which have an important structuring role in kelp forest communities, occur in the southern part of the study region and are increasingly sighted as far north as Point Reyes.

There are no commercial kelp harvest leases in the MLPA North Central Coast Study Region. The administrative status of all kelp beds in the study region is “closed”.

3.1.6 Sandy/Soft Bottoms

Soft bottom habitats are the predominant habitat on the continental shelf and slope throughout the region (Eitrem, 2002). Nearshore and offshore environments include soft bottom habitats in areas that range from flat expanses to slopes. Soft bottom habitats lack the structural complexity and relief of hard-bottom substrata and are generally dominated by bottom dwelling invertebrates and fishes; assemblages differ with depth (Allen et al., in press; Johnson et al 2001). Soft bottom habitats can be highly dynamic in nature as sediments shift due to wave action, bottom currents, and geological processes. Landslides and slumps can extend offshore.

Soft bottom habitats predominate over hard bottom habitats in all depth zones (Table 5, maps [3a](#), [3b](#), [3c](#), [3d](#), [3e](#), [3f](#)). Soft-sediment communities reach their peak in diversity of invertebrate epifauna and infauna around 70-230m, especially in areas where the shelf is wide and riverine input is present (J.Oliver, Moss Landing Marine Laboratory, pers.comm). Soft-bottom habitats in different depth zones should be considered separate habitats (CDFG 2005a).

Spatial mapped data on hard and soft bottom habitats are available for most of the study region based on recent seafloor mapping by Kvittek et al 2007 (this data collection effort is described in section 3.1.7 below). Table 5 shows hard and soft bottom habitats by depth zone in the study region.

Table 5: Approximate Amount of Hard and Soft Bottom Habitats by Depth Zone in Study Region

Depth Zone	Hard Substrata, mi ¹ (% of depth zone area)	Soft Substrata mi ¹ (% of depth zone area)	Unknown Substrata ² (% of depth zone area)
0-30m	37.0 (10.0 %)	221.9 (60.1%)	110.1 (29.8%)
30-100m	48.4 (12.5%)	338.4 (87.2%)	1.4 (0.4%)
100-200m	0.0 (0.0%)	5.5 (100%)	0.0 (0.0%)
>200m	0.0 (N/A)	0.0 (N/A)	0.0 (N/A)
Total	85.4 (11.2%)	565.8 (74.2%)	111.5 (30.2%)

1: These estimates based on Kvitek et al 2007 data.

2: These areas have not been mapped.

3.1.7 Hard Bottom / Rocky Reefs

Hard bottom habitats (also called “rocky reefs”) have been mapped at a fine scale for most, but not all, of the study region (maps [3a](#), [3b](#), [3c](#), [3d](#), [3e](#), [3f](#)). Fine-scale substrata data were collected by Kvitek et al (including collaboration between Seafloor Mapping Lab, California State University Monterey Bay, and Fugro Pelagos, Inc.) during the summer of 2007. Vessel-based multi-beam side scan sonar was used to collect data to a shoreward depth of 20 meters and aircraft-based Light Detection and Ranging (LIDAR) equipment was used for nearshore measurements where possible. These data were classified as either rocky or soft substrata by using a 3x3 cell rugosity analysis and divided into one of four depth categories (as defined by the MLPA Science Advisory Team). In some cases, proxies, such as presence of kelp (north of Bolinas) were used to identify rocky substrata in near-shore areas. Estuaries were assumed to be soft substrata. The Farallon Islands were mapped using a combination of existing fine-scale data and some coarse scale data.

Rocky substrata are much less common than soft substrata in the region at all depth zones (Table 5). The species that associate with hard bottoms differ greatly with depth and type of substratum; the amount of topographic relief changes with gravel, cobble, boulders, and smooth rock outcrop (Cross and Allen, 1993). Rocky reefs provide hard substratum to which kelp and other alga can attach in the nearshore (<30m depth). In addition, many invertebrates such as deep sea corals, sponges, and anemones require hard substratum for attachment in deeper waters (Engle and Coyer, 1981). In addition to attached organisms, the structural complexity of rocky reefs provides habitat and protection for mobile invertebrates and fish (Carr, 1991; CDFG, 2001). Hard bottom habitat in each depth zone should be considered separate habitats (CDFG 2005a).

The ecological assemblages associated with rocky habitats can also be influenced by the type of rock (example, sedimentary versus granitic reefs or size of substrata, such as cobble versus boulder). Rocky reefs in each of these geologically-distinct zones should be considered separate habitats (CDFG 2005a).

3.1.8 Underwater Pinnacles

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 resulting movement of large rocks (Gary Greene, Moss Landing Marine Laboratory, pers.comm). Pinnacles are located in state waters along the north central coast but have not been mapped; they can be important bathymetric features that attract certain fish and invertebrate species (Carr, 1991; CDFG, 2001). On substrata maps (maps [3a](#), [3b](#), [3c](#), [3d](#), [3e](#), [3f](#)), pinnacles in the study region are not categorized separately from other hard bottom habitats.

3.1.9 Submarine Canyons

There are no major submarine canyons in state waters in the north central coast study region. However, there are some major canyons well offshore in federal waters, including Bodega Canyon and Pioneer Canyon. Submarine canyons provide areas of high bathymetric complexity, support deep water communities, and effect local and regional circulation patterns. Offshore canyons provide habitat for adult stages of rockfish and flatfish that rear in nearshore waters and move offshore in their adult stages. In addition, offshore canyons and other bathymetric features are important foraging areas for seabirds and marine mammals (Yen et al 2004).

3.1.10 Oceanographic Habitats

The SAT recommended that habitats defined in the MLPA be expanded to include oceanographic features (specifically upwelling centers, retention areas, and freshwater plumes) that significantly affect productivity, ecological assemblages, and recruitment patterns. While highly complex and dynamic, some oceanographic features are relatively predictable or persistent and create important habitat features.

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, as well as dispersal and recruitment patterns of sedentary species that have planktonic phases. Poor oceanographic conditions can affect food web dynamics well into the future, in addition to impacting individual species.

Regional oceanographic patterns and temporal variability: The study region is characterized by upwelling and a Mediterranean climate. Offshore of north central California, large-scale currents are the California Current, which is comprised of southward flowing surface waters and extends more than a hundred miles offshore, and the subsurface northward flowing Davidson Current (typically deeper than 100m and just offshore of the shelf-slope break). The California Current has a weak southerly mean flow (about 3cm/s), but it is characterized by strong variability in the form of large eddies with typical current speeds faster than the mean southward flow. The flow of the California Current and wind-driven currents are reduced in the

winter and the Davidson Current can surface nearshore. The strongest currents are directly wind-driven and found over the shelf (“coastal upwelling jet”). These currents are mostly alongshore towards the south, but with an important offshore movement of near-surface waters (“Ekman transport”) that results in upwelling of cold waters from depth. When winds weaken for a few days during the summer northerly wind period, currents near to the coast tend to reverse so that the mean alongshore flow is often zero within several miles of the coast. Even closer to the shoreline (about a mile, depending on bottom depth), currents are slowed by the drag of the shoreline and shallow bottom. In addition to wind-driven currents and offshore California Current effects, water over the shelf moves with the tides; strongest tidal currents are observed in and near enclosed waters such as San Francisco and Tomales Bays. Specific flow features are associated with topographic features (e.g., Point Reyes, Cordell Bank) and with the convergence of waters of different density (e.g., low-salinity bay outflow interacting with ocean waters).

The region is strongly influenced by a large persistent upwelling center at Point Arena, an area characterized by nutrient rich waters with little phytoplankton biomass. The area of active upwelling expands and contracts as the wind varies and active upwelling may extend along the entire coast from Arena to Bodega. These cold nutrient-rich upwelled waters move rapidly along the coast in the coastal upwelling jet and slowly offshore due to Ekman transport, with waters from the perennial upwelling center at Point Arena typically moving over Cordell Bank and past the Farallon Islands some days later (maps [4a](#), [4c](#)). Waters upwelled south of Point Arena also travel downcoast and offshore, but typically are deflected by Point Reyes so that the coastal upwelling jet is diverted offshore into the outer Gulf of Farallones. While Point Reyes is immersed in cold water, it is not considered a separate upwelling center (only limited local upwelling).

The upwelled waters provide the nutrients to cause a phytoplankton bloom within 3-7 days (if waters remain in well-lit shallow depths). One therefore expects chlorophyll peaks 30-140 kilometers downstream from the upwelling center (assuming average current of 0.1-0.2m/s). The Farallon Islands and Cordell Bank are thus bathed in highly productive waters that were upwelled at Point Arena around five days prior and are therefore rich in phytoplankton. Outflow from San Francisco Bay may also play an important role in fueling the productivity of the Gulf of Farallones, but this is not yet clear.

The study region is characterized by three oceanographic “seasons”: the upwelling season, relaxation season, and storm season (Largier et al 1993 – see Table 6). Upwelling of cold nutrient rich waters occurs in early spring and summer and generally peaks in May and June; however, there is significant variability in upwelling between years and with latitude (Pennington and Chavez, 2000). The relaxation season may also be characterized by phytoplankton blooms in the shallow stratified surface layer (blooms dominated by dinoflagellates, which may be toxic at times, i.e., “red tides”).

Table 6: Oceanic Seasons in North Central California

Oceanic Season	Typical Months	Characteristics
Upwelling season	April – July	Upwelling is variable in duration and intensity; generally upwelling episodes are 3-10 days.
Relaxation season	August – November	Winds are light and seas generally calm, with upwelling events less frequent.
Storm season	December – March	Low pressure systems from Alaska generate southerly winds, large waves, and storms. Northward flow is enhanced during this season.

The region is characterized by highly variable oceanographic conditions. The El Niño-Southern Oscillation is a large-scale change in atmospheric pressure, trade winds, and sea surface temperatures of the tropical Pacific that occurs every several years and has significant effects on the California Current System. Map [4b](#) shows sea surface temperatures prior to El Niño (August 1996-April 1997) and during El Niño (August 1997-April 1998) periods (data presented are averaged for the given month and summarized in a 9 kilometer grid; from Airame et al. 2004).

During El Niño-Southern Oscillation events, there is a reduction in upwelling of cold nutrient rich waters, increased onshore and northward flow, increased sea surface temperature, and increased northward advection of warm subtropical waters. El Niño – Southern Oscillation events generally result in a decline in zooplankton and reductions in productivity that can affect fish, seabird, and marine mammal populations. Longer term decadal and multi-decade climatic cycles also affect ocean conditions and thus a wide variety of marine organisms. Changes in atmospheric circulation in the central and northern Pacific and other factors yet unknown result in shifts in mean sea surface temperature every 20-30 years that have large-scale impacts on zooplankton and fish productivity throughout the region; the effects of these climatic regime shifts (called Pacific Decadal Oscillations) are being studied. Also, there are underlying trends in sea level and ocean temperature due to global climate change.

Oceanographic conditions such as currents, water masses, and temperature strongly influence marine biodiversity. Variation in factors such as water temperature, upwelling and currents determine areas of productivity where krill, squid, anchovy, seabirds, and marine mammals congregate in the pelagic ecosystem (Forney, 2000; Yen et. al., 2004). Oceanographic features include fronts where two water masses meet, recirculation eddies in the lee of headlands or islands, upwelling plumes, river or bay outflow plumes, and warm surface-water layers in sheltered bay environments. Many of these oceanographic features can be associated with high abundances and biodiversity hotspots – for example, persistent features associated with bathymetric features such as the shelf-slope break or headlands, predictable time-varying features associated with upwelling or land runoff, and ephemeral features associated with passing eddies and filaments (Pelagic Working Group 2002; Yen et al 2004). In addition, transport patterns associated with oceanographic features can significantly affect recruitment patterns of fish and invertebrates in intertidal and nearshore communities (Farrell et al 1991; Roughgarden et al 1991; Wing et al 1995). Strong upwelling and upwelling shadows south of

major headlands can affect settlement of invertebrates, with crabs and urchins settlement correlated with relaxation events along the coast north of Point Reyes (Wing et al 1995, Mace et al 2006). The importance of these processes and their predictability over time is leading to a greater emphasis on identifying oceanographic features and better mapping their areal extent and temporal persistence.

Upwelling centers: Upwelling centers are areas along the coast where cold nutrient-rich waters are brought to the surface. These waters are subsequently advected alongshore and slowly move offshore. Ultimately these waters are likely to be entrained into the offshore eddies, jets and filaments of the California Current. Major upwelling centers are found at Point Arena (in this region), Cape Mendocino (north of this region), and Pigeon Point (on southern boundary of this region). The upwelling center at Point Arena is one of the largest and most persistent in the world, being active year-round but strongest in the upwelling and relaxation seasons. Waters upwelled at Arena are likely to move south and offshore, crossing over Cordell Bank 3-5 days later. During stronger winds, upwelling occurs along the entire coast from Point Arena to Bodega Bay, with water upwelled closer to Bodega being deflected offshore at Point Reyes and moving past the Farallon Islands. While upwelling patterns along the coasts of Point Reyes are not well understood, upwelling is unlikely along the north side of the headland although upwelling can be observed as a narrow band along the coast between Drakes Estero and Bolinas and again to the south of Point San Pedro (reaching a maximum near Pigeon Point). In the vicinity of the mouth of San Francisco Bay, tidal currents are strong and the relative strengths of wind or tide-driven upwelling are unclear. Although the process of upwelling has specific spatial pattern, the entire north central coast region is characterized by cold nutrient-rich waters in the upwelling season. Map [4a](#) shows average seasonal sea surface temperature (1996-1999) and chlorophyll (1998-2000) maps for the upwelling, relaxation, and storm seasons (from Airame et al 2004). Map [4c](#) shows general movement of upwelled water. In addition to coastal upwelling features, jets/squirts/filaments are often observed as cold-water features extending far offshore from upwelling centers, such as Point Arena.

Retention areas: Upwelling is typically strongest at larger headlands and weak or non-existent in bays. Graham and Largier (1997) described the concept of “upwelling shadows” as regions where upwelling is absent downwind of a major headland and where one will often find recirculation due to separation of the flow past the headland. These upwelling shadows are considered to be retention areas (Largier, 2004): regions where there is an increase in retention (or reduction in dispersion) of planktonic organisms. Northern Monterey Bay is the prototype upwelling shadow. Additionally, headlands and their resulting upwelling shadows can have direct impacts on breeding seabirds, with leeward foraging seabirds showing less among-year variability in diet than those foraging in windward waters (Robinette et al in press).

More field observations are needed to properly quantify and map retention areas for this region, but it is clear that Drakes Bay is an important upwelling shadow (Wing et al 1998), although less sheltered from winds than northern Monterey Bay. Drakes Bay is an important retention area for larvae (high concentrations of rockfish and crab larvae have been documented south of Point Reyes) that settle near the coast and northward via a poleward movement of water during the relaxation period (Wing et al 1998). Retention time in this area is probably on the order of several days. In addition to Drakes Bay, it is thought that the Shelter Cove area (north

of the north central region) is a retention area downwind of Cape Mendocino. Further, a small-scale retention zone has been observed in Bodega Bay, which is in the lee of the small Bodega Head headland (Roughan et al 2005). Similar small-scale retention zones may be found in Bolinas Bay and immediately south of Pillar Point. These small-scale zones are expected to exhibit shorter retention times (at most, a few days), but they offer opportunities for active plankton to be retained for longer periods of time (Roughan et al 2005).

Tomales Bay and Bodega Harbor combine with Bodega Bay to create a special case of retention, with limited tidal exchange between the enclosed waters and Bodega Bay. Within the enclosed bays, residence times can be long (many weeks for Tomales Bay in the dry seasons, Largier et al 1997), but only a limited number of plankton will be retained in this location so the implications of this retention for the larger region are not clear.

A second special case is the nearshore region along the north side of Point Reyes. While not a retention area, the onshore orientation of winds and currents results in a convergence and slowing of water movement, creating a “detention” area with higher phytoplankton levels and warmer water being observed due to the increased aging of upwelled waters in this non-upwelling location (Vander Woude et al 2006). At times a similar feature is apparent in satellite images along the coast immediately north of Point Arena, but this region has not yet been studied in detail.

Estuaries: There are many estuaries in this region, which can be categorized into two types (excluding San Francisco Bay); each type has distinct oceanographic patterns, including stratification, longitudinal zonation and water residence times.

1. Low-inflow (bay or lagoon) estuaries like Tomales Bay, Drakes Estero, Bolinas Lagoon, and Bodega Harbor have permanently open mouths but they are characterized by long residence times in the dry season (upwelling and relaxation seasons) and a well-defined longitudinal zonation from marine to hypersaline to riverine. The inner regions of these low-inflow estuaries are anomalously warm for the cold coast and this presents a distinct habitat for both native and invasive species.
2. Bar-built (river valley) estuaries like the Russian River, Gualala River, Garcia River, and many smaller systems (e.g., Salmon and Pescadero Creeks) have limited tidal exchange with the ocean in the upwelling and relaxation seasons, resulting trapping of the salt wedge and a highly stratified water column. Deeper waters may be hypoxic or anoxic (and very warm in shallower systems). At times the mouth closes entirely and exchange with the ocean is absent until the mouth is naturally or artificially opened again.

River and bay plumes: Land runoff and tidal rise and fall in enclosed bays result in outflow plumes that can be clearly seen and that are important determinants of oceanographic habitat. In particular, the outflow from San Francisco Bay has a strong influence on the region’s oceanography. San Francisco Bay is the largest estuary on the West Coast and freshwater from the entire Central Valley of California drains into it primarily from the San Joaquin and Sacramento River systems. Low-salinity waters exit San Francisco Bay on the outgoing or ebb tide, while ocean waters enter the Bay at depth and specifically on the incoming or flood tide.

Although tidal currents dominate in the vicinity of Golden Gate, amidst significant mixing, there is a net outflow of waters, which forms a low-salinity “plume”. In the absence of winds and offshore currents, the low-density bay outflow will turn north and travel along the coast past Point Reyes and Bodega, as it does in the winter - as well as at times when the upwelling winds weaken during the upwelling and relaxation seasons. Being of lower salinity and often warmer than the ocean waters, this plume of water rides over the denser ocean waters. During times of stronger freshwater runoff, the outflow is visible as a distinct plume (photographs and satellite imagery). During the upwelling season, however, the southward currents and winds force this plume southward, although local upwelling along the coast tends to keep these plume waters away from the shoreline. The plume reaches its greatest extent during spring snowmelt and after winter storms. Tidal outflow through Golden Gate can reach 6 knots and the tidal front found offshore during ebb tides is an important foraging area for seabirds, especially from the large colonies on the Farallon Islands (Largier 1996; Wilkerson et al 2002). Much more is known about San Francisco Bay. A schematic diagram showing movement of San Francisco Bay water is provided in Map [4c](#).

Other rivers and streams also introduce freshwater, sediment, nutrients, and pollutants into nearshore waters. While typically localized in impact, and with strong seasonal variability, these features may dominate the oceanographic habitat in plume regions. The Russian River plume is the largest and muds from the Russian extend up the shelf to Point Arena (winter deposition) while low-salinity effects due to the Russian River outflow can be seen as far south as Point Reyes in the early upwelling season (specifically in years of late spring rains). Maps of rivers plumes are not readily available at this stage.

3.1.11 Rocks and Islands

While not a habitat identified in the draft master plan for MPAs (CDFG 2006), rocks and offshore islands in the study region represent important and unique areas of rocky intertidal habitat, shallow habitats offshore from the mainland, and important nesting/breeding areas for seabirds and marine mammals.

Farallon Islands: Seven islands and several rock outcroppings comprise the Farallon Islands archipelago, which is located 28 miles west of San Francisco and 20 miles south of Point Reyes. Above sea level, the seven islands are mainly clustered in three groups (Southeast, Middle, and North Farallon). Below sea level, these features are part of a longer submarine ridge (sediment covered in places) that extends north to Cordell Bank. Situated in a large coastal upwelling center and supplemented with nutrients discharged from the San Francisco Bay estuary, these islands are an important biological hotspot along the California Coast. Twelve species of seabirds, including over 300,000 individuals, breed on the islands, including Leach’s storm-petrel, the Ashy storm-petrel, Double-crested cormorant, Brandt’s cormorant, Pelagic cormorant, Black oystercatcher, Western gull, Common murre, Pigeon guillemot, Cassin’s auklet, Rhinoceros auklet, and Tufted puffin (USFWS 2002). Pelagic cormorants, pigeon guillemots, Brandt’s cormorants, and Cassin’s auklets forage in significant densities within state waters around the islands (Jahncke, PRBO 2007).

The Farallon Islands have the largest number of breeding seabirds of any location in the lower 48 states (Mills et al 2005). The islands also have at least 35 regular visiting species, including Pacific and red-throated loons, red-necked and western grebes, black-footed albatross, pink-footed, Buller's, and black-vented shearwaters, herring and glaucous-winged gulls, black and surf scoters, and the endangered California brown pelican. The federally threatened marbled murrelet uses the waters around the Farallon Islands (Karl et al 2001).

At least 36 species of marine mammals visit the waters adjacent to the Farallon Islands, including the federally endangered blue, humpback, fin, sei, right, and sperm whales, and six pinnipeds breed or haul out on the islands, including the northern fur seal, Guadalupe fur seal, Steller sea lion, California sea lion, Harbor seal and northern elephant seal (Karl et al 2001, USFWS 2002). Gray whales and California sea lions are observed foraging in significant densities within state waters around the islands (Jahncke, PRBO 2007). The Farallon Islands are the only breeding site in northern California for the northern fur seal and one of a few rookeries in California for the federally threatened Steller sea lion.

The Farallones are also an important feeding ground for white sharks, which are protected by California state law and several international treaties (Karl et al 2001). In recognition of the Farallon Islands' rich biological value, the islands were designated a national wildlife refuge in 1909 (protection expanded in 1969). Further protection was given to the area with the designation of the Farallon Islands State Game Refuge in 1971, the Gulf of the Farallones National Marine Sanctuary in 1981, and the Farallon Islands Ecological Reserve (now State Marine Conservation Area) in 1991. In 1988, the Farallon Islands were internationally recognized as part of the UNESCO Golden Gate Biosphere Reserve. The islands and their surrounding waters have been used by humans in the past for harvesting fur seals and seabird eggs as well as a disposal location for dredge material and nuclear waste. A lighthouse, originally constructed in 1853, is located on Southeast Farallon Island.

Today, the Farallon Islands are used primarily for long-term ecological research and as a wildlife viewing location, though public access is limited. PRBO Conservation Science, in cooperation with the US Fish and Wildlife Service, has been conducting year round, continuous wildlife research, monitoring, and stewardship in the Farallones since 1968 and has specific programs that focus on seabirds, terrestrial birds, white sharks, seals and sea lions (PRBO 2005, USFWS 2002; Warzybok et al 2006). GFNMS has been conducting intertidal monitoring on the Farallon Islands for 15 years. Data showing areas of biodiversity for marine birds and mammals in the Farallon Islands and throughout the study region are shown in maps [5a](#), [5b](#), [5c](#), [5d](#), [5e](#).

Other Rocks/Islets: Statewide, over 20,000 islands, rocks, exposed reefs and pinnacles are included in the California Coastal National Monument, managed by the Bureau of Land Management, which was designated by presidential proclamation in January of 2000 and runs along the entire California coast (1,100 miles). The monument is designed to protect the biologic and geologic values of these features and the important forage and breeding grounds of associated marine birds and mammals. Some of the notable offshore rocks with seabird colonies located within the north central coast study region include:

- Hog Island in Tomales Bay
- Bird Rock near Tomales Point
- Double Point Rocks, Stormy Stack, Point Resistance Rocks, and Millers Point Rocks, south of Point Reyes
- Bird Island near Point Bonita
- Seal Rocks in San Francisco
- Devil's Slide Rock and San Pedro Rock on the San Mateo coast
- The Farallon Islands

3.2 Important Regional Species

A brief discussion of regional species likely to benefit from establishment of MPAs, species currently described as depleted or overfished, and species that receive special protections due to their legal status (protected, threatened, or endangered) is provided below.

3.2.1 Species likely to benefit from MPAs

The MLPA requires that species likely to benefit from MPAs be identified. The identification of these species will contribute to the identification of habitat areas that will support achieving the goals of the MLPA. The SAT assembled in 2007 has reviewed and refined the list of species likely to benefit developed during the central coast process, in order to make it applicable to the north central coast study region; this list is included as Appendix II(a). As new information regarding species likely to benefit becomes available, this list and accompanying rationale will be updated by the SAT.

3.2.2 Depleted and Overfished Species

In its second goal in Section 2853(b), the MLPA refers to the term “depleted” in reference to marine life populations.

State Managed Fisheries: While there is no formal definition for the term “depleted” as related to state fisheries management, CDFG applies this term to five species of abalone, all of which were previously harvested commercially.

The Marine Life Management Act includes the following definition of a “depressed” fishery:

Depressed: The condition of a marine fishery that exhibits declining fish population abundance levels below those consistent with maximum sustainable yield (California Fish and Game Code, Section 90.7).

Federally Managed Fisheries: The Magnuson Stevens Fishery Conservation Management Reauthorization Act of 2006 defines “overfishing” and “overfished” as a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce a maximum sustainable yield on a continuing basis (GovTrack.us 2006).

Overfished: (National Marine Fisheries Service (NMFS), Magnuson Stevens Act) a population that does not produce maximum sustainable yield on a continuing basis (MSA) and in the California Nearshore FMP and federal Groundfish FMP also means a population that falls below the threshold of 30% or 25%, successively, of the estimated unfished biomass. (www.pcouncil.org/facts/acronyms.pdf).

The term generally describes any stock or stock complex determined to be below a minimum biomass threshold. The default proxy is generally 25% of its estimated unfished biomass. The rebuilding target is 40% of unfished levels for stocks such as groundfish. Any species assessed to be between 40% and 25% are managed under “precautionary zone” management, where harvest rates are reduced to slow depletion rate. Species currently managed under precautionary zone measures include cabezon, petrale sole and sablefish.

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 in *California’s Marine Living Resources: A Status Report* (CDFG 2001 and CDFG 2004a) at www.dfg.ca.gov/mrd/status/. In addition, information on species managed by the Pacific Fishery Management Council can be found at www.pcouncil.org/groundfish. Depleted is also a designation under the federal Marine Mammal Protection Act.

Abalone: Four species of abalone, black, flat, pinto, and red abalone, may occur within the north central coast study region. Black, flat, and pinto abalone are thought to be relatively rare, by contrast red abalone are comparatively more abundant. While red abalone populations are fairly robust and continue to support a viable fishery some concern remains about the concentration of fishery effort in Sonoma and Mendocino counties. Additionally, evidence of low abundance of juveniles at Bodega State Marine Reserve, Salt Point State Marine Conservation Area, and Fort Ross State Marine Conservation Area over the last ten years suggests low recruitment in these areas (CDFG 2005b).

A recreational fishery for red abalone occurs north of a line drawn through the center of the mouth of San Francisco Bay. The use of scuba or surface-supplied air to take abalone is prohibited. Currently, management of the sport fishery is guided by the Abalone Recovery and Management Plan (CDFG 2005b). Under the interim management plan in the Abalone Recovery and Management Plan, the northern sport red abalone fishery continues with existing regulations that control take and provides for a sustainable fishery. The interim management plan employs a loose total allowable catch that is adjusted by the use of size limits (7 inches minimum), seasonal closures (Dec. through March and July), catch limits (both daily bag limit of three and annual limit of twenty-four) and an abalone harvest reporting system (report card). Possible adjustments to the total allowable catch can happen every three years based on fishery independent assessment of eight index sites, four of which lie within the study region and overall annual take estimated from punch card information.

The Abalone Recovery and Management Plan includes recommendations on the use of MPAs for abalone management and recovery. The plan advises that new or expanded MPAs should

be established to address the shortcomings of the current MPAs, including an insufficient range of habitats and scientific understanding of abalone population dynamics. Specific areas are not delineated, but criteria are proposed for consideration in the MLPA process.

The recovery of sea otters has resulted in suppressed populations of abalone where sea otters occur (Hines and Pearse, 1982). The Abalone Management Plan states that abalone recovery (i.e. to a status in which a fishery may be permitted) may not be possible within the established range of sea otters. Sea otters occur in the study region from Pigeon Point to approximately Half Moon Bay (CDFG 2001), thus interaction between sea otters and abalone should be considered in this area.

Groundfish (rockfishes, flatfishes, etc): There are seven federal groundfish species which are currently declared by NMFS to be overfished (note: lingcod was under a rebuilding plan until 2006, when it was found to be rebuilt). Six of the seven overfished groundfish species occur within the MLPA North Central Coast Study Region for some or all of their life histories (for example, juveniles generally occur closer to shore than adult populations):

- Bocaccio
- Canary rockfish
- Cowcod
- Darkblotched rockfish
- Widow rockfish
- Yelloweye rockfish

Many of the overfished groundfish species listed above have their primary range outside of the study region. Cowcod, for instance, are distributed from Baja, Mexico to Newport, Oregon and are common from northern California to the northern part of Baja, Mexico (Love et al 2002). The seventh overfished groundfish species, Pacific Ocean perch, is uncommon within the latitudes of the study region. Five of the overfished species are distributed primarily on the shelf, while darkblotched rockfish is found primarily on the slope. It should be noted that less than 1% of the study region is deeper than 100 meters (55 fm, 382 ft), where the shelf/slope break begins. Thus, there is very little slope habitat within the north central coast study region. Based on their life history traits, habitat requirements and small home range (Yoklavich 1998; Parker *et al.* 2000; Parrish *et al.* 2000), the shelf species in particular could potentially benefit from the establishment of MPAs, including MPAs in which the primary goal is not related to fishery management, if appropriate habitats are protected in a way that is consistent with the life history and behavior of the species. It should be noted that as a result of fishery closures recommended by the Pacific Fishery Management Council and implemented by NMFS, overfishing of the above mentioned groundfish species is no longer occurring. However, the rebuilding plans for these species will take considerable time (decades) to achieve success; until then, these species continue to be considered as overfished and are managed under federal rebuilding plans. In addition to these species, several groundfish species are considered by NMFS to be in the "precautionary zone" – a population level that is below the level capable of producing Maximum Sustainable Yield (defined federally as below 40% of unfished biomass).

The concern over shelf rockfish species is evidenced by the establishment of significant recreational and commercial fishery closures in 2002, in the form of Rockfish Conservation Areas (RCAs). Within the study region in 2007, the depth-based recreational RCA and non-trawl commercial RCA each cover approximately 31.5% of the study region with full-time closures focused primarily on the shelf. These area closures and accompanying small optimum yields (a form of annual catch limit), are significantly limiting factors in the study region and federal waters, and often prevent access to healthy stocks of fish (with the exception of nearshore stocks).

Copper rockfish, for example, is a shelf rockfish species that has not yet been formally assessed in California, is considered to be vulnerable to and may have already undergone localized depletion (CDFG 2001). This species occurs within the study region and can benefit from localized protection due to small home ranges.

Though formal stock assessments have not been done for many species, declines have been noted for some species of rockfish. Levin et al. (2005) noted species such as canary rockfish have experienced an 85% decline, and bocaccio a 96% decline, in population since 1977. Further, O'Farrell and Botsford (2006) estimated the lifetime egg production of the black rockfish to have declined in recent years to 50% of the median 1980 levels. However, some nearshore species appear less vulnerable to overfishing. For example, the gopher rockfish gopher stock north of Point Conception appears to be healthy (MacCall et al. 2005). CDFG is currently trying to gather more information on nearshore stocks.

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 (sparse within 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.

Areas of importance for demersal (bottom-dwelling) fish density and diversity in the top 20th percentile, as mapped by the NOAA Biogeographic Assessment off North / Central California, are shown on [maps 6a-6b](#). Identification of these fish diversity and density hotspots was based on data from CDFG hook and line recreational data (for the 5-200m range) and NMFS shelf, slope, and midwater trawl data (NOAA 2004).

3.2.3 Special Status Species

Some fish, marine mammals and seabirds of the north central coast study region, whose populations have declined, receive special protections under either the state or federal endangered species acts (ESA). A list of special status species is provided in Appendix II(b). In addition, marine mammals are protected under the Marine Mammal Protection Act and

migratory seabirds and shorebirds in the study region are protected under the Migratory Bird Treaty Act. While many seabirds and marine mammals are highly mobile, there are many species that are short ranging and highly dependent on nearshore resources, especially during the breeding season when they are confined to central place foraging. These species may benefit directly from MPA establishment. For example, pelagic cormorants, Brandt's cormorants, pigeon guillemots, black oystercatchers, and harbor seals all have short foraging ranges (less than 20 km) while breeding and all feed heavily on sedentary demersal and benthic species.

Some specific locations in the north central coast study region host many special status species. Tomales Bay, for instance, has California freshwater shrimp, tidewater gobies, coho salmon, steelhead trout, as well as pinnipeds, such as harbor seals (year round) and Steller sea lions (occasionally), and numerous birds, such as the western snowy plover (The Tomales Bay Watershed Stewardship Plan 2003). The Farallon Islands, on the other hand, host the largest concentration U.S. seabird colony south of Alaska, with 30% of California's nesting seabirds. The Farallon Islands host 12 species of nesting seabirds, including the ashy storm-petrel, Brandt's commerant, pelagic commerant, Cassin's auklet, rhinoceros auket, and tufted puffin (Mills et al 2005). The waters around the Farallones host at least 36 species of marine mammals, including the federally endangered blue; humpback; fin; sei; right; and sperm whales, and the federally threatened steller sea lion; Guadalupe fur seal; and southern sea otter (Karl et al 2001). Point Reyes National Seashore is home to over 30 species of federally recognized endangered, threatened, and species of concern dependent on coastal and marine environments. A complete list of these species can be found at: http://www.nps.gov/archive/pore/nature_wldlf_tande.html.

A complete listing of State listed endangered or threatened species (updated October, 2006) can be found at: <http://www.dfg.ca.gov/whdab/pdfs/TEAnimals.pdf>. A complete listing of federally listed endangered or threatened species (updated November of 2006) can be found at <http://www.nmfs.noaa.gov/pr/species/esa.htm>.

A list of special status species expected to occur in the region compiled by the MBNMS and edited with information from GFNMS and PRBO Conservation Science is provided in Appendix II(b). A brief description of selected species follows.

In addition, PRBO Conservation Science recently compiled information regarding abundance and distribution of birds and marine mammals in the Gulf of the Farallones in addition to other locations. This information can be viewed at: http://www.prbo.org/cms/docs/marine/CCS_Seabird_Mammal_Atlas.pdf.

Coho and Chinook salmon and steelhead trout: Three species of salmon and steelhead trout (*Oncorhynchus* spp.) are considered endangered or threatened under the Endangered Species Act in the north central coast study region: Coho and Chinook salmon and Steelhead trout. Streams and rivers with documented presence of these three species within the last ten years based on a variety of sources (Adams et al 1999; Jigour et al 2004; Busby et al, 1996; Titus et al 2000) are displayed in [maps 6a-6b](#). These species of salmon and steelhead are of a highly migratory nature and are not likely to directly benefit from the establishment of offshore

MPAs; however, due to their dependence on healthy estuarine environments during juvenile stages, some species may benefit from estuarine MPAs.

Two evolutionarily significant units (ESUs) of Chinook salmon (*O. tshawytschus*) are listed as threatened. One is the California Coastal ESU, which includes the Russian River where populations are slowly increasing. Since 2000, adult Chinook salmon counts have ranged from approximately 1,400 to 6,100 (Sonoma County Water Agency, 2007). No data are available on the size of the Chinook run prior to 2000. The other threatened Chinook salmon ESU is the Central Valley Spring Run ESU, which has only three wild populations left in Mill, Deer, and Butte Creeks (fish have also recently returned to Big Chico Creek), mostly due to blocked access to traditional spawning areas by dams, which impair salmon migration. The Sacramento River Winter Run ESU, which was greatly affected by the construction of Shasta Dam, is listed as endangered and had escapement as low as 200 in during the 1990's. However, these numbers have increased to almost 10,000 female spawners in 2004. Both the Sacramento River and Winter Run and Central Valley Spring Run ESUs have spawning habitat outside of the study region; however, these fish populations inhabit California coastal waters during their adult lives and pass under the Golden Gate on their inland migration. In 1994, the Chinook salmon fishery in waters around the Farallones, where they live during some of their adult stage, was valued at \$24 million (Karl et al 2001).

One ESU of Coho salmon (*O. kisutch*), the Central California Coast ESU, is listed as endangered. This ESU runs from Punta Gorda in the north to the San Lorenzo River in the south. Of the 133 historical runs, only 56 (or 42%) are now considered occupied. The highest occupation is in Mendocino County (62% of historical runs), followed by Marin (40%), Sonoma (4%), and San Francisco Bay tributaries (0%). Central California Coast Coho salmon return to major rivers in the study region, including the Garcia, Gualala, Russian, and Tomales Bay Rivers, as well as numerous smaller creeks (Good et al 2005). Since 2001, a the Russian River Coho salmon Captive Broodstock Program has been re-establishing coho in the Russian River. The program captures, rears, and spawns coho broodstock, and young fish are released in area tributary streams. Growth and survival is monitored until the time arrives for them to move downstream and into the Pacific Ocean. For more information, see <http://groups.ucanr.org/RRCSCBP/>.

Three distinct population segments (DPS) of steelhead (*O. mykiss*) are listed as threatened in the north central coast study region. The Northern California DPS ranges from Redwood Creek in Humboldt to the Gualala River and is found in both the Garcia and Gualala Rivers. The Central California Coast DPS ranges from the Russian River, which probably hosted the largest historic population, to Soquel Creek, and includes some tributaries in San Francisco and San Pablo Bays. Both the Northern California and Central California Coast DPS's have benefited from a prohibition of ocean harvest of steelhead enacted in 2002. The California Central Valley DPS is also listed as threatened and it has been estimated that 95% of their traditional spawning habit is inaccessible due to dams, though they are thought to be widespread, if not abundant, in accessible streams and rivers. (Good et al 2005)

North American green sturgeon: The southern distinct population segment of North American green sturgeon (*Acipenser medirostris*) is listed as threatened under the ESA. Population

numbers have dropped for this distinct population segment due to habitat loss resulting from dam construction, including the Keswick and Shasta Dams on the Sacramento River and the Oroville Dam on the Feather River. Coast-wide, ocean catch of green sturgeon have decreased from a high of 9065 in 1986, to 512 in 2003. Today, the Sacramento River contains the only known spawning population of the Green Sturgeon Southern distinct population segment (NMFS 2005).

Though green sturgeon do pass under the Golden Gate Bridge on their migration up the Central Valley rivers, these fish, similarly to salmon and steelhead, are a highly migratory species that are unlikely to directly benefit from MPAs. Though green sturgeon may benefit from protection of estuarine habitats that they utilize during juvenile life stages, these environments are located outside of the north central coast study region for the southern distinct population segment.

White sharks: White sharks (*Carcharodon carcharias*) are wide-ranging and known to inhabit coastal waters in the north central coast study region, though the population off California is small: probably a few hundred to a few thousand adults (Karl et al 2001). Subsisting mostly on marine mammals and scavenged large animal carcasses, white sharks often feed off the Marin Headlands and the Farallon Islands, especially during the late summer and fall. In recent years, several San Francisco-based organizations have begun to offer cage-diving tours with white sharks in the waters around the Farallon Islands. Though not formally protected under the Federal or State ESA, in 1994 the state of California placed white sharks on the list of species protected in state waters (Karl et al 2001) and in 1997 California state law permanently prohibited take of white sharks (SB 144, Thompson). Gulf of the Farallones National Marine Sanctuary proposed regulations will prohibit attracting white sharks in the entire sanctuary and approaching them (within 50 meters) within 2 nautical miles of the Farallon Islands (October 2006 Draft Management Plan – GFNMS 2006). The Monterey Bay National Marine Sanctuary currently prohibits attraction within state waters and has proposed expanding this protection throughout the sanctuary (October 2006 Draft Management Plan-MBNMS 2006). In addition, white sharks are protected under several international treaties. In 1996, white sharks were included in the World Conservation Union Red List of Threatened Species under the vulnerable category. In 2002, they were listed in appendices I and II of the Convention on Migratory Species. Most recently, in 2004, white sharks were included in the Convention on International Trade in Endangered Species of Fauna and Flora (Convention on International Trade in Endangered Species of Wild Fauna and Flora).

Breeding seabirds: The region supports a diverse assemblage of seabirds, many of whom aggregate into colonies, especially during the breeding season. The major marine bird breeding colonies in the study region are located at Point Reyes and in the North and South Farallon Islands (as well as in San Francisco Bay and Alcatraz Island, which are not included in the study region). Other major colonies include (G. McChesney, pers. comm.):

- Devil's Slide
- The "Drake's Bay" area
- Bird Rock at Tomales Point

- Bodega Rock
- The Russian River area
- Gualala point
- Fish Rocks

Prey resources, including fish, squid, and krill, are often abundant because of the high productivity of the California current and there are numerous cliffs, offshore rocks and islands for roosting and nesting habitat. Most of the rocks and islets along the coast are protected in the California Coastal National Monument, managed by the Bureau of Land Management. Millions of seabirds migrate through or breed in the region annually. Many populations of seabirds in the region are sensitive to changes in oceanographic conditions, with reproductive success and population size fluctuating with changes in food availability associated with warm and cold water events (Mills and Sydeman 2003; Ainley and Boekelheide 1990). Upwelling areas, persistent fronts, the shelf-slope break, and other bathymetric features are all important foraging areas for seabirds in the region (Yen et al 2004). The north central coast study region supports thirteen breeding species of seabirds, including approximately 340,000 breeding individuals (G. McChesney, pers. comm.).

One important site for seabirds and shorebirds is Tomales Bay, which harbors at least nine state or federally threatened or endangered bird species. Both the California clapper rail, which is federally endangered and on the state threatened list, and the black rail, which is on the state threatened list, have been known to nest in Tomales Bay. Additionally, the marbled murrelet, which is on the federal threatened list, is a year-round resident of Tomales Bay. A total of 39 bird species with special status have been seen in Tomales Bay. While some of these birds have state or federal ESA listings, others have special status as “Migratory Nongame Birds of Management Concern” by the USFWS, “California Special Concern Species” by CDFG, or are on the Audubon or Partners in Flight Watch List (Kelly and Stallcup 2003).

The Gulf of the Farallones is another important site for seabirds hosting 12 breeding species (common murre, Cassin’s and rhinoceros auklets, western gulls, Brant’s and pelagic cormorants, storm petrels, pigeon guillemots, and tufted puffins) including 300,000 breeding individuals and 35 regular visitors (Pacific and red-throated loons, red-necked and western grebes, black-footed albatross, pink-footed, Buller’s, and black-vented shearwaters, herring and glaucous-winged gulls, and black and surf scoters), many of which have special status. The islands are the largest colony in the world for three species (McChesney pers. comm.). Marbled murrelets, which are federally threatened, visit the Farallon Islands during the winter (Karl et al 2001). The Farallon Islands host the largest number of breeding seabirds of any location in the lower 48 states (Mills et al 2005).

Drakes Estero and Estero de Limantour, located within the Point Reyes National Seashore, also host large numbers of federally endangered, threatened, or species of concern, including osprey, white pelican, brown pelican, black brant, western snowy plover and marbled murrelet (NPS 2006). Marbled murrelets are regularly seen around Point Reyes Headland. The Point Reyes and Drakes Bay area is home to nine nesting seabirds, including approximately 70,000 breeding individuals (G. McChesney, pers. comm.).

Pescadero Marsh is another important location for seabirds and migratory waterfowl. Marbled murrelets breed in the Pescadero watershed and have been observed in various locations in this area, including Portola and Butano State Parks.

Other important breeding sites include numerous offshore rocks and pinnacles along the north central California coast. Some seabird species with colonies in the north central coast study region include common murre, pigeon guillemot, least tern (in San Francisco Bay, adjacent to the study region), black oystercatcher, pelagic cormorant, and Brandt's cormorant.

Sea bird colony locations in the north central coast study region are shown on Map [5a](#) based on data compiled by USFWS (Sowls et al 1980; Carter et al. 1992) and updated in the Phase II NOAA Biogeographic Assessment (2007).

Areas of high seabird diversity and density based on a synthesis of data compiled by the NOAA Biogeographic Assessment of the region (NOAA 2004) are shown on maps [5b](#) and [5c](#). The biogeographic assessment itself, along with associated maps, can be found at: http://www.ccma.nos.noaa.gov/products/biogeography/canms_cd/welcome.html. Further information on seabird abundance in the offshore area surrounding the Farallon Islands, compiled by PRBO Conservation Science can be found at: <http://data.prbo.org/cadc/sefimap/>.

Southern sea otters: Populations of the southern sea otter (*Enhydra lutris*) are concentrated mostly south of the north central coast study region, though sightings have occurred as far north as Point Reyes (Point Reyes Headlands, Double Point, Duxbury Reef) (NCCOS 2003) and even in the waters around the Farallon Islands (Steve Shimek pers. comm.). Once ranging from northern California to Japan to Punta Abreojos in Baja California Sur, including approximately 15,000 animals in California, southern sea otters are now mostly found from Purisima Pt in Santa Barbara County to Pt Año Nuevo in Santa Cruz County (USFWS 1995, 2003). The population of sea otters was drastically reduced during the 18th and 19th centuries due to commercial hunting and has been generally increasing from as few as 50 individuals in 1914. The sea otter population fluctuates from year to year and 3026 animals were counted in the 2007 statewide census (Hatfield 2007). The geographic range of the southern sea otter also fluctuates, and between 1995 and 1999 it expanded both to the north and to the south (USFWS 2003). In 2007 there was a significant increase in the number of otters sighted north of Pigeon Point (Hatfield 2007). Anecdotal accounts support this finding, and in recent years otters have been increasingly sighted within the north central coast study region, with up to 24 observations of independent (not with pups) otters per year in Point Reyes (Steve Shimek, the Otter Project, pers. comm.) as well as along the Sonoma Coast (Don Neubacker, pers. comm.).

Otters have been shown to be a keystone species, exerting strong top-down control on their prey species where they are present (Estes and Palmisano 1974, Estes and Duggins 1995). Their predation on sea urchins has been shown to limit urchin abundance, allowing for the growth of giant kelp forests and associated species (Estes and Palmisano 1974, Estes and Duggins 1995). A study conducted within the north central coast study region suggests that the absence of sea otters off the Sonoma coast has contributed to increased red abalone density and size. The study further indicates that recovery of sea otter populations in this area may

result in restoration of ecological biodiversity and function in benthic communities, but that the density and size of abalone populations may decrease (Fanshawe and VanBlaricom 2003).

Sea otters are listed as threatened under the federal endangered species act, depleted under the Marine Mammal Protection Act, and are considered a “fully protected species” by CDFG. Threats to otter populations include incidental drowning in gill and trammel nets, oil spills, toxic contaminants, other human impacts, and disease (Hanni et al 2003, Miller et al 2004, USFWS 2003).

Pinnipeds: Like sea otters, populations of pinnipeds were hunted to very low levels during the 19th century. California sea lion, northern elephant seal, northern fur seal, Guadalupe fur seal, and harbor seal populations are recovering, while Steller sea lion populations are federally listed as threatened. Six species of pinnipeds have either colonial rookeries or haulout sites in north central coastal California based on data collected and compiled by NOAA and the USFWS (Mark Lowry, pers. comm.; Lowry 2002; Lowry and Carretta 2003, USFWS 2002; S. Allen pers comm..) and summarized in maps [5d](#) and [5e](#). Little to no information on historical abundances was available for California sea lions and harbor seals, although some early estimates are included for the purposes of comparison with later systematic censuses. Major pinniped rookeries and haul out sites in the study region include (S. Allen, pers. comm.):

- The Farallon Islands
- Point Reyes
- Bolinas Lagoon
- Areas in Drakes Bay
- Bird Rock off Tomales Point
- Tomales Bay, Bodega Rock
- The Russian River Area
- Fish Rocks

Additional information on pinnipeds and cetaceans in the north central coast study region is currently being compiled in an updated NOAA Biogeographic Assessment – Phase II (to be released in 2007).

California sea lion: The range of the California sea lion (*Zalophus californianus*) extends from the Pacific coast of Baja California to southern British Columbia. These animals breed primarily in the southern part of their range from the Gulf of California to San Miguel Island. Commercial hunting in the 19th and early 20th centuries likely reduced California sea lion populations. In the late 1920s, only 1,000-1,500 California sea lions were counted on the shores of California. Since a general moratorium on hunting marine mammals was imposed with passage of the Marine Mammal Protection Act in 1972, the population has grown substantially to a current estimate of 237,000-244,000 animals. Between 1975 and 2001, the population grew at an average annual rate of 5.4%. California sea lions are opportunistic feeders on a variety of prey, especially seasonally abundant schooling species such as Pacific hake, northern anchovy, Pacific sardine, spiny dogfish, and squid. They tend to feed in cool upwelling waters of the continental shelf. In a recent study at Año Nuevo Island, sea lions were found to feed on

rockfishes, Pacific whiting, market squid, Pacific sardine, northern anchovy, spiny dogfish shark, and salmonids (Weise and Harvey 2005a). California Sea lions can be found in large numbers on and around Año Nuevo and the Farallon Islands where they have minor rookeries. California sea lions have haul out sites along the Point Reyes Headlands, at Bodega Rock, Fish Rocks, and Seal Rocks on the outer San Francisco coast, as well as locations in San Francisco inside the bay (NCCOS 2003, Karl et al 2001). Sea lions have been shown to prey on salmonids and other species causing economic loss to fishermen (Weiss & Harvey 2005b).

Steller sea lion: The Eastern distinct population segment of the Steller sea lion (*Eumatopias jubatus*), also known as the northern sea lion, extends from Cape Suckling Alaska to Central California, and is listed as threatened under the federal ESA. The north central coast study region is near the southern extent of the Steller sea lion, and haulouts can be found at Fish Rocks, Northwest Cape Rocks, Bodega Rock, Point Reyes Headland, and on the Farallon Islands (NCCOS 2003). The Farallon Islands host one of the southernmost breeding colonies of the Steller sea lion and females and juveniles can be found in the Gulf of the Farallones year-round (Karl et al 2001) (Año Nuevo, just south of the study region, is the southernmost rookery for Steller sea lions). Other breeding colonies can be found at Point Reyes and at Fort Ross (Allen pers. comm.). The diet of Steller sea lions is dominated by a variety of fish (especially demersal roundfish) and squid (Pauly et al 1998). In the waters around the Farallones, they feed mostly on rockfish, sardines, smelt, squid, octopus, and salmonid fish.

Northern elephant seal: Elephant seals (*Mirounga angustirostris*) haul out two times per year, during the breeding (December through March) season and during the molt (April through August). Most breeding sites are also molting haul out sites. Juvenile seals also haul out in high numbers at these traditional sites during the fall preceding the breeding season. The current breeding sites in this region include South Farallon Islands (Southeast Farallon Island and West End) and Point Reyes Headland (the whole length and overflowing onto Drakes Beach and the Great Beach) (Año Nuevo Islands and Point Año Nuevo, south of the study region, are also breeding colonies). This species does not occur in high numbers on the shelf waters of the Gulf of the Farallones. Instead, elephant seals feed off the continental shelf in deep waters and they also migrate to forage along the Kenai Peninsula in Alaska and to the north Pacific Gyre. Their diet is poorly understood but likely includes squid, hake, salmon, dogfish, hagfish and demersal fish (Don Neubacher, pers. comm.).

Harbor seal: Harbor seals (*Phoca vitulina*) are widely distributed in the coastal areas of the northern Pacific and northern Atlantic. Harbor seals in the eastern Pacific range from the Pribilof Islands in Alaska to Isla San Martin off Baja. Between the Mexican and Canadian borders, harbor seals have been managed as three separate stocks, of which one is the stock off California. After passage of the Marine Mammal Protection Act in 1972, harbor seal abundance grew rapidly until 1990, when stocks leveled off. There has been no net population growth in California since 1990 (Caretta et al. 2004). In 2002 the population was estimated at 27,863 animals. The north central coast region has the highest concentration of harbor seals in the state, outside of the southern Channel Islands. The highest concentrations occur at Point Reyes at several locations including Tomales Bay, Tomales Point, Drakes Estero-Estero de Limantour, Double Point and Bolinas Lagoon. Estuaries provide habitat for a large number of harbor seals and Drakes Estero is the largest colony in the region and one of the largest in the

state. Together these sites represent around 20% of the mainland population of harbor seals during the breeding season (Lowry et al. 2005). Harbor seals are also abundant in the southern portion of the study region and haul out at locations such as Fitzgerald Marine Reserve. The seals are year round residents at most of the haul out sites depicted on the maps (5d, 5e), but are seasonally abundant with the highest numbers of seals present during the breeding season (March-June) and the molt (June-July). Harbor seals eat a wide variety of pelagic and benthic prey, including small schooling fishes such as northern anchovy, many species of flatfishes, bivalves, and cephalopods (Antonelis and Fiscus 1980, Weise and Harvey 2001 and references therein). In the Russian River, harbor seals have been documented preying on lamprey (Hanson 1993). In a southern California study, harbor seals were found to mostly eat rockfish, octopus, spotted cusk-eel, and plain midshipman (Stewart and Yochem 1994). Diet studies of harbor seals in central California did not find evidence of predation on salmonids, though they are known to eat small salmonids in northern California (NMFS 1997).

Northern fur seal: The northern fur seal (*Callorhinus ursinus*) was once abundant along the California coast, but populations rapidly decreased during the early 1800's. Prior to 1997, northern fur seals had not been known to breed within the study region for over 170 years (NOAA 2006). Today, relatively dense aggregations of these fur seals (1 seal per km²) are found on the Farallon Islands, where they have two potential breeding harems and their numbers are growing. The colony on the Farallon Islands is only the second colony for this species south of Alaska. Fur seals feed on sablefish, rockfish, anchovies, squid, and crabs and (Karl et al 2001). In August of 2006, 166 seals, including 80 pups, were counted in the Farallon Islands census (an increase from 6 individuals in previous years) (PRBO 2006). Fur seals occur on the mainland in this region infrequently, and primarily during ENSO years.

Guadalupe fur seal: The only known breeding rookery of Guadalupe fur seals (*Arctocephalus townsendi*) is located on Guadalupe Island, off the coast of Mexico, though increasing numbers have been observed in the Channel Islands, off southern California and at the Farallon Islands off San Francisco (Marine Mammal Center 2001). Fur seals occur on the mainland in this region infrequently, and primarily during ENSO years.

Cetaceans: Few places in the world have the diversity and abundance of cetaceans that occur in the Gulf of the Farallones. More than 33 species have been documented in the region and more than a third occurs regularly. A few species likely calf in the region, but most species migrate through or forage in the region. Several species of whales can be seen in the Gulf of the Farallones, including around the Farallon Islands and Point Reyes Headland.

Around the Farallones, several species of cetacean have been observed year round, including Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Dall's porpoise (*Phocoenoides dalli*), Risso's dolphin (*Grampus griseus*) and right whale dolphin (*Lissodelphis borealis*) (Keiper et al. 2005). The Farallones annually support a small population (1-3 individuals) of resident grey whales throughout the spring and summer that are always found close to shore. Several species of federally endangered whales (blue, humpback, fin, sei, right, and sperm whales) have been found off the Farallon Islands where they feed on a variety of species including krill (primarily *Thysanoessa spinifera* and *Euphausia pacifica*), schooling fish (such as anchovy, sardines, and juvenile rockfish.), and occasionally pelagic red crabs during warm water

conditions. Pacific white-sided and common dolphins, harbor porpoises, Dall's porpoises and Risso's dolphins have also be found in Gulf of the Farallones waters as well, where they feed on schooling fish and squid (Karl et at 2001). Sperm whales in the study region feed on octopus and squid, including the Humboldt squid which has occurred more in recent years.

Gray whales migrate through and over summer at Point Reyes and around the Farallon Islands. They regularly forage in Drakes Bay and Tomales Bay as they migrate north in the spring. The entire California coast is part of the annual gray whale migration route and gray whales can be observed from shore. Point Reyes is an important point along this migration route (Allen pers. comm.).

Two cetacean species that likely occur year round in the mainland state waters are mink whale and harbor porpoise. Minke whale likely give birth in the region since dead calves have been documented washed ashore. Harbor porpoise also occur year round and calf in the Gulf of the Farallones and occurs mostly in nearshore waters less than 40 fm. These two species feed primarily on squid and small schooling fish such as anchovy, sardines, and smelt. Bottlenose dolphins are also relatively common in nearshore waters.

3.3 Areas of Biodiversity Significance

Spatial data are available to begin identifying specific locations in the study region that have high biodiversity significance based on the guidelines provided in the master plan framework (CDFG 2005a) and results of regional scientific research and mapping efforts. Specific locations can be identified using existing maps, by overlaying relevant data layers in the Internet Mapping Service site, or conducting more sophisticated GIS analysis. The following is a partial list of types of areas that have regional biodiversity significance:

- Areas where numerous habitats are found in close proximity and areas with unique combinations of habitats
- Large open estuaries (e.g. Tomales Bay, Drakes Estero, Estero de Limantour, and Bolinas Lagoon) with eelgrass beds, tidal flats, and coastal marsh (maps [2a](#), [2b](#), [2c](#), [2d](#), [2e](#), [2f](#))
- Stream outlets and estuaries with presence of coho, chinook, or steelhead populations (maps [6a-6b](#))
- Marine areas off headlands, especially those with kelp forests.
- Marine areas which offer retention adjacent to upwelling centers, especially those with kelp forests and rocky reefs.
- Large kelp beds (maps [2a](#), [2b](#), [2c](#), [2d](#), [2e](#), [2f](#)) and nearshore rocky reefs (maps [3a](#), [3b](#), [3c](#), [3d](#), [3e](#), [3f](#)).
- Areas of high bathymetric complexity which provide topographic relief and a variety of habitats in close proximity
- Rocky substrata in all depth zones, since rocky habitat is much less common than soft-bottom habitat and is important for depleted rockfish species (maps [3a](#), [3b](#), [3c](#), [3d](#), [3e](#), [3f](#))

- Rocky intertidal shores, especially wave-cut rocky platforms (which provide habitat at diverse tidal elevations), boulder fields, and rare sheltered rocky shores (maps [2a](#), [2b](#), [2c](#), [2d](#), [2e](#), [2f](#))
- Seabird colonies and marine mammal rookeries and haulouts (maps [5a](#), [5b](#), [5c](#), [5d](#), [5e](#))
- Areas of high fish or seabird diversity and/or density and abundance (maps [5a](#), [5b](#), [5c](#), [5d](#), [5e](#), [6a-6b](#), and [7a](#), [7b](#), [7c](#), [7d](#), [7e](#)).
- Offshore islands such as the Farallon Islands and associated waters

4.0 Land-Sea Interactions

Important land-sea interactions happen across variable time scales and wide geographic ranges. They vary significantly along the coastal region because they depend upon a unique combination of variables that include biotic and abiotic factors such as climate, geomorphology, human use, and ocean currents. 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 impacts the effectiveness of an MPA in meeting its objectives. The consequences of 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 non-point sources of pollution) (Stoms et al. 2005).

Many associations exist between watersheds and coastal waters. Watersheds bring freshwater and sediments to bays, estuaries, and the ocean, for example. Episodic and seasonal factors influence terrestrial input to marine environments. In the study region, nutrient loading from terrestrial sources can be significant at local scales especially during high flow periods which generally correspond to wind-relaxed oceanographic conditions (upwelling). Substantial net export from rivers and estuaries to the ocean usually occurs during the rainy season and primarily during storm events. Furthermore, since the California Current is such a nutrient-rich upwelling zone, the contributions of nutrients from land use are not considered significant relative to ocean-derived nutrients (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 north central coastal California:

- 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. harbor seal haulouts, sea bird rookeries, anadromous fish).
- Socioeconomic interactions between land and sea at the coastal margin (e.g. beach closures or seasonal bans that may affect ecotourism and management of environments) (Coastal Reserves Working Group, 2005).

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 these watershed-coastal water linkages and land-sea interactions may help MPA managers prevent future degradation of MPA areas. For example, today the degradation of watersheds and freshwater ecosystems and the presence of barriers to fish passage have contributed to the decline of many native anadromous fish stocks throughout California, which are now in danger of extinction. Impacts on coastal watersheds (i.e. a stream or estuary) have

repercussions for the entire coastal ecosystem. Estuaries and bays are particularly vulnerable to coastal 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/associations

Watersheds and coastal waters have many complex ecological linkages/associations. Watersheds carry freshwater, nutrients, and sediments to bays, estuaries, and the ocean. San Francisco Bay, for instance, is a major source of nutrients for the Gulf of the Farallones during most winters and adds stability to nutrient supplies in coastal waters over a range of climatic variability events such as El Niño and La Niña (Wilkerson et al 2002). Throughout the study region many short streams flow into small estuaries in which mixing and dilution occur within a short distance of river mouths. Many of the estuaries, embayments, coastal lagoons, and remaining wetlands have high importance relative to their size and the number of resident and migrating species (Coastal Reserves Working Group, 2005). Studies have shown that some species, including flatfish, rely on intricate associations between estuarine and coastal environments during different life stages (Brown 2006). There are quite a few bays and estuaries along the north central coast study region (see section 3.1.3) and they support thousands of birds during migration; numerous marine species use embayments, and estuaries as spawning and nursery grounds.

Some examples of critical ecological associations along the north central coast study region are described below for selected marine species (based on Airamé et. al., 2003).

- **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. Some species, including Pacific herring, spawn in eelgrass beds, among other habitats. The structure of eelgrass beds provides protection from predation for juvenile invertebrates and fishes. Bat rays, leopard and smoothhound sharks, plainfin midshipman, Pacific herring, starry flounder, 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 central coast study region once supported large numbers of steelhead trout, Coho and Chinook salmon, and sturgeon. However, due to degradation of watersheds and freshwater ecosystems and the presence of barriers to fish passage, many native anadromous fish stocks throughout California are currently threatened or endangered.
- **Catadromous fish** live in fresh water, but travel to marine environments to breed. These species include eels and lampreys. In the north central coast study region, lampreys migrate into both Tomales Bay and the Russian River.

- **Shorebirds and waterfowl**, such as black rail, saltmarsh common yellowthroat, and saltmarsh song sparrow, inhabit coastal lagoons, estuaries, and salt marshes. 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 and bays 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, 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**, such as macroalgal mats, composed primarily of *Nereocystis*, *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 managers better design MPAs for resource protection and recreation and other uses, as well as examine and reduce negative impacts caused by agriculture, forestry, urbanization, and boating, to name a few (see 4.4.2, “Nonpoint Sources”).

4.2 Coastal Watersheds and Land Use in Study Region

The MLPA North Central Coast Study Region extends for over 367.6 miles along the Californian coast, includes 763.5 square miles of ocean, and drains nearly 4,200 square miles from 6 major watersheds. The north central coast study region also receives runoff from an additional 59,000 square miles (40% of California’s total land area) from the San Francisco Bay drainage as it flows into the study region beneath the Golden Gate Bridge (Nichols et al 1986). The largest coastal watersheds of the region include the Big-Navarro-Garcia and Russian subbasins (Table 7). San Francisco Bay, which is not included in the study region, drains much of the interior of the state and the tidal plume under the Golden Gate Bridge is a very significant input into the study region.

Table 7: Major Watersheds in the Study Region

Hydrologic Unit Name	Area (hectares)	Area (square miles)
Mendocino Coast	414,046	1,598
Russian River	384,437	1,484
Bodega	38,235	147
Marin Coastal	88,557	341
San Mateo	66,566	257
Big Basin	95,175	367
COASTAL TOTAL	1,087,020	4,197

Hydrologic Unit Name	Area (hectares)	Area (square miles)
San Francisco Bay Drainage	15,300,000	59,074
TOTAL	16,387,020	63,271

Land use adjacent to the study region includes agriculture, timberlands, urban and rural developments, industrial uses, and parks and open space. Maps [8a-8c](#) show the coastal basins that touch the shoreline classified by the percentage of urban area, percentage of agriculture, and road density (linear kilometer of road/hectares) (see 4.4.2, “Nonpoint Sources”).

4.3 Coastal Water Quality

Coastal water quality information is important in MPA planning to ensure that any potential threats to marine resources from poor water quality in MPAs can be identified and addressed through MPA siting or coordination with agencies with jurisdiction over water quality. *The Water Quality Control Plan for Ocean Waters of California* (California Ocean Plan), prepared by the State Water Resources Control Board (SWRCB), has been in effect since 1972 and is regularly updated. This plan outlines all of the requirements and implementation measures for management of waste discharge to the ocean (<http://www.swrcb.ca.gov/plnspols/oplans/docs/bactffed.pdf>).

Two regulatory bodies share jurisdiction over the north central coast study region, along with the SWRCB, under the California Ocean Plan, which establishes water quality standards for ocean waters. The North Coast Regional Water Quality Control Board (RWQCB) manages Region 1, which is constituted by the North Coastal Basin and the Klamath River Basin. The north central coast study region includes the portion of the North Coastal Basin that touches the Pacific Ocean in the area between the mouth of Tomales Bay (Marin county) and Point Arena (Mendocino County). The San Francisco Bay RWQCB manages Region 2, which includes the San Francisco Bay drainage basin and all or most of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties. The north central coast study region does not include San Francisco bay, so only the portions of Marin, San Francisco, and San Mateo Counties that are adjacent to the Pacific Ocean will be considered in this regional profile.

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 statewide monitoring programs, such as the State Mussel Watch Program and Toxic Substances Monitoring Program, as well as regional surveillance and monitoring programs and models, such as the Water Quality Model for the

Russian River. The basin plan for Region 1 can be viewed online at:

<http://www.waterboards.ca.gov/northcoast/programs/basinplan/basin.html>.

The basin plan for Region 2 can be viewed online at:

<http://www.waterboards.ca.gov/sanfranciscobay/basinplan.htm>.

The State Water Resources Control Board establishes “areas of special biological significance” (ASBSs) through the California Ocean Plan. Individuals may nominate areas for designation as an ASBS and criteria for nomination include areas that are “intrinsically valuable or have recognized value to man for scientific study, commercial use, recreational use, or esthetic reasons.” Areas proposed for ASBS designation should have the potential to benefit from protection beyond that offered by standard waste discharge restrictions and other measures. These ASBSs are a subset of state water quality protection areas (SWQPAs) that 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 types of managed areas described in the Marine Managed Areas Improvement Act and within SWQPAs waste discharges are prohibited or limited.

There are 10 SWQPAs in the north central coast study region (Table 8). The majority of the SWQPAs in the study region are located downstream from rural watersheds, though some, notably the James V. Fitzgerald ASBS, are located downstream from urban water sheds.

Table 8: SWQPAs in the North Central Coast Study Region

SWQPA Name	Area (sq mi)	SWQPA ID Number
Saunders Reef	0.97	5
Del Mar Landing	0.12	2
Grestle Cove	<0.01	3
Bodega	0.31	4
Bird Rock	0.11	14
Point Reyes Headlands	2.12	12
Double Point	0.13	13
Duxbury Reef	2.54	11
Farallon Islands	17.60	10
James V Fitzgerald	1.57	9

Source: State Water Resources Control Board, 2006

The 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 non-point source pollution (NPSP) to marine areas with recognized high resource value” (CCA website http://www.coastal.ca.gov/nps/Web/cca_textfind.htm). Seventeen areas in the study region have been designated as critical coastal areas (Table 9). This list of CCAs includes “impaired water bodies” identified in the section 303(d) list (see section 4.3.1 below), as well as marine managed areas, wildlife refuges, waterfront parks, and beaches and ASBSs.

Table 9: Critical Coastal Areas in the Study Region

Critical Coastal Area Name	CCA ID Number
Saunders Reef	16
Del Mar Landing	17
Gerstle Cove	18
Bodega	19
Estero Americano	20
Estero de San Antonio	21
Walker Creek	22
Tomales Bay	23
Lagunitas Creek	24
Bird Rock	25
Point Reyes Headlands	26
Double Point	27
Duxbury Reef	28
James V Fitzgerald	29
San Gregorio Creek	30
Pescadero Creek	31
Butano Creek	32

Offshore areas of the north central coast study region have several documented water quality problems. Dredge disposal sites, sunken vessels (including the SS Jacob Luckenbach, the Tanker Vessel Puerto Rican, and the USS Independence), and radioactive waste dump sites exist in federal waters off the Farallon Islands (outside of the study region), which may affect local water quality (NOAA 2006). In addition, San Francisco Bay, though not included in the north central coast study region, drains into the study region under the Golden Gate Bridge and has water and sediment quality issues (SWRCB 2006). A broad area adjacent to the Golden Gate Bridge may therefore experience degraded water and sediment quality resulting from its close proximity to San Francisco Bay and the export of broad range of contaminants found in the bay. Also, some localized nearshore coastal areas, harbors, lagoons, estuaries, and tributaries face a number of problems, including elevated levels of nitrates, sedimentation/siltation, pesticides and other persistent organic pollutants, metals, pathogens, detergents, and oils. These contaminants can result in a variety of biological impacts, including bioaccumulation, reduced recruitment of anadromous species (those, like salmon, that migrate from salt water to spawn in fresh water), mortality due to toxicity, pathogen contamination, and interference with recreational uses of coastal areas. These adverse water quality impacts can impair designated beneficial uses.

4.3.1 Impaired Water Bodies in the North Central 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 to resolve the problems associated with the listed water bodies. Typically, a total maximum daily load (TMDL) is

developed for such impaired waters. 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 (US EPA, 2007). An implicit or explicit margin of safety is also factored into this analysis. The TMDL then allocates the allowable loading to all point and non-point sources to the water body and establishes an implementation plan to ensure that the allocations and water quality standards are achieved.

Based on data from 2006, a number of water bodies in the north central coast study region are designated as impaired (maps [9a](#) and [9b](#)). Some of the water bodies in the north central coast for which TMDL's have been established are described below.

The Garcia River flows into the Pacific Ocean just north of Point Arena, in the northern part of the study region, and has a TMDL listing for temperature and sediment. While the source for sediment impairment is unknown, temperature impairment stems from unspecified non-point sources and habitat modification, including removal of riparian vegetation and streambank modification/destabilization. Timber production is a major land use in the Garcia River basin and contributes to high erosion rates when combined with the natural erodability of the landscape. Increased sediment loads can contribute to increased temperatures, which may be detrimental to Coho salmon and steelhead trout populations.

The Gualala River, located 114 miles north of San Francisco and south of the Garcia River, is listed as a TMDL site for temperature and sedimentation and siltation. High erosion rates in the 300 square mile area that drains into the Gualala River have contributed to high levels of sediment, which has degraded the habitat for Coho salmon and steelhead trout. A number of factors contribute to the sedimentation/siltation impairment, including highway/road/bridge construction, land development, and erosion from habitat modification. Specialty crop production is another source of sedimentation/siltation impairment. Silviculture also plays a role, with creation of logging roads and harvesting activities. Timber production, in addition to grazing and rural development, is the most common land use in the Gualala drainage basin, and may have increased effects when superimposed upon unstable geology and high precipitation in the drainage basin, which accounts for high natural erosion (USEPA 2000). Temperature impairment in the Gualala river stems chiefly from habitat modification, which includes channel erosion, removal of riparian vegetation, and streambank modification/destabilization.

Tomales Bay, 30 miles northwest of San Francisco, is listed as a TMDL due to the presence of harmful pathogens as well as mercury, nutrients, and sedimentation/siltation. Tributaries to the bay, including Walker, Lagunitas, and Olema creeks, have similar issues. The bay, which covers an area of 11 square miles, is considered impaired by pathogens present in human and animal waste. Such pathogens pose a threat to recreational users, shellfish consumers, and the bay's aquatic ecosystem. Potential sources for these pathogens include: on-site sewage disposal systems, small wastewater treatment facilities and sewage holding ponds, boat discharges, grazing lands, dairies, equestrian facilities, and municipal runoff (Ghodrati and Tuden 2005). Mercury impairment in the bay and tributaries stems from mine tailings, while

agriculture contributes toward nutrient and sedimentation impairment. Hydromodification, in the form of upstream impoundment, is an additional source of sedimentation.

Tables 10 and 11 show impaired water bodies in regions 1 and 2 that fall within, or drain into the study region. Other information provided includes: pollutants/stressors, general source of impairment, and the status of TMDL's for each location.

More information on these water bodies, including GIS data and more detailed information on pollutants, sources, and TMDL's, is available at http://www.swrcb.ca.gov/tmdl/303d_lists2006approved.html.

Table 10: Impaired Water Bodies in Region 1 (Regional Water Quality Control Board)

Name	Pollutant/Stressor	Source	TMDL Status
Garcia River	Temperature, sediment	Habitat modification, non-point source, unknown (sediment)	TMDL Required (Temperature), Being addressed by USEPA TMDL (sediment)
Gualala River	Temperature, Sedimentation/Siltation	Habitat modification, non-point source, construction/development, silviculture, agriculture	TMDL Required (Temperature), Being addressed by USEPA TMDL (sediment)
Ukiah HSA (Upper Russian River HA)	Sedimentation/Siltation, Temperature	Agriculture, habitat modification, construction/development, urban runoff, natural sources (sediment), resource extraction (sediment), silviculture, hydromodification, non-point source	TMDL Required
Forsythe Creek (Upper Russian River HA)	Sedimentation/Siltation, Temperature	Habitat modification, non-point source, hydromodification	TMDL Required
Coyote Valley HSA (Upper Russian River HA)	Sedimentation/Siltation, Temperature	Agriculture, hydromodification, habitat modification, construction/development, silviculture, non-point source	TMDL Required
Lake Mendocino (Upper Russian River HA)	Mercury	Resource extraction, non-point source	TMDL Required
Warm Springs HSA (Middle Russian River HA)	Temperature, sedimentation/siltation	Hydromodification, habitat modification, construction/development, silviculture, non-point source, agriculture	TMDL Required

Name	Pollutant/Stressor	Source	TMDL Status
Santa Rosa Creek (Middle Russian River HA)	Pathogens, Sedimentation/Siltation, Temperature	Non-point sources, point sources (pathogens), agriculture, hydromodification, habitat modification, construction/development, natural sources (sediment), urban runoff	TMDL Required
Mark West Creek (Middle Russian River HA)	Sedimentation/Siltation, Temperature	Agriculture, habitat modification, construction/development, silviculture, urban runoff, hydromodification, non-point source	TMDL Required
Geyserville HSA (Middle Russian River HA)	Sedimentation/Siltation, Temperature	Habitat modification, agriculture, hydromodification, construction/development, silviculture, urban runoff, non-point source	TMDL Required
Big Sulphur Creek (Middle Russian River HA)	Sedimentation/Siltation, Temperature, specific conductivity	Habitat modification, construction/development, non-point source, unknown (specific conductivity),	TMDL Required
Laguna de Santa Rosa (Middle Russian River HA)	Low Dissolved Oxygen, Mercury, Nitrogen, Phosphorus, Sedimentation/Siltation, Temperature	Natural sources, non-point sources, point sources, unknown (mercury), habitat modification, hydromodification, construction/development, erosion from derelict land, urban runoff,	TMDL Required
Lake Sonoma (Middle Russian River HSA)	Mercury	Resource extraction, non- point source	TMDL Required
Guerneville HSA (Lower Russian River HA)	Pathogens, Sedimentation/Siltation, Temperature, pathogens, pH	Unknown (pH), Unknown non-point/point source (pathogens), agriculture, habitat modification, hydromodification, construction/development, silviculture, non-point source	TMDL Required
Austin Creek (Lower Russian River HA)	Sedimentation/Siltation, Temperature	Habitat modification, construction/development, hydromodification, silviculture, non-point source	TMDL Required
Salmon Creek Park (south)	Indicator Bacteria	Unknown	TMDL Required

Name	Pollutant/Stressor	Source	TMDL Status
Campbell Cove	Indicator Bacteria	Unknown	TMDL Required
Bodega Harbor HA	Exotic Species	Unknown	TMDL Required
Doran Regional Park	Indicator Bacteria	Unknown	TMDL Required
Estero Americano	Nutrients, Sedimentation/Siltation	Agriculture (grazing), habitat modification, hydromodification, non-point source	TMDL Required
Americano Creek	Nutrients	Agriculture (intensive animal feeding operations, dairies)	TMDL Required
Stemple Creek/Estero de San Antonio	Sediment	Agriculture, habitat modification, construction/development	Being addressed by USEPA TMDL

HU: Hydrologic Unit; HA: Hydrologic Area; HAS: Hydrologic Sub-Area
Source: State Water Resources Control Board, 2006.

Table 11: Impaired Water Bodies in Region 2 (Regional Water Quality Control Board)

Name	Pollutant/Stressor	Source	TMDL Status
Walker Creek	Mercury, Nutrients, Pathogens Sedimentation/Siltation	Mine tailings/surface mining (mercury), agriculture, unknown (pathogens)	Being addressed by USEPA TMDL (pathogens), TMDL required (others)
Lagunitas Creek	Nutrients, Pathogens, Sedimentation/Siltation	Agriculture, urban runoff	Being addressed by USEPA TMDL (pathogens), TMDL required (others)
Olema Creek	Pathogens	Unknown	Being addressed by USEPA TMDL
Tomales Bay	Mercury, Nutrients, Pathogens, Sedimentation/Siltation	Mine tailings (mercury), agriculture, intensive animal feeding operations (pathogens) septage disposal (pathogens), hydro-modification	Being addressed by USEPA TMDL (pathogens), TMDL required (others)
Lawson's Landing (Tomales Bay)	Indicator Bacteria	Unknown	TMDL Required
Chicken Ranch Beach (Tomales Bay)	Indicator Bacteria	Unknown	TMDL Required
Millerton Point (Tomales Bay)	Indicator Bacteria	Unknown	TMDL Required
Golden Hinde Beach (Tomales Bay)	Indicator Bacteria	Unknown	TMDL Required
Hearts Desire Beach (Tomales Bay)	Indicator Bacteria	Unknown	TMDL Required
Bolinas Beach	Indicator Bacteria	Unknown	TMDL Required

Name	Pollutant/Stressor	Source	TMDL Status
Muir Beach	Indicator Bacteria	Unknown	TMDL Required
Baker Beach	Indicator Bacteria	Unknown	TMDL Required
Lake Merced	Low Dissolved Oxygen, pH	Unknown	TMDL Required
Rockaway Beach	Coliform Bacteria	Urban runoff, non-point source	TMDL Required
Pacifica State/Linda Mar Beach	Coliform Bacteria	Urban runoff, non-point source	TMDL Required
San Pedro Creek	Coliform Bacteria	Urban runoff, non-point source	TMDL Required
Fitzgerald Marine Reserve	Coliform Bacteria	Nonpoint source	TMDL Required
San Vicente Creek	Coliform Bacteria	Nonpoint source	TMDL Required
Pillar Point	Mercury	Unknown	TMDL Required
Pillar Point Beach	Coliform Bacteria	Nonpoint source	TMDL Required
Venice Beach	Coliform Bacteria	Nonpoint source	TMDL Required
San Gregorio Creek	Coliform Bacteria, Sedimentation/Siltation	Nonpoint source	TMDL Required
Pomponio Creek	Coliform Bacteria	Nonpoint source	TMDL Required
Pescadero Creek	Sedimentation/Siltation	Nonpoint source	TMDL Required
Butano Creek	Sedimentation/Siltation	Nonpoint source	TMDL Required

Source: State Water Resources Control Board, 2002.

4.3.2 Beach Closures, Postings, and Rain Advisories

Beach closures, postings, and rain advisories are direct indicators of the negative impacts to beneficial uses at beaches. The State of California has mandated beach water monitoring, which began in 1999. Weekly monitoring is required between April and October for beaches with more than 50,000 visitors annually or located adjacent to storm drains flowing during the summer. The waters are tested for coliform, fecal coliform, and enterococcus bacteria. Beach closings are generally triggered in three ways: by the presence of bacteria, discharge of untreated sewage, and excessive rainfall.

Table 12 lists the number of closure days for each year from 2002-2005 by county within the study region. This table also lists the number of incidences when beaches were closed for an extended period of time (7-13 consecutive weeks). Table 13 lists all beach closures in the study region in 2005. Many beaches in California are long, and closings are sometimes targeted for a certain section of the beach. Therefore, some beaches may have more than one closing at the same time. Multiple closures at the same beach have been aggregated in this list (for more information about these data, see <http://www.nrdc.org/water/oceans/tw/sumcal.pdf>). The north central coast study region generally has had far fewer beach closures in comparison to the rest of California, though the overall number of closures has increased in recent years.

Table 12: Beach Closings, Postings, and Rain Advisories by County: Year-to-Year Comparison

County	2005			2004			2003			2002		
	Days	X	P	Days	X	P	Days	X	P	Days	X	P
Marin	363	2	0	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mendocino	0	0	0	0	0	0	20	0	0	0	0	0
San Francisco	107	0	0	162	0	0	120	0	0	89	0	0
San Mateo	77	1	1	73	1	0	167	0	1	135	1	0
Sonoma	8	0	2	24	0	0	52	1	0	29	0	0
Study Region Counties Total	555	3	3	259	1	0	359	1	1	253	1	0
California Total	5,175	13	7	3,985	12	7	5,384	9	31	4,553	10	32

Source: NRDC 2006.

Days: Number of closure days within county

X: Extended closing/advisory events lasting 7 to 13 consecutive weeks.

P: Permanent closing/advisory events lasting more than 13 consecutive weeks.

ND: No data.

Table 13: Beach Closures in 2005 in the Study Region by County

County	Beach	Cause	2005 Closures
Sonoma	Campbell Cove State Beach	Bacteria	2
Sonoma	Salmon Creek State Park Beach	Bacteria	3
Marin	Heart's Desire	Bacteria	1
Marin	Lawson's Landing	Bacteria	2
Marin	Miller Point	Bacteria	3
Marin	Chicken Ranch Beach	Bacteria	4
Marin	Millerton Point	Bacteria	1
Marin	Shell Beach	Bacteria	2
Marin	Bolinas Beach	Bacteria	4
Marin	Stinson Beach	Bacteria	3
Marin	Muir Beach	Bacteria	5
Marin	Rodeo Beach	Bacteria	1
Marin	Golden Hinde	Bacteria	2
San Francisco	Baker Beach	Preempt-rain/sew, Bacteria	18
San Francisco	China Beach	Preempt-rain	3
San Francisco	Fort Funston	Preempt-rain	3
San Francisco	Ocean Beach	Preempt-rain, Bacteria	15
San Mateo	Dunes State Beach	Bacteria	1
San Mateo	Fitzgerald Marine Reserve (Moss Beach)	Bacteria	1

County	Beach	Cause	2005 Closures
San Mateo	Roosevelt State Beach	Bacteria	1
San Mateo	Venice State Beach	Bacteria	3

Source: NRDC 2006

4.4 Effects of Land Use on Coastal Waters

Consideration of ecological interactions between the land and the sea should be considered in MPA site selection. Modification of natural watershed land cover and ecological processes can significantly affect downstream rivers and coastal waters. A variety of land use practices in watershed areas results in degraded quality of receiving waters. Maps [8a-8c](#) show the “human footprint” in coastal watersheds in the region as described by percent of land cover in agriculture and urban areas and road density. Generally, pollution caused by such practices is not concentrated at any one point, but is diffuse in nature. This type of pollution, therefore, is called nonpoint source pollution (NPSP). Additionally, there are spatially specific discharges of pollutants associated with industrial sources or wastewater treatment; such sources are called point sources. In order to understand how human activities in watersheds can effect the quality of receiving waters in the north central coast study region, it is useful to begin with a consideration of how local geology plays a role in watershed processes. Further spatial data on land cover (impervious surfaces and tree canopy) in the study region can be accessed in data layers available on the Internet Map Service site (www.marinemap.org/mlpa).

4.4.1 Impacts of Local Geology on Water Quality

The north central coast study region is a diverse and geologically active part of the California coastline. Situated between the North American and Pacific plates along the San Andreas fault system, this coast is dominated by sedimentary rocks of the Franciscan complex, Great Valley Complex, and Salinian terrane. The unstable nature of many coastal cliffs has led to high rates of erosion (with average long term rates of approximately 10-30 cm/year) and some large scale landslides (Griggs and Patsch, 2004). In the spring of 2006, the unstable nature of tall, coastal cliffs was evidenced at Devil’s Slide, south of Pacifica, when landslides resulted in several months of road closure.

Natural landslides and erosional processes provides sediment needed for coastal processes, as well as nutrients such as iron that are often limited in near-shore waters; however, increased sediment delivery results in disruption of biological communities due to the smothering of marine habitats and increasing turbidity of the nearshore water column (MBNMS, 2003). Excess stream turbidity can also be detrimental to salmonoids.

4.4.2 Nonpoint Sources

Superimposed onto this highly erodible geological landscape are the many human land use activities that can result in non-point source pollution (NPSP). Runoff from NPSP sources is the primary cause of impairment for more than 76 percent of the water bodies where TMDLs are required in California (SWRCB, 2005). Five sources of NPSP in the north central coast study

region include: agriculture, forestry operations, urban areas, boating and shipping, and hydromodification.

Agriculture

The NPSP typically associated with agriculture include nutrients, animal waste, sediments, and pesticides that enter receiving waters by direct runoff to surface waters or seepage into ground water. Sediment, pesticides, and excess nutrients all effect aquatic habitats by causing eutrophication, turbidity, temperature increases, toxicity, and decreased oxygen (SWRCB 2005b). Major agricultural activities in the study region include confined animal facilities, grazing, vineyards, orchards, and cultivation of various other crops. Confined animal feeding operations, including dairy producers and ranchers, are significant sources of NPSP in the study region and are regulated by State and Regional water boards through point source and non point source programs (RWQCB-North Coast Region 2005, RWQCB-San Francisco Bay 2002). The watershed that drains into Tomales Bay is a one example of this kind of pollution, as livestock grazing and dairy farming are two of the largest land uses in the watershed, and significant numbers of beef, sheep, and dairy farms have existed in the area since the mid-1800s (Ghodrati and Tuden 2005). These agricultural land uses have had significant effects on water quality in Tomales Bay, which has TMDL listings for pathogens as well as for nutrients and sediment. Such NPSP poses a threat to both humans and aquatic ecosystems.

Forestry operations

The primary concern for forestry operations is that they tend to cause erosion, thus increasing sediment concentrations in receiving waters. Other impacts of forestry operations 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 2005b). Forestry operations occur mostly in the northern portion of the study region, in the form of commercial logging and timberland use conversions (RWQCB-North Coast Region 2005). In this area, 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 in the northern portion of the study region may have detrimental effects on Coho salmon and steelhead trout populations. Many of the coastal streams in the northern part of the study region are impaired by sediment or temperature.

Urban Areas

The largest city in the study region is San Francisco: the 13th most populous American city according to the 2000 US Census. Some of the pollutants found in runoff from San Francisco, as well as other cities, include polychlorinated biphenyls, polyaromatic hydrocarbons, registered pesticides (e.g., diazinon and chlorpyrifos), mercury, copper, nickel, and other heavy metals, pathogenic bacteria, viruses, sediment, nutrients, trash, and plastics (San Francisco Estuary Institute 2006, SWRCB 2005b). Almost 90 percent of floating marine debris is plastic. Due to its durability, buoyancy, and ability to absorb and concentrate toxins present in the ocean,

plastic is especially harmful to marine life (California Coastal Commission, 2007). Pollution from San Francisco Bay, which flows to the study region under the Golden Gate Bridge, potentially impacts the nearshore environment. Generally, this flow increases during winter months due to increased precipitation (Largier, J.L., 1996, Wilkerson et al 2002) and during the spring due to snow melt. Surface currents tend to carry these materials southeastward and slightly offshore. Though contaminants in the San Francisco Bay plume have not been explicitly tracked, sediments derived from the Sacramento-San Joaquin watersheds have been identified in a narrow strip north of the Golden Gate Bridge and in a much broader area, extending to the edge of the continental shelf, south of the Golden Gate (Karl et al 2001). Smaller municipalities, as well as road construction, throughout the study region also generate urban NPSP.

Boating and Shipping

The port of San Francisco is heavily visited by cruise ships and commercial vessels, which can have significant impacts on the marine environment. For example, In May of 2006, 23 cruise ships visited San Francisco, carrying over 60,000 passengers. Approximately 175,000 cruise ship passengers visit the city each year (Armstrong 2005, SFGOV 2006). This huge number of passengers, as well as the ships themselves, generate large amounts of pollution that can have adverse effects on the marine environment including sewage, gray water, oily bilge water, ballast water, hazardous wastes, and solid wastes (MBNMS 2005).

Commercial vessels are another potentially significant source of pollution. The Monterey Bay National Marine Sanctuary reports approximately 4,000 large vessel transits through the sanctuary per year, with approximately 20% of these transits being crude oil tankers. The majority of the rest of the transits are large commercial vessels, such as container ships and bulk product carriers. The large commercial vessels are of particular concern in the north central coast study region, as they travel within 2 miles of shore and carry up to 1 million gallons of bunker fuel, which is similar to crude oil.

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 is significant (MBNMS 2005). For instance, the 1984 sinking of the tanker vessel Puerto Rican off the Farallon Islands released 1.47 million gallons of oil which killed over 2,874 birds and had detrimental effects on elephant seals and northern fur seals and the larvae of Dungeness crab, rockfish, shrimp, and krill. The stern portion of this vessel sank with 365,500 gallons of bunker fuel, which has continued to discharge into the Gulf of the Farallones (GFNMS T/V Puerto Rican Factsheet).

Ballast water from commercial vessels, as well as from cruise ships, is an additional concern as it is a potential source of invasive species which can have adverse affects on the marine environment. San Francisco Bay, for instance, is considered one of the most invaded aquatic ecosystems in the world with over 255 introduced species (NOAA 2006). Ballast water is regulated by the California State Lands Commission.

Smaller ports in the study region may pose additional NPSP problems. Poorly flushed waterways, physical alteration of wetlands and benthic communities, and pollutants discharged from boat maintenance activities are some of the issues of concern in marinas, which are

located near the water's edge and therefore not buffered or filtered by natural processes (SWRCB 2005b).

Hydromodification

Hydromodification includes the alteration of stream and river channels, installation of dams and water impoundments, and streambank and shoreline erosion. Such activities can reduce the quality of aquatic habitats by altering temperature and sediment transport (SWRCB 2005b). Large-scale hydromodification is not a major issue in the north central coast study region, though regional water boards throughout the study region address this issue through NPSP programs where appropriate (RWQCB- North Coast Region 2005, RWQCB- San Francisco Bay 2002). Some state and national organizations are engaged in restoration efforts in the study region. For instance, Point Reyes National Seashore has initiated a restoration project for the Drakes Bay watershed which includes removal of dams to water and fish passage on the streams that flow into Drakes Estero and Estero de Limantour. Point Reyes National Seashore has also initiated restoration of 562 acres of wetlands in Tomales Bay which are currently pasture land, surrounded by levees.

4.4.3 Point Sources

There are also specific locations (point sources) where pollution enters coastal waters. Approximately 20 municipal wastewater treatment facilities are located in the north central coast study region and at least four discharge directly into the ocean (Table 14). The largest of these four treatment facilities is the San Francisco Oceanside Wastewater Treatment Facility which is one of the biggest dischargers of wastewater in the state, with an average dry flow of 17 million gallons per day and a maximum flow of 65 million gallons per day (Dominic Gregorio, SWRCB, pers. comm., www.sfwater.org). Many more treatment facilities discharge into San Francisco Bay, which enters the study region by flowing under the San Francisco Bridge. This includes the San Francisco Southeast Treatment Plant, which has an average dry flow of 67 million gallons per day and a maximum flow of 250 million gallons per day (www.sfwater.org). In the northern portion of the study region, on-site waste treatment and disposal systems are increasingly becoming permanent alternatives to centralized sewage systems. These on-site facilities have significant potential to cause water pollution, health hazards, and nuisance if not properly sited, designed, constructed, and maintained. As a result, the North Coast RWQCB has drafted specific polices with regard to such facilities (North Coast RWQCB Basin Plan). In addition, some water districts in the study region have switched from using chlorine to chloramine for treating tap water, which may have effects on aquatic life.

In addition to municipal wastewater treatment and disposal systems, other kinds of permitted pollution discharge points exist in the region; these point sources are also shown in Table 14.

Table 14: Point Sources in the MLPA North Central Coast Study Region

Point Source	Effluent	Pollution Rating
Municipal Wastewater Treatment Facilities		
Mendocino County Waste Water Disposal, Anchor Bay	Treated sanitary wastewater	minor
San Francisco City and County Oceanside Waste Water Treatment Plant	Treated sanitary wastewater	major
North San Mateo Waste Water Treatment Plant	Treated sanitary wastewater	major
Mid-Coastside Waste Water Treatment Plant	Treated sanitary wastewater	major
Other Permitted Pollution Discharge Points		
Bodega Bay Fish Farm	Aquaculture wastewater	minor
University of California, Bodega Marine Laboratory	Marine lab waste seawater	minor

Source: CDFG GIS data, Dominic Gregorio, SWRCB, pers. com.

Another kind of point source within the study region includes wet weather outfalls, which are a source of untreated storm water. These exist throughout the study region, and include Mile Rock (Lands End) in the Presidio of San Francisco and several outfall structures on Ocean Beach, San Francisco.

4.5 Some Water Quality Projects in the North Central Coast Study Region

The master plan framework (CDFG 2005a) recognizes the importance of maintaining water quality and integrity of habitat along the California coastline. Many different water quality and watershed management programs exist throughout the study region. While not all of these programs will have a significant effect on regional implementation of the MLPA and designation of MPAs, they are nonetheless important for understanding how different efforts can be integrated and coordinated between MPA managers and other agencies and programs.

4.5.1 Water Quality Monitoring Programs

The following are some water quality and monitoring programs that take place or have taken place throughout the north central coast study region:

- The [MBNMS Water Quality Protection Program](http://montereybay.noaa.gov/resourcepro/urban.html) is a partnership of 25 federal, state and local agencies, public and private groups dedicated to protecting and enhancing water quality in the Monterey Bay National Marine Sanctuary and its watersheds. Using a collaborative approach involving key stakeholders in each issue, four detailed plans—urban runoff, marinas and boating, regional monitoring, and agriculture and rural lands—an ecosystem-based water quality management process (<http://montereybay.noaa.gov/resourcepro/urban.html>).

- The GFNMS is working with nine other agencies on addressing water quality impacts from vessels in Tomales Bay. The GFNMS also monitors the coast for oil pollution and assists in taking at sea samples to detect harmful algal blooms.
- The State Water Resources Control Board, via the regional water quality control boards, is managing a number of U.S. Environmental Protection Agency (USEPA)-funded projects in the north central coast study region which address a wide range of watershed water quality issues. These projects include studies of various toxins and non-point pollution sources as well as analyses of sediment and gravel sources in creeks and rivers. Information on these projects can be found at http://www.epa.gov/Region9/water/projects/reg_1.html and http://www.epa.gov/Region9/water/projects/reg_2.html.
- The California Coastal Commission addresses water quality through programs including its Water Quality Unit, Local Coastal Programs, Interagency Coordination Committee, Model Urban Runoff Program, Contaminated Sediments Task Force, Snapshot Day, and First Flush programs (NOAA 2006). In addition, various county health departments monitor for bacteria and harmful algal blooms.
- The National Park Service is engaged with other agencies through the Tomales Bay Watershed Council and other groups in the region to monitor water quality. More information can be found at: <http://www.nature.nps.gov/water/waterquality/index.cfm>
- The San Francisco Estuary Institute manages the Regional Monitoring Program for Water Quality in San Francisco Bay in conjunction with the Regional Water Quality Control Board for region 2 and the regulated discharger community. This program gathers numerous kinds of data regarding contaminants and their effects on the ecology of San Francisco Bay (<http://www.sfei.org/rmp/index.html>).
- The Tomales Bay Watershed Council has outlined a 10-year plan for monitoring the chemical, physical, and biological characteristics of surface waters in the bay. The plan includes provisions for long term trend, source area, and baseline monitoring as well as the creation and maintenance of a database for water quality information (www.tomalesbaywatershed.org/waterqualitymonitoring.pdf)
- The California Environmental Protection Agency has, with the assistance of the coastal regional water quality control boards and three contractors, completed an inventory of the coastal water quality monitoring programs in California. The inventory identifies the agencies that conduct monitoring, where they sample, what they measure, how they analyze samples, and how to acquire more information about specific programs such as concentrations of particular analyses. Information can be found at <http://www.sfei.org/camp>.
- The National Park Service San Francisco Bay Area Network of National Parks monitors water quality in the study region. Details of the program and locations sampled can be found at: <http://www.nature.nps.gov/im/units/sfan/>

5.0 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 marine resource use patterns, coastal livelihoods, and human activities and will be taken into account during the regulatory process. A brief overview of coastal counties, ocean economy, demographics, and resource use in the study region is provided as regional context.

Information provided in this section has also been collected from a variety of sources. Data from the U.S. Census Bureau, California Department of Finance, California Employment Development Department, and the National Ocean Economics Program 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). Data from the National Ocean Economics Program have also been utilized.

The National Ocean Economics Program's Ocean Sector and Industry Data provides information for industries which depend on and derive their source from the ocean and shoreline. These data are referenced below for six ocean industry sectors (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:

- **Coastal Construction** (marine construction).
- **Living Resources** (fishing, fish hatcheries and aquaculture, seafood markets and seafood processing).
- **Offshore Minerals** (limestone, sand and gravel; oil and gas exploration and production)
- **Tourism and Recreation** (amusement and recreation services, boat dealers, eating and drinking places, hotels and lodging places, marinas, recreational vehicle parks and campgrounds, scenic water tours, sporting good retailers, zoos and aquaria).
- **Transportation** (deep sea freight transportation, marine passenger transportation, marine transportation services, search and navigation equipment, and warehousing).

It should be noted that recreational fishing is included in the "Tourism and Recreation" category and not in the "Living Resources" category.

5.1 Coastal Counties

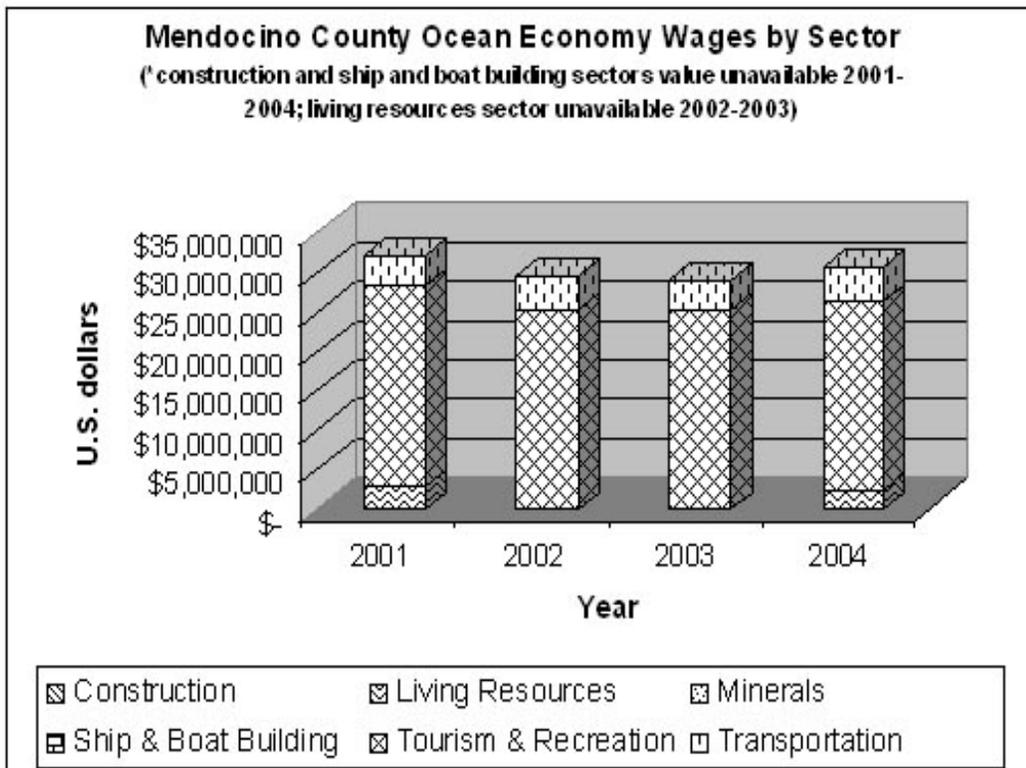
There are five coastal counties that abut the north central coast study region. They are briefly discussed below, in order from north to south. It should be noted that individuals residing outside of these five counties may utilize marine resources within the north central coast study region. Detailed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

5.1.1 Mendocino County

Mendocino County encompasses 3,510 square miles and has a shoreline span of roughly 100 miles. The north central coast study region encompasses only the portion of Mendocino County south of Alder Creek near Point Arena which represents a shoreline span of roughly 20 miles. Tourism is the primary industry in the county, distributed among five distinct regions: Anderson Valley, South Mendocino coast, North Mendocino coast, Northern Mendocino county, and the Russian River Valley (Employment Development Department of California 2006).

The following economic data is for Mendocino County as a whole whereas the north central coast study region encompasses only the portion of Mendocino County south of Alder Creek near Point Arena and therefore does not include the major population centers in the county. In terms of the sectors of the economy which depend upon ocean resources, “tourism and recreation” surpassed all other sectors in wages earned, at roughly \$25 million per year. By comparison, the “living resources” and “transportation” sectors total wages were roughly \$2-\$5 million annually (see Figure 1).

Figure 1: Mendocino County Ocean Economy Wages by Sector

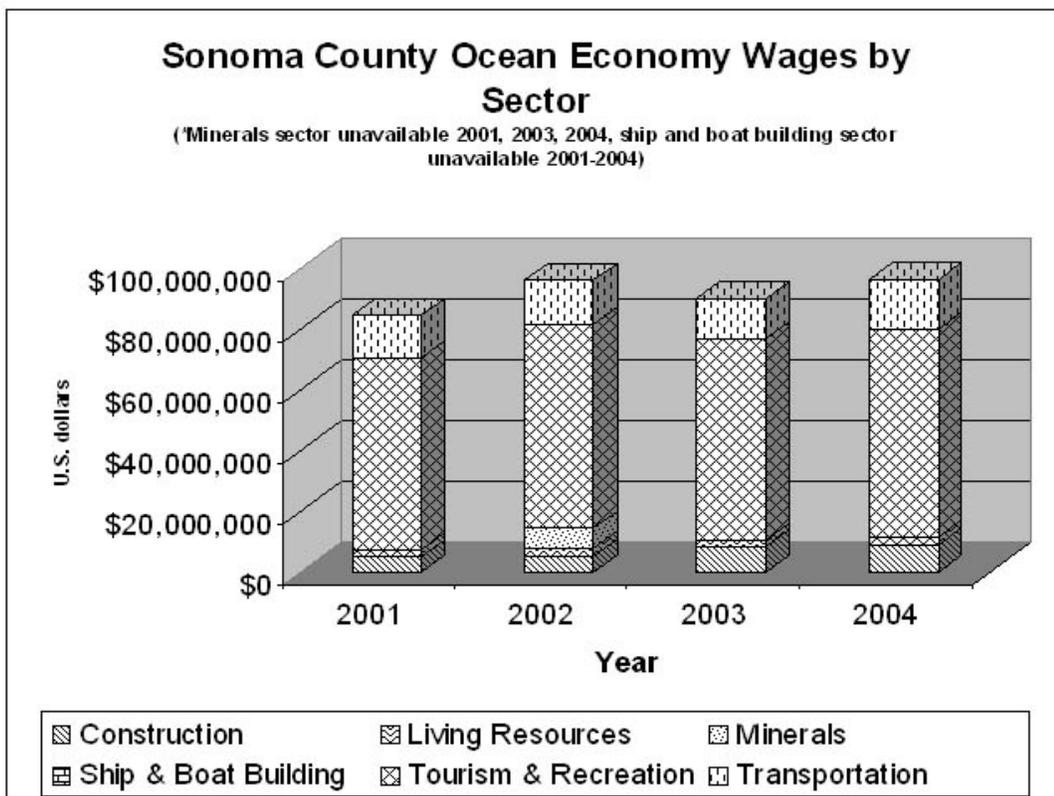


Source: National Ocean Economics Program 2006. Note: All dollar values are converted to year 2000 equivalents. It should also be noted that contributions to California’s Gross State Product and total wages by some sectors listed in Figure 1 for Mendocino County are not publicly available in order to protect the confidentiality of business establishments’ information. Because of the lack of data on contribution to Gross State Product in Mendocino County, total wages is used to illustrate the scope of various sectors of the ocean economy.

5.1.2 Sonoma County

Sonoma County encompasses 1,604 square miles and has a shoreline span of roughly 65 miles. In terms of the sectors of the economy which depend upon ocean resources, “tourism and recreation” sector wages averaged roughly \$65 million per year, far exceeding any other sector. The “transportation” sector followed with an average of roughly \$15 million per year, followed by “construction” and “living resources” with averages of \$5 million and \$2 million, respectively. The “minerals” sector data is unavailable 2001, 2003, 2004 and “ship and boat building” sector are unavailable 2001-2004 to protect the confidentiality of business establishments (Figure 2).

Figure 2: Sonoma County Ocean Economy Wages by Sector



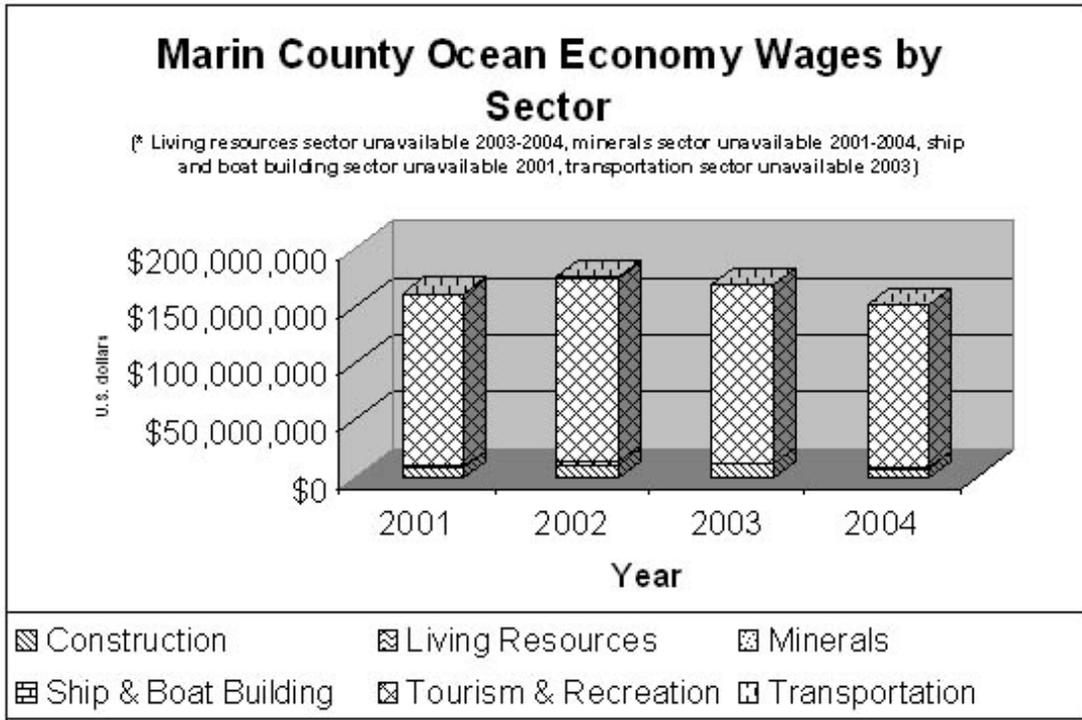
Source: National Ocean Economics Program 2006
 Note: All dollar values are converted to year 2000 equivalents

5.1.3 Marin County

Marin County encompasses 580 square miles and its outer coast has a shoreline span of roughly 60 miles (excluding Tomales Bay) (Employment Development Department of California 2006). In terms of the sectors of the economy which relate directly to ocean resources, “tourism and recreation” wages surpass all other sectors with roughly \$150 million in wages annually. The “construction” sector follows with average wages of roughly \$10 million. The “living

resources” sector produced roughly \$2 million annually in wages (2001-2002), while “ship and boat building” and “transportation” sectors produced less than \$1 million annually in wages. Data on wages produced by the “minerals” sector was not available in order to protect the confidentiality of the few businesses in Marin county that participate in this sector (Figure 3).

Figure 3: Marin County Ocean Economy Wages by Sector

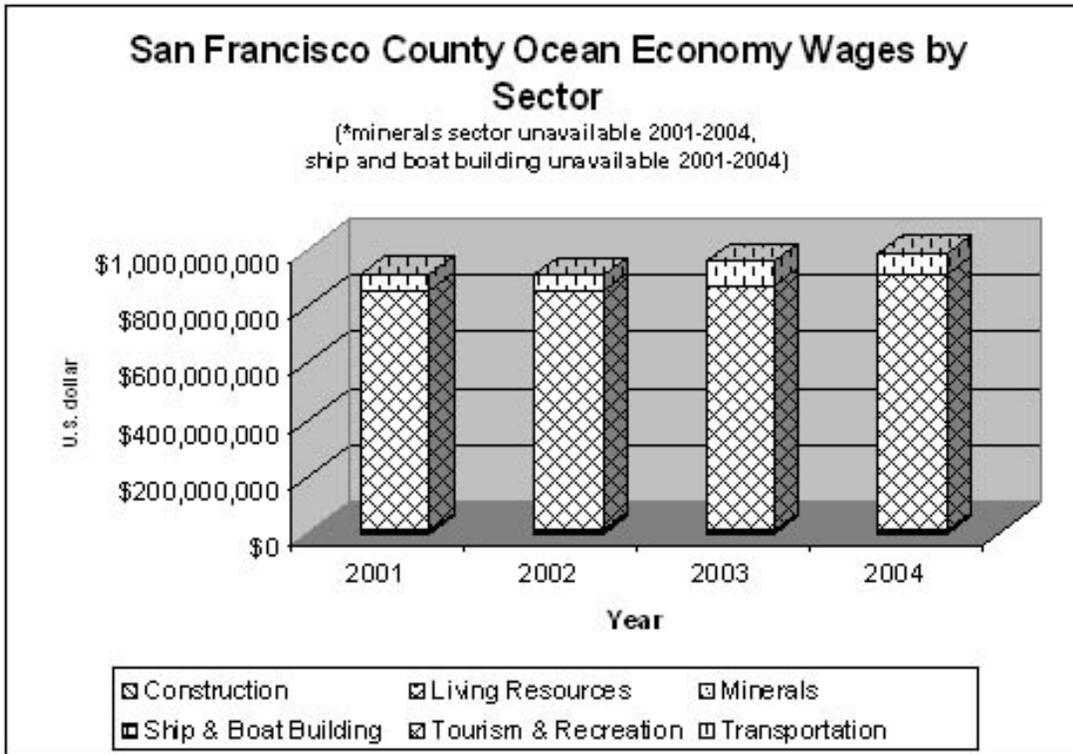


Source: National Ocean Economics Program 2006
 Note: All dollar values are converted to year 2000 equivalents

5.1.4 San Francisco County

San Francisco County encompasses just 47 square miles and has a shoreline span of 8 miles west of the Golden Gate Bridge. In terms of the sectors of the economy which depend upon ocean resources, “tourism and recreation” far surpassed all other sectors in terms of annual wages produced with \$860 million. The “transportation” sector followed with \$68 million in annual wages produced, followed by “living resources” and “construction” with \$11 million and \$4 million, respectively. The “minerals” and “ship and boat buildings” contribution to wages over the time period are not available (Figure 4).

Figure 4: San Francisco County Ocean Economy Wages by Sector



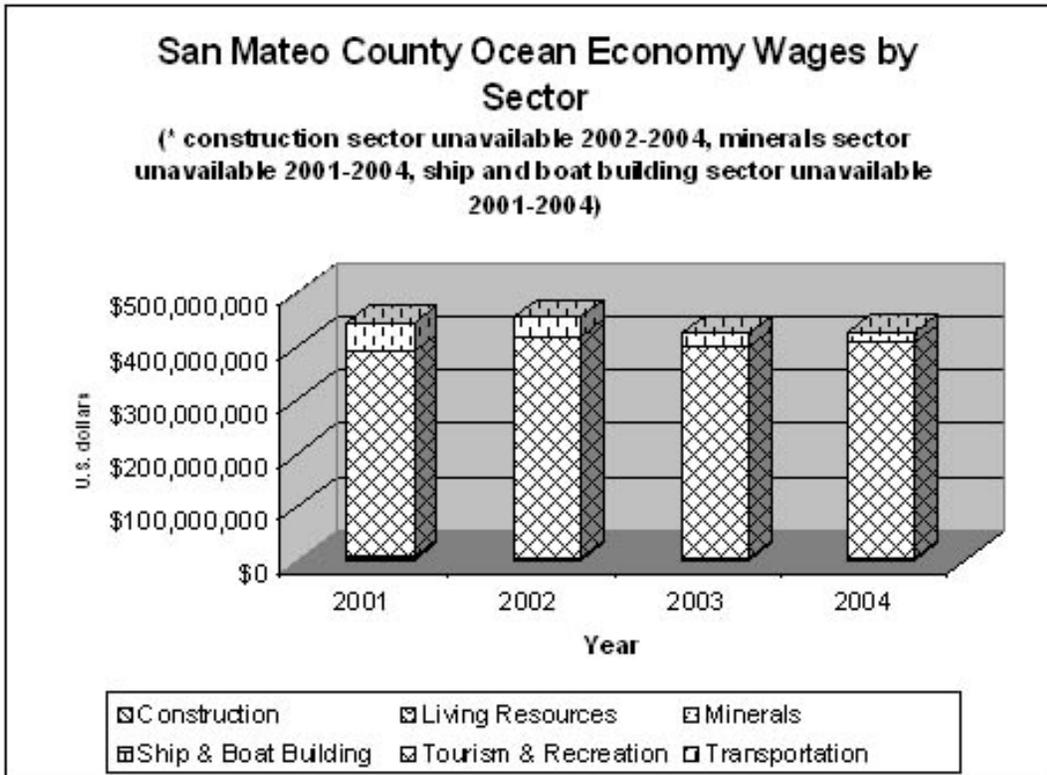
Source: National Ocean Economics Program 2006
 Note: All dollar values are converted to year 2000 equivalents

5.1.5 San Mateo County

San Mateo County encompasses 531 square miles and has a shoreline span of roughly 50 miles. The north central coast study region encompasses most of San Mateo County with the exception of the portion of the county south of Pigeon Point (roughly 8 miles of coastline). The coastal Santa Cruz Mountains divide the county, with the western, coastal side being characterized by more rural activities such as farming, game preserves, watersheds, parks, and undeveloped lands.

Ocean industry data are presented below are for all of San Mateo County; however, as stated above, the study region does not include the entirety of the county. Like the other counties in the study region, the “tourism and recreation” sector far surpassed all other sectors in terms of wages produced with \$400 million produced annually. The “transportation” and “living resources” sectors followed with \$34 and \$6 million in wages produced annually, respectively. Data on wages was unavailable for the “construction”, “minerals”, and “ship and boat building” sectors (Figure 5).

Figure 5: San Mateo County Ocean Economy Wages by Sector



Source: National Ocean Economics Program 2006
 Note: All dollar values are converted to year 2000 equivalents

5.2 Coastal Communities

Table 15 below describes the characteristics of some of the major communities within the north central coast study region. Figure 6 describes the percent employment by sector of the same communities.

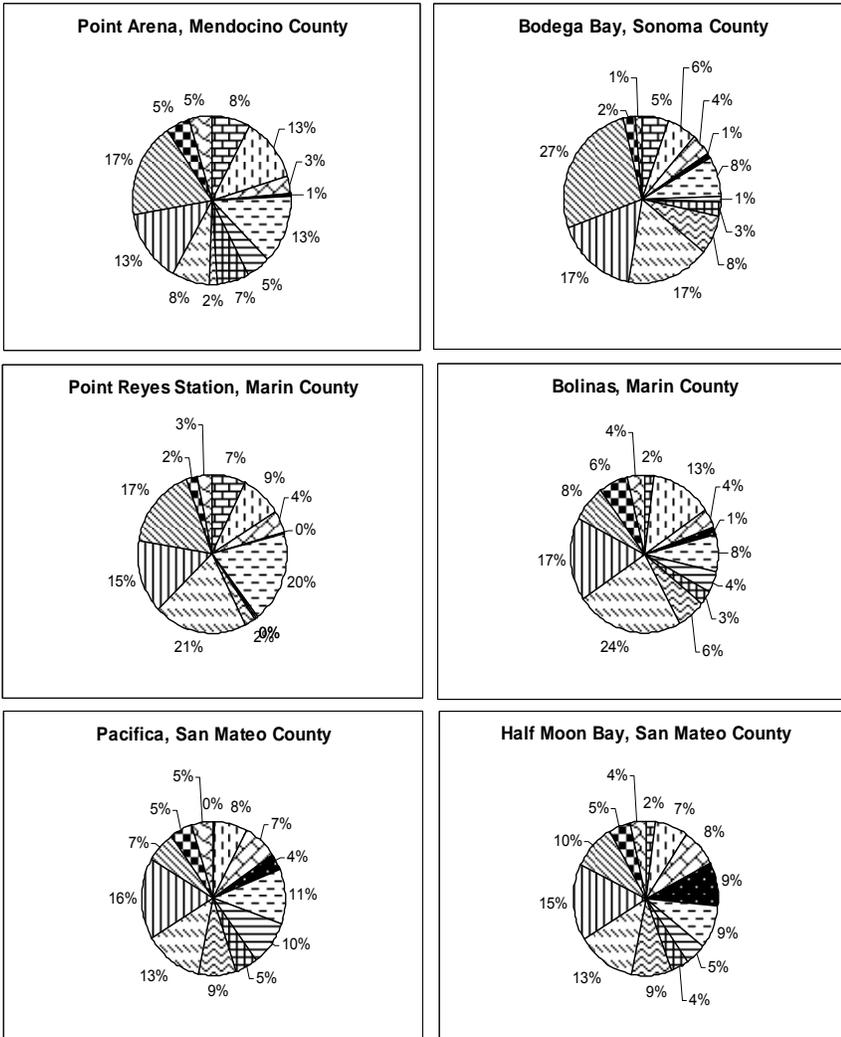
Table 15: Population, Unemployment, Per-Capita Income, Median Household Income, and % of Population Below Poverty Line for Some Communities Within the Study Region

Community	County	Population (2000)	Unemployment rate	Per-capita income	Median household income	% below poverty line
Point Arena	Mendocino	474	2.7%	12,591	27,083	26.0%
Bodega Bay	Sonoma	1,423	2.6%	37,226	56,818	4.0%
Point Reyes Station	Marin	818	1.1%	39,339	69,821	6.0%
Bolinas	Marin	1,246	0.7%	28,973	53,188	10.2%
Pacifica	San Mateo	38,390	2.5%	30,183	78,361	2.9%

Community	County	Population (2000)	Unemployment rate	Per-capita income	Median household income	% below poverty line
Half Moon Bay	San Mateo	11,842	2.6%	37,963	78,473	6.1%

Source: U.S. Census Bureau 2006

Figure 6: Employment by Sector of the Economy for Several Coastal Communities Within the Study Region



- Agriculture, forestry, fishing and hunting, and mining
- Construction
- Manufacturing
- Wholesale trade
- Retail trade
- Transportation and warehousing, and utilities
- Information
- Finance, insurance, real estate, and rental and leasing
- Professional, scientific, management, administrative, and waste management services
- Educational, health and social services
- Arts, entertainment, recreation, accommodation and food services
- Other services (except public administration)
- Public administration

Source: U.S. Census Bureau 2006

5.3 Population Projections

Most of the population of California lives near the coast. Seventy-six percent of California's population lives in coastal counties that represent only twenty-five percent of the state's total area (Kildow 2005). As of 2000, San Francisco and San Mateo counties have a greater population density than the remainder of the study region (Table 16). Major population centers adjacent to the north central coast study region include Santa Rosa, the eastern portions of Marin County, San Francisco and the broader Bay Area, and the largely urbanized eastern portion of San Mateo County, and the greater San Jose area.

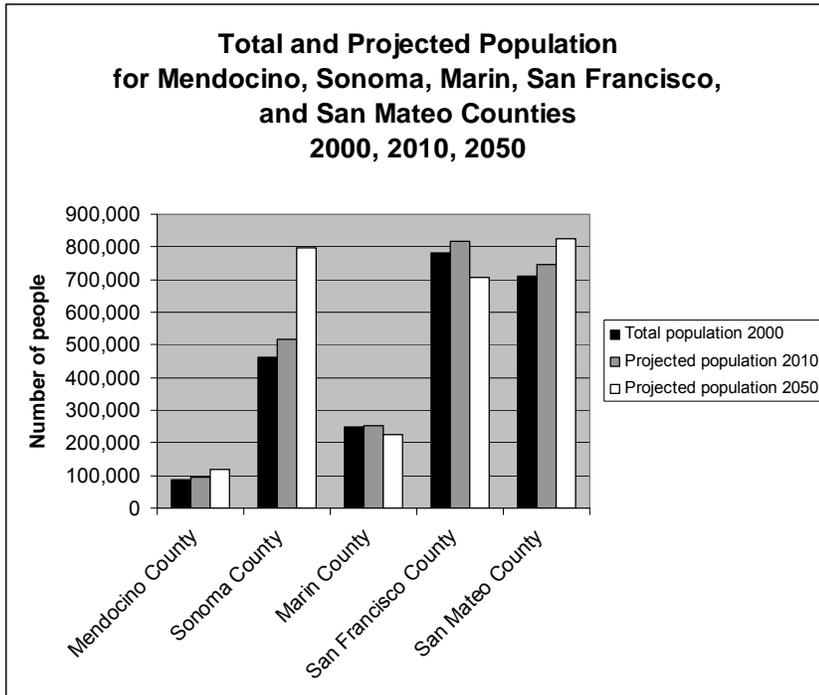
Population growth trends in coastal counties will result in increasing pressure on and impacts to coastal and marine resources and habitats. Based on a demographic model that incorporates fertility, migration, and survival rates, population projections indicate that Sonoma County will have the highest percent change in population growth (+11.84% for 2000-2010 and +72.71% for 2000-2050) among counties along the north central coast study region. Marin and San Francisco counties are expected to grow slightly between 2000 and 2010, but are expected to decrease by 9.4% and 9.6%, respectively by 2050 (Table 16, Figure 7). Rapid growth is occurring in the counties where the average population density is currently the lowest.

Table 16: Total Population, Population Change, and Projected Growth in Coastal Counties in the Study Region

Coastal County	Total population 2000	Projected population 2010	% Projected population change 2000-2010	Projected population 2050	% Projected population change 2000-2050	People per square mile (2000)*
Mendocino County	86,852	94,300	8.58%	118,621	36.58%	24.6
Sonoma County	461,347	515,968	11.84%	796,792	72.71%	291
Marin County	248,473	252,440	1.60%	225,127	-9.40%	475.7
San Francisco County	781,174	816,230	4.49%	706,192	-9.60%	16,634.4
San Mateo County	710,493	747,134	5.16%	826,342	16.31%	1,574.7

Sources: California Department of Finance 2004; U.S. Census Bureau 2006

Figure 7: Total and Projected Population for Mendocino, Sonoma, Marin, San Francisco, and San Mateo Counties for 2000, 2010, and 2050



Source: California Department of Finance 2004

5.4 Commercial Fisheries

The California Department of Fish and Game (CDFG) 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 CDFG 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 is available electronically from this database from 1969 to the present. Longer landings data trends are available for many species statewide preceding the 1980's that is not comparable to the current CFIS database. For purposes of this section, data from the past 15 years were extracted from the CFIS database. Historic data preceding the CFIS database is available on CDFG's website at <http://www.dfg.ca.gov/mrd/status/index.html>. Maps [10a](#), [10b](#), [10c](#), [10d](#), [10e](#), [10f](#), [10g](#), [10h](#), [10i](#), [10j](#) show commercial logbook data for 11 different fisheries, including rockfish, California halibut, red abalone, dungeness and rock crab, herring, surfperch, flatfish, red urchin, squid, salmon, and sharks, skates, and rays.

Species included in analysis: All fish and invertebrate species caught in ocean waters in the study region were included in the landings data analysis. Because San Francisco Bay is not within the north central coast study region, species that are normally only found within the bay were excluded from all San Francisco Bay analyses below. These freshwater and estuarine species include roe herring, herring roe on kelp, bay shrimp, brine shrimp, Sacramento blackfish, carp, yellowfin goby, longjaw mudsucker, staghorn sculpin, shad, threespine stickleback, sucker, brown bullhead, hardhead, and bullfrog. However, some species or species groups may be caught either within the bay or in ocean waters of the study region, and landed at the same San Francisco Bay ports. These include California halibut, surfperches, shark unspecified, and leopard shark. Bay-caught fish and ocean-caught fish, could not be separated effectively from landing receipts. Therefore data for the San Francisco Bay port complex should be interpreted with this in mind.

Tomales Bay and Bodega Bay are 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 central coast study region include; trolling gear, pots/ traps, long lines, hook and line, and hand picking using hooka gear. Trolling, a method of fishing using the boat engine to pull lines and hooks through the water column, is utilized in the salmon fishery as well as in the California halibut fishery. Pots, also known as traps, are utilized in both the crab fishery and sometimes in the nearshore finfish and rockfish fishery, 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 also utilize hook and line (rod and reel) as well as stick gear (described as a vertical longline). The red sea urchin fishermen dive for urchins using compressed air systems ("hooka") with collection done by hand. Gill nets are also utilized in Tomales Bay for the Pacific herring fishery with the ends anchored and a weighted lead line to keep the net on the bottom. The use of trawl gear, seine nets, and gill nets other than in the Tomales Bay herring fishery is prohibited inside state waters. However, these

gears are used outside of state waters to target species groups like wetfish, squid, California halibut, and federal groundfish, which are then landed in ports of the study region.

5.4.1 Port Complexes

For reporting purposes, CDFG 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, but other tables in public reports also list landings by individual ports provided there is more than one dealer in a port. The north central coast study region encompasses two port complexes: Bodega Bay and San Francisco. In addition, Point Arena and Anchor Bay, which are the two southernmost ports in the Fort Bragg port complex, are within the study region. The port of Princeton-Half Moon Bay is normally included in the San Francisco port complex, but for the purposes of providing more area-specific information in this report, it will be reported separately in this section and in Appendix III. All ports within the study region where landings have occurred in recent years (2003-2006) are listed in Table 17 with their average volume and value for the last 15 years (1992-2006), at both the port and port complex level.

During the 1992-2006 period, average annual landings in the north central coast study region totaled nearly 17 million pounds with an average annual ex-vessel value of almost \$18 million (not adjusted for inflation) (Table 17). Important ports in the study region in terms of both volume and value are Bodega Bay, Point Arena, San Francisco, and Princeton-Half Moon Bay. The number of fishermen per port complex from 1992 through 2006 can be viewed in Figures 8 – 12 and is displayed by port complex and fishery in Appendix III(k). The number of fishermen in a port area that may be needed to sustain a fishing community is not known. However, a 2006 federal socioeconomic study that considered the needs of fishing communities conducted by PFMC and NMFS have 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).

Table 17: Average Annual Commercial Landings from 1992-2006 at North Central Coast Study Region Ports that had Landings Activity in Recent Years (2003-2006)

Port Complex	Port	Average Recent Volume 2003-2006* (lbs)	Average Recent Value 2003-2006*	Average Volume 1992-2006* (lbs)	Average Value 1992-2006*
Fort Bragg**	Point Arena	708,961	\$563,383	1,252,020	\$1,418,598
	Anchor Bay***	----	----	----	----
	Total	708,961	\$563,383	1,252,020	\$1,418,598
Bodega Bay	Bodega Bay****	2,535,448	\$5,157,652	4,269,742	\$5,848,182
	Marshall	185,129	\$63,829	299,538	\$223,750
	Point Reyes	72,102	\$144,718	63,394	\$149,491
	Bolinas	72,500	\$184,437	42,084	\$117,224

Port Complex	Port	Average Recent Volume 2003-2006* (lbs)	Average Recent Value 2003-2006*	Average Volume 1992-2006* (lbs)	Average Value 1992-2006*
	Tomales Bay	3,909	\$4,442	33,000	\$9,650
	Marconi Cove	1,611	\$4,043	1,399	\$3,634
	All Other Ports*****	7,195	\$21,606	10,362	\$25,183
	Total	2,877,894	\$5,580,727	4,719,519	\$6,377,114
San Francisco	San Francisco	5,584,293	\$8,934,710	5,140,240	\$6,775,352
	Princeton - Half Moon Bay	4,226,037	\$5,765,433	5,400,292	\$6,252,059
	Sausalito	7,893	\$22,565	228,087	\$462,384
	Oakland	12,944	\$26,932	117,897	\$232,645
	Alviso	4,092	\$2,734	1,783	\$1,810
	Berkeley	33,862	\$80,534	66,219	\$121,450
	Richmond	11,621	\$37,126	13,839	\$41,508
	Alameda	7,243	\$17,659	14,793	\$30,217
	China Camp	6,632	\$23,910	3,939	\$10,475
	Emeryville	14,636	\$21,093	5,474	\$7,844
	South San Francisco	1,293	\$3,330	2,189	\$6,050
	All Other Ports*****	28,122	\$17,320	28,519	\$45,181
	Total	9,938,668	\$14,953,346	11,023,271	\$13,986,975
All Ports Total		13,525,523	\$21,097,456	16,994,810	\$21,782,687

Note: Dollar values are adjusted for inflation (2006\$).

*2006 data are preliminary (March 2007)

**Only the two southernmost ports in this port complex, Point Arena and Anchor Bay, were considered in the analysis.

*** No commercial landings were made in Anchor Bay from 2003-2006.

**** Prior to 1999, CDFG reported confidential landings for Bodega Bay in the San Francisco "All Other Ports" category.

***** "All Other Ports" category is the sum of other minor ports in the port complex.

Fishing Communities

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

Southern Fort Bragg port Complex - Point Arena/Anchor Bay: Port Arena and Anchor Bay are part of the Fort Bragg port complex but are the only two ports from the complex that are within the bounds of the study region. These two ports are located approximately 130 and 115 miles north of San Francisco, respectively. In 2006, there were 31 commercial vessels, 33 commercial fishermen, and 17 processors that reported landings in Point Arena with none reported for Anchor Bay (CFIS, March 2007). The top ten fisheries (see Appendix III(I) for the

list of species included in each market category) landed in these ports in 2006, in order of importance (total value landed), were red urchin, salmon, nearshore finfish, Dungeness crab, lingcod, shelf rockfish, sablefish (non-trawl - line and trap), tuna, spot prawn (trap), and slope rockfish/grenadier (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 and are included in the above analyses). The total value of all landings in 2006 was over four million dollars, with over half a 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 Point Arena, located within Mendocino County, was classified as “vulnerable” utilizing the same criteria (PFMC & NMFS 2006).

Bodega Bay port complex: The Bodega Bay Port complex includes various ports north of San Francisco. The port complex delineation for the Bodega Bay port complex follows the Commercial Fishery Information System database guidelines and includes ports such as: Dillon Beach, Timber Cove, Marshall, Bodega Bay, Inverness, Point Reyes, Marconi Cove, Bolinas and Tomales Bay. In 2006, there were 302 commercial vessels, 311 commercial fishermen, and 84 processors that reported landings in these ports (CFIS, March 2007). The top ten fisheries landed in these ports in 2006, in order of importance (total value landed), were Dungeness crab, salmon, nearshore finfish, tuna, Dover sole/thornyhead/sablefish (trawl), “other” flatfish, California halibut, shelf rockfish, roe herring, and slope rockfish/grenadier (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 and are included in the above analyses). The total value of all landings in 2006 was over five million dollars with more than two million pounds landed. In a 2006 federal socioeconomic study to consider the needs of fishing communities, the town of Bodega Bay was classified as “vulnerable” with high levels of dependence on commercial fishing and low levels of resilience (PFMC & NMFS 2006).

San Francisco Bay port complex: The San Francisco Bay Port complex includes various ports in and around San Francisco Bay. The port complex delineation for the San Francisco Bay port complex follows the Commercial Fishery Information System database guidelines and includes ports such as San Francisco, Princeton/Half Moon Bay (see below), Sausalito, Richmond, Oakland, and Berkeley. In 2006, there were 271 commercial vessels, 270 commercial fishermen, and 114 processors that reported landings in these ports (CFIS, March 2007). The major fisheries landed in these ports in 2006, in order of importance (total value landed), were Dungeness crab, California halibut, salmon, Dover sole/sablefish/thornyhead (trawl), “other flatfish,” sablefish (non-trawl – line and trap), nearshore finfish, slope rockfish/grenadier, shelf rockfish, and lingcod (note that trawl fisheries (e.g. sablefish) occur outside of state waters and therefore outside the study region. However, these fisheries are still considered economically important to this port complex and are included in the above analyses). The total value of all landings in 2006 was over six and a half million dollars with more than three million pounds landed. In a 2006 federal socioeconomic analysis to consider the needs of fishing communities, the city of Oakland was classified as “vulnerable” with high levels of dependence on commercial fishing and low levels of resilience (PFMC & NMFS 2006).

Princeton/Half Moon Bay: Princeton and Half Moon Bay are a subset of the San Francisco Bay port complex where major commercial landings occur (second highest landings pounds and value in the north central coast study region) (Table 17). They are located approximately 30 miles south of San Francisco. The majority of commercial landings occur in Princeton at Pillar Point Harbor, where processing facilities exist, although small landings do occur along the beach in Half Moon Bay. In 2006, there were 163 commercial vessels, 175 commercial fishermen, and 72 processors that reported landings in these ports (CFIS, March 2007). The top ten fisheries landed in these ports in 2006, in order of importance (total value landed), were Dungeness crab, salmon, California halibut, other flatfish, sablefish (non-trawl - line and trap), sanddab, tuna, nearshore finfish, lingcod, and Dover sole/sablefish/thornyhead (trawl) (note that trawl fisheries (e.g. sablefish) occur outside of state waters and therefore outside the study region. However, these fisheries are still considered economically important to this port complex and are included in the above analyses). The total value of all landings in 2006 was near five million dollars with close to 3 million pounds landed.

The National Oceanic and Atmospheric Association's (NOAA) Northwest Fisheries Science Center has compiled a draft "Community Profiles" on the major ports in the study region and includes the ports of Bodega Bay, Corte Madera, Dillon Beach, El Sobrante, El Granada, Half Moon Bay, Novato, Point Arena, Princeton, San Jose, San Francisco, Santa Rosa, Sausalito, and Sebastapol. These profiles provide information such as community demographics, including race, age, population and education, as well as brief overviews of the history of the area, descriptions of the economy as well as information on the types of fisheries in the ports and businesses associated with fishing (NOAA Fisheries 2006, <http://www.nwfsc.noaa.gov/research/divisions/sd/communityprofiles/index.cfm>).

In a study commissioned by the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries, Ecotrust performed a socioeconomic profile of fishing activities and port communities associated with the sanctuaries (Ecotrust 2001). This study profiles both the historic fisheries and the evolution of fishing activities occurring in the sanctuaries. The study includes information on actual numbers of boats actively engaged in each fishery, areas where the fishery is taking place, gear types, catch levels, a socio-economic profile of the harbors and marinas accessing the sanctuaries, and an understanding of markets, changing gear types, and changing fisheries management regulations. Ecotrust is currently undergoing a similar study in 2007 to gather current information covering the entire north central coast study region.

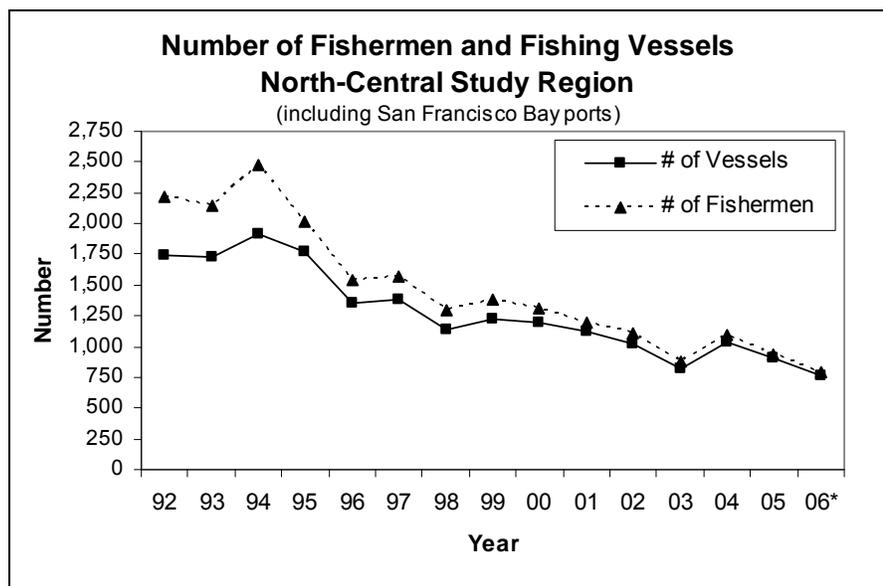
Final Groundfish Essential Fish Habitat Environmental Impact Statement (NOAA Fisheries Service 2005). This report provides socioeconomic data for fishing communities along the West Coast (California, Oregon and Washington). The document focuses on West Coast fisheries managed federally. Ports included from the north central coast study region are: Point Arena, Sonoma, Bodega Bay, Marin, Tomales Bay, Point Reyes, Sausalito, San Francisco, Contra Costa, Richmond, Alameda, Berkeley, Oakland, Alameda, San Mateo, and Princeton. 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 for the study region and San Francisco Bay combined has declined for the period 1992 through 2006 (Figure 8). The total number of fishermen and vessels by port complex can be viewed in Figures 9-12. The number of fishermen, by port complex and fishery, can be viewed in Appendix III(k). The number of fishermen shown in Figures 8-12, and in Appendix III(k), 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 for each year.

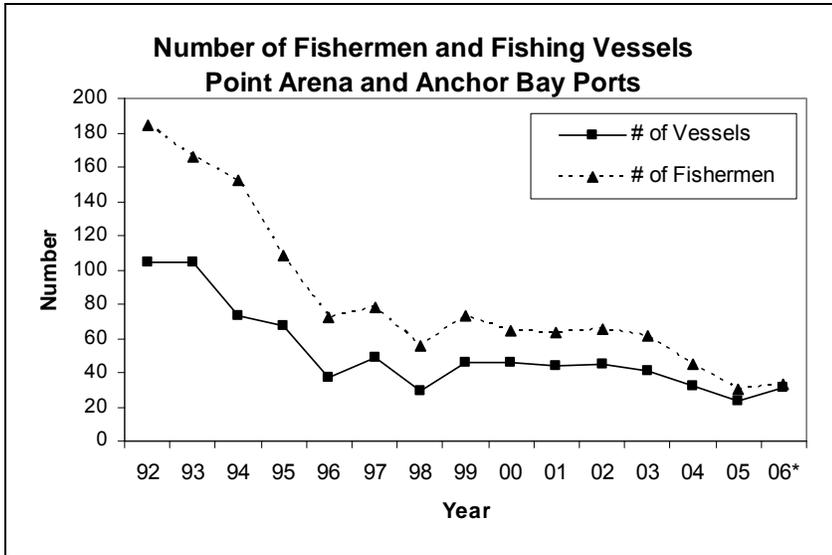
Figure 8: Total Number of Commercial Fishermen and Vessels for All Ports within the North Central Coast Study Region and San Francisco Bay, 1992-2006



Source: Data were compiled from the Commercial Fishery Information System database (extraction date: 14 March 2007).

*Data for 2006 are preliminary.

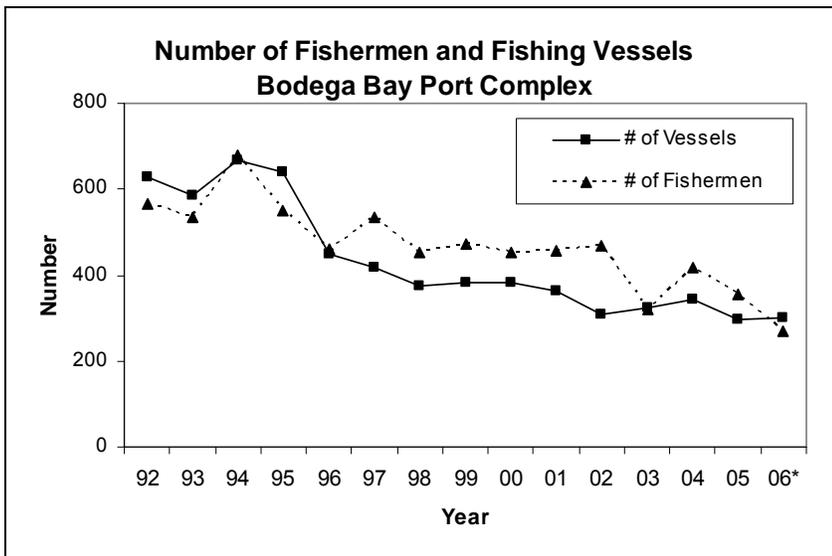
Figure 9: Total Number of Commerical Fishermen and Vessels for All Ports within Point Arena and Anchor Bay Ports, 1992-2006



Source: Data were compiled from the Commercial Fishery Information System database (extraction date: 14 March 2007).

*Data for 2006 are preliminary.

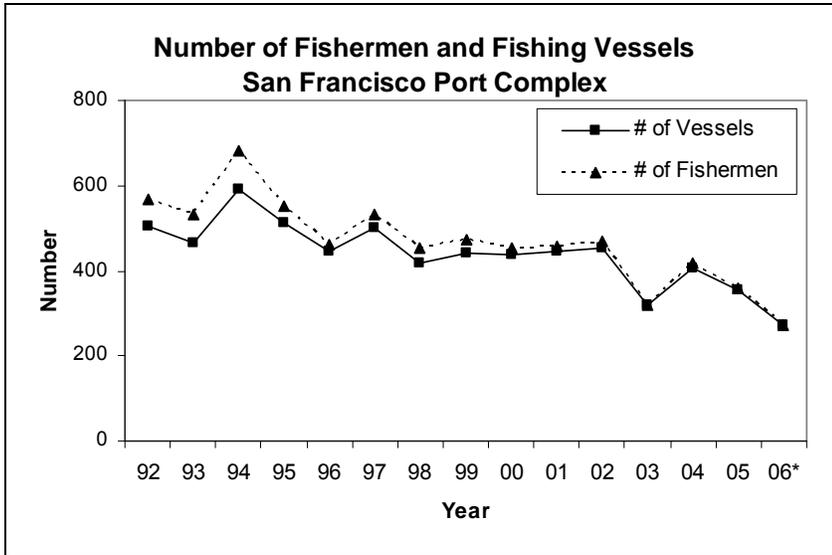
Figure 10: Total Number of Commerical Fishermen and Vessels for All Ports within the Bodega Bay Port Complex, 1992-2006



Source: Data were compiled from the Commercial Fishery Information System database (extraction date: 14 March 2007).

*Data for 2006 are preliminary.

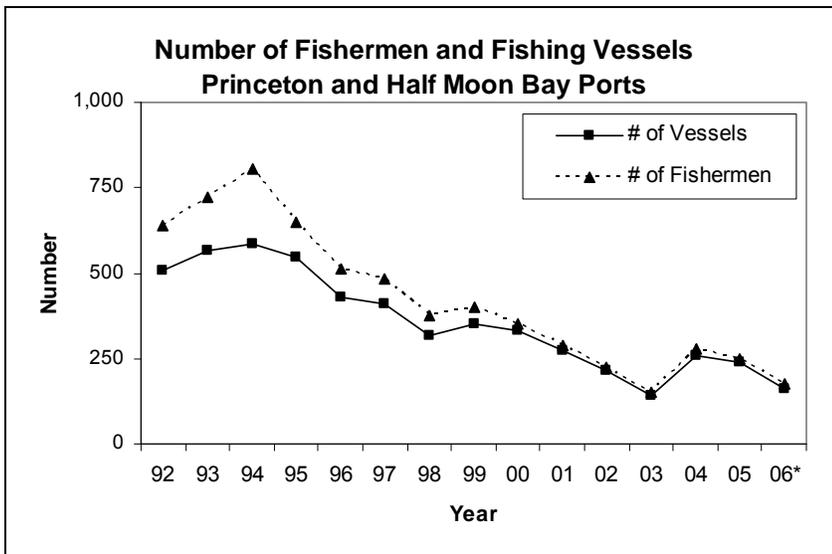
Figure 11: Total Number of Commercial Fishermen and Vessels for All Ports within the San Francisco Port Complex, 1992-2006



Source: Data were compiled from the Commercial Fishery Information System database (extraction date: 14 March 2007).

Note: Port complex delineations follow existing CFIS guidelines with the exception of the Princeton/Half Moon Bay Ports, which were analyzed separately (see Figure 23). *Data for 2006 are preliminary.

Figure 12: Total Number of Commercial Fishermen and Vessels for All Ports within Princeton and Half Moon Bay Ports, 1992-2006



Source: Data were compiled from the Commercial Fishery Information System database (extraction date: 14 March 2007).

*Data for 2006 are preliminary.

5.4.2 Description of Commercial Fisheries

This section provides data on the commercial fisheries in the north central 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 1992-2006 are listed in Table 18. See Table 19 for a similar summary for recent years (2003-2006). The top ten commercial fisheries by average annual landings compose 94.9% of the total average annual landings from 2003-2006 and 95.6% of the total average annual value (Table 19).

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. In the California Commercial Landings for 2005-2006, 105 categories of fishes and 14 categories of invertebrates were landed in the Bodega Bay and/or San Francisco port complexes, and/or Point Arena and Anchor Bay ports (not including estuarine categories that only occur outside the study region – see above) (CFIS 2007). 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 18: Average Annual Landings and Value for 1992-2006* for Major Commercial Fisheries in the North Central Coast Study Region, In Order of Highest Average Annual Landings for Study Region

Average Annual Landings (lbs) by Port Complex						
Market Category Groupings**	Fort Bragg Port Complex***	Bodega Bay Port Complex	San Francisco Bay Port Complex		Average Annual Landings (lbs) for Study Region	Average Annual Value (\$) for Study Region
			Princeton -Half Moon Bay Port	San Francisco Bay - All other ports		
Dungeness crab	17,552	907,632	770,706	1,083,318	2,779,208	5,461,658
Dover sole/ Thornyheads/ Sablefish Trawl	****	1,047,937	386,959	918,680	2,353,576	1,101,844
Salmon	18,525	610,273	747,232	744,925	2,120,956	4,490,437
Red urchin	1,202,886	786,646	27,880	40,728	2,058,140	1,663,251
Market squid	0	18,395	1,446,160	170,144	1,634,698	328,871
Shelf rockfish	544	525,928	300,122	803,573	1,630,167	792,139
Other flatfish	21	157,751	309,745	373,308	840,825	550,226
Sanddab	1	6,217	509,488	191,214	706,920	282,505
Coastal pelagics*****	20	1,056	423,026	151,318	575,420	51,289

Average Annual Landings (lbs) by Port Complex						
Market Category Groupings**	Fort Bragg Port Complex***	Bodega Bay Port Complex	San Francisco Bay Port Complex		Average Annual Landings (lbs) for Study Region	Average Annual Value (\$) for Study Region
			Princeton -Half Moon Bay Port	San Francisco Bay - All other ports		
California halibut	****	17,722	132,917	267,394	418,032	1,035,622
Herring	0	327,250	0	0	327,250	177,062
Sablefish, nontrawl	893	31,655	64,011	176,572	273,131	325,580
Tuna	368	84,882	25,328	156,879	267,458	273,213
Slope rockfish, grenadier	124	40,760	59,628	162,980	263,492	91,424
Lingcod	2,021	42,271	49,433	94,145	187,870	112,578
Swordfish	0	27,483	2,646	111,525	141,654	357,144
Nearshore fish	9,251	39,632	30,778	58,983	138,644	317,441
Skates, rays, sharks	45	7,440	29,605	54,512	91,602	44,722
Rock crab	****	10,629	40,477	3,978	55,085	68,911
Croaker	10	8,490	12,317	32,063	52,881	38,753
Red abalone*****	0	5	29,240	140	29,385	224,615
Thornyheads, nontrawl	****	2,199	1,017	10,968	14,184	23,678
Ocean shrimp	0	11,158	442	****	11,599	5,110
Surfperch	13	2,267	173	9,038	11,491	23,194
Smelt	****	618	255	4,751	5,625	3,622
Dover sole, nontrawl	****	3,699	501	1,221	5,420	2,750
Spot prawn, trap	****	475	205	608	1,288	8,960
Grand Total	1,252,274	4,720,470	5,400,292	5,622,967	16,996,003	17,856,598
Percent of total landings	7	28	32	33		

*2006 data are preliminary

**See appx III-I for market categories included in each grouping

***Only the two southernmost ports in this port complex, Point Arena and Anchor Bay, were considered in the analysis.

**** Data cannot be disclosed due to confidentiality considerations.

*****Includes Pacific sardine, northern anchovy, jack mackerel, and Pacific mackerel

*****The commercial red abalone fishery was abolished in 1997.

Table 19: Recent Average Annual Landings and Value for 2003-2006* for Major Commercial Fisheries in the North Central Coast Study Region, In Order of Highest Average Annual Landings for Study Region

Recent Average Annual Landings (lbs) by Port Complex						
Market Category Groupings**	Fort Bragg Port Complex***	Bodega Bay Port Complex	San Francisco Bay Port Complex		Recent Average Annual Landings (lbs) for Study Region	Recent Average Annual Value (\$) for Study Region
			Princeton-Half Moon Bay Port	San Francisco Bay – All other ports		
Dungeness Crab	30,379	1,545,781	1,406,094	2,321,901	5,304,154	9,993,386
Market Squid	0	****	1,004,796	633,630	1,638,457	435,908
Salmon	36,079	862,040	556,845	772,983	2,227,947	6,431,117
Dover Sole, Thorneyhead & Sablefish (Trawl)	0	103,039	32,182	791,091	926,312	535,715
Red Urchin	627,125	50,344	****	15,121	692,804	354,942
Other Flatfish	****	37,537	245,250	264,853	547,640	473,450
California Halibut	****	16,913	164,217	323,155	504,311	1,383,945
Coastal Pelagic*****	****	287	485,507	170	486,031	20,144
Sanddab	****	404	217,686	39,715	257,705	121,896
Swordfish	0	0	0	158,232	158,232	388,902
Roe Herring	0	184,124	0	0	184,124	61,312
Slope Rockfish, Grenadier	11	8,126	6,054	135,189	149,377	71,393
Sablefish, Non-Trawl (Line and Trap)	0	4,145	40,794	101,161	146,099	241,639
Tuna	****	34,564	17,566	17,949	70,124	98,822
Shelf Rockfish	805	7,189	5,846	32,160	46,000	46,611
Nearshore Finfish	11,498	12,350	4,517	11,636	40,001	206,172
Skates, Rays & Sharks	****	1,454	15,660	21,110	38,371	21,473
Croaker	0	676	3,202	27,249	30,957	33,240
Lingcod	2,729	4,467	9,477	10,620	27,292	47,503
Surfperch	****	1,499	52	14,389	15,942	41,202
Rock Crab	0	3,049	9,269	3,031	15,349	33,750

Recent Average Annual Landings (lbs) by Port Complex						
Market Category Groupings**	Fort Bragg Port Complex***	Bodega Bay Port Complex	San Francisco Bay Port Complex		Recent Average Annual Landings (lbs) for Study Region	Recent Average Annual Value (\$) for Study Region
			Princeton-Half Moon Bay Port	San Francisco Bay – All other ports		
Thornyheads (Non-trawl)	****	0	570	11,427	12,010	50,221
Dover Sole (Non-Trawl)	0	0	****	****	1,751	962
Smelt	****	298	208	4,146	4,535	3,755
Grand Total	708,624	2,877,867	4,225,792	5,710,918	13,525,525	21,097,457
Percent of total landings	5.2%	21.3%	31.2%	42.2%		

Note: Dollar values are adjusted for inflation (2006\$).

*2006 data are preliminary

** See appx III-L for market categories included in each grouping

***Only the two southernmost ports in the Fort Bragg port complex, Point Arena and Anchor Bay, were considered in the analysis.

**** Data cannot be disclosed due to confidentiality considerations.

*****Includes Pacific sardine, northern anchovy, jack mackerel and Pacific mackerel

The commercial fisheries that are located in waters of the north central coast study region and/or are economically important to the fishing communities in the study region, and had landings in the years 2003 through 2006 are listed below (listed in descending order of average annual landings for all port complexes):

Finfishes: Salmon, Dover sole/thornyheads/sablefish (trawl), other flatfish, California halibut, coastal pelagics, sanddabs, swordfish, roe herring, slope rockfish/grenadier, sablefish (non-trawl – line and trap), tuna, shelf rockfish, nearshore finfish, skates/rays/sharks, croaker, lingcod, surfperch, thornyheads (non-trawl), Dover sole (non-trawl), and smelt

Invertebrates: Dungeness crab, Market squid, Red urchin, Rock crab

Note: Market categories represented by these groupings can be found in Appendix III(I).

Commercial fisheries most likely to realize both short-term potential impacts to fishing activities and long-term potential benefits through increased species abundance and sustainability after new MPAs are established are those which occur primarily or significantly within state waters, i.e. within the study region. These fisheries target primarily residential, non-migratory species. Market categories that are fished in state waters and may receive direct benefits from MPAs include those listed below (in descending order of average annual landings):

Finfishes: Other flatfish, California halibut, sanddab, herring, sablefish (non-trawl – line and trap), shelf rockfish, nearshore finfish, skates/rays/sharks, croaker, lingcod, surfperch, thornyheads (non-trawl), Dover sole (non-trawl), smelt

Invertebrates: Dungeness crab, Red urchin, rock crab

Notes: Market categories represented by these groupings can be found in Appendix III(l).

5.4.3 Commercial Landings

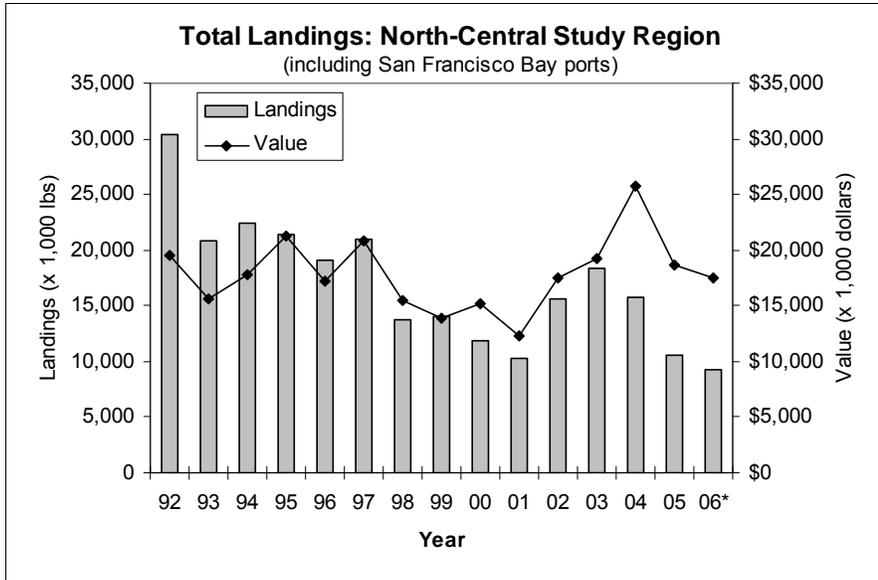
In general, total landings in the study region and each port area have declined over the period 1992 through 2006 (Figures 13-17). Total values have varied over these years, and show no consistent trend. Values have not been adjusted for inflation. Some practices have added value to landings over time, such as landing and selling fish live, e.g., nearshore rockfish, and the way some fish species are handled at sea, e.g., tuna processed for sushi-grade. Graphs of landings and value for each major commercial fishery are provided in Appendix III(k).

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, and the relative value derived from, specific areas are key components to MPA planning. Landing receipts collected by CDFG require that catch locations for all market categories be included. This data is reported by coded 10-minute blocks. However, this data is usually filled in by the processors, rather than by the fishermen, and contains inaccuracies. For example, the Dungeness crab and California halibut data show major catches from areas west of the Farallon Islands, where water is too deep for these species to occur. The MLPA Initiative plans to establish a contract to collect data to help fill the gaps in spatial catch information. Ecotrust performed a socioeconomic profile of fishing activities and port communities associated with the sanctuaries in a study commissioned by the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries (Ecotrust 2001). This study profiles both the historic fisheries, and the evolution of fishing activities occurring in the sanctuaries. The study includes information on actual numbers of boats actively engaged in each fishery, areas where the fishery is taking place, gear types, catch levels, a socio-economic profile of the harbors and marinas accessing the sanctuaries, and an understanding of markets, changing gear types, and changing fisheries management regulations. Ecotrust is currently conducting a similar study in 2007 covering the entire north central coast study region.

More information on commercial fisheries is included in Appendix III, including:

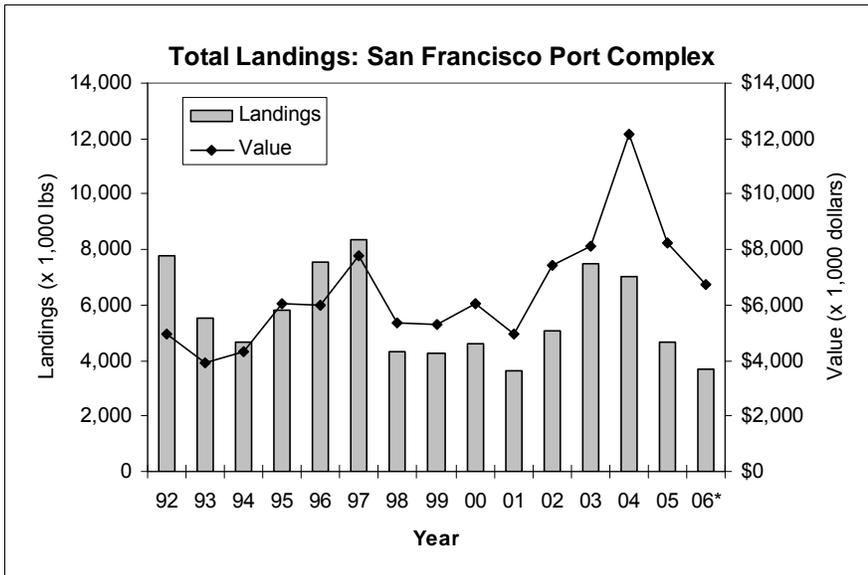
- Fishery summary tables, including number of fishermen and vessels, gear types, recent average annual landings (2003-2006), and average annual landings (1992-2006)
- Landings by market category and year for 2001-2006
- Fishery profiles, including regulations and graphs of landings for 1992-2006, and species included in market categories

Figure 13: Total Landings and Values for All Ports within the North Central Coast Study Region and San Francisco Bay, 1992-2006



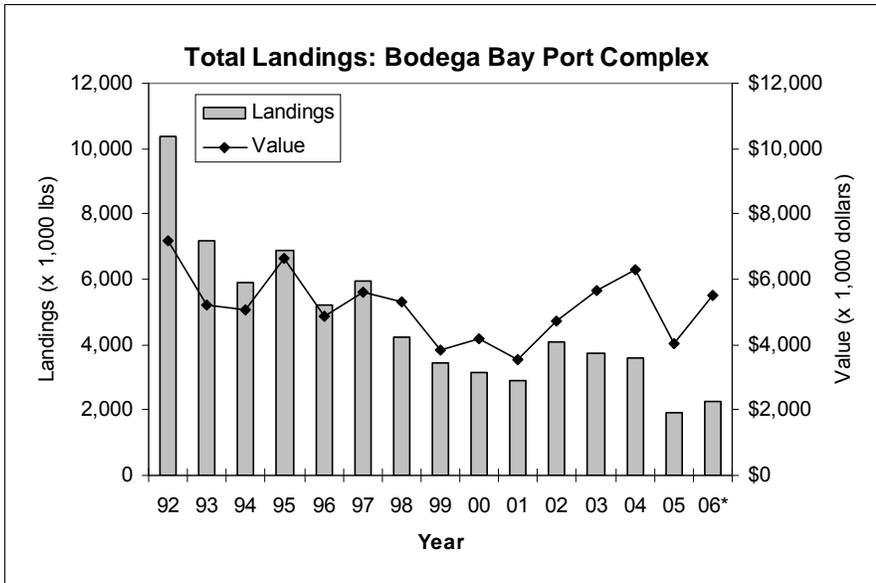
Source: Data were compiled from the Commercial Fishery Information System database (extraction date: 14 March 2007). *Data for 2006 are preliminary. Note: Values were adjusted for inflation (2006\$).

Figure 14: Total Landings and Values from the San Francisco Port Complex, 1992-2006



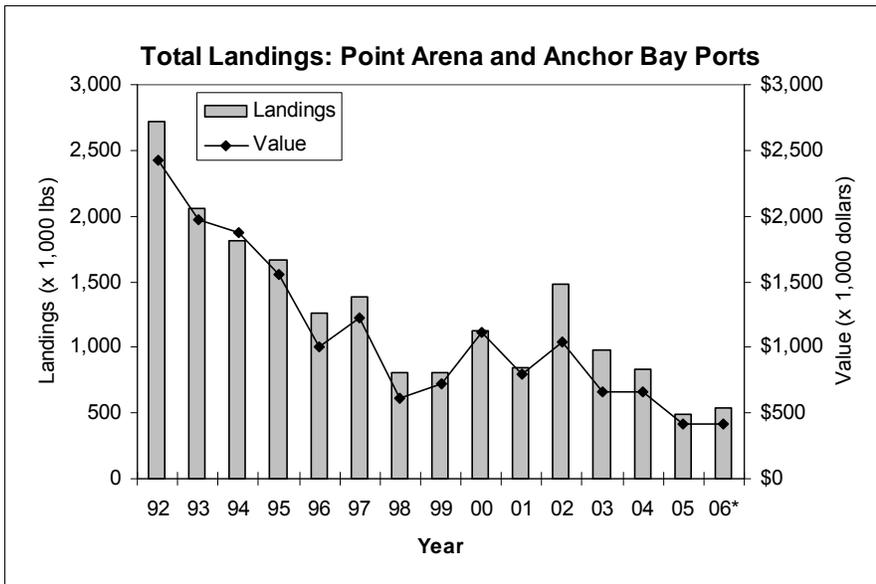
Source: Data were compiled from the Commercial Fishery Information System (CFIS) database (extraction date: 14 March 2007). Note: Port complex delineations follow existing CFIS guidelines with the exception of the Princeton/Half Moon Bay Ports, which were analyzed separately. *Data for 2006 are preliminary. Values were adjusted for inflation.

Figure 15: Total Landings and Values from the Bodega Bay Port Complex, 1992-2006



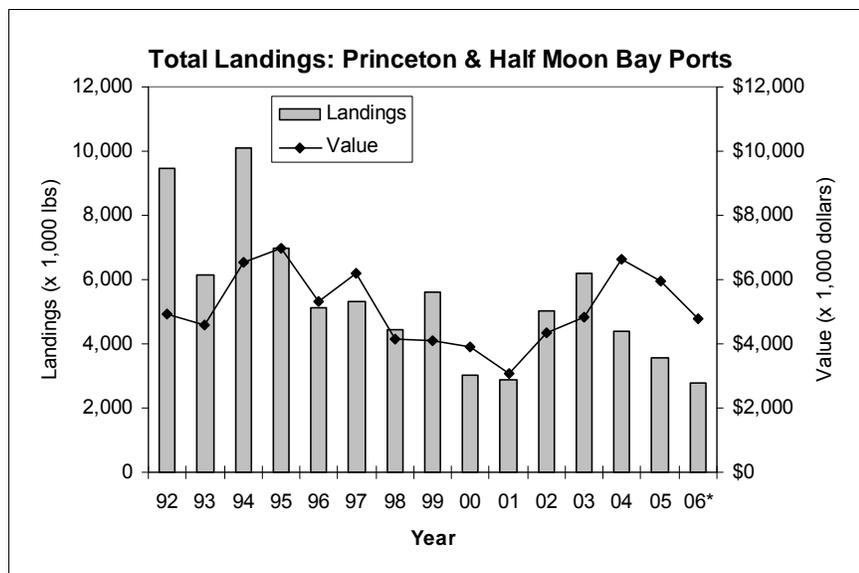
Source: Data were provided from the Commercial Fishery Information System (CFIS) database (extraction date: 14 March 2007). Note: Port complex delineations follow existing CFIS guidelines. *Data for 2006 are preliminary. Values were adjusted for inflation (2006\$).

Figure 16: Total Landings and Values from the Point Arena and Anchor Bay Ports, 1992-2006



Source: Data were provided from the Commercial Fishery Information System (CFIS) database (extraction date: 14 March 2007). *Data for 2006 are preliminary. Note: Values were adjusted for inflation (2006\$).

Figure 17: Total Landings and Values from the Princeton / Half Moon Bay Ports, 1992-2006



Source: Data were provided from the Commercial Fishery Information System database (extraction date: 14 March 2007). *Data for 2006 are preliminary. Note: Values were adjusted for inflation (2006\$).

5.5 Kelp and Aquaculture Leases

While the presence of existing aquaculture leases or harvestable kelp bed leases can be a potential conflict with the establishment of state marine reserves or state marine parks that do not allow for commercial take, none of the administrative kelp beds in the region are open for commercial take.

5.5.1 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 (*Nereocystis lutkeana*) only. The entire coastline, including southern offshore islands, 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.

There are 8 administratively numbered kelp beds within the north central coast study region; all of these are closed to the leasing of kelp and no harvest is allowed.

Table 20: Kelp Bed Location and Lease Status in the North Central Coast Study Region

Kelp Administrative Bed Number	Geographic Extent	Lease Status of Bed
224	Point Ano Nuevo to Pescadero Point	Closed
225	Pescadero Point to Point Montara	Closed
226	Point Montara to Fort Point	Closed
301	Fort Point to Point Reyes	Closed
302	Point Reyes to Duncan's Point	Closed
303	Duncan's Point to Gualala Point	Closed
304	Gualala Point to Iverson Point	Closed
305	Iverson Point to Point Arena	Closed

Note: These data accurate as of October 19, 2006

No kelp or other aquatic plant may be harvested in a state marine reserve or state marine park. Between April 1 and July 31, a kelp harvester may not harvest bull kelp from a non-leased bed that lies partially or totally within the boundary of the Monterey Bay National Marine Sanctuary extending from Santa Rosa Creek, San Luis Obispo, northward to rocky Point, Marin County. However, bull kelp may be removed from beaches within the sanctuary during the seasonal closure.

At least one commercial harvester of non-kelp, edible seaweed exists in the north central coast study region (Tom Moore pers. comm.). CDFG issues licenses for these activities.

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. In addition, permits for harvest of kelp by Native American groups are issued by CDFG.

5.5.2 Aquaculture Leases

Tomales Bay, Drakes Estero, and Pillar Point Harbor have active aquaculture leases where oysters, clams, mussels, and abalone are grown for commercial sale and consumption. There are 12 active leases in Tomales Bay covering 513 acres and 2 active leases in Drakes Estero covering 1060 acres (Table 21). The presence of active leases and commercial production is inconsistent with designation of state marine reserve or state marine park status; however may be consistent with state marine conservation area designation depending on allowable uses proposed. A spatial data layer showing location of these lease areas is available; lease areas are shown on maps [16a](#), [16b](#), [16c](#), [16d](#), [16e](#), [16f](#).

An active state water bottom lease is one held by a currently registered aquaculturist who has 1) Fish and Game Commission approval in the form of a lease, 2) time remaining on the lease period, and 3) is currently meeting planting and harvesting requirements as set forth in Title 14, Section 237, (i) through (j). A lease defines the boundary and acreage of a specified state water bottom parcel and defines the terms and conditions of usage of that area for a specified time at

an annual cost based on a rate per acre as a result of a competitive bidding in a lease auction. No changes to terms or conditions of the lease can be made without Fish and Game Commission approval (Tom Moore, CDFG Marine Region Aquaculture Coordinator, Tomales Bay and Drakes Estero Active State Water Bottom Lease Summary Information 2006).

Table 21: Summary of Active Tomales Bay and Drakes Estero Aquaculture Lessees, Lease Acreage, Acreage in Use, Approved Species, and Approved Culture Methods.

Lessee	Lease Number	Lease Acreage	Acreage in Use (estimate)	Approved Species For Cultivation in Lease Agreement	Approved Culture Methods in Lease Agreement
TOMALES BAY					
Marin Oyster Company	M-430-02	5	5	Pacific, Kumomoto, Suminoe, Eastern, and Flat Oysters, Manila Clam, and Blue Mussels	Longline, Rafts, Rack and Bag, Longline on Stakes, Rack and Tray, Groundline and Bag, Bottom Culture, and Floats
Charles Friend	M-430-04	62	10	Pacific, Kumomoto, Suminoe, Eastern, and Flat Oysters, Manila Clam, and Blue Mussels	Longline, Rafts, Rack and Bag, Stakes, Rack and Tray, Bottom Culture, and Floats
Marin Oyster Company	M-430-19	25	1	Pacific, Kumomoto, Suminoe, Eastern, and Flat Oysters, Manila Clam, and Blue Mussels	Longline, Rafts, Rack and Bag, Rack and Tray, Bottom Culture, and Floats
Cove Mussel Company	M-430-06	10	5	Bay Mussels, Pacific Oyster, Manila Clam	Longline, Rack and Bag
Hog Island Oyster Company	M-430-10	5	5	Pacific, European, Eastern, & Kumamoto Oysters, Manila Clam, and Bay Mussels	Raft, Longline, Rack and Bag, Groundline and Bag
Hog Island Oyster Company	M-430-11	5	5	Pacific, Eastern, and European Oysters, Bay Mussels, and Littleneck Clams	Longline, racks, stakes, and Modified Stakes
Hog Island	M-430-12	25	5	Pacific, Eastern,	Raft and Rack and

Lessee	Lease Number	Lease Acreage	Acreage in Use (estimate)	Approved Species For Cultivation in Lease Agreement	Approved Culture Methods in Lease Agreement
Oyster Company				and European, Kumamoto Oysters, and Bay Mussels	Bag
Hog Island Oyster Company	M-430-15	128	40	Pacific, European, Eastern, & Kumamoto Oysters, Manila Clam, and Bay Mussels	Raft, Longline, Rack and Bag, Groundline and Bag
Point Reyes Oyster Company	M-430-14	5	<1	Pacific, Eastern, European, Suminoe, and Native Oysters, Bay Mussels, Manila and Quahog Clams, Rock and Japanese Scallops, and Red, Green, and Pink Abalone	Raft, and Longline
Point Reyes Oyster Company	M-430-13	25	<1	Pacific, Eastern, European, Suminoe, and Native Oysters, Bay and Sea Mussels, Manila Clam	Raft, and Longline
Point Reyes Oyster Company	M-430-17	62	15	Pacific, Suminoe, Eastern, European, and Native Oysters, Manilla Clam, and Bay and Sea Mussels	Longline, Rafts, Floats, Stakes, Rack and Bag, Rack and Tray, Bottom Culture, and In-Ground Culture With Net Cover
Tomales Bay Shellfish Farms Inc.	M-430-05	156	60	Pacific & European Oysters, Bay Mussels	Raft, Rack and Bag, Stake and Bag
Tomales Bay Active Lease Totals	12	513	153		
DRAKES ESTERO					
Drakes Bay	M-438-01	1, 059		Pacific (<i>C. gigas</i>)	

Lessee	Lease Number	Lease Acreage	Acreage in Use (estimate)	Approved Species For Cultivation in Lease Agreement	Approved Culture Methods in Lease Agreement
Oyster Company (formerly Johnson Oyster Company)				and European Flat (O. edulis) Oysters	
Drakes Bay Oyster Company (formerly Johnson Oyster Company)	M-438-02.	1		Purple-hinged rock scallops (Crassodoma gigantea) and Manila clam (Venerupis philipinarum).	
Drakes Estero Active Lease Totals	2	1,060			
TOTAL					
Active Aquaculture Lease Totals in Region	15	1, 573			

Source: Tom Moore, CDFG Marine Region Aquaculture Coordinator, Tomales Bay and Drakes Estero Active State Water Bottom Lease Summary Information 2006. Note: A previous lease for abalone in submerged cages in Pillar Point harbor was due to expire at the time of publication.

5.6 Recreational Fisheries

Various forms of recreational fishing occur throughout the north central coast study region. According to data provided by the Pacific States Marine Fisheries Commission, more than 109 species of finfishes were caught by recreational anglers from 2004 to 2006 within the study region, although many of these were seen infrequently in sampled catches. The recreational salmon fishery is important to many anglers utilizing boat-based modes of fishing throughout the study region. Other important fisheries associated with both boat-based and shore-based modes are rockfish, lingcod, cabezon, greenling, and California halibut. Also important to the recreational fishery in the north central coast study region (NCCSR) are the harvest of invertebrates such as Dungeness crab, red abalone, and various species of clams.

Boat-based anglers and divers generally have a target species or species group in mind when they head out to fish, although some anglers or divers fish for whatever happens to be available in their region. Primary target species/species groups in this region are Chinook salmon, rockfishes/lingcod/cabezon/kelp greenling, California halibut, sanddabs, and albacore. Additional effort (excluding divers) is directed towards the recreational harvest of Dungeness crab using traps, often in combination with trips for other target species.

5.6.1 Modes of Fishing

The distribution of recreational fishing effort varies by mode of fishing and availability of access. Some modes have the capability of traveling to fishing areas further from port and during varying ocean conditions than other modes, such as kayaks, which are limited to protected areas closer to launch sites. The following are common modes of recreational fishing throughout the NCCSR.

Boat -based Modes

- Commercial passenger fishing vessels (CPFVs)¹
- Private and rental skiffs¹
- Kayaks (angling, diving, or freediving)

Shore-based modes

- Beach and bank fishing¹
- Fishing from manmade structures¹
- Poke-poling
- Free-diving and shore picking
- Spearfishing

¹ *Sampled by CRFS*

In January 2004, California began an integrated recreational fishery sampling and assessment program called the California Recreational Fisheries Survey (CRFS). CRFS was implemented through the Recreational Fisheries Information Network program at Pacific States Marine Fisheries Commission using federal funds from the National Marine Fisheries Service and state funds from CDFG. This program represents an expansion and improvement within California of the previous national sampling program, the Marine Recreational Fisheries Statistics Survey. The CRFS sampling protocol is a significant improvement over the Marine Recreational Fisheries Statistics Survey in that it increases sampling effort, uses a regional scale, and achieves higher resolution data than MRFS. CRFS has combined the efforts of CDFG's Ocean Salmon Project with other modes of recreational finfish sampling, expanded the number of anglers contacted by samplers, and has provided a more accurate telephone-based survey for estimating private boat angler effort from marinas or from night fishing (not sampled in the field by CRFS). Further detail regarding CRFS may be found at the Recreational Fisheries Information Network webpage, <http://www.recfin.org/>.

Other modes of fishing and fisheries that are not fully captured by the CRFS program include: consumptive diving (including dive charters and private shorebased or skiff diving), kayak angling, Dungeness crab, and the abalone and clam fisheries. Although the CRFS program does provide some information on recreational consumptive diving and kayak angling it is limited by sampling frequency and whether or not these activities occur at sites that are sampled. The recreational take of Dungeness crab is partially captured by the CRFS program, however, logbook data provides the best measure of that fishery. The CRFS program does not

collect data on recreational catch of abalone by shore-pickers or free-divers, nor does it collect data on the recreational take of clams. See below for information on CDFG monitoring of the recreational abalone fishery.

Boat-Based Modes

Commercial Passenger Fishing Vessels (CPFVs)

CPFVs, also called party boats, carry recreational anglers to ocean fishing locations for a fee. CPFVs have the greatest range of any recreational fishing mode and are generally limited by travel time. CPFVs in the study region operate out of ports in Bodega Bay, Berkeley, Emeryville, Sausalito, San Francisco, and Princeton (maps [14a](#), [14b](#), [14c](#), [14d](#), [14e](#), [14f](#)). CPFVs may carry up to 40-50 anglers, although a passenger load of 10-30 is more common; some small CPFVs are known as “six-packs” due to their reduced passenger-carrying ability. In general CPFVs north of and including Bodega Bay operate in nearshore waters north to Fort Ross, while CPFVs from Bodega Bay and Tomales Bay may operate south to Point Reyes. Several CPFVs conduct single-day trips to the Farallon Islands. Additionally, many San Francisco Bay-based CPFV operators make ocean trips. CPFVs from Princeton and Half Moon Bay tend to fish in nearshore waters between Pillar Point and Pigeon Point. CPFVs generally target salmon, California halibut, rockfish, and may also target Dungeness crab. Within the NCCSR recreational crabbing effort is concentrated near the Russian river mouth, north of Bodega head, outer Bodega Bay 10 Mile Beach, and along a 40 fm contour out to the Farrallon Islands. For more information see maps [11a](#), [11b](#), [11c](#) and Appendix IV.

Private and Rental Skiffs

Private and rental skiffs, with some exceptions, generally fish closer to port or launch ramp areas than CPFVs, although salmon and albacore anglers may travel considerable distances. The port areas for private and rental boats within the study region are generally the same as those for CPFVs. Additionally, various boat ramps and launch facilities are used; some of which include, Timber Cove, Westside Ramp, Doran Park, Lawson’s Landing, Miller Park, Sausalito, Berkeley, Estuary Park, Oyster Point, Ocean Cove, Anchor Bay and Princeton (see maps [14a](#), [14b](#), [14c](#), [14d](#), [14e](#), [14f](#)). More information on this mode is located in Appendix IV.

The coastline near Bodega Bay, along the ocean side of Marin County, Half Moon Bay and Pescadero Point receive the majority of the private and rental skiff effort for rockfish. However some rockfish/lingcod fishermen often travel farther to find good fishing, and during fair weather or in larger boats anglers will venture well offshore, including to the Farallon Islands. Halibut fishermen fish around Bodega Bay, Tomales Bay, and Point Bonita. Albacore and salmon fishermen may travel to the Gulf of the Farallones or even outside the islands. Within the NCCSR recreational crabbing effort is concentrated near the Russian river mouth, north of Bodega head, outer Bodega Bay 10 Mile Beach, and along a 40 fm contour out to the Farrallon Islands.

Consumptive Diving

One form of recreational fishing not sampled by the CRFS program is the consumptive dive charter industry. Within this study region only a few such boats operate; vessel owners are

required to submit CDFG logbooks summarizing their activities. Target species include rockfish, lingcod, cabezon, and California halibut. Appendix IV describes this fishery in further detail.

Kayaks

Kayak fishing generally has a range of 5 miles from any publicly accessible beach or other launch site. Furthermore, kayakers also require calm bays or beaches to launch from. A 46-page report compiled by the Kayak Fishing Association of California lists the most frequently used launch sites from Point Conception to Point Arena (http://www.dfg.ca.gov/mrd/mlpa/pdfs/comments/kfasc_030805.pdf). Another good source of launch site information is the NorCal Kayak Anglers website (<http://www.norcalkayakanglers.com>). Additionally, stakeholders have identified several launch sites that are of particular importance and the target species generally sought at each location (see Appendix IV(f)).

Kayak fishing effort and catch data may be captured by the CRFS program where launch sites overlap with sample sites. However, it is generally acknowledged that CRFS does not fully capture kayak fishing effort. Kayaks are often used for multiple fishing modes, including angling and consumptive diving (spear fishing and abalone). Due to the multiple-use nature of kayak fishing it is difficult to quantify the importance of the various fisheries. Some important areas in the NCCSR are Bean Hollow State Beach, Pedoti, Goat Rock, Anchor Bay, and the area around Jenner.

Shore-Based Modes

Shore based consumptive diving is not directly sampled by the CRFS program. There are no reporting requirements for this group except abalone are reported through CDFG's abalone report card program as described below. Stakeholder input during the MLPA initiative process will be needed to describe these modes of fishing.

Beach and Bank

The beach and bank mode consists of shore-based anglers but also includes divers or anglers entering the water in kayaks, royaks, or on other floatation devices directly from the shore. This shore-based mode is sampled by CRFS. Primary target species/species groups in this region are surfperches, jacksmelt, anchovy, halibut, nearshore rockfishes, including greenlings, lingcod, and cabezon.

Some of the frequently used shore access areas in ocean and estuarine waters north of the San Francisco Bay entrance include Point Arena, Anchor Bay, Ocean Cove, Timber Cove, Fort Ross, Goat Rock, Doran, Lawson's Landing, and Point Reyes. South of the San Francisco Bay entrance shore access points include Baker Beach, Pillar Point, Princeton, and Half Moon Bay. Access points can be found in maps [14a](#), [14b](#), [14c](#), [14d](#), [14e](#), [14f](#). More information on this mode is located in Appendix IV.

Manmade Structures

Manmade structures consist of piers, jetties and breakwaters; if these structures are public a fishing license is not required. This mode is sampled by CRFS. These structures are relatively limited outside of San Francisco Bay within the north central coast study region. Some of these

include; Doran, Lawson's pier, Fort Baker, Pacifica pier, and Princeton pier and jetty (maps [14a](#), [14b](#), [14c](#), [14d](#), [14e](#), [14f](#)). For more information on pier fishing in the NCCSR see Jones 2004 ("Pier Fishing in California-The Complete Coast and Bay Guide, 2nd Edition").

Primary target species/species groups in this region for anglers fishing from manmade structures are Pacific sardine, northern anchovy, jacksmelt, surfperches, white croaker, several nearshore rockfishes, cabezon, and monkey-face prickleback. More information on this mode is located in Appendix IV.

Poke-poling

This mode of fishing is usually done in rocky intertidal areas and jetties at lower ocean tides. Target species include lingcod, cabezon, nearshore rockfish, sculpin, monkey-face prickleback, and the rock prickleback. Poke-poling is sometimes captured by CRFS as "hook and line", but is dependent on whether a CRFS sampler makes contact with people poke-poling.

Free-diving and Shore Picking – Abalone

Free-diving and shore picking modes include anglers harvesting red abalone from rocky intertidal and subtidal zones (north of the golden gate bridge). Free-divers enter the water from skiffs, kayaks, or shore and are prohibited from using SCUBA or "Huka" equipment to harvest red abalone. Anglers also harvest red abalone by wading out into the shallow rocky intertidal areas at low ocean tides and pick abalone out of the rocks and crevices.

The recreational red abalone fishery is another fishery not sampled by the CRFS program. Instead, red abalone catch is reported through a report card system. Anglers wishing to collect abalone are required to purchase an abalone report card. On the report card abalone catches must be reported for every fishing day as well as the general location from which they were harvested. CDFG summarizes annual catch and effort data from returned cards. Abalone punch card reporting locations are shown on map [13a-13c](#).

It is legal to harvest red abalone north of a line drawn due west magnetic from the center of the mouth of San Francisco Bay. Abalone is harvested in intertidal areas during negative low tides or while free diving. Free divers either swim out from shore, or use boats or kayaks to reach the dive sites. Important sites include Fort Ross, Fort Ross Reef Camp, Salt Point, Sea Ranch, Arena Cove, Point Reyes, Tomales Point, and Bodega Head (maps [13a-13c](#)). However, during abalone season nearly every accessible cove in Sonoma and Mendocino counties, where effort is greatest, may experience harvesting.

Another area used by recreational red abalone fishermen is located approximately one mile south of Point Arena at Stornetta Ranch. Prior to June 2004, the area was subject to minimal abalone harvest and had high intertidal population estimates. Stornetta Ranch was transferred from private ownership to the Bureau of Land Management (BLM) in June 2004, and has since been exposed to higher recreational harvest levels. An estimated 97,000 abalone trips were made in 2002, 110,000 trips in 2003, and 104,000 trips in 2004 (BLM 2007, PISCO 2007, Rogers-Bennett 2004)

Abalone creel and index sites exist throughout the study region. These sites provide important catch and effort data through angler contact during creel surveys and periodic subtidal SCUBA assessments provide population trend information and density data in these areas. The creel survey sites exist in high use areas for red abalone harvesting and provide indices for management measures. There are a total of 8 abalone index sites along the northern coast of California, 5 of which are within the NCCSR. Index sites are located in locations with varying level of effort. Index sites within the study region are located at the following sites (relative level of effort is indicated in parenthesis):

- Arena Cove (High use)
- Salt Point (High use)
- Timber Cove (Moderate use)
- Ocean Cove (Moderate use)
- Fort Ross (High use)

Information collected from index sites may be used to adjust the annual total allowable catch for the recreational abalone harvest based on evidence of recruitment and density conditions at abalone index sites (Abalone Management and Recovery Plan-CDFG 2005b). These abalone index sites are shown on maps [13a-13c](#). More information on this fishery is located in Appendix IV.

Clamming

Clamming involves anglers digging into mud or sand flats with rakes, shovels, or trowels to harvest clams out of the substrata. Target species of clam include common littleneck clams, Washington clams, gaper clams, and occasionally geoduck clams at extreme negative ocean tides. Recreational clamming effort in the NCCSR is mostly concentrated within and around Bodega and Tomales Bay. Significant clamming areas include Bodega Bay, Doran Beach, Clam Island, and Seal Island near the mouth of Tomales Bay. Target species include Gaper clams, Common Littleneck clams, Washington clams, and occasionally Geoduck clams at extreme minus ocean tides. Effort data is limited for the recreational clamming fishery, however, data from the 1980's showed that approximately 50,000 gaper clams were harvested annually from the Tomales Bay area (Kalvass presentation NCCSRG meeting August 22, 2007)

Spearfishing

Information on spearfishing in the NCCSR is sparse, and sampling of this mode of fishing is periodically focused without comprehensive information. Cen Cal spearfishing competitions have been sampled sporadically CDFG biologists over the years. Historically some of these locations were Anchor Bay, Ocean Cove, Salt Point, Timber Cove, Fort Ross, and Sharp Park. Some target species for this mode are cabezon, nearshore rockfish, kelp and rock greenling, lingcod, monkey-face prickleback, and California halibut.

5.6.2 Recreational Fishing Effort

Estimates of effort, in terms of angler days, are calculated differently for each of the fishing modes in the CRFS program, all of which differ from the way historical programs computed effort. Effort sampling at man-made structures is done by a unique “roving site cluster” method. Effort is determined by counting anglers on the structures during time intervals and interviewing them for average trip duration to account for angler turnover. The average fishing trip time, average interval count, and average daylight hours are used to calculate average daily angler trips for weekend days and weekdays. These data are then expanded to the number of days by day-type in the month and months are summed for the total effort for the year.

Recreational fishing effort in angler-days differs by fishing mode in the north central coast study region (Table 22). In 2006 shore-based angling, fishing from man-made structures and beach and bank, accounted for 64% of the fishing effort that is sampled by the CRFS program in the north central coast study region. Fishing from CPFVs or private and rental boats accounted for 36% of all fishing effort. Within each of those modes, man-made structures accounted for 47% of all fishing while fishing from CPFVs only comprised 11% of all fishing.

Table 22: 2006 Estimated Angler Days by Fishing Mode

Fishing Mode	Effort (angler days)
CPFVs ¹	66,584
Private and Rental Boats ¹	151,805
Beach and Bank ¹	100,815
Man-made structures ²	280,917

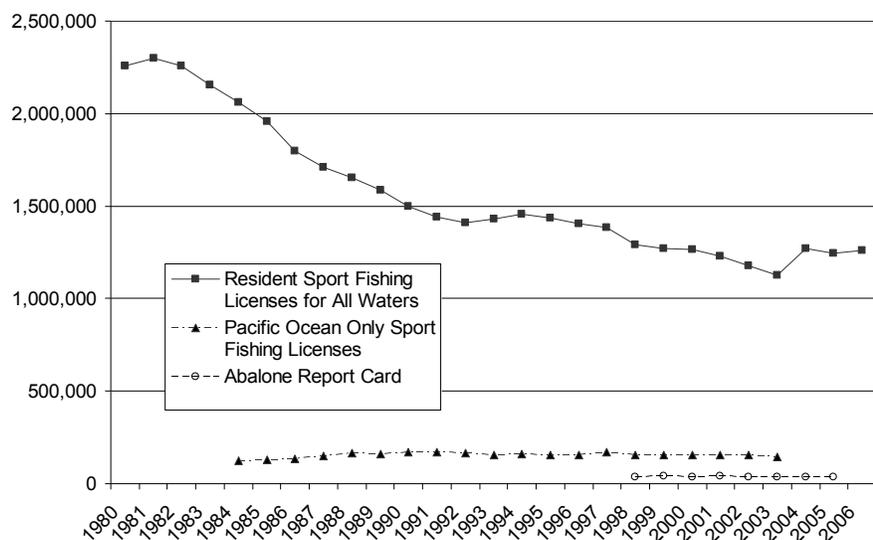
¹ Estimate derived from CRFS database for all of San Francisco and Wine districts for ocean only trips

² Estimate derived from CRFS database and includes only ocean sites and only sites in Mendocino County within the study region, does not include Tomales Bay

Trends in recreational fishing license sales and boat registrations for CPFVs have not mirrored the trend of an increasing human population in California. Recreational resident fishing license sales for all waters (inland and ocean) declined steadily from approximately 2.25 million in 1980 to approximately 1.27 million in 2000. This represents a 44% decrease in a 20-year period. However, a small but sharp increase occurred from 2003 to 2004 and in the last 3 years sales have remained fairly stable (Figure 18).

The trend in the sale of Pacific Ocean only sport fishing licenses is quite different (Figure 18). CDFG issued this type of license from 1984 to 2003. From 1984 to 1991 license sales increased by 37%, then gradually declined by 16% during the next 12 years to a level higher than that in 1984. The sharp rise in resident sport fishing licenses for all waters in 2004 is likely due to the halt of sales of Pacific Ocean only licenses after 2003.

Figure 18: Resident Sport Fishing Licenses for All Waters; Pacific Ocean Only Sport Fishing Licenses; and Abalone Stamps: 1980-2006



CDFG began selling abalone report cards in 1998. Abalone report card sales from 1998 to 2005 have remained fairly stable, ranging from 35,180 to 40,841, respectively (Figure 18). The proportion of all sport fishing license buyers who also purchased abalone stamps ranged from 28% to 33% between 1998 and 2005.

Data are not available for the number of CPFV registrations in the north central coast study region. However, as a proxy, data are available which show the number of registered CPFVs in the north central coast study region which have submitted logbooks; this is representative of the active CPFVs in the region. The number of CPFVs in the study region that submitted logbooks annually from 2004 to 2006 were 106, 100, and 78 respectively. These represent 24%, 22%, and 18% of the logbooks submitted for the entire state for those years.

5.6.3 Distribution of Recreational Fishing Effort

Recreational fisheries within the north central coast study region which have the greatest potential to be impacted by the implementation of new or expanded MPAs are those which target primarily residential, non-migratory species. These include the following: nearshore and shelf rockfishes, lingcod, cabezon, kelp greenling, California halibut, jacksmelt, surfperches, Dungeness crab, and red abalone.

Spatially explicit data on recreational fishing effort are provided from these primary sources:

1. For CPFV fishing targeting rockfish, California halibut, and salmon, CDFG has compiled landing data (for the sampled trips by microblock) from 2004 thru 2006. This provides an estimate of the relative number of fish landed in discrete locations, which is in turn an estimate of the relative value of particular locations to the CPFV industry. The data are

available as a series of maps panning the north central coast study region, with the number of landed California halibut, rockfish, and salmon by different colors (maps [11a](#), [11b](#), [11c](#)). Note that some data recorded on these maps is inaccurate, specifically offshore microblocks which display catch or effort data higher than what is possible for those fisheries.

2. For private and rental boat recreational fishing, CDFG has compiled spatially-explicit data within the MLPA Initiative north central coast study region from 2004, the first year of the California Recreational Fisheries Survey program thru 2006. While these data are depth-limited in scope for bottom-oriented fishes due to regulations, they are the only data available with this degree of resolution for private and rental boat fishing. Data are presented on microblock (one minute of latitude by one minute of longitude) maps with colors representing the total number of sampled trips targeting the California halibut, rockfish complex, and salmon to each microblock (maps [12a](#), [12b](#), [12c](#)). It is important to note that these data include fishing trips in which no catch occurred. The microblocks compiled in this data set are those reported by the fishermen to the samplers. Also note that some data recorded on these maps is inaccurate, specifically offshore microblocks which display catch or effort data higher than what is possible for those fisheries.
3. For red abalone, CDFG has summarized landings from submitted abalone report cards. These data are available as summary data for the nearest access points (maps [13a-13c](#)). Since 2002 regulation changes further limited the daily and annual take of red abalone. Nevertheless, summary data indicate the importance of particular sites to abalone fishermen. Areas with high abalone catches are either representative of easy access and therefore high use and/or are more productive areas and experience a higher catch per unit effort.

5.6.4 Recreational fishery profiles

Seven profiles are provided in Appendix IV for recreational fishing in the north central coast study region:

- a) Commercial passenger fishing vessels (CPFVs)
- b) Private and rental skiffs
- c) Beach and bank fishing
- d) Fishing from manmade structures
- e) Consumptive diving (charter and private/ shorebased)
- f) Kayak fishing
- g) Free-diving and shore-picking

Each of the recreational fishery profiles in Appendix IV is organized as follows:

- Port area
- Fishing mode
- Species targeted
- Estimated number of fishing trips from 2004 to 2006 in study region by target species
- 2004 to 2006 estimated catch (number of fish)

- 2004 to 2006 estimated catch (weight of fish)
- Comments
- Primary depth range in which fishing occurs
- Primary area of fishery (state waters and/or federal waters)
- Synopsis of regulations applicable to the north central coast study region

5.6.5 Commercial and Recreational Fisheries

Relative importance. Many species are harvested by both commercial and recreational fisheries. The market categories with measured landings from both commercial and recreational fisheries are provided below in Table 23. Unfortunately, due to changes in sampling protocol, as discussed above in section 5.6, recreational landings (for species other than Chinook salmon) are not comparable for years before 2004, so average annual landings for 2005 and 2006 are provided to show the relative importance of the commercial and recreational sectors. Dover sole, grenadier, sablefish, and thornyheads had no recreational landings in 2005 or 2006 so were not included in Table 23.

Ocean Salmon Project: CDFG’s Ocean Salmon Project has surveyed both commercial and recreational salmon fisheries since 1986. Consequently, we are able to provide a longer time series of commercial/recreational data for Chinook salmon (Table 24). From 1989-2006, the number of commercial salmon vessel permits issued by CDFG decreased from 5,429 to 1,554. Although the data does not show a steady increase in the proportion of salmon harvested by the recreational sector during this period, 2006 had the highest recreational proportion of harvest during the 15-year period, and 1986-90 had the lowest. In general, the proportion of harvest by the recreational sector is increasing in this region.

Table 23: Average Annual Landings (2005–2006) for Commercial and Recreational Fisheries within the North Central Coast Study Region

Market Category	Commercial ¹		Recreational ²	
	Average of 2005 & 2006 Landings (lbs)	% of Total	Average of 2005 & 2006 Landings (lbs) ¹	% of Total
Nearshore Rockfish	37,821	5.4	664,655	94.6
Shelf Rockfish	45,699	56.0	35,910	44.0
Flatfish Other	568,317	99.9	209	0.1
Cabazon	8,015	13.2	52,872	86.8
California Halibut	517,260	85.4	88,707	14.6
Coastal Pelagics ³	364,684	91.7	10,937	2.9
Lingcod	27,018	6.1	412,463	93.9
Greenling (rock & kelp)	425	0.3	120,956	99.7
Chinook Salmon ⁴	108,850	64.1	61,050	35.9
Sanddabs	131,677	94.1	8,319	5.9
Tuna	23,217		-NO DATA-	
Surfperch	10,008	15.2	55,799	84.8
Sharks, Skates & Rays	35,757	50.6	34,954	49.4

Market Category	Commercial ¹		Recreational ²	
	Average of 2005 & 2006 Landings (lbs)	% of Total	Average of 2005 & 2006 Landings (lbs) ¹	% of Total
Croaker	12,069	43.7	15,568	56.3
Dungeness Crab ⁵	5,194,651		1,774	
Smelt	5,418	72.0	2,106	28.0

¹Commercial fishery information is from the CFIS database (extraction date: March 14, 2007) estimates include landings from Point Arena and Anchor Bay ports, Bodega Bay port complex and San Francisco Bay port complex and includes both state and federal waters.

²Estimates derived from Recreation Fisheries Information Network database, includes all ocean waters in the San Francisco and Wine districts except for waters of the San Francisco Bay. The Wine district includes Sonoma and Mendocino counties with portions of Mendocino outside the study region (these are draft and will be updated to include only those portions with-in the study region when available).

³Coastal pelagics include Pacific sardines, Pacific anchovy and Jack mackerel.

⁴Salmon reported in numbers of fish not pounds.

⁵Recreational Dungeness crab landings are reported in numbers not pounds

Table 24: Estimated Chinook Salmon Harvest in the North Central Coast Study Region* from 1986 to 2006

Year	Commercial		Recreational		Total (1000s of fish)	No. Commercial Permits
	1000s of fish	% of Total	1000s of fish	% of Total		
1986-90	1,755.6	94.7%	98.3	5.3%	1,853.9	5,429 (1989)
1991	174.8	82.4%	37.3	17.6%	212.1	4,705
1992	95.8	67.0%	47.2	33.0%	143	3,444
1993	155	66.3%	78.7	33.7%	233.7	3,455
1994	219.9	60.9%	141	39.1%	360.9	3,056
1995	357.5	69.7%	155.7	30.3%	513.2	3,224
1996	167.4	66.5%	84.5	33.5%	251.9	2,435
1997	253.5	67.2%	124	32.8%	377.5	2,273
1998	126.1	64.0%	71	36.0%	197.1	1,986
1999	181	72.3%	69.3	27.7%	250.3	1,957
2000	250.4	79.5%	64.7	20.5%	315.1	1,944
2001	136.6	77.4%	39.9	22.6%	176.5	1,839
2002	242.9	73.6%	87	26.4%	329.9	1,865
2003	202.9	78.2%	56.6	21.8%	259.5	1,720
2004	298.2	69.6%	130.2	30.4%	428.4	1,764
2005	170.5	70.1%	72.8	29.9%	243.3	1,697
2006	47.2	48.9%	49.3	51.1%	96.5	1,554
1991-2006 Average	192.5	69.6%	81.8	30.4%	274.3	2,432.4

*North Central study region includes ports of Bodega Bay, Sausalito, Berkeley, Emeryville, San Francisco and Princeton (Half Moon Bay).

5.7 Scientific Collecting

Title 14, Section 650 of the California Code of Regulations, authorizes the take or possession of marine plants or animals for scientific, educational, or propagation purposes with a permit issued by CDFG. Permits may be issued to:

1. Employees of local, state and federal agencies who take specimens in connection with their official duties.
2. Faculty, professional staff, college level students of, or individuals hired by public or private companies, educational institutions, zoological gardens or aquariums, in or out of state.
3. Individuals who take wildlife or marine plants for other permittees or pursuant to environmental protection documents required by law.
4. Individuals who possess a valid federal Bird Marking and Salvage Permit. Holders of this federal permit are not required to obtain a state permit to take migratory birds, other than raptorial birds.

There are three types of permits: resident, non-resident, and student. Resident and non-resident permits are valid for two years, and student permits are valid for one year. Each permit is reviewed and approved on a case-by-case basis. In some areas, such as in Marine Protected Areas, additional specific restrictions may be applied; however, scientific collecting may be allowed on a case-by-case basis in all three classifications of state MPAs. There are standard exceptions to the scientific collecting permit, including state- and federally-listed species, for which additional state and/or federal authorizations must be obtained.

Permit requestors must indicate on their application the following components:

1. species and numbers to be collected
2. collection locations
3. methods/techniques
4. purpose for collecting
5. disposition of specimens

CDFG has an electronic database for processing scientific collecting permit applications, which is recorded on a statewide basis. The total number of permits issued in California from 1989 through 2006 is shown in Table 25. The trend in the number of permits issued clearly reflects the bi-annual permit cycle from 1989 through 2001, with a relatively constant trend in number of permits issued. From 2002 forward, an annual cycle emerged. From 1991 to 2001 the number of permits issued was relatively constant every other year, until 2002 when this pattern is no longer apparent. The highest numbers of permits issued since the database began were in 2004 and 2005.

Scientific collecting permits are authorized by type of organism to be collected (e.g. marine fishes, freshwater fishes, amphibians, mammals, birds). Authorization categories for marine

organisms are marine fishes, marine aquatic plants, and marine invertebrates. Table 26 shows number of permits issued in California for marine authorizations in 2005 and 2006.

One condition of the scientific collecting permit is that the holder must submit a Report of Specimens Collected or Salvaged within 30 days of permit expiration. To determine the types of organisms and locations collected within the north central coast study region, reports submitted during the past year-and-a-half were reviewed. There were 65 reports filed during this period for the north central coast study region, reflecting collections made from 1999 through 2006, although it must be noted that compliance with report submission is not 100 percent. Of these reports, 94 percent of permits were for marine invertebrates, 49 percent were for marine fishes, and 32 percent were for marine plants (note that multiple species can be authorized on a single permit, so that these numbers do not total 100%). In addition, one leatherback turtle was captured and salvaged in 2004 off of San Francisco. See Table 27 for a breakdown of reports submitted by subregion in the north central coast study region. By far, the highest number of collections were reported in subregion 3, due to the high incidence of collections within and around Bodega Bay. Table 28 lists the reported methods of capture identified in the 65 analyzed reports.

In addition, the National Park Service has a scientific collecting permitting program (see <http://science.nature.nps.gov/research/ac/ResearchIndex>). Roughly 25 % of the permits are issued for studies in the marine environment.

Table 25: Number of scientific collecting permits issued by CDFG statewide, 1989-2006

Year	Number of Permits
1989	1,654
1990	455
1991	1,347
1992	812
1993	1,229
1994	931
1995	1,207
1996	989
1997	1,212
1998	913
1999	1,169
2000	975
2001	1,078
2002	1,218
2003	1,306
2004	1,740
2005	1,717
2006	1,492

Table 26: Number of scientific collecting permits with marine organism authorizations issued by CDFG statewide, 2005 and 2006.

Year	Number of Unique Scientific Collection Permits			
	Marine Fishes	Marine Aquatic Plants	Marine Invertebrates	Marine Fishes, Aquatic Plants and Invertebrates*
2005	542	473	700	830
2006	592	470	674	805

* Each permit may have multiple authorizations, and therefore the numbers are not additive.

Table 27: Percent Scientific Collecting Permit reports filed in each subregion of total submitted for North Central Coast study region (65), over 1-1/2 year period

Subregion No.	Subregion Name	Percent of Scientific Collecting Permits for which Reports were Filed*
1	Alder Creek/Point Arena to Horseshoe Point	12%
2	Horseshoe Point to Bodega Head	18%
3	Bodega Head to Double Point	62%
4	Double Point to Point San Pedro	12%
5	Point San Pedro to Pigeon Point	23%
6	Farallon Islands	3%

*Each report may cover multiple subregion

Table 28: Methods of capture used for scientific collecting permits within the North Central Coast Study Region, and number of times the method was used

Capture method	Number of times used* (sorted by most common method)
Hand	39
Seine net	10
Hook & line	5
Dip net	4
Traps	3
Scuba	3
Hand net	3
Core	2
Crab net	2
Trawl net	2
Minnow trap	2
Shore picking	1
Intertidal	1
Knife	1
Shovel	1

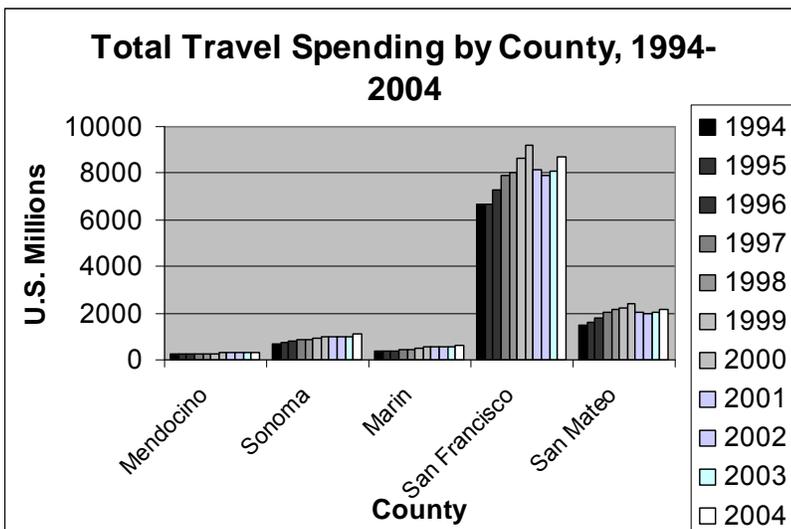
Hammer/chisel	1
Gill net	1
Box trap	1
Slurp gun	1
Fouling panel	1
Settlement plate	1
Free diving	1
Electrofishing	1

*Tallied by permit

5.8 Coastal Tourism

California is the most visited state in the U.S., and travel and tourism comprise the fourth largest industry and employer in the state. Total direct travel spending in California was \$88.1 billion in 2005, a 7.6 percent increase over the preceding year. The year 2005 was the third straight year of positive growth and the greatest increase since 2000. During 2005, travel spending in California directly supported nearly 912,000 jobs, up 5.4 percent from 2004 figures. Travel spending generated the greatest number of jobs in food service (263,300); arts, entertainment and recreation (229,100); and accommodations (202,900). Californians account for 83% of all domestic visitors to the state (California Travel and Tourism Commission 2006).

Figure 19: Total Travel Spending by County, 1994-2004



Source: California Travel and Tourism Commission 2006

Coastal tourism alone in California generates \$9.9 billion in revenue annually (Gulf of the Farallones National Marine Sanctuary 2006). Visits to the beach and waterfront activities are the fourth most popular expenditure-based activities after “dining, shopping and entertainment”, “sightseeing”, and “theme and amusement parks” (California Travel and Tourism Commission 2006). Tourism and recreation are economic drivers in the north central coast study region.

Within the study region, San Francisco County has the highest travel spending, varying between \$6.6 and \$9.2 billion between 1994 and 2004. San Mateo, Sonoma, Marin, and Mendocino fall significantly below the travel spending in San Francisco County (see Figure 20).

The counties within the study region boast the first, fourth and fifth most popular national parks in the state, including the Golden Gate National Recreation Area (13,602,629 visitors in 2005), Point Reyes National Seashore (1,988,585), and the Fort Point National Historic Site (1,682,041) (California Travel and Tourism Commission 2006).

The Sonoma Coast State Beach is overwhelmingly the most popular state park adjacent to the shore within the study region with approximately 3 million visitors annually and is the third most visited state park in the entire state (see Table 29).

Table 29: Ten Most Frequently Visited California State Parks Adjacent to the Shore in Study Region

Park Name	County	Total Attendance (Fiscal Year 2004/2005)
Sonoma Coast State Beach	Sonoma	3,059,141
Half Moon Bay State Beach	San Mateo	838,872
Mt. Tamalpais State Park	Marin	411,907
San Gregorio State Beach	San Mateo	392,582
Pescadero State Beach	San Mateo	383,480
Bean Hollow State Beach	San Mateo	284,763
Salt Point State Park	Sonoma	281,983
Pomponio State Beach	San Mateo	184,317
Fort Ross State Historic Park	Sonoma	135,596
Ano Nuevo State Reserve	San Mateo	126,816

Source: California Department of Parks and Recreation 2006

5.9 Non-consumptive Uses

Non-consumptive uses include beach-going, swimming, surfing, kayaking, diving, wildlife viewing, photography, and other activities that do not involve the take or extraction of marine resources. In 1999 and 2000, more than 43% of all Americans participated in some form of marine recreation. Americans flock to beaches and shores to swim, fish, boat, and view the natural scenery. 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. 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 30 (Leeworthy 2001).

The National MPA Science Center and the Marine Biology Conservation Institute (MCBI) have conducted a pilot study of non-consumptive use focused on identifying use pattern for four user groups: kayaking, diving, whalewatching and wildlife viewing, and tidelpooling. Data will be available from that study in October 2007.

Table 30: Participation in Coastal Recreation in California

Coastal Activity	Estimated Numbers Statewide for California
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.

5.9.1 Recreational Beach Use

The study region’s approximately 367.6 miles of coastline provide not only these intrinsic natural and aesthetic values, but also recreational opportunities for its users and great economic benefits to the local, regional, and state economies. 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 beaches in the study region from user fees and concessions were approximately \$2.5 million during the 2004/2005 fiscal year (Table 31) (California Department of Parks and Recreation 2006).

Table 31: California State Park Revenue for Parks Located Adjacent to Shore in North Coast Study Region 2004/2005

California State Park	County	Total Revenue (Fiscal Year 2004/2005) ¹
Half Moon Bay State Beach	San Mateo	\$605,049
Sonoma Coast State Beach	Sonoma	\$578,847
Ano Nuevo State Reserve	San Mateo	\$245,670
Salt Point State Park	Sonoma	\$230,038
San Gregorio State Beach	San Mateo	\$144,874
Fort Ross State Historic Park	Sonoma	\$127,539
Tomales Bay State Park	Marin	\$69,850
Manchester State Park	Mendocino	\$47,221
Pomponio State Beach	San Mateo	\$27,939
Pescadero State Beach	San Mateo	\$4,356
Gray Whale Cove State Beach	San Mateo	\$446
Bean Hollow State Beach	San Mateo	\$0
Montara State Beach	San Mateo	\$0
Schooner Gulch State Beach	Mendocino	\$0
Pigeon Point Lighthouse State Historic Park	San Mateo	\$0
Marconi Conference Center State Historic Park	Marin	\$0
Point Montara Light Station	San Mateo	\$0
Thornton State Beach	San Mateo	\$0
Pacifica State Beach	San Mateo	\$0

Source: California Department of Parks and Recreation 2006 ¹. Some state parks do not charge an entrance fee nor a parking fee. Therefore, there is no revenue listed for these parks.

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. This value, known as consumer surplus, has been estimated to range from a low of \$10.98 (in 2001 dollars) for visits to Cabrillo Beach in Los Angeles County to a high of over \$70 (in 2001 dollars) per person per trip for visits to San Diego beaches. Using a fairly 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 estimate the non-market value of beach visits in California to be approximately \$2.5 million annually (Kildow and Colgan 2005).

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).

The study region’s miles of beaches, from narrow cove beaches flanked by rocky cliffs and containing some rocky intertidal area, to long strips of sand, offer non-consumptive recreational activities such as swimming, sunbathing, boating, diving, sightseeing, hiking, surfing, kayaking, canoeing, whale watching, and tidepooling, to name a few.

There are numerous beaches in the study region. The Point Reyes National Seashore and the Golden Gate National Recreation Area, for instance, have many beaches that are visited by the public, with Ocean Beach being the most visited beach. Other important beaches include Rodeo Lagoon Beach, Baker Beach and Stinson Beach of Golden Gate National Recreation Area, and RCA Beach, Limantour Beach, Drakes Beach, and the Great Beach of Point Reyes National Seashore. Additionally, there are several beaches in Tomales Bay within the Point Reyes National Seashore which issue permits to the public for camping.

Approximately 1.1 million surfers live in California, surfing at popular spots along the coast, many of which are in the study region (NOAA 2000). Table 32 lists some surf spots in the region.

Table 32: Surfing Spots in the Study Region

Location in Region	Name of surfing location		
Mendocino County south of Alder Creek and Sonoma County	Manchester Point Arena Salmon Creek	Black Point Beach Doran Beach	Russian Rivermouth
Marin County	Dillon Beach Bolinas Drakes Beach	Point Reyes (north) Stinson Beach	Point Reyes (south) Rodeo Beach
San Francisco County	Potato Patch	Fort Point	Ocean Beach
San Mateo County north of Pigeon Point	Sharp Park Pedro Point Mavericks Martin’s Beach	Rockaway Montara Princeton Jetty Tunitas Creek	Linda Mar Ross’ Cove Half Moon Bay Pescadero

Source: www.surflife.com

The *California Coastal Access Guide* describes each coastal area along California’s 1,100 miles of continent abutting the Pacific Ocean. There are dozens of coastal destinations between Point Arena in Mendocino County and Pigeon Point, the region encompassed in this study (Table 33).

Table 33: Facilities at Beaches in the North Central Coast Study Region

County	# Campgrounds	# Stairways to Beach	# Paths to Beach	# Hiking Trails	# Boating Facilities	# Fishing Sites
Mendocino	1	1	9	0	1	8
Sonoma	8	6	20	13	2	15
Marin	9	0	26	29	4	7
San Francisco	1	1	7	8	0	1
San Mateo	4	8	14	14	1	13

(Source: California Coastal Commission, *California Coastal Access Guide*, 1997)

5.9.2 Boating

Boating is a popular as well as economically important activity in the north central coast study region. In 2000, over four million people in California were involved in activities related to marine boating (California Resources Agency 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).

The California Department of Boating and Waterways published a report titled “California Boating Facilities Needs Assessment” (California Department of Boating and Waterways, 2002) as a survey and assessment of boating and boating facilities needs in California. The California Boating Facilities Needs Assessment (BNA) breaks the state into regions, two of which encompass the north central coast study region. The North Coast region of the BNA includes Del Norte, Humboldt, Mendocino, and Sonoma Counties. The San Francisco Bay Area region includes Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, and Solano Counties. The following statements provide an overview of information about boating in these two BNA regions.

The offshore waters in the North Coast BNA region are cold and hazardous, and do not attract many pleasure cruising vessels. More boats are used for commercial fisheries than for recreational activities. This was the only region in the Department of Boating and Waterways report for which this was true. However, boat ownership within the North Coast BNA region was found to be “relatively high for its small population,” with almost 5 boats per 100 people. This is in spite of the fact that boating facilities in this region represent only 5 percent of facilities statewide. The BNA “top ten waterways” for the North Coast region included the marine waterways of the Pacific Ocean, Bodega Bay, and Tomales Bay.

Boat ownership in the San Francisco Bay Region of the BNA was average for the state, with 2.45 boats per 100 people. With numerous launch ramps in the bay, most boating activity took place within the San Francisco Bay and the Sacramento-San Joaquin Delta, but the Pacific Ocean was listed as one of the “top ten waterways.” Table 34 summarizes some additional relevant information from the BNA.

Table 34: Boats and boaters information summarized from California Boating Facilities

BNA Region	Total Registered/ Documented Vessels	Mean # of Trips in 2000	Top 5 Reasons Identified for Using a Waterway	Marine Areas Identified in “Top 10 Waterways” List
North Coast	34,643	20.2	Good fishing, close to home, convenience, near vacation home or camps, large water area, good sailing	Pacific Ocean, Bodega Bay, Tomales Bay
San Francisco Bay	158,223	25.0	Close to home, good fishing, convenience, near vacation home or camp, pleasure	Pacific Ocean

Source: California Department of Boating and Waterways 2002

Non-Consumptive Boat Data from CDFG recreational survey: The California Recreational Fisheries Survey (CRFS) is a cooperative program of the California Department of Fish and Game, the Pacific States Marine Fisheries Commission, and the National Marine Fisheries Service. CRFS staff conducts interviews of anglers returning to public launch ramps as part of the data collection for recreational fishing effort and catch estimates. Under the Primary Private Boat Survey, boaters are interviewed at primary launch ramps approximately eight days per month (Van Buskirk, Pacific States Marine Fisheries Commission 2007). “Primary” launch ramps are defined as “those where the majority of the managed species, in any particular month, are landed” (Pacific States Marine Fisheries Commission 2007). Supplemental data collected include the number of private and rental boats that are not recreationally fishing for finfish. Table 35 summarizes CRFS survey results of boat trip types from January through November 2006 for Bodega Bay and Pillar Point Harbor, which are the two “primary” launch ramps that occur within the north central coast study region. Data represent totals for survey days only (approximately 8 days per month, 11 months), not estimated totals for the year.

The CRFS program also surveys three primary launch ramps located around San Francisco Bay: Berkeley ramp, Grand Street ramp in Alameda County, and Clipper Launch ramp in Marin County. There were 763 boats that fished recreationally for finfish in the open ocean from these ramps during January through November 2006. CRFS does not note the location where non-fishing activities took place. Since activities taking place within the San Francisco Bay are not in the north central coast study region, and ocean trips could not be separated from bay trips, non-fishing data for primary ramps in San Francisco Bay are not presented here.

For the two primary launch ramps within the north central coast study region, CRFS samplers intercepted 4,317 private and rental boats upon return to port; almost 97 percent of the intercepted boats had fished or intended to fish recreationally. Less than one percent were commercial fishing vessels. The remaining 2.7 percent were involved in nonconsumptive activities, including sightseeing, sailing, research, and vessel maintenance. These proportions should not be seen as representing the complete picture of boating activities within the north

central coast study region, since primary ramps represent only a fraction of total launching facilities.

Table 35: Number of Trailored Private and Rental Boats surveyed by CRFS in the months January through November 2006

Type of Activity	Number of Counted Vessels			Percent of Total
	Bodega Bay	Pillar Point	Total	
Fished recreationally for finfish	2,347	1,766	4,113	95.3
Fished recreationally for invertebrates	26	21	47	1.1
Intended to fish recreationally but no gear in water	6	7	13	0.3
Total recreational fishing	2,379	1,794	4,173	96.7
Fished commercially	19	10	29	0.7
Total Vessels Fishing	2,398	1,804	4,202	97.3
Sailing/sightseeing	12	13	25	0.6
Non-consumptive diving	0	0	0	0
Maintenance	5	11	16	0.4
Enforcement (public agency)	1	0	1	0.0
Research (public agency)	4	1	5	0.1
Personalized Watercraft	0	0	0	0
Removing boat from harbor	37	18	55	1.3
Unidentified/Other	0	13	13	0.3
Total Vessels Not Fishing	59	56	115	2.7
Totals All Boats	2,457	1,860	4,317	

Recreational boating is a popular activity within the north central coast study region. The number of registered boats increased by more than 50% in the state between 1978 and 1991, although it is not known what proportion of boats are used in marine waters. Jet skis (also known as motorized personal watercraft) comprise 11% of all recreational vehicles in 1994 (Guerrero and Kvitek 1996).

According to the California Department of Motor Vehicles, there are approximately 51,000 registered recreational marine or aquatic vessels in the study region (Table 36).

There are several marinas and boat launches in the study region, many of which are not sampled through the CRFS program. Some examples of these facilities are listed in tables 37 and 38.

Table 36: Number of registered recreational marine or aquatic vessels in the North Central Coast Study Region as of December 31, 2005

County	Number registered recreational vessels
Mendocino	5,231
Sonoma	19,641
Marin	9,338
San Francisco	4,089
San Mateo	12,636

Source: California Department of Motor Vehicles 2006

Table 37: Marinas in or Adjacent to the Study Region

Marina ^{1, 2}	City	County
Spud Point, Porto Bodega, Mason's Marina	Bodega Bay	Sonoma
Golden Hinde Inn and Marina	Inverness	Marin
Marshall Anchorage (anchorage only)	Marshall	Marin
Pillar Point Harbor, Pillar Point Yacht Club	Princeton-by-the-Sea	San Mateo
Arques Shipyard and Marina, Clipper Yacht Harbor, Horseshoe Harbor & Presidio Yacht Club, Marina Plaza Harbor, Pelican Harbor, Richardson Bay Marina, Sausalito Cruising and Yacht Club, Sausalito Yacht Harbor, Schoonmaker Point Marina, Ayala Cove, San Francisco Yacht Club, Corinthian Yacht Club, Paradise Cay Yacht Harbor	Sausalito/Tiburon	Marin
Loch Lomond Marina and Yacht Club, Marin Yacht Harbor and Yacht Club, Lowrle Yacht Harbor, San Rafael Yacht Club	San Rafael	Marin
Point San Pablo Yacht Harbor, Brickyard Cove Marina, Channel Marina, Richmond Yacht Harbor, Marina Bay Yacht Harbor, Berkeley Marina, Emeryville City Marina, Emery Cove Marina	Richmond/Berkeley	Contra Costa
Jack London Marina, Portobello Marina, 5 th Ave Marina, North Basin, Embarcadero Cove Marina, Union Point Marina, Marina Village Yacht Harbor, Oakland Yacht Club, Encinal Yacht Club, Fortman Marina and Alameda Yacht Club, Grand Marina, Alameda Marina, Alameda Marina and Island Yacht Club, Ballena Isle Marina and Yacht Club	Oakland	Alameda
Brisbane Marina and Sirra Yacht Club, Oyster Cove Marina, Oyster Point Marina and Yacht Club, Coyote Point Marina and Yacht Club, Bair Island Marina, Pete's Harbor, Redwood City Yacht Harbor and Sequoia Yacht Club	So. SF to Redwood City	San Mateo
San Francisco Marina, Pier 39 Marina, Pier 38, Treasure Island Marina, South Beach Harbor	San Francisco	San Francisco

Source: Charternet.com; Marina Recreational Association; Boatharbors.com

1. Note that the marinas within San Francisco Bay are located outside of the study region, but that vessels using these marinas may travel into the study region under the Golden Gate Bridge.

2. This list of marinas is not comprehensive

Table 38: Boat Launch Locations within the Study Region

Boat Launch Locations	City	County
Point Arena	Point Arena	Mendocino
Anchor Bay	Anchor Bay	Mendocino
Ocean Cove	Jenner	Sonoma
Stillwater Cove	North of Fort Ross	Sonoma
Salt Point	Fort Ross area	Sonoma
Doran Park	Bodega Bay	Sonoma
West Side/Porto Bodega	Bodega	Sonoma
Timber Cove	Jenner	Sonoma
Lawson's Landing	Dillon Beach	Marin
Miller's Park	3 miles north of Marshall	Marin
Marconi Cove	Marshall	Marin
Golden Hinde Inn and Marina	Inverness	Marin
Pillar Point Harbor	Princeton-by-the-Sea	San Mateo
Keating Boat Launch	Pacifica	San Mateo

Source: www.boatramslocator.com

5.9.3 Recreational SCUBA Diving

SCUBA diving is a popular activity within the study region, especially within Sonoma and Mendocino counties.

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 comprises an estimated 12% total of the national revenue generated by recreational SCUBA diving, generates approximately \$180 million annually in revenue from diving; in equipment sales it produces 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). 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. There are at least thirteen dive shops in the coastal counties in north central coast study region.

In addition to the local dive shops and dive boats, numerous local businesses in the study region are involved in the increasingly popular activity of underwater photography.

The majority of the SCUBA diving sites in the study region are found in Sonoma and Mendocino Counties. The portion of the study region south of Sonoma County is not as popular because of the relative scarcity of rocky habitat and shark sightings.

Table 39: Some SCUBA Diving Sites in the Study Region

SCUBA diving site	County	SCUBA diving site	County
Arena Rock	Mendocino	Timber Cove	Sonoma
Arena Cove	Mendocino	Windmere Point, Lomer Gulch	Sonoma
Arena Bay	Mendocino	Fort Ross Cove	Sonoma
Collins Landing	Mendocino	Fort Ross Reef	Sonoma
Stewarts Point	Sonoma	Red Barn, Pedotti's Ranch, Sheep Ranch	Sonoma
Richardson	Sonoma	Russian Gulch	Sonoma
Horseshoe Cove	Sonoma	Tomales Point	Marin
Fisk Mill Cove	Sonoma	Abalone Point/Double Point	Marin
Stump Beach	Sonoma	San Agustin	Main
Gerste Cove	Sonoma	Noonday Rock	San Francisco
Gerstle Pinnacle	Sonoma	Isle of St. James	San Francisco
Ocean Cove	Sonoma	Middle Farallon	San Francisco
Stillwater Cove	Sonoma	Henry Bergh	San Francisco
Cemetery Reef	Sonoma		

Sources: www.jawsclub.org/coast.html, Watkins 2000

5.9.4 Other Recreational Activities

More than ½ 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). There are at least eleven kayak rental shops in the coastal counties in study region and some popular kayak sites are listed in Table 40.

Whalewatching and wildlife viewing is also very popular in the study region. There are at least 15 boats that participate in whale watching activities within the study region, many of which participate in both whalewatching and sportfishing depending upon the season.

Table 40: Partial List of Popular Kayak Sites in the Study Region

Popular kayak sites	County
Russian River	Sonoma
Bodega Bay	Sonoma
Tomales Bay	Marin
Drakes Estero	Marin
Estero Americano	Marin
Limantour Estero	Marin
Bolinas	Marin
Muir Beach	Marin
Fitzgerald Marine Reserve	San Mateo
Pillar Point Harbor	San Mateo

5.9.5 Tidepool Visitors and Wildlife Watching From Shore

Tidepool visitation is a popular recreational activity within the study region. Tidepool locations in the study region were taken from “Pacific Intertidal Life” by Russo and Olhausen and are listed in Table 41. It was also noted which of these locations are monitoring sites for the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and Multi-Agency Rocky Intertidal Network.

Table 41: Tidepooling Sites

County	Site	PISCO / Multi-Agency Rocky Intertidal Network Monitoring Site
Mendocino	Stornetta Ranch	Yes
Sonoma	Sea Ranch	Yes
Sonoma	Russian Gulch	Yes
Sonoma	Duncans Landing	Yes
Sonoma	Horseshoe Cove	Yes
Sonoma	Mussel Point	Yes
Sonoma	Bodega	Yes
Marin	Slide Ranch	Yes
Marin	Santa Maria Creek	Yes
Marin	Bolinas Point	Yes
Marin	Point Bonita	Yes
San Mateo	Fitzgeald Marine Reserve	Yes
San Mateo	Pigeon Point	Yes

Watching wildlife from shore is a popular activity in the north central coast study region. Pinnipeds, cetaceans, seabirds, and shorebirds can be viewed from numerous locations. While these areas have not yet been mapped, many prominent points of land can be used to view

whales and other cetaceans, while estuaries in the study region are often locations used for viewing sea and shore birds.

5.10 Cultural Uses

Several groups of both Pomo and Miwok Native American tribal groups have both current and historical ties to marine resources within the north central coast study region. These groups engage in both non-consumptive and consumptive activities at many locations within the study region. In addition, several sites of cultural importance exist throughout the north central coast. Examples of current and historic areas of importance include the Sonoma Coast, Tomales Bay, and the area from Tomales Point to Point Reyes. Many archaeological sites are present throughout the Point Reyes National Seashore, the Presidio, Fort Point, and Fort Ross. Further information and spatial data regarding areas of importance for these groups are currently being gathered to inform the MLPA process.

5.11 Navigation

5.11.1 Lighthouses

The area within the study region has a rich maritime heritage including several lighthouses which are still active today (Table 42). These active lighthouses not only serve their function as navigational aids, but are also popular tourist destinations.

Table 42: Active Lighthouses in Study Region

Active Lighthouse	Closest city	County
Point Arena	Point Arena	Mendocino
Point Reyes	Inverness	Marin
Point Bonita	Sausalito	Marin
Point Diablo	Sausalito	Marin
Farallon Island	San Francisco	San Francisco
Mile Rock Lighthouse	San Francisco	San Francisco
Point Montara	Montara	San Mateo
Pigeon Point	Pescadero	San Mateo

5.11.2 Vessel Traffic

The area west of the Golden Gate Bridge contains some of the busiest shipping lanes in the state. Over 6,000 commercial vessels (excluding domestic fishing vessels) enter and exit the San Francisco Bay each year. Less than 25% of the vessels are of intermediate size (draft <50 feet) and about 5% are large vessels (draft >50 feet) (GFNMS 2006).

The Ports and Waterways Act authorizes the US Coast Guard to establish shipping lanes in order to promote navigation, vessel safety, and the protection of the marine environment. The San Francisco Vessel Traffic Separation Schemes consists of two mile-wide inbound and outbound vessel traffic lanes with separation zones located between (GFNMS 2006) (see Map [14d](#)).

6.0 Academic Institutions, Research, Public Outreach, and Education

Academic institutions, government agencies, and non-governmental organizations in the San Francisco Bay area and surrounding region contribute to marine research, education and public outreach in the north central coast study region. Locations of research institutions and long-term monitoring sites are shown on maps [15a](#), [15b](#), [15c](#), [15d](#), [15e](#), [15f](#).

6.1 Major Marine Institutions in the North Central Coast Study Region

Major academic institutions that conduct research in coastal and marine ecosystems in north central California include University of California, Berkeley, San Francisco State University, University of California, Davis, through support for the Bodega Marine Lab, and Stanford University and University of California, Santa Cruz, whose PISCO intertidal and subtidal monitoring extends north through the region. Marine laboratories in the north central coast study region include Bodega Marine Lab, Romberg Tiburon Center, PRBO Conservation Science, the Marine Mammal Center, Tomales Bay Marine Station, Point Reyes National Seashore, and Southwest Fisheries Science Center. Several government agencies contribute to research in the north central coast study region, including California Department of Fish and Game, California Sea Grant, Cordell Bank, Gulf of the Farallones and Monterey Bay National Marine Sanctuaries, San Francisco Bay National Estuarine Research Reserve the National Park Service, and U.S. Geological Survey. Some non-governmental organizations also contribute to research in the north central coast study region, including Oikonos-Ecosystem Knowledge.

6.2 Scientific Research and Collecting

The scientific research within the north central coast study region is diverse, ranging from intertidal ecology to studies of the pelagic zone and deep ocean (Table 43). Much of the research in the north central coast study region is concentrated around marine laboratories.

- Research at the Bodega Marine Laboratory, affiliated with the University of California, Davis, includes marine ecology, coastal/nearshore oceanography, environmental toxicology biochemistry, molecular biology, physiology, and pathology.
- The Romberg Tiburon Center, operated by San Francisco State University, focuses on research to understand the San Francisco Bay and its surrounding wetland environments, and the open ocean.
- Research conducted at PRBO Conservation Science, founded in 1965, focuses on four key areas: (1) Ocean predators as bio-indicators of climate change and habitat quality, (2) population dynamics, reproduction, and survival of seabird, marine mammal and white shark populations, (3) life history characteristics: diet, feeding ecology, and energetic needs of seabirds in relation to marine fisheries and pollution, and (4) creation of marine protected areas and marine reserves to protect ocean ecosystems.
- The Southwest Fisheries Science Center, adjacent to University of California Santa Cruz's Long Marine Laboratory, supports research on stock assessments, population

dynamics, ecological linkages, and economics of Pacific coast groundfish and Pacific salmon.

- Research at The Marine Mammal Center focuses on marine mammal health in order to understand the causes of marine mammal strandings, and links to ocean health and veterinary techniques.
- 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 the University of California, Santa Cruz, and Stanford University. PISCO maintains an array of intertidal and subtidal monitoring sites in the north central coast study region.

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

- The California Department of Fish and Game monitors and assesses the distribution and abundance of priority species and habitats to assist decision-makers in managing California's marine region.
- California Sea Grant, administered by the University of California, focuses on research, conservation and use of coastal and marine resources.
- Three national marine sanctuaries, Monterey Bay, Gulf of the Farallones, and Cordell Bank, are engaged in research in the north central coast study region. The Gulf of the Farallones National Marine Sanctuary (GFNMS) supports several long-term monitoring programs including Beach Watch and Sanctuary Ecosystem Assessment Surveys for the Pelagic and Rocky Intertidal Habitats. The Cordell Bank National Marine Sanctuary, in partnership with the National Marine Fisheries Service Laboratory in Santa Cruz, the U.S. Geological Survey, and CDFG, initiated a long term study to classify habitats and monitor fishes and macro-invertebrates on and around Cordell Bank. The Cordell Bank, Gulf of the Farallones, and Monterey Bay national marine sanctuaries participate in the West Coast Observation Project, which collects various oceanographic measurements.
- The San Francisco Bay National Estuarine Research Reserve (NERR) supports long-term research and monitoring by staff, visiting scientists, and graduate students.
- The National Park Service at Point Reyes National Seashore and the Golden Gate National Recreation Area also sponsor, coordinate, and collaborate in marine research in the study region.
- The U.S. Geological Survey is engaged in research and dissemination of information about marine ecosystems in central and northern California.
- The Monterey Bay National Marine Sanctuary coordinates the Sanctuary Integrated Monitoring Network and works with more than forty institutions and organizations in the Monterey Bay area that are currently investigating various aspects of the Monterey Bay National Marine Sanctuary, including intertidal habitats, rocky reefs, kelp forests, sandy seafloor habitats, and oceanography. This program is currently being expanded to the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries.

Non-governmental organizations also contribute to research in the region. Oikonos-Ecosystem Knowledge is a non-profit 501(c)(3) organization working locally and internationally to study distributions and important areas for seabirds and marine mammals off north and central California.

Table 43: Research and Monitoring Programs in the Study Region

<p>Beach Watch Beach Watch, established by Gulf of the Farallones National Marine Sanctuary in 1993, trains citizen-scientists to survey seabirds and marine mammals on coastal beaches from Point Año Nuevo to Bodega Head. Beach Watch volunteers conduct oil spill sampling and tar ball retrieval to assist the California Office of Spill Prevention and Response. (http://farallones.nos.noaa.gov)</p>
<p>Center for Integrative Coastal Observation, Research and Education The California State University CI-CORE is a distributed coastal observatory for applied coastal research and monitoring in the nearshore (<100 m water depth) along the entire California coastline.</p>
<p>Bodega Ocean Observing Node A coastal ocean observing system within the Central and Northern California Ocean Observing System (CeNCOOS) based at the Bodega Marine Laboratory. (www.bml.ucdavis.edu)</p>
<p>California Current Marine Conservation Initiative PRBO Conservation Science is implementing this initiative with a primary goal of conserving the complex food webs of the California Current System, with an emphasis on central California. (www.prbo.org/)</p>
<p>California Sea Grant The statewide program works in partnership with scientists and engineers at public and private universities, and with industry, government, and the public to conduct research on water quality, aquaculture, fisheries, fish habitat, and non-indigenous species. (http://cemarin.ucdavis.edu/Agriculture_and_Natural_Resources123/Marine_Resources.htm)</p>
<p>Central California Ocean Observing System This new initiative is part of the national Integrated Ocean Observing System (IOOS). For more information: (www.cencos.org)</p>
<p>Coastal Oceans Currents Monitoring Program A state multi-institution, interagency collaboration at Bodega Marine Laboratory for monitoring coastal currents with high frequency (HF) radar units at Point Reyes, Bodega Marine Laboratory and Gerstle Cove, and as far north as Point Arena. (www.bml.ucdavis.edu)</p>
<p>Computational Assessments of Scenarios of Change for the Delta Ecosystem USGS researchers are adapting and developing hydrologic, hydrodynamic, and biological models of the Bay-Delta watershed and Sacramento-San Joaquin River Delta to explore scenarios of change induced by factors such as global warming, water and ecosystem management, land use, and earthquakes. (www.usgs.gov)</p>
<p>Cordell Bank Ocean Monitoring Program Research on variability in the pelagic ecosystem around Cordell Bank was initiated by the</p>

<p>Cordell Bank National Marine Sanctuary and Point Reyes National Seashore in 2004. (www.cordellbank.noaa.gov)</p>
<p>Cooperative Research and Assessment of Nearshore Ecosystems The Cooperative Research and Assessment of Nearshore Ecosystems 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. (www.dfg.ca.gov/regions/region3.html/)</p>
<p>Longterm Monitoring Program and Experiential Training for Students Monitoring key intertidal, sandy shore, and offshore areas in the five west coast National Marine Sanctuaries. Monitoring is conducted by students in middle and high schools, and other volunteer groups. (http://limpets.noaa.gov/)</p>
<p>Long-term Monitoring of Cordell Bank The Cordell Bank National Marine Sanctuary, in partnership with the National Marine Fisheries Service Laboratory in Santa Cruz, the U.S. Geological Survey, and the California Department of Fish and Game, initiated a long term study to classify habitats and monitor fishes and macro-invertebrates on and around Cordell Bank. (www.cordellbank.noaa.gov)</p>
<p>Oikonos-Ecosystem Knowledge The organization supports scientists to collect and assemble the data, develop maps, and assess spatial and temporal distributions of marine mammals and seabirds off the California coast. (www.oikonos.org)</p>
<p>Pacific Estuarine Ecosystem Indicator Research Center A collaborative effort at Bodega Marine Laboratory by 28 principal scientists, including ecotoxicologists, ecologists, biochemists, microbiologists, and remote sensing experts, at University of California Davis and University of California Santa Barbara with the goal of developing new indicators of estuarine wetland health in marsh plants and animals. (www.bml.ucdavis.edu)</p>
<p>Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) Interdisciplinary research focuses on three issues: (1) how currents, upwelling, and other physical and ecological processes affect the plants and animals of coastal marine ecosystems, (2) how coastal ocean ecosystems respond to shifts in water temperature, currents, and other factors that may vary with global climate change, and (3) how ocean circulation affects the dispersal of marine organisms in their earliest larval stages. PISCO maintains an array of intertidal and subtidal monitoring sites in central northern California. (www.piscoweb.org)</p>
<p>PRBO Conservation Science For over 30 years PRBO scientists have gathered year-round observations of seabirds and marine mammals on the Southeast Farallon Islands through a cooperative agreement with the U.S. Fish and Wildlife Service. Since the 1971 oil spill in San Francisco, PRBO scientists collected comprehensive information on beached birds in the Pacific (1971-1986) and documented oiled wildlife on the Farallon Islands daily since 1977. (www.prbo.org/)</p>
<p>Resource Assessment Program The California Department of Fish and Game is initiating 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. (www.dfg.ca.gov/regions/region3.html/)</p>

<p>Rocky Intertidal Monitoring A long-term monitoring program designed by Gulf of the Farallones National Marine Sanctuary to track population dynamics of organisms in rocky intertidal habitats. (http://farallones.nos.noaa.gov)</p>
<p>San Francisco Bay National Estuarine Research Reserve The reserve supports a variety of research projects on nutrient loading, seagrass restoration, habitat mapping and change, channel geomorphology, and the impacts of invasive species and participates in a NERR System-wide Monitoring Program. (http://sfbaynerr.org/)</p>
<p>Sanctuary Education Awareness and Long Term Stewardship Since 1996, more than 65 volunteers have helped the Gulf of the Farallones National Marine Sanctuary protect pupping harbor seals in Tomales Bay and Bolinas Lagoon. (http://farallones.nos.noaa.gov)</p>
<p>Sanctuary Ecosystem Assessment Surveys of the Pelagic Habitat Surveys designed by Gulf of the Farallones National Marine Sanctuary to investigate the relationship between hydrographic conditions, physical features and the distribution and abundance of marine organisms (seabirds, marine mammals, sea turtles, krill, and phytoplankton) in the vicinity of the Gulf of the Farallones region and the coastal and pelagic region west of Sonoma County. (http://farallones.nos.noaa.gov)</p>
<p>Sanctuary Integrated Monitoring Network The Sanctuary Integrated Monitoring Network is composed of many institutions and agencies that perform monitoring activities in the Monterey Bay National Marine Sanctuary and share their summary information with the Sanctuary Integrated Monitoring Network. (www.mbnms-simon.org)</p>
<p>Southwest Fisheries Science Center Research is focused on population dynamics, ecological linkages, and economics of Pacific coast groundfish and Pacific salmon. Groundfish under study include rockfishes, flatfishes, Pacific whiting, sablefish, and lingcod; salmon include coho, chinook, and steelhead. Conduct aerial surveys of pinnipeds and cetaceans (www.nmfs.noaa.gov/).</p>
<p>The Marine Mammal Center Research is focused on diseases carried by marine mammals, diagnostic tests and clinical procedures to improve care of marine mammals, and tagging studies to monitor rehabilitated marine mammals following their release. (www.tmcc.org)</p>
<p>United States Geological Survey The USGS maintains a website "Access San Francisco Bay and Delta" (http://sfbay.wr.usgs.gov/), which contains information about the region. The Bay Area Regional Database (BARD, http://bard.wr.usgs.gov/index.html), supported by the U.S. Geological Survey, contains bathymetry for the San Francisco Bay and Suisun Bay and Delta, and other related information.</p>
<p>Tomales Bay Life The Tomales Bay Watershed Council in collaboration with the National Park Service is conducting an all tax biodiversity inventory of species in Tomales Bay. Numerous researchers from across the US have conducted rapid inventories of species ranging from diatoms to fish within the bay. http://tomalesbaylife.org</p>
<p>National Park Service Inventory and Monitoring Program</p>

Long-term monitoring of several indicators of ecosystem health in the San Francisco Bay Area. Wetlands delineation, Western Snowy Plovers, and pinnipeds are examples. For pinnipeds, data have been collected by trained volunteers and technical biologists on harbor seals during the breeding season and molt, on elephant seals during the breeding season and molt, and sea lions year round within the parks. The data include population counts and productivity, with annual reports. The area of survey for harbor seals extends beyond the parks from Sea Ranch south to Fitzgerald Marine Reserve.

(<http://www1.nature.nps.gov/protectingrestoring/IM/inventoryandmonitoring.htm>)

West Coast Observation Project

All five National Marine Sanctuaries on the west coast of the United States (including the three in or adjacent to the north central coast study region, participate in this effort which gathers data on ocean temperature, currents, oxygen, salinity, windspeed, turbidity, fluorescence, and other indicators.

(http://www.mbnms-simon.org/sections/obs/nmsp_wco.php)

6.3 Public Education and Outreach

Local, state, and federal agencies and institutes throughout the north central coast study region offer public outreach and education about coastal and marine ecosystems. Table 44 lists some key academic, research, and education institutions in the north central coast study region that have a focus on coastal or marine ecosystems, including:

- University and graduate education is available through numerous educational institutions including the University of California, Santa Cruz, Stanford University, University of California, Berkeley, San Francisco State University, and marine laboratories, including Bodega Marine Lab, Romberg Tiburon Center, and The Marine Mammal Center.
- Public education and student and teacher training are available through the aquariums, including the Steinhart Aquarium and the Aquarium of the Bay, and the Lawrence Hall of Science.
- State and federal agencies, including the California Coastal Commission, Cordell Bank, Gulf of the Farallones and Monterey Bay National Marine Sanctuaries, Point Reyes National Seashore, the Golden Gate National Recreation Area, and the San Francisco Bay National Estuarine Research Reserve, provide opportunities for public education, K-12 education and teacher training.
- Dedicated education programs, such as California Center for Ocean Sciences Education Excellence (COSEE) and Marine Activities Resources and Education develop and distribute curricula, linked to California state teaching standards, on ocean science.

Public education is the primary focus of aquariums. The California Academy of Science and the Steinhart Aquarium, which opened in 1923, provides docent-lead tours and class activities for students, grades 3-5, and teacher workshops on coral reefs and environmental sustainability, among other topics, and teacher resources. Aquarium of the Bay, which opened in 1996, features aquatic life of San Francisco Bay and the surrounding waters. Aquarium of the Bay offers free guided tours, classroom programs that can be adapted for K-12, and teacher workshops. Programs developed by Aquarium of the Bay focus on fish, tidepools, plankton, sharks, wetlands, sloughs, and mudflats, and the food web in the San Francisco Bay.

Education centers are designed to connect students and teachers with scientists and current scientific information.

The University of California, Berkeley, Lawrence Hall of Science offers residential summer camps about marine and coastal biology at Point Reyes and Bodega, with hands-on environmental education activities for K-12 students. Marine Activities Resources and Education, based at the Lawrence Hall of Science, is a K–8 science program that offers “Ocean Immersion” for students and professional development for educators through a series of workshops and on-site “Ocean Immersion” coaching. Marine Activities Resources and Education offers print, audiovisual and web-based educational materials, guest speakers and field trip ideas.

The California Center for Ocean Sciences Education Excellence (COSEE), also based at the Lawrence Hall of Science, connects scientists with education and outreach institutions. COSEE is working to increase awareness of K-12 students and their communities about ocean issues. COSEE provides ocean-related educational materials for K-12 schools and opportunities for scientists to connect with the schools. COSEE also distributes an undergraduate and graduate course, “Communicating Ocean Science.” In addition, COSEE is creating a website on ocean science and technical careers. The Headlands Center is one educational center within the Golden Gate National Recreation Area that focuses on marine environments.

Although education is usually their secondary focus, research institutions often develop educational opportunities for undergraduate and graduate students. The Bodega Marine Laboratory, affiliated with University of California, Davis, offers college students a range of educational opportunities from personal mentoring with resident scientists to Research Education for Undergraduates. Scientists at the Romberg Tiburon Center, San Francisco State University) train undergraduate and graduate students through courses on a variety of ocean-related topics. The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) offers two interdisciplinary summer courses for graduate students: “Physical Oceanography and Marine Ecosystems” at the University of California, Santa Cruz, and “Ecological Physiology and Genetics” at Hopkins Marine Station in Pacific Grove.

Some research institutions expand education programs to include K-12 students and teachers. Graduate students from the Romberg Tiburon Center teach local 6 through 12 graders marine science on board the *Research Vessel White Holly*, departing from Sausalito. Romberg Tiburon Center and the Bay Area Discovery Museum collaborate to share science about San Francisco Bay with local children ages ten and younger and their families. Romberg Tiburon Center and the San Francisco Bay National Estuarine Research Reserve (NERR) offer free one-day workshops for middle and high school teachers to provide teachers with local scientific resources and ideas for classroom science projects.

The Marine Mammal Center offers docent-led tours, educational programs for students, outreach to Bay Area schools through the Whale Bus, and annual volunteer training. Point PRBO Conservation Science works with children, interns, volunteers and the public to increase environmental stewardship. PRBO offers teaching tools and curriculum for educators, field trips

to the Palomarin Field Station and the Bird Banding Laboratory and classroom visits in Marin and San Francisco counties. The Fisheries Ecology Division of the Southwest Fisheries Science Center sponsored an interactive educational exhibit at nearby Seymour Marine Discovery Center, a part of the University of California, Santa Cruz, Marine Science Campus.

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

- The California Coastal Commission Public Education Program offers information on Coastal Cleanup Day (3rd Saturday in September), Coastweeks (annual 3-week celebrations of coastal and water resources), Boating Clean and Green, and educational materials for teachers and students, grades 3-12. The Coastal Commission offers three classroom activity guides: "Waves, Wetlands, and Watersheds," "Our Wetlands, Our World," and "Save Our Seas."
- California Sea Grant regularly conducts public workshops about water quality, fish habitat needs, and land use for both large and small agricultural landowners.
- Educators, students, and families can learn about coastal and marine ecology through hands-on experiences at Point Reyes National Seashore. The national seashore offers interactive displays in the visitor centers, a Junior Ranger program, a 4-6 day family summer camp, paid summer internships for high school students, and educational information on the World Wide Web.
- The San Francisco Bay National Estuarine Research Reserve (NERR) education program shares the results of research from the reserve and the San Francisco Bay estuary. The NERR and Romberg Tiburon Center offers one day workshops for teachers and science curriculum for middle and high school classes. NOAA's National Ocean Service offers "Discovery Kits" with curriculum about estuaries for classroom teachers. The NERR System began a Coastal Training Program to provide science, tools, and techniques to coastal residents.
- The Golden Gate National Recreation Area also engages in public education and has numerous visitor centers located throughout the park as well as having programs for K-12 students and teacher training.

Public education is a priority for the National Marine Sanctuary Program. As noted above, GFNMS and northern MBNMS are located within the north central coast study region. Cordell Bank National Marine Sanctuary (CBNMS), west of the study region, offers opportunities for the public to learn about the sanctuary program through visitor center displays at the Bear Valley Visitor Center in Point Reyes National Seashore and Bodega Marine Lab, brochures, a radio show, outreach events, lecture series, field seminars, coastal signage and teacher trainings. A CBNMS exhibit is planned for the Oakland Museum of California. The CBNMS provides curriculum materials for educational activities about Black-footed Albatross, benthic habitat, and national marine sanctuaries. In collaboration with Point Reyes National Seashore Association's Field Seminars, CBNMS hosts an annual wildlife watching seminar to introduce participants to pelagic seabirds and marine mammals. GFNMS provides educational opportunities through visitor centers at the Presidio and in Pacifica. GFNMS hosts exhibits at the Pigeon Point Lighthouse (joint with MBNMS), the Bear Valley Visitor Center in Point Reyes National Seashore, and Bodega Marine Lab. GFNMS is in the process of installing a major exhibit at the

California Academy of Sciences and an interpretive trail focusing on the local fishing community at Pillar Point Harbor.

The Sharkmobile, Crab Cab and Webs Under Waves are all traveling educational programs provided by the GFNMS to classrooms in the bay area. Crab Cab targets kindergarten through 2nd grade, Webs under Waves targets 3rd through 5th graders, and Sharkmobile targets 4th through 6th graders. Additionally, GFNMS and San Francisco's Recreation and Park Department offer the Sanctuary Explorers Summer Camp, free for inner city youth, ages 8-13 years. The GFNMS Sanctuary Education Program provides curriculum guides, scripted slide shows, field trips for teachers, and web-based fact sheets about the sanctuary, oceanography, marine food webs, sandy beaches, oil spills, intertidal habitats, salmon, seabirds and shorebirds. High school students can volunteer to learn how to conduct research with the sandy beach and rocky intertidal monitoring program, LiMPETS. The GFNMS also has a volunteer-based Sanctuary Naturalist Corp whose members conduct monthly shoreline wildlife surveys, volunteer in the Presidio visitor center, and educate the public at various outreach events.

MBNMS provides curricula on a variety of ocean-related topics for teachers and teaching resources on the World Wide Web. MBNMS participates in Multicultural Education for Resource Issues Threatening Oceans, a marine conservation outreach program to serve multicultural students, teachers, adults and families. The Bay Watershed Education and Training Program implemented through the MBNMS, GFNMS, and CBNMS, improves student and teacher understanding of environmental stewardship by education.

Non-governmental organizations also contribute to education and outreach in the north central coast study region. The Bay Institute, founded in 1981, uses a combination of scientific research, political advocacy, and public education to restore the entire watershed which drains into San Francisco Bay. Oikonos Ecosystem Knowledge, a non-profit 501(c) (3) organization, encourages stewardship of ocean ecosystems through the participation of middle and high-school students in albatross tracking studies.

Table 44: Academic, research, and education institutions with a focus on coastal and marine ecosystems in north central coastal California

Aquarium of the Bay	PIER 39 Embarcadero at Beach St San Francisco, CA 94133 888-732-3483	www.aquariumofthebay.com
The Bay Institute	500 Palm Drive Novato, CA 94949 415-506-0150	www.bay.org
Bodega Marine Lab University of California, Davis	P.O. Box 247 Bodega Bay, CA 94923 707-875-2211	www.bml.ucdavis.edu
California Academy of Science and The Steinhart Aquarium	875 Howard St San Francisco, CA 94103 415-321-8000	www.calacademy.org/aquarium/

California Center for Ocean Sciences Education Excellence (COSEE)	Lawrence Hall of Science University of California Berkeley, CA	http://cacosee.net/
California Coastal Commission	Public Education Program 45 Fremont St, Ste 2000 San Francisco, CA 94105 415-904-5400	http://www.coastal.ca.gov/publiced/
California Department of Fish and Game	Marine Region 7329 Silverado Trail Napa, CA 94558 707-944-5500	www.dfg.ca.gov/regions/region3.html/
California Sea Grant, University of California, Cooperative Extension	1682 Novato Boulevard Suite 150-B Novato, CA 94947 415-499-4204	http://cemarin.ucdavis.edu/Agriculture and Natural Resources123/Marine Resources.htm
Cordell Bank National Marine Sanctuary	1 Bear Valley Rd Point Reyes Station, CA 94956 415-663-0314	www.cordellbank.noaa.gov
Friends of Fitzgerald Marine Reserve	P.O. Box 451 Moss Beach, CA 94038	http://www.fitzgeraldreserve.org/
Golden Gate National Recreation Area	Golden Gate National Recreation Area Fort Mason, Bldg 201 San Francisco, CA 94123	http://www.nps.gov/goga
Gulf of the Farallones National Marine Sanctuary	991 Marine Drive The Presidio San Francisco, CA 94129 415-561-6622	http://farallones.nos.noaa.gov
Lawrence Hall of Science University of California, Berkeley	Centennial Drive Berkeley, CA 94720 510-642-5132	www.lawrencehallofscience.org
Marine Activities Resources and Education	Lawrence Hall of Science Centennial Drive Berkeley, CA 94720 510-642-5132	www.lawrencehallofscience.org/MARE/
Monterey Bay National Marine Sanctuary	299 Foam Street Monterey, CA 93940 831-647-4201	www.montereybay.noaa.gov/
The Marine Mammal Center	Marin Headlands 1065 Fort Cronkhite Sausalito, CA 94965-2609 415-289-7330	www.tmcc.org
Oikonos Ecosystem Knowledge	PO Box 1932 Benincia, CA 94510 415-868-1399	www.oikonos.org
PISCO	UCSC Long Marine Lab 110 Shaffer Road Santa Cruz, CA 95060;	www.piscoweb.org

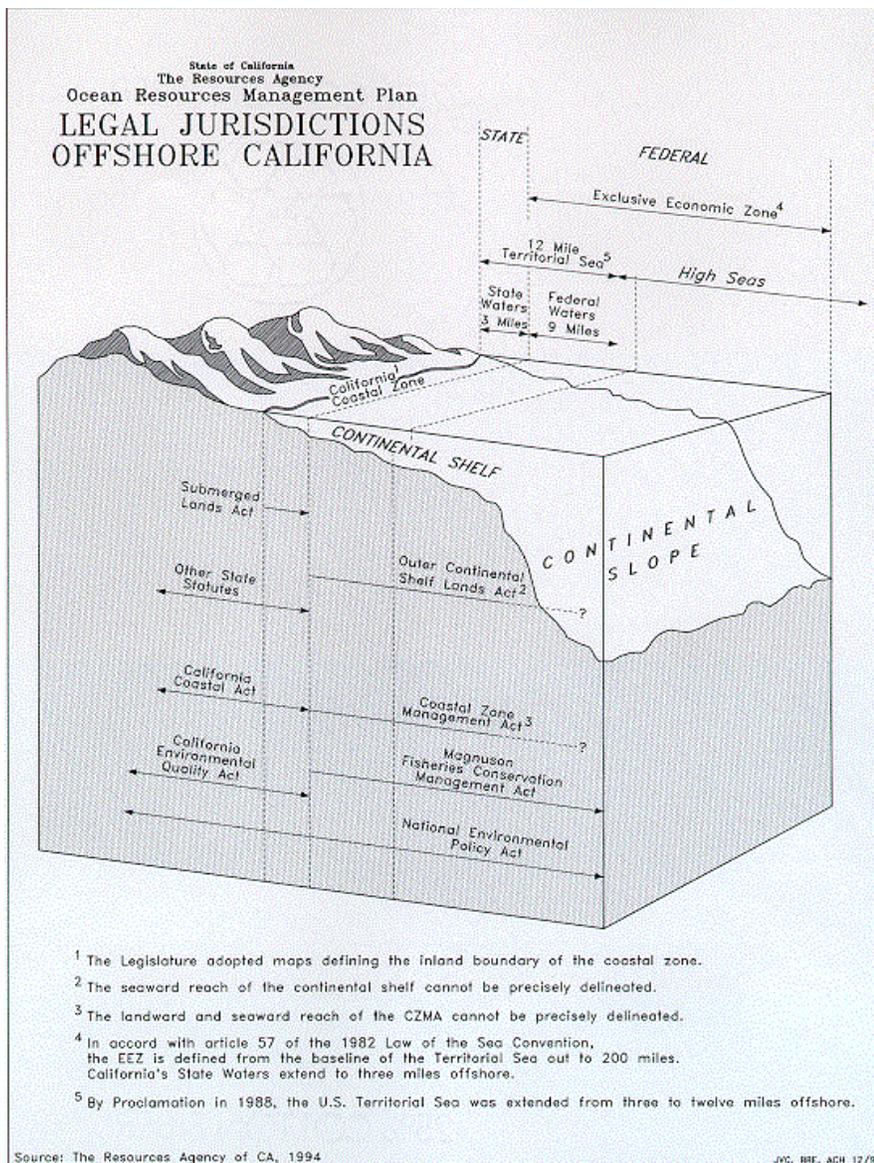
	Hopkins Marine Station Oceanview Boulevard Pacific Grove, CA 93950	
PRBO Conservation Science	3820 Cypress Drive #11 Petaluma, CA 94954 707-781-2555	www.prbo.org/
Point Reyes National Seashore	1 Bear Valley Rd Point Reyes Station, CA 94956 415-464-5100 x2	www.nps.gov/pore
Romberg Tiburon Center	San Francisco State University 3152 Paradise Drive Tiburon, CA 94920 415-338-6063	http://rtc.sfsu.edu/
San Francisco Bay National Estuarine Research Reserve	San Francisco State U. 1600 Holloway Ave San Francisco, CA 94132 415-338-3707	http://sfbaynerr.org/
San Mateo Outdoor Education	11000 Pescadero Road La Honda, CA 94020 (650) 747-0414	http://www.smcoe.k12.ca.us/outdoored/SMOLibrary/SMOLib001/SMOLib001AboutOE.html
Southwest Fisheries Science Center	110 Shaffer Road Santa Cruz, CA 95060 Phone: (831) 420-3900 Fax: (831) 420-3980	www.nmfs.noaa.gov/
U.S. Geological Survey	345 Middlefield Rd Menlo Park, CA 94025 650-853-8300	www.usgs.gov

7.0 Jurisdiction and Management

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

No single federal, state, or local agency has complete jurisdiction over the coastal and marine environment. Rather, jurisdiction varies spatially and with respect to the resource being managed. Figure 20 illustrates the division of jurisdictions between state and federal agencies offshore of California. The main federal, state, local, and Native American entities are highlighted below with a brief description of their role and responsibility.

Figure 20: 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 responsibility for ocean and coastal resources, which are described below:

The **National Oceanic and Atmospheric Administration (NOAA)** conducts research and manages ocean resources through three units which have direct interest in MPA issues: the National MPA Center, the National Marine Sanctuary Program, and NOAA Fisheries. The NOAA Biogeographic Assessment Team has conducted an assessment of the region of the coast included within the three national marine sanctuaries of central and north central California (NOAA 2004).

The National MPA Center was established by Executive Order 13158 of 2000 to oversee efforts to create a national system of MPAs and to assist government agencies in participating in this effort; the National MPA Science Center is located in Santa Cruz. The National MPA Center also supports the MPA Federal Advisory Committee established under the executive order as well as a Science Institute which provides scientific information and policy analysis to support the planning, management and evaluation of the nation's MPAs (California Marine Life Protection Act Initiative 2005).

The **National Marine Sanctuary Program** manages 14 marine protected areas that encompass more than 150,000 square miles of marine and Great Lakes waters from Washington State to the Florida Keys, and from Lake Huron to American Samoa. The system includes 13 national marine sanctuaries and the Papahānaumokuākea Marine National Monument. Since 1972, the National Marine Sanctuaries Program has worked cooperatively with the public and federal, state, and local officials to protect sanctuary resources while allowing compatible commercial and recreational activities. Increasing public awareness of marine heritage, scientific research, monitoring, exploration, educational programs, and outreach are the principal tools the National Marine Sanctuaries Program uses to fulfill its mandates. Sanctuaries have authority for establishing regulations under the National Marine Sanctuaries Act (Brookhart 2006). The Gulf of the Farallones National Marine Sanctuary and northern portion of the Monterey Bay National Marine Sanctuary lie within the north central coast study region. Cordell Bank National Marine Sanctuary lies in federal waters westward of Point Reyes.

NOAA Fisheries (the National Marine Fisheries Service or NMFS) has regulatory authority for marine finfishes, invertebrates, and marine mammals other than sea otters in waters 3-200 nautical miles from shore. NOAA Fisheries derives its authority from the Magnuson-Stevens Fisheries Conservation and Management Act of 1976 (Magnuson-Stevens Act), the Marine Mammal Protection Act and the federal Endangered Species Act. Under the Magnuson-Stevens Act, NOAA Fisheries manages any fishery that is the subject of a fishery management plan developed by regional fishery management councils (see below) as well as some non-fishery management plan species (California Marine Life Protection Act Initiative 2005).

The **Pacific Fishery Management Council** is one of eight regional fishery management organizations established by the Magnuson-Stevens Act. The councils develop fishery management plans for fisheries between 3 and 200 nautical miles of shore; these plans must be approved by the secretary of commerce and are implemented by NOAA Fisheries. The secretary of commerce, acting through NOAA Fisheries, has management authority for approximately 80 species of finfishes, primarily those associated with the bottom (groundfish), but also others such as highly migratory species (California Marine Life Protection Act Initiative 2005).

The **National Estuarine Research Reserve System** is a network of terrestrial and aquatic areas established for long-term research, education and stewardship. Within California, there are three national estuarine research reserves, one each in Elkhorn Slough, the Tijuana River, and San Francisco Bay. NOAA manages them jointly with CDFG, California Department of Parks and Recreation, and San Francisco State University, respectively. There are no national estuarine research reserves located in the north central coast study region. Long-term research, stewardship, and public education are the main objectives of the reserves. NOAA provides 70% of the sites' funding, while the state partner is required to provide the remaining 30%. Enforcement activities generally are the responsibility of the state partners (Goldfarb 2005).

The **U.S. Department of Interior** also has several agencies with responsibility for ocean and coastal-resources, which are described below.

The **United States Fish and Wildlife Service (USFWS)** conserves, protects and enhances populations of fish, other wildlife, and plants and manages the system of National Wildlife Refuges. The system includes the following coastal refuges in California: Castle Rock, Humboldt Bay, San Pablo Bay, Marin Islands, Farallon, Don Edwards San Francisco Bay, Salinas River, Guadalupe-Nipomo Dunes, Seal Beach, and the Tijuana Slough. The Farallon National Wildlife Refuge is the only refuge within the north central coast study region.

The **National Park Service (NPS)** has several park lands located along the California coast including Redwood National Park, Point Reyes National Seashore, Golden Gate National Recreation Area, Channel Islands National Park and the Cabrillo National Monument. Some key park lands in the north central coast study region are listed in Table 45. The typical seaward boundary of coastal national park lands extends to 1000 feet offshore, with the exception of the Channel Islands National Park which has a seaward boundary that extends to 1 nautical mile. The National Park Service regulates the use of the seabed within these 1000 feet but there is ambiguity as to its authority to regulate the harvest of living marine resources (Neubacher 2006). Adjacent to the Golden Gate National Recreation Area, there are several underwater areas (mostly former military properties) that remain the property of the federal government (Ueber 2006).

Table 45: National Parks Adjacent to the Study Region

Name of National Park	County
Golden Gate National Recreation Area	Marin, San Francisco, and San Mateo
Point Reyes National Seashore	Marin
Presidio of San Francisco*	San Francisco
Fort Point National Historic Site*	San Francisco
Muir Woods National Monument	Marin

*encompassed within the Golden Gate National Recreation Area.

The **Bureau of Land Management (BLM)** has management responsibility for the California Coastal National Monument established in 2000, which extends from shore to twelve nautical miles seaward and is composed of thousands of small rocks and pinnacles above mean high tide, including many rocks and islets in the north central coast study region. The primary purpose of the monument is to protect geological values, including habitat. The BLM would need to work through the regulatory process of the California Fish and Game Commission to establish regulations affecting living marine resources in state waters adjacent to any part of the monument. The BLM manages living marine resources in cooperation with CDFG; a memorandum of understanding formalizes this agreement and includes the California Department of Parks and Recreation (California Marine Life Protection Act Initiative 2005; Hanks 2006).

The **U.S. Minerals Management Service** manages the nation's natural gas, oil and other mineral resources on the outer continental shelf.

The **U.S. Geological Survey (USGS)** is the earth science research and information agency and has conducted research on the continental shelf in the study region (California Marine Life Protection Act Initiative 2005).

The **U.S. Department of Defense** has installations along the California coast for which there may be a conflict between military activities and protection of natural resources offshore of the bases. The Department of Defense and CDFG have made efforts in the past to allow for military activities within MPAs located offshore of military installations. Governor Schwarzenegger's *California's Action Strategy* of September 2004 declares that state agencies should coordinate ocean and coastal management activities that impact military facilities or operations with the Department of Defense (California Resources Agency and California Environmental Protection Agency 2004). There are several U.S. Coast Guard facilities in the study region, but no military bases.

The **U.S. Coast Guard** is the primary maritime law enforcement agency (California Marine Life Protection Act Initiative 2005). The U.S. Coast Guard has a station in Bodega Harbor and eastward of the Golden Gate Bridge at Point Bonita.

The **U.S. Army Corp of Engineers** plans, designs, constructs, operates, and maintains a wide variety of water infrastructure to support U.S. national economic interests (navigation structures, channels, shore protection, and restoration projects) (California Marine Life Protection Act Initiative 2005).

The **U.S. Environmental Protection Agency (USEPA)**, Office of Waters, is responsible for implementing the Clean Water Act and Safe Drinking Water Act, and other portions of laws focused upon pollution prevention and watershed management. The USEPA manages the National Estuary Program which identifies, restores, and protects nationally significant estuaries. The San Francisco Bay falls under the jurisdiction of the National Estuary Program, but the bay itself is not part of the north central coast study region (California Marine Life Protection Act Initiative 2005).

7.1.2 State Agencies and Programs

The **California Department of Fish and Game (CDFG)** has management authority over living marine resources within state waters (generally between 0 and 3 nautical miles from shore or around offshore islands and including estuarine areas) as well as authority to regulate fisheries that deliver catch to Californian ports. Thus, CDFG has some authority beyond state waters and often enforces regulations in this area. In addition, the CDFG regulates marine aquaculture within state waters, such as the leases for oyster mariculture that exist in Tomales Bay and Drakes Estero in the north central coast study region (California Fish and Game Code, sections 15000-15007).

The **California Department of Parks and Recreation** is responsible for almost one-third of California's scenic coastline and manages coastal wetlands, estuaries, beaches, and dune systems within State Park system units. Through State Water Bottom Leases, the California Department of Parks and Recreation has management authority over fifteen underwater areas, though it does not have authority to restrict the take of living marine resources. The California Park and Recreation Commission has the authority to establish, modify, or delete state marine reserves, state marine parks, and state marine conservation areas, but must have the concurrence of the California Fish and Game Commission on any proposed restrictions to the extraction of living marine resources (California Public Resources Code, section 6725). Of the fifteen underwater areas, three can be found in the north central coast study region and are under lease from the State Lands Commission until 2029. Salt Point State Park, Fort Ross State Historic Park, and Sonoma Coast State Beach contain 940, 90 and 667 acres of underwater area, respectively. State Parks adjacent to the coast in the north central coast study region include those listed in Table 46.

Table 46: California State Parks Located Adjacent to Shore in Study Region 2004/2005

Name of State Park	County
Manchester State Park	Mendocino
Schooner Gulch State Beach	Mendocino
Salt Point State Park	Sonoma
Fort Ross State Historic Park	Sonoma
Sonoma Coast State Beach	Sonoma
Marconi Conference Center State Historic Park	Marin
Tomales Bay State Park	Marin
Thornton State Beach	San Mateo
Pacifica State Beach	San Mateo
Gray Whale Cove State Beach	San Mateo
Montara State Beach	San Mateo
Point Montara Light Station	San Mateo
Half Moon Bay State Beach	San Mateo
San Gregorio State Beach	San Mateo
Pomponio State Beach	San Mateo
Pescadero State Beach	San Mateo
Bean Hollow State Beach	San Mateo
Pigeon Point Lighthouse State Historic Park	San Mateo
Ano Nuevo State Reserve	San Mateo

Source: California Department of Parks and Recreation 2006

The **California State Lands Commission** has responsibility for leasing state lands, including submerged lands in state waters (excluding aquaculture which is regulated by the CDFG).

The **California Coastal Commission** regulates the use of land and water in a legislatively-designated coastal zone. Development in the San Francisco Bay is regulated by the San Francisco Bay Conservation and Development Commission. The coastal zone varies between several hundred feet above mean high tide in highly urbanized areas and up to five miles in rural areas and extends to the state water offshore boundary. The California Coastal Commission's jurisdiction extends into federal waters because of the federal consistency review responsibilities delegated to it under the Coastal Zone Management Act of 1972. Any proposed action by a federal agency that will have a reasonably foreseeable impact on resources within the coastal zone must be consistent with the policies of the state's federally-approved coastal zone management program. Activities proposed by nonfederal applicants for federal licenses or permits, and state agencies or local governments applying for federal funds are also subject to the federal consistency requirement. The establishment of MPAs may require a coastal development permit from the California Coastal Commission or the San Francisco Bay Conservation and Development Commission if public access is limited or if there is any physical development (such as signage) (California Coastal Commission 2005).

The **California State Coastal Conservancy** protects, restores, and improves coastal resources, and provides access to shore. The California State Coastal Conservancy manages the Critical Coastal Areas Program (CCA) which fosters collaboration among local stakeholders and government agencies to focus resources and efforts to reduce polluted runoff in coastal zone watersheds (California Marine Life Protection Act Initiative 2005). For a list of CCAs, please see section 4.3.

The **State Water Resources Control Board (SWRCB)** has regulatory authority over discharges into marine waters from point and nonpoint sources, as well as other water-quality related aspects. SWRCB has authority to create state water quality protection areas and areas of special biological significance (ASBS). Regional water quality control boards are the units within the SWRCB that oversee local management issues throughout the state (California Marine Life Protection Act Initiative 2005). For a list of ASBSs, please see section 4.3.

The **California Department of Water Resources** protects, conserves, develops, and manages California's water supplies in coordination with other agencies. These activities directly impact water quality and quantity in estuaries and nearshore ocean environments (California Marine Life Protection Act Initiative 2005).

The California Ocean Protection Act of 2004 created the **California Ocean Protection Council**. The Ocean Protection Council is chaired by the Secretary of Resources and includes the State Lands Commission Chair, the Secretary for Environmental Protection, and two non-voting, ex-officio members of the California Legislature.

The purpose of the Council is to:

- Coordinate activities of ocean-related state agencies to improve the effectiveness of state efforts to protect ocean resources within existing fiscal limitations.
- Establish policies to coordinate the collection and sharing of scientific data related to coastal and ocean resources between agencies.
- Identify and recommend to the Legislature changes in law.
- Identify and recommend changes in federal law and policy to the Governor and Legislature (California Ocean Protection Council)

The Ocean Protection Council approved a five-year strategic plan in June 2006 which calls for the creation of a State Agency Steering Committee composed of senior representatives of state agencies with responsibility for coastal- and ocean-management. The State Agency Steering Committee met for the first time in September 2006.

The purpose of the State Agency Steering Committee is to:

- Identify top priorities for each fiscal year
- Identify strategies and projects within and across agencies to address these top priorities
- Assess the capabilities of agencies to carry out their ocean and coastal protection responsibilities
- Identify necessary funding for priority actions-either through redeploying existing funds, developing cross-cutting budgets, or identifying new funding

- Recommend any necessary legislative action or regulatory changes to implement priority actions and strategies (California Ocean Protection Council)

In the fall of 2006, the Ocean Protection Council approved funding for seafloor mapping of the north central coast study region to support MPA planning under the MLPA.

7.1.3 Local Government Programs

7.1.3.1 Local Coastal Programs

The federal Coastal Zone Management Act passed in 1972 encouraged coastal states to develop polices to protect coastal resources. The California Coastal Act of 1976 established the California Coastal Commission as a permanent coastal management and regulatory agency. The California 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 local coastal plan (LCP). Each LCP includes a land use plan that prescribes land use classifications, types and densities of allowable development, and goals and policies concerning development; and zoning and other ordinances and administrative procedures needed to implement the plan.

After an LCP is approved, the Commission's permitting authority is delegated to the local county/city government. The 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 central coast study region, there are 9 LCP segments, including the following:

- Point Arena
- Sonoma County
- Marin County South (Unit I)
- Marin County North (Unit II)
- San Francisco City and County
- Olympic Club
- Daly City
- Half Moon Bay
- San Mateo County

The Olympic Club segment has failed to file an LCP while the remaining 8 segments all have approved LCPs (California Coastal Commission 2005).

7.1.4 Native American jurisdiction/treaty rights

The United States Constitution recognizes Native American tribes as separate and independent political communities within the territorial boundaries of the United States. Tribes promulgate and administer their own laws and operate under their own constitutions.

There are 109 federally recognized Native American tribes in California, 15 of which lie within the five coastal counties of the north central coast study region. In addition, there are numerous tribes petitioning to be federally recognized.

Federally recognized tribes in coastal counties in the study region include:

Mendocino County

Round Valley Indian Tribes of the Round Valley Reservation
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

Sonoma County

Cloverdale Rancheria (recognized, but do not currently own land)
Dry Creek Rancheria of Pomo Indians of California
Federated Indians of Graton Rancheria
Kashia Band of Pomo Indians of the Stewarts Point Rancheria
Lytton Rancheria (recognized, but do not currently own land)

Marin County

Federated Indians of Graton Rancheria

California Fish and Game Code is not applicable to recognized members of Native American tribes within the boundaries of the reservation or rancheria, although the sale of bird, mammal, fish, or amphibia is still prohibited (Fish and Game code §12300). However, outside reservation or rancheria property, Native American citizens are subject to Fish and Game Code. The Department of Fish and Game grants permits to Native American citizens for the collection of seaweed for religious or ceremonial purposes.

7.2 Non-governmental Organizations and Programs

Dozens of local, community-based voluntary organizations participate in efforts to address issues in coastal watersheds in the five counties of the north central coast study region. Many such organizations also support volunteer water-quality monitoring programs in harbors and along beaches.

8.0 Existing MPAs and Coastal Protected Areas

This section provides an overview of existing marine and coastal protected areas and marine managed areas in the study region, and includes their existing regulations as outlined in Table 47.

8.1 Existing State Marine Protected Areas in the Study Region

A marine protected area, 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. The MLPA requires an analysis of the regions' existing MPAs to assess the need for changing existing MPAs or adding new ones in order to fulfill the requirements of the MLPA.

Preliminary site characterizations and evaluations of existing MPAs in the entire state were completed by CDFG (CDFG 2004b). A more formal evaluation of existing state MPAs, based on guidelines in the master plan, is currently being conducted by the MLPA Master Plan Science Advisory Team convened in 2007.

There are 13 MPAs that are in the north central coast study region (Maps [16a](#), [16b](#), [16c](#), [16d](#), [16e](#), [16f](#)) that together encompass 3.25% of the total study region area (Table 47). The majority of these protected areas were established in the 1960's and 1970's, but quantitative baseline studies and monitoring have occurred in only a few, including Sonoma Coast SMCA, Bodega SMR, and Duxbury Reef SMCA. In general, these MPAs are approximately one square mile or less in area, with the exceptions of Manchester and Arena Rock SMCA (6.77 mi²), Salt Point SMCA (1.75 mi²) and Farallon Islands SMCA (13.51 mi²), and do not extend to deeper offshore waters. Studies of MPAs in California's central coast (Starr et al 2002b; Starr et al 2002c) suggest that MPAs of this size are generally not large enough to achieve the goals of conserving biodiversity and protecting representative and unique habitats.

There are several MPAs with overlapping boundaries that potentially present management or enforcement difficulties. For instance, Gerstle Cove SMCA is located within Salt Point SMCA, but has different regulations. In addition, the northern part of Bodega SMR overlaps with the southern end of Sonoma Coast SMCA.

Table 47: Existing State MPAs in the MLPA North Central Coast Study Region

MPA NAME	Allowed Take	Area (mi²)	% of Total Region
Manchester and Arena Rock SMCA	Allows recreational and commercial take of finfish and some invertebrates. Allows commercial take of some algae.	6.68	0.87%
Del Mar Landing SMP	Take of all living marine resources is prohibited except the recreational take of finfish by hook and line or spear.	0.09	0.01%
Salt Point	Only the following species may be taken recreationally: finfish,	1.63	0.21%

MPA NAME	Allowed Take	Area (mi²)	% of Total Region
SMCA	<p>red abalone, chiones, clams, cockles, rock scallops, native oysters, crabs, lobsters, ghost shrimp, sea urchins, mussels and marine worms except that no worms may be taken in any mussel bed unless taken incidentally to the take of mussels.</p> <p>Only the following species may be taken commercially: finfish, crabs, ghost shrimp, jackknife clams, sea urchins, algae (except giant kelp and bull kelp) and worms except that no worms may be taken in any mussel bed, nor may any person pick up, remove, detach from the substrate any other organisms, or break up, move or destroy any rocks or other substrate or surfaces to which organisms are attached.</p>		
Gerstle Cove SMCA	Take of all living marine resources is prohibited except the commercial take of finfish and algae (except giant kelp and bull kelp).	0.01	0.00%
Fort Ross SMCA	<p>No recreational take of living or non-living marine resources is allowed except: finfish, red abalone, chiones, clams, cockles, rock scallops, native oysters, crabs, lobsters, ghost shrimp, sea urchins, mussels and marine worms except that no worms may be taken in any mussel bed unless taken incidentally to the take of mussels.</p> <p>Commercial take of species other than giant kelp and bull kelp is allowed.</p>	0.11	0.01%
Sonoma Coast SMCA	<p>No recreational take of living or non-living marine resources is allowed except: finfish, red abalone, chiones, clams, cockles, crabs, ghost shrimp, mussels, native oysters, rock scallops, sea urchins and marine worms except that no worms may be taken in any mussel bed unless taken incidentally to the take of mussels.</p> <p>Commercial take of species other than giant kelp and bull kelp is allowed.</p>	0.87	0.11%
Bodega SMR	All commercial and recreational take prohibited.	0.28	0.04%
Tomales Bay SMP	Take of all living marine resources is prohibited except the recreational hook and line take of species other than marine aquatic plants. Only lightweight, hand-carried boats may be launched or operated within the Park.	0.63	0.08%
Point Reyes Headlands SMCA	Take of all living marine resources is prohibited except the commercial take of finfish and algae other than giant kelp and bull kelp.	0.79	0.10%
Estero de Limantour SMCA	Take of all living marine resources is prohibited except the commercial take of finfish and algae other than giant kelp and bull kelp.	0.86	0.11%
Duxbury Reef SMCA	Only the following species may be taken recreationally: red abalone, Dungeness crab, rock crabs, rockfish (family	0.66	0.09%

MPA NAME	Allowed Take	Area (mi ²)	% of Total Region
	Scorpaenidae), lingcod, cabezon, surfperch (family Embiotocidae), halibut, flounder, sole, turbot, salmon, kelp greenling, striped bass, steelhead, monkeyface-eel, wolf-eel, smelt, and silversides. Commercial take of species other than giant kelp and bull kelp is allowed.		
James V. Fitzgerald SMP	Take of all living marine resources is prohibited except the recreational take by hook and line or spear of: rockfish (family Scorpaenidae), lingcod, surfperch (family Embiotocidae), monkeyface eel, rock eel, white croaker, halibut, cabezon, kelp greenling, and smelt (Families Osmeridae and Atherinidae).	0.76	0.10%
Farallon Islands SMCA	Vessel Operation/anchoring closure in a portion of the SMCA seasonally. No take of groundfish from 0-10 fathoms.	13.51	1.77%
Total Area of State Marine Reserves		0.28	0.04%
Total Area of State Marine Parks		1.49	0.19%
Total Area of State Marine Conservation Areas		25.12	3.29%
Total Area of State MPAs in North Central Coast Study Region		26.88	3.52%
Total Area of North Central Coast Study Region		763.5	

8.2 Marine Managed Areas and Other Fishery Closures

The MLPA North Central Coast Study Region has several existing marine managed areas where marine resource use is restricted.

8.2.1 National Marine Sanctuaries

Portions of two National Marine Sanctuaries (NMS) are located within the north central coast study region, including the Monterey Bay NMS and Gulf of the Farallones NMS. The Cordell Bank NMS also exists in close proximity to the study region, but in federal waters. These sanctuaries, established in 1992, 1981, and 1989, respectively, primarily regulate oil and gas extraction, vessel and other discharge, wildlife disturbance, seabed construction, and extraction of historical/cultural resources.

The Monterey Bay National Marine Sanctuary covers a total of 5,322 square miles and has a shoreline extent of 276 miles, stretching from Cambria in San Luis Obispo County in the south to Rocky Point in Marin County in the north. On average, the MBNMS extends 30 miles from shore and reaches to a depth of over two miles at its deepest point. The San Francisco exclusion zone, an area from rocky point, north of the Golden Gate Bridge, to Point San Pedro, near Pacifica, is not included in the sanctuary. The sanctuary covers many diverse oceanographic habitats, including Monterey submarine canyon (located outside of the study region), and hosts at least 36 species of marine mammals, 94 species of marine birds, and 345 species of fish. The MBNMS has a large number of research and monitoring programs, as well

as programs for education and outreach. The sanctuary also regulates activities including: oil, gas, and mineral exploration, vessel discharge, seabed construction, seabird, marine mammal, and sea turtle protection, use of historical resources, and use of personalized water craft.

The Gulf of the Farallones National Marine Sanctuary is contiguous with the MBNMS and extends from the MBNMS northern boundary, rocky point, to bodega head. The GFNMS covers a total area of 1,255 square miles and covers many important coastal features in the study region, including Bolinas Lagoon, Point Reyes, Tomales Bay, Estero Americano, Estero de San Antonio, Bodega Bay, and the waters around the Farallon Islands. This biologically rich area hosts at least 36 species of marine mammals, 52 species of rockfish, 27 endangered or threatened species, and supports the largest breeding concentration of seabirds in the contiguous United States. In addition to significant research, monitoring, education, and outreach activities, the GFNMS regulates oil, gas, and mineral exploration, vessel discharge, seabed construction, protection of biologically significant areas, use of historical resources, wildlife protection, and use of personalized water craft.

The Cordell Bank National Marine Sanctuary is contiguous with the GFNMS and includes the offshore area north of the GFNMS, approximately 20 miles west of Point Reyes, to bodega head, covering 526 square miles. Though this sanctuary is located outside of the north central coast study region, it covers rocky submerged islands and pinnacles that are important for both marine species and human-use activities in close proximity to the study region.

In an effort to better coordinate their activities, the three sanctuaries described above have recently conducted a joint management plan review process, including public review. More information on the joint management plan review and on newly proposed regulations can be found at: <http://www.sanctuaries.nos.noaa.gov/jointplan>.

8.2.2 Fishery Closures Within or Adjacent to the North Central Coast Study Region

Several areas in the north central coast study region and adjacent offshore waters are closed to fishing by other regulations. These areas are important to consider when establishing MPAs. Such fishery closures include:

Year-round closures for commercial and recreational fishing by all gear types

- Waters of Cordell Bank less than 100 fathoms (fms) in depth, no retention of groundfish except for “other flatfishes” with specified hook and line gear (50 CFR Part 660, subpart G). “Other flatfish” is defined in federal regulations at 50 CFR Part 660 as butter sole, curlfin sole, flathead sole, Pacific sanddab, rex sole, rock sole, and sand sole.
- Waters off the Farallon Islands less than 10 fms in depth, no retention of groundfish except “other flatfish” with specified hook and line gear.

Year-round closures to specified commercial gear types

- All waters within 3 miles of shore are closed to use of trawl gear.
- Within the Rockfish Conservation Area* (RCA), take and possession of federal groundfish species and ocean whitefish is prohibited with the following gear types: trawl nets, traps, hook and line gear (including longline gear), set gill and trammel nets, and spear. Exceptions to this prohibition apply to vessels participating in the primary whiting fishery, vessels fishing with demersal seine gear shoreward of the 100 fm boundary line, and vessels fishing for “other flatfish” with specified hook and line gear.
- In waters shoreward of the RCA but outside 3 miles from shore, small footrope gear is required on trawl nets.
- Within state waters, the use of gill nets and trammel nets to take rockfish is prohibited.
- Gill nets and trammel nets may not be used within 3 miles of the mainland shore.
- Groundfish Essential Fish Habitat Closures: Recently established Groundfish Essential Fish Habitat Conservation Areas are spatial closures for specific gear types implemented by the National Marine Fisheries Service. Though these areas primarily exist outside of state waters (for example, no bottom contact shallower than 50 fathoms is allowed at Cordell Bank), Groundfish Essential Fish Habitat Conservation Areas do exist within state waters in the vicinity of the Farallon Islands. These areas can be seen in maps [17a](#) and [17b](#).

* The RCA, defined by coordinates approximating depth zones, is different for trawl and non-trawl fisheries and may change within a year. For trawl fisheries, the RCA is 100-150 fm within the north central coast study region. In latitudes between 40°10' N and 38°N the RCA is 100-200 fm January, February, November, and December, and 100-150 fm the rest of the year. For non-trawl fisheries, the portion of the RCA that is closed year round lies between 30 and 150 fathoms. In the north central coast study region the RCA effectively only covers depths between 30-69 fm (69 fm is the greatest depth within the north central coast study region). Therefore, the RCA depth zone accounts for approximately 31.5% of the study region area.

Year-round closures to recreational fishing for groundfish species (includes rockfish, lingcod, cabezon, and kelp greenling)

- Waters within the recreational RCA. In the north central coast study region this area is from the shoreline to the Exclusive Economic Zone (EEZ) January-May and December, and from 30 fm to the EEZ the rest of the year. This area may change within the year.
- Waters less than 10 fms around the Farallon Islands and Noonday Rock closed to fishing for groundfish, except for “other flatfish” with specified hook and line gear.

In addition to the above year-round closures, seasonal closures exist for many commercial and recreational fisheries within the north central coast study region. While these seasonal closures provide benefits by helping to sustain those fisheries, unlike year-round closures, they do not

allow populations of fished species to achieve the same size and age structure. See the appendices for summaries of fishing regulations including seasonal closures for each profiled commercial and recreational fishery. For RCA seasonal coordinate data go to:

http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/Groundfish-Closed-Areas/Index.cfm#CP_JUMP_30272

The north central coast study region differs from the central coast study region in that the maximum depth zone is only 60-69 fms while the central coast study region had much greater maximum depths in Monterey Canyon. Thus, the north central coast study region only contains portions of depth-related regional fishery closures, such as the RCA, while the central coast study region contained entire depth zones identified by these types of closures.

8.3 Military, and Powerplant Closures

Three military establishments exist within the north central coast study region: a US Coast Guard training center in Petaluma, a US Coast Guard Station in Bodega Bay, and a US Coast Guard Station at Point Arena. None of these establishments has associated spatial closures in the marine environment.

Currently, there are no coastal powerplants or associated spatial closures that operate within the study region. However, the city of San Francisco is considering both tidal and wave energy projects in the future.

8.4 Terrestrial Protected Areas in Coastal Watersheds

In addition to state MPAs, there are also a variety of terrestrial protected areas within coastal watersheds of the region (maps [16a](#), [16b](#), [16c](#), [16d](#), [16e](#), [16f](#)). These include many state parks, state beaches, national wilderness areas, and military lands along the coast which provide some protection for shoreline and estuarine habitats (Table 48). Agencies managing terrestrial protected areas may make good partners for research, monitoring, and enforcement. Furthermore, the presence of terrestrial protected areas can help to minimize impacts from land use in the adjacent watershed.

Table 48: Summary of Terrestrial Protected Areas

Type of Protected Area	Locations	#
National Monuments	Muir Woods, California Coastal	2
National Recreation Areas	Golden Gate	1
National Seashores	Point Reyes	1
National Wildlife Refuges	Farallon Islands	1
State Beaches	Manchester, Schooner Gulch, Sonoma, Thornton, Pacifica, Gray Whale Cove, Montara, Half Moon Bay, San Gregorio, Pomponio, Pescadero, Bean Hollow	1 2
State Parks	Manchester, Salt Point, Tomales Bay, California, Samuel P Taylor, Mt Tamalpais, Portola, Butano	8
State Historic Parks	Fort Ross, Marconi Conference Center, Pigeon Point Lighthouse	3

Game Refuges	Mt Tamalpais, Farallon Islands, San Francisco	3
State Reserves	Kruse Rhododendron, Año Nuevo	2
County Parks	Stillwater Cove, Doran, San Pedro Valley, Pescadero Creek, Bolinas Lagoon	5
Other Parks	Lincoln, Golden Gate, Sharp, Harding	4
Other Terrestrial Protected Areas	Austin Creek State Recreation Area, Stornette Ranch Property (BLM), Gualala Point Regional Park, Tomales Bay Ecological Reserve, Limantour Estero Reserve, PRBO Conservation Science, Bolinas Lagoon Nature Reserve, Audubon Canyon Ranch, Slide Ranch, Fort Baker Military Reserve, Fort Point National Historic Site, Presidio of San Francisco, San Francisco Zoological Gardens, Fort Funston, Fitzgerald Marine Reserve (terrestrial component), Pescadero Marsh Natural Preserve	1 5

9.0 Summary by Subregion

Highlights and basic information on the ecological and socioeconomic setting and existing managed areas in each of the six subregions are summarized in the following sections. Table 49 shows habitats present within each of the six subregions and the proportion of each habitat that lies within each subregion. Note that subregions were created for the ease of displaying information on maps.

Table 49: Subregional Summary of Habitats [square miles or linear miles (% of total in study region)]

Habitat	Subregion 1	Subregion 2	Subregion 3	Subregion 4	Subregion 5	Subregion 6	Total Region
Total Area	135.0 (17.7%)	105.7 (13.8%)	178.7 (23.4%)	133.5 (17.5%)	116.4 (15.2%)	94.3 (12.3%)	763.5 (100%)
Total Shoreline Length [^]	64.5 (17.6%)	45.7 (12.4%)	141.2 (38.4%)	58.8 (16.0%)	50.2 (13.7%)	7.1 (1.9%)	367.6 (100%)
Intertidal Rock	50.1 (29.6%)	29.0 (17.1%)	37.7 (22.2%)	24.8 (14.7%)	20.5 (12.1%)	7.1 (4.2%)	169.5 (100%)
Intertidal Sand	24.0 (12.8%)	24.8 (13.2%)	74.6 (39.6%)	36.1 (19.2%)	28.7 (15.2%)	0.1 (<0.1%)	188.3 (100%)
Intertidal Coastal Marsh	1.2 (2.4%)	2.3 (4.4%)	35.9 (69.3%)	7.5 (14.5%)	4.9 (9.4%)	0.0 (0.0%)	51.8 (100%)
Intertidal Tidal Flats	0.4 (0.7%)	0.0 (0.0%)	46.8 (77.2%)	9.9 (16.4%)	3.5 (5.7%)	0.0 (0.0%)	60.6 (100%)
Hard 0-30 m	7.8 (21.1%)	4.9 (13.2%)	5.2 (14.1%)	7.5 (20.1%)	7.0 (19.0%)	4.6 (12.5%)	37.0 (100%)
Hard 30-100 m	9.6 (19.9%)	5.2 (10.8%)	18.1 (37.3%)	1.8 (3.8%)	6.5 (13.4%)	7.2 (14.8%)	48.4 (100%)
Hard 100-200 m	0.0 (NA)	0.0 (NA)	0.0 (100%)				
Hard >200 m	0.0 (NA)	0.0 (NA)	0.0 (100%)				
Soft 0-30 m	3.2 (1.4%)	10.7 (4.8%)	28.5 (12.8%)	79.4 (35.8%)	24.3 (11.0%)	75.9 (34.2%)	221.9 (100%)
Soft 30-100 m	99.5 (29.4%)	74.3 (21.9%)	96.0 (28.4%)	18.3 (5.4%)	49.1 (14.5%)	1.2 (0.4%)	338.4 (100%)
Soft 100-200 m	0.1 (1.7%)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	5.4 (98.3%)	5.5 (100%)
Soft >200 m	0.0 (NA)	0.0 (NA)	0.00 (100%)				
Unknown 0-30 m	14.6 (13.3%)	10.2 (9.2%)	30.6 (27.8%)	25.9 (23.5%)	28.8 (26.1%)	0.0 (0.0%)	14.6 (100%)
Unknown 30-100 m	0.1 (8.1%)	0.4 (30.0%)	0.1 (8.4%)	0.6 (43.3%)	0.1 (10.2%)	0.0 (0.0%)	0.1 (100%)
Unknown 100-200 m	0.0 (NA)	0.0 (NA)	0.0 (100%)				
Unknown	0.0 (NA)	0.0 (NA)	0.0				

Habitat	Subregion 1	Subregion 2	Subregion 3	Subregion 4	Subregion 5	Subregion 6	Total Region
>200 m							(100%)
Pinnacles	NA	NA	NA	NA	NA	NA	NA
Kelp ('05)	0.8 (88.4%)	0.1 (11.6%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.9 (100%)
Kelp ('04)	0.9 (65.2%)	0.4 (30.8%)	< 0.1 (0.9%)	< 0.1 (1.2%)	< 0.1 (1.9%)	0.00 (0.0%)	1.4 (100%)
Kelp ('03)	0.9 (78.4%)	0.2 (20.3%)	<0.1 (0.6%)	0.0 (0.0%)	<0.1 (0.7%)	0.0 (0.0%)	1.2 (100%)
Kelp ('02)	0.5 (26.4%)	1.2 (68.6%)	< 0.1 (1.0 %)	0.1 (3.5%)	< 0.1 (0.6%)	0.0 (0.0%)	1.7 (100%)
Kelp ('99)	2.1 (84.4%)	0.4 (15.6%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	2.5 (100%)
Kelp ('89)	2.7 (78.9%)	0.7 (20.9%)	0.0 (0.0%)	< 0.1 (0.2%)	0.0 (0.0%)	0.0 (0.0%)	3.4 (100%)
Average Kelp	1.3 (72.1%)	0.5 (27.9%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	1.8 (100%)
Estuary	0.1 (0.6%)	0.3 (1.7%)	17.1 (87.9%)	1.8 (9.4%)	0.1 (0.3%)	0.0 (0.0%)	19.5 (100%)
Seagrass (surfgrass)	0.0 (0.0%)	3.9 (5.6%)	28.6 (41.6%)	20.0 (29.1%)	15.9 (23.1%)	0.4 (0.6%)	68.8 (100%)
Seagrass (eelgrass)	0.0 (0.0%)	0.0 (0.0%)	6.0 (100%)	0.0 (0.0%)	0.0 (0.0%)	0.00 (0.00%)	6.1 (100%)
Oceanographic Habitats							
Upwelling Center	Point Arena		Point Reyes				
Retention Area							
Freshwater Plume							
Depth Zones							
Intertidal to 30m	27.2 (9.0%)	25.3 (8.4%)	68.8 (22.9%)	111.3 (37.0%)	65.2 (21.7%)	2.9 (1.0%)	300.9 (100%)
30m – 100m	107.6 (23.6%)	79.9 (17.6%)	108.2 (23.8%)	21.9 (4.8%)	51.1 (11.2%)	86.3 (19.0%)	455.1 (100%)
100m – 200m	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	< 0.0 (0.8%)	0.0 (0.0%)	4.9 (99.2%)	5.0 (100%)
Greater than 200m	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (100%)

^Shoreline length is based on the Environmental Sensitivity Index (ESI) database.

9.1 Alder Creek/Point Arena to Horseshoe Point (Subregion 1)

Subregion 1 covers 135.0 mi², with 64.5 miles of coastline oriented northwest to southeast with Point Arena being the only major promontory. The continental shelf is relatively narrow. Prominent coastal features include: Point Arena, Point Arena Lighthouse, Sea Lion Rocks, Arena Cove, Iverson Point, Havens Neck, Fish Rocks, Havens Anchorage, Robinson Point,

Gualala Point, Black Point, Fishermen Bay, Rocky Point, "The Football," Horseshoe Cove, and Horseshoe Point.

9.1.1 Ecological Setting

Shoreline: Open, mostly rocky exposed coast in an upwelling region.

Estuaries: Garcia and Gualala estuaries

Seagrass: None mapped.

Kelp: Bull kelp along whole subregion length, biggest patches are located just south of Point Arena.

Depth Range: Mostly soft bottom in the 30-100 m range with some shallower areas near the coast (about a fifth of the subregional area). No areas deeper than 100 m.

Rock/Sand Bottom: Several rocky reefs including Saunders and Robinson reefs. Most mapped rocky reef is just south of Point Arena.

Oceanographic Habitats: Dominated by persistent Point Arena upwelling center. Cold nutrient-rich, but plankton-poor, water carried south along Sonoma coast. North of Point Arena there is reduced upwelling where winds blow onshore. Shelter Cove area is a retention zone. Gualala estuary – bar built with stratified pools. Gualala outflow plume is locally important in winter [J. Largier, pers. comm.].

Seabird Colonies: Fish Rocks (Leach's Storm Petrel, Brandt's Cormorant, Pelagic Cormorant, Western Gull, Pigeon Guillemont, Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin) and Gualala Point Island (Brandt's Cormorant, Western Gull, Pigeon Guillemont), are major colonies for multiple species. Pelagic Cormorant and Pigeon Guillemont at many sites throughout the subregion. Point Arena and the Gualala River mouth are important for marbled murrelets. Many small scattered colonies

Marine Mammal Rookeries: Point Arena, Fish Rocks, and Gualala for California sea lions and harbor seals. Fish Rocks is a minor rookery for Steller sea lions. Sea Ranch for harbor seals. Many small scattered rookeries.

Marine Mammal Haulouts: Largest haulouts are located at Fish Rocks, 5km south of Gualala Point, Stewarts Point, and 1.5km south of Point Arena. Many small scattered haul out sites.

Other Areas for Marine Mammals: Harbor Porpoises are present around river mouths and from Point Bonita out to 35 fathoms.

9.1.2 Land-Sea Interactions

Coastal watersheds: Mendocino Coast

Major rivers: Garcia and Gualala Rivers

Anadromous fish streams: Gualala (steelhead); Garcia (steelhead, chinook, coho)

Hardened shoreline: Arena Cove (riprap)

Impaired water bodies: Garcia River (temperature), Gualala River (temperature, sediment)

Major point sources: Wastewater treatment facility at Anchor Bay.

Other issues: Copper/iron concentration in Point Arena Mountain Beaver Population (USFWS study), "Junk Beach" near Point Arena as a potential contaminants.

9.1.3 Socioeconomic Setting

Counties: Mendocino, Sonoma

Coastal towns/ports/harbors: Point Arena, Fish Rock, Anchor Bay, Gualala, Stewarts Point

Public access areas, boat ramps, piers, etc: Manchester State Beach (campground, fishing, beach), Garcia River Access (fishing), Arena Cove (boating, fishing), Fish Rock Beach (campground, disabled access, fishing), Collins Landing (fishing), Gualala River Mouth (fishing), Gualala Point Regional Park (campground, disabled access, fishing), North Horseshoe Cove (fishing).

Commercial fisheries: Some of the major commercial fisheries landed in Point Arena and Anchor Bay ports are salmon, Dungeness crab, urchin, nearshore finfish, and lingcod. Important areas include Point Arena, Arena Cove, Saunders Reef, Trigger Fish, Gualala Point, Anchor Bay, Blacks Point, Alder Creek

Consumptive recreational use: Major recreational fisheries occurring in subregion 1 include abalone, rockfish, lingcod, salmon, California halibut, and Dungeness crab. Important areas include Arena Cove, Moat Creek, Schooner Gulch, Saunders Reef, Anchor Bay, Gualala Point, Rocky Point, Horseshoe Cove, Stornetta Ranch, Alder Creek, Flag Rock

Non-consumptive recreational use (diving, kayaking, wildlife viewing, beaches, etc): Important areas include Arena Cove, Point Arena, Havens Neck, Gualala Point, Blacks Point, Schooner Gulch

9.1.4 Research and Monitoring

Research institutions: None

Existing monitoring sites: Point Arena (CENCOOS, PISCO intertidal), Stornetta Ranch (PISCO intertidal), Arena Cove (CENCOOS), Gualala River (CENCOOS), Sea Ranch, south of Del Mar Point (PISCO intertidal).

9.1.5 Existing MPAs, Marine Managed Areas, and Coastal Protected Areas

Existing state MPAs: Manchester and Arena Rock SMCA just north of Point Arena (Allows recreational finfish and some invertebrates and commercial take of some invertebrates); Del Mar Landing SMP (allows recreational finfish).

RCAs and other fishery closures: No overlap with RCA

Other marine managed areas: None

Coastal protected areas: Stornetta Ranch Property (BLM), Gualala Point Regional Park, Schooner Gulch State Beach, Manchester State Beach

9.1.6 Other Issues

To be determined.

9.2 Horseshoe Point to Bodega Head (Subregion 2)

Subregion 2 covers 105.7 mi² and 45.7 miles of coastline oriented northwest to southeast with major freshwater input from the Russian River. The continental shelf is relatively narrow.

Prominent coastal features include: Horseshoe Point, Fisk Mill Cove, Gerstle Cove, Ocean Cove, Timber Cove, Northwest Cape, Goat Rock, Peaked Hill, Duncan's Point, Bodega Head.

9.2.1 Ecological Setting

Shoreline: Open, exposed coast in an upwelling region; mostly rocky shoreline in the north giving way to sandy beach backed by dunes in the south.

Estuaries: Russian River estuary

Seagrass: None mapped.

Kelp: Bull kelp along the northern portion, mostly concentrated between Stewarts Point and just south of Fort Ross.

Rock/Sand Bottom: Several rocky reefs including Fort Ross and Sunken reefs. Most mapped rocky reef is off of Bodega Head.

Depth Zones: Mostly soft bottom in the 30-100 m depth range with some shallower areas near the coast (about a quarter of the subregional area). No areas deeper than 100 m.

Oceanographic Habitats: This whole sub-region is part of the Arena upwelling center during stronger winds. During weaker winds, nearshore currents reverse and waters from the Gulf of Farallones are observed here – most frequently in the south. Off Bodega Head, the mean current is northward as a result of these northward flows during relaxation events. Thermal stratification is strong at these times and very high levels of phytoplankton are observed (Largier et al 2006). Russian River outflow drops sediment to north in winter and flows south in summer. [J. Largier, pers. comm.]

Seabird Colonies: Arched Rock (Brandt's Cormorant, Western Gull), Russian River Rocks (Double-Crested Cormorant, Brandt's Cormorant, Pelagic Cormorant, Western Gull), Russian Gulch (Pelagic Cormorant, Western Gull, Pigeon Guillemont), Gull Rock (Leach's Storm Petrel, Pelagic Cormorant, Western Gull). Colonies north and south of the Russian River Mouth for marbled murrelets. Bodega Rock is important for Brant's Cormorant. Many scattered small colonies, foraging around river mouths.

Marine Mammal Rookeries: Northwest Cape Rocks/Fort Ross (Steller sea lion), Bodega Rock (Steller sea lions). Major harbor seal colony at Salt Point.

Marine Mammal Haulouts: Largest 1.1 km north of salt point, Horseshoe Cove, Bodega Rock, and Fort Ross Cove. Bodega Rock hosts four species of marine mammals. Bodega head and the Russian River mouth are also important.

Other Areas for Marine Mammals: Foraging takes place at river mouths. Gray whales are often seen near the Russian River mouth..

9.2.2 Land-Sea Interactions

Coastal watersheds: Mendocino Coast, Russian River, Bodega

Major rivers: Russian River

Anadromous fish streams: Russian River (coho, steelhead)

Hardened shoreline: Russian River estuary (riprap) and $\frac{3}{4}$ mile south of Russian River Estuary (riprap).

Impaired water bodies: Russian River (temperature, sediment, pathogens)

Major point sources: Bodega Marine Lab at Bodega Head.

Other issues: Septic tanks along Russian river as a potential source of pollution

9.2.3 Socioeconomic Setting

Counties: Sonoma

Coastal towns/ports/harbors: Fort Ross, Oceanview, Sereno Del Mar, Jenner, Carmet

Public access areas, boat ramps, piers, etc: Fisk Mill Cove (fishing), Ocean Cove Reserve (campground, fishing), Timber Cove Campground and Boat Landing (campground, boating, fishing), Fort Ross Historic State Park (disabled access, fishing), Rivers End (campground, fishing, boating), Jenner visitor center (disabled access, boating, fishing), Bridgehaven campground (campground, fishing), Fort Ross Reef Campground (campground, disabled access, fishing), North Jenner Beaches (fishing), Stump Beach (fishing), Salt Point State Park (campground, disabled access, boating, fishing), Goat Rock (disabled access, fishing), Shell Beach (disabled access, fishing), Duncans Mills Camping Club (campground, disabled access, fishing), Casini Ranch Family Campground (camping, boating, fishing), Wrights Beach (campground, disabled access, fishing), Duncans Cove and Landing (fishing), Salmon Creek Beach (fishing).

Commercial fisheries: Some of the major commercial fisheries landed in the Bodega Bay Port Complex are salmon, Dungeness crab, tuna, flatfish, and neashore finfish.

Consumptive recreational use: Major recreational fisheries occurring in subregion 2 include clam, abalone, rockfish, lingcod, salmon, California halibut, and Dungeness crab. Important areas include Ocean Cove, Horseshoe Point, Salt Point, Timber Cove, Fort Ross, Fisk Mill Cove, Jenner, Pedoti

Non-consumptive recreational use (diving, kayaking, wildlife viewing, beaches, etc): Important areas include Horseshoe Point, Salt Point, Gerstle Cove, Fort Ross, Russian River Outlet

9.2.4 Research and Monitoring

Research institutions: University of California Marine Laboratory (Bodega)

Existing monitoring sites: Gerstle Cove (CENCOOS), Russian Gulch (PISCO intertidal), Russian River mouth (CENCOOS), Russian River near Moscow (CENCOOS, Sonoma County Water Agency fisheries and biological assessments), Duncans Landing (PISCO intertidal), Mussel Point (PISCO intertidal), Salmon Creek Estuary (Salmon Creek Watershed Group), Bodega Marine Lab (PISCO intertidal), Horseshoe Cove (PISCO intertidal), Bodega head (CENCOOS (x2))

9.2.5 Existing MPAs, Marine Managed Areas, and Coastal Protected Areas

Existing state MPAs: Salt Point SMCA (allows recreational and commercial take of finfish and some invertebrates); Gerstle Cove SMCA (allows commercial take of finfish and some algae); Fort Ross SMCA (allows recreational take of finfish and some invertebrates and commercial take of finfish, invertebrates, and some algae); Sonoma Coast SMCA (allows recreational take of finfish and some invertebrates and commercial take of finfish, invertebrates, and some algae), Bodega SMR (no take).

RCAs and other fishery closures: No overlap with RCA

Other marine managed areas: None

Coastal protected areas: Kruse Rhododendron State Reserve, Salt Point State Park, Stillwater Cove County Park, Fort Ross State Historic Park, Sonoma Coast State Beach,

9.2.6 Other Issues

To be determined.

9.3 Bodega Head to Double Point (Subregion 3)

Subregion 3 is the largest of the subregions and covers 178.7 mi² and 141.2 miles of coastline dominated by the large coastal promontory of Point Reyes. The continental shelf widens as one moves from north to south in this subregion. Prominent coastal features include: Bodega Head, Bodega Harbor, Bodega Bay, Tomales Bay, Sand Point, Tomas Point, Preston Point, Pelican Point, Abbotts Lagoon, Hog Island, Tomales Point, Bird Rock, Point Reyes, Point Reyes Lighthouse, Drakes Bay, Drakes Estero, Bull Point, Schooner Bay, Home Bay, Drakes Head, Estero De Limantour, Point Resistance, Millers Point, Alamere Falls, Stormy Stack, and Double Point.

9.3.1 Ecological Setting

Shoreline: Diverse shoreline types with several large promontories, bays, and estuaries in an upwelling region.

Estuaries: Estero Americano, Estero de San Antonio, Tomales Bay, Olema Marsh, Livermore Marsh, Marshall Marsh, Abbotts Lagoon, Drakes Estero, Estero de Limantour,

Seagrass: Eelgrass in Bodega Bay, Estero Americano, Tomales Bay, and Drakes Estero

Kelp: Very little kelp.

Rock/Sand Bottom: Significant rocky reefs are located off Bodega Head, south of Tomales Point, and off Point Reyes.

Depth Zones: About 60% soft and hard bottom in the 30-100 m depth range and 40% soft and hard bottom in the 0-30 m depth range. No areas deeper than 100 m.

Oceanographic Habitats: The sub-region is dominated by Point Reyes, with reduced upwelling along the north and south shores of the peninsula. Warmer waters suggest a “detention zone” on the north side of Point Reyes and a “retention zone” in Drakes Bay, to the south. Waters upwelled north of this area are deflected offshore by Point Reyes and typically move past the Farallon Islands. San Francisco Bay waters are typically present in the surface layer up to Point Reyes, with stratification more persistent here than elsewhere along the coast. Significant fronts are observed in the vicinity of Bolinas. Tomales Bay, Drakes Estero, and Bodega Harbor are important low-inflow estuaries, each offering distinct (and rare) oceanographic habitats. [J. Largier, pers. comm.]

Seabird Colonies: Point Reyes (Common Murre, Ashy Storm Petrel, Brandt’s Cormorant, Pigeon Guillemont, Pelagic Cormorant, Western Gull, Tufted Puffin), Double Point Rocks (Common Murre, Ashy Storm Petrel, Brandt’s Cormorant), Point Resistance (Common Murre, Double-Crested Cormorant), Millers Point Rocks (Common Murre, Brandt’s Cormorant, Pigeon Guillemont), Bird Rock (Ashy Storm Petrel, Western Gull, Pigeon Guillemont, Rhinoceros Auklet, Tufted Puffin). Bodega bay and bird rock are key areas for wintering shorebirds. Brant's cormorants winter in Tomales Bay. Drake's Estero is the largest colony of shorebirds in Marin

County and is also important for Brant's cormorant. Hog's head island is important for double crested cormorants.

Marine Mammal Rookeries: Point Reyes (Steller sea lion, elephant seal). Seal Island is important in the winter and is a rookery. Several colonies in the Drake's Bay area including Point Resistance, Miller's Point, and Double Point. Double point has California sea lions and over 1000 harbor seals during breeding season.

Marine Mammal Haulouts: Very large haulouts at Double Point, Drakes Estero, north of Tom's Point, Sea lion Cove, and Bird Rock. Harbor seals and sea lions are common at bird rock. Four species of marine mammals are found near the Point Reyes headland and it is the northern most important area for elephant seals. Point Reyes is also a major haul out for Steller sea lions and a minor one for harbor seals.

Other Areas for Marine Mammals: Gray whales hug the shore near Point Reyes. Humpback whales use Drake's Bay and Minke whales calve there. Porpoises are found in Drakes and Bodega Bay.

Other: Leatherback turtles are often found off of the Point Reyes headlands.

9.3.2 Land-Sea Interactions

Coastal watersheds: Bodega, Marin Coastal

Major rivers: Estero Americano, Estero de San Antonio, Walker Creek, and Lagunitas Creek

Anadromous fish streams: Coast Creek (steelhead), Walker Creek (steelhead), Lagunitas Creek (steelhead, coho), Drakes Estero (steelhead)

Hardened shoreline: Bodega Harbor (riprap and seawalls), Tomales Bay, Nicks Cove (riprap), Tomales Bay, ½ mile south of Nick Cove (riprap), Tomales bay, South of Marshall (riprap, seawalls)

Impaired water bodies: Estero Americano (nutrients, sediment), Americano Creek (nutrients), Estero de San Antonio (nutrients, sediment), Walker Creek (mercury, nutrients, sediment), Lagunitas Creek (pathogens, nutrients, sediment), Tomales Bay (pathogens, nutrients, sediment, mercury)

Major point sources: Bodega Bay Fish Farm at Estero Americano

9.3.3 Socioeconomic Setting

Counties: Sonoma, Marin

Coastal towns/ports/harbors: Bodega Bay, Bodega Harbor, Dillon Beach, Ocean Roar, Hamlet, Marshall, Reynolds, Marconi, Millerton, Inverness, Inverness Park, Point Reyes Station, and Limantour

Public access areas, boat ramps, piers, etc: Bodega Harbor, including Westside Regional Park, Spud Point Marina, Masons Marina, Porto Bodega, and Doran Beach Regional Park (camping, disabled access, boating, fishing), Dillon Beach (fishing, boating), Lawsons Landing (fishing, boating), Keys Creek Public Fishing Access (fishing), Tomales Bay State Park, Millerton Point (disabled access, fishing), Miller Park Launching Facility (boating, fishing).

Commercial fisheries: Some of the major commercial fisheries landed in the Bodega Bay Port Complex are salmon, Dungeness crab, tuna, flatfish, and nearshore finfish.. A commercial fishery for herring also exists within Tomales Bay. Also unique to subregion 3 are the presence of commercial oyster, mussel, and clam mariculture operations within Tomales Bay and Drakes

Estero. Some important areas for commercial fisheries include Stinson Beach, 10 Mile Beach, Elephant Rock, "Radio Towers", Potato Patch, Double Point

Consumptive recreational use Major recreational fisheries occurring in subregion 3 include clam, rockfish, lingcod, salmon, California halibut, and Dungeness crab. Important areas include Bodega Bay and Head, Tomales Bay, Slide Ranch, Muir Beach, 10 Mile Beach, Point Reyes, Stinson Beach, Lawsons Landing, Nicks Cove, Drakes Bay, "Radio Towers", Potato Patch, Double Point

Non-consumptive recreational use (diving, kayaking, wildlife viewing, beaches, etc): Bodega Bay, Tomales Bay, Tomales Point, Point Reyes, Drakes Estero, Estero De Limnatour, Elephant Rock

9.3.4 Research and Monitoring

Research institutions: University of the Pacific Marine Station

Existing monitoring sites: Bodega Harbor (CENCOOS(x4)), Estero Americano (CENCOOS), Estero de San Antonio (CENCOOS), Tomales Bay (CENCOOS (x14)), Walker Creek (CENCOOS (x5)), Lagunitas Creek (CENCOOS (x2)), Point Reyes (CENCOOS (x3)), Santa Maria Creek (PISCO intertidal)

9.3.5 Existing MPAs, Marine Managed Areas, and Coastal Protected Areas

Existing state MPAs: Tomales Bay SMP (allows recreational take by hook and line), Point Reyes Headlands SMCA (allows commercial take of finfish and some algae), Estero de Limantour SMCA (allows commercial take of finfish and some algae)

RCAs and other fishery closures: No overlap with RCA

Other marine managed areas: Gulf of the Farallones NMS

Coastal protected areas: Doran County Park, Point Reyes National Seashore, Tomales Bay Ecological Reserve, Tomales Bay State Park, Tomales Bay State Park - Alan Sieroty Beach, Limantour Estero Reserve, Samuel P. Taylor State Park

9.3.6 Other Issues

Bolinas Lagoon Ecosystem Restoration Project: Potential dredging of Bolinas Lagoon by the US Army Corps of Engineers to remove accumulated sediment.

9.4 Double Point to Point San Pedro (Subregion 4)

Subregion 4 covers 133.5 mi² and 58.8 miles of coastline dominated by the mouth of San Francisco Bay in the lee (south of) Point Reyes. The continental shelf is relatively wide as it stretches to the Farallon Islands. Prominent coastal features include: Double Point, Abalone Point, Bolinas Point, Duxbury Point, Bolinas Bay, Bolinas Lagoon, Kent Island, Rocky Point, Gull Rock, Pirates Cove, Tennessee Cove, Tennessee Point, Bolinas Channel, Rodeo Cove, Rodeo Lagoon, Bird Island, Point Bonita, Point Bonita Lighthouse, Mile Rocks Light/Horn, Lands End, Mori Point, Shelter Cove, San Pedro Rock, and Point San Pedro

9.4.1 Ecological Setting

Shoreline: Steep, rocky coastal topography with one significant estuary, Bolinas Lagoon, and the mouth of the largest estuary in California, San Francisco Bay (San Francisco Bay itself is not included in the study region). Mostly rocky shores north of San Francisco Bay and sandy beach south of it.

Estuaries: Bolinas Lagoon, Rodeo Lagoon.

Seagrass: None mapped.

Kelp: Very little kelp. Small patches north of Bolinas Point.

Rock/Sand Bottom: Significant rock located in the vicinity of Bolinas Point and Point San Pedro. Sandy shoals located near the mouth of San Francisco Bay including the “potato-patch” and Four-fathom bank.

Depth Zones: Mostly shallow (< 30 m) hard and soft bottom with some deeper, mostly soft, areas in the 30-100 m depth range and a very small amount of soft bottom in the 100-200 m depth range. No areas deeper than 200 m.

Oceanographic Habitats: The San Francisco Bay outflow dominates this subregion. Strong tidal currents are found in the vicinity of the mouth and bar. Plume water moves north alongshore to Bolinas under most conditions and then continues to Point Reyes and beyond during periods of large freshwater influence and reduced northerly winds. During the upwelling season, the bay outflow flows south and moves offshore. There are strong waves and large sandy bars offshore of the Golden Gate in response to large waves and currents. Active upwelling is observed along the shoreline between Drakes Estero mouth and Bolinas. Drakes Estero and Bolinas Lagoon are two important low-inflow estuaries along this coast. [J. Largier, pers. comm.]

Seabird Colonies: Lobos Rock and Land’s End (Brandt’s Cormorant), Point Bonita (Pelagic Cormorant, Pigeon Guillemont). Duxbury reef has rocky intertidal habitat used by shorebirds. Bolinas lagoon has migratory shorebirds and waterfowl. Seal Rocks (near the Cliffhouse) has Brant’s cormorants and brown pelican roosting. Point San Pedro has nesting shorebirds and roosting pelicans. Seabirds forage at the mouth of San Francisco Bay.

Marine Mammal Rookeries: Bolinas Lagoon has a large harbor seal rookery.

Marine Mammal Haulouts: Largest at Seal Rocks, Point Bonita, Bolinas Lagoon, and Duxbury Point. Duxbury has a small harbor seal haulout. Few haulouts from Bolinas to Point Bonita. California and Steller seal lions at seal rocks. Harbor seals at Point San Pedro.

Other Areas for Marine Mammals: Minke whales are found within three nautical miles outside of the Golden Gate Bridge. This subregion has the highest concentration of harbor porpoises in the north central coast study region. Bottlenose dolphins are found at Bakers Beach and in Pacifica. The mouth of San Francisco Bay is a foraging area for mammal marine mammals.

Other: Leatherback turtles are found off San Francisco Bay

9.4.2 Land-Sea Interactions

Coastal watersheds: Marin Coastal, San Mateo, San Francisco Bay Drainage

Major rivers: None

Anadromous fish streams: Pine Gulch Creek (steelhead, coho), McKinnan Gulch (steelhead), Redwood Creek (steelhead, coho), San Pedro Creek (steelhead)

Hardened shoreline: Mouth of Bolinas Lagoon (riprap), Rodeo Lagoon (riprap), Golden Gate Bridge (seawall), Mussel Rock Park (riprap), Pacifica, north of pier (riprap), Pacifica Pier.

Impaired water bodies: Pacific Ocean at Rockaway State Beach (coliform), Pacific Ocean at Pacifica State Beach (coliform), San Pedro Creek (coliform)

Major point sources: San Francisco Oceanside Wastewater Treatment Facility, North San Mateo County Wastewater Treatment Facility

9.4.3 Socioeconomic Setting

Counties: Marin, San Francisco, San Mateo

Coastal towns/ports/harbors: Bolinas, Stinson Beach, Muir Beach, San Francisco, Daly City, Pacifica.

Public access areas, boat ramps, piers, etc: Duxbury Reef SMCA (fishing), Bolinas Beach (fishing), Golden Gate State Park (disabled access, boating, fishing), Baker Beach (disabled access, fishing), Mussel Rock City Park (disabled access, fishing), Sharp Park beach and Pacifica Pier (disabled access, fishing), Rockaway Beach (fishing), San Pedro Beach (disabled access, fishing), Phillip Burton Memorial Beach (fishing)

Commercial fisheries: Some of the major commercial fisheries landed in the San Francisco Bay Port Complex are salmon, Dungeness crab, dover sole (trawl fishery), thornyheads (trawl fishery), sablefish (trawl fishery), flatfish, and California halibut. Some important areas are North Bar, Double Point, Rocky Point, Duxbury Reef, Point Bonita, Muir Beach, Mori Point, Point San Pedro

Consumptive recreational use: Major recreational fisheries occurring in subregion 4 include clam, rockfish, lingcod, salmon, California halibut, and Dungeness crab. Some important areas are Bolinas, Double Point, Rocky Point Duxbury Reef, North Bar, Muir Beach, Mori Point, Point San Pedro, Bonita Cove, Point Bonita, Ocean Beach, Thornton Beach, Pacifica Pier

Non-consumptive recreational use: Duxbury Reef, Muir Beach, Ocean Beach, Rockaway Beach, Linda Mar.

9.4.4 Research and Monitoring

Research institutions: PRBO Conservation Science, Audobon Canyon Ranch, Slide Ranch, Marine Mammal Center, San Francisco State University, Steinhart Aquarium

Existing monitoring sites: Duxbury Reef (GFNMS), Bolinas Point (PISCO intertidal (x2)), Bolinas Lagoon (CENCOOS), Offshore of rocky point (CENCOOS (x6)), Near Golden Gate Bridge (CENCOOS (x5)), San Francisco County Northwest Coast (CENOS (x6)), Offshore Daly City (CENCOOS (x13)), Pacifica (CENCOOS (x2)), Offshore Pacifica (CENCOOS (x6)).

9.4.5 Existing MPAs, Marine Managed Areas, and Coastal Protected Areas

Existing state MPAs: Duxbury Reef SMCA (allows recreational take of some finfish and invertebrates and commercial take of finfish, invertebrates, and some algae)

RCAs and other fishery closures: No overlap with RCA

Other marine managed areas: Gulf of the Farallones NMS, Monterey Bay NMS.

Coastal protected areas: Point Reyes Bird Observatory, Point Reyes National Seashore, Golden Gate National Recreation Area, Bolinas Lagoon County Park, Bolinas Lagoon Nature

Reserve, Audubon Canyon Ranch, Slide Ranch, Mt Tamalpais Game Refuge, Mt Tamalpais State Park, Muir Woods National Monument, Fort Baker Military Reserve, Fort Point National Historic Site, Presidio of San Francisco, Lincoln Park, Golden Gate Park, San Francisco Zoological Gardens, Harding Park, Fort Funston, Thornton State Beach, Sharp Park, San Pedro Valley County Park, San Francisco State Fish and Game Refuge.

9.5 Point San Pedro to Pigeon Point (Subregion 5)

Subregion 5 covers 116.4 mi² and 50.2 miles of coastline oriented north to south with a promontory at Montara Mountain between Pacifica and Half Moon Bay. The continental shelf is relatively narrow. Prominent coastal features include: Point San Pedro, Devils Slide, Point Montara, Point Montara Lighthouse, Seal Cove, Pillar Point, Half Moon Bay, Miramontes Point, Eel Rock, Seal Rock, Pescadero Point, Bolsa Point, Pigeon Point Lighthouse, Pigeon Point.

9.5.1 Ecological Setting

Shoreline: Steep rocky headlands in the north giving way to rolling river valleys in the south. Sandy beaches in Half Moon Bay and between Pescadero and San Gregorio Creeks.

Estuaries: Pescadero Marsh.

Seagrass: None mapped

Kelp: Very little kelp.

Rock/Sand Bottom: Significant rocky reef exists in this subregion from San Pedro Point to the outlet of San Gregorio Creek. The area south of Half Moon Bay has particularly broad rock coverage.

Depth Zones: About half of the subregional area is hard and soft bottom in the 0-30 m range and half is hard and soft bottom in the 30-100m range. No areas deeper than 100 m.

Oceanographic Habitats: South of Point San Pedro, upwelling is again important with a noted center at Pigeon Point and small-scale enhanced upwelling at Pillar Point. Half Moon Bay may act as a retention area where water could be retained for a few days. [J. Largier, pers. comm.]

Seabird Colonies: Devil's Slide Rock (Common Murre, Pigeon Guillemont, Pelagic Cormorant, Western Gull), Seal Rock Cliffs (Pelagic Cormorant, Brandt's Cormorant), Martin's Beach (Pelagic Cormorant, Pigeon Guillemont), San Pedro Rock (Pigeon Guillemont). The area between Devil's Slide and Point San Pedro is important for murrens and pigeon guillemont. Abundant foraging area between Devil's Slide and Pescadero, but not many nesting sites. Pillar Point, Point San Pedro, and Pescadero Point are important for marbled murrelets and foraging for many species. Martin's beach cliffs is also an important foraging area.

Marine Mammal Rookeries: None.

Marine Mammal Haulouts: Largest south of Miramontes Point, Bean Hollow State Beach, north of Bolsa Point, and reefs west of Half Moon Bay. Many small haul out sites including Fitzgerald Marine Reserve, Cowell Ranch, and Pescadero Creek mouth south to Bean Hollow State Beach.

Other Areas for Marine Mammals: There is much foraging in this area. Humpback whales forage here. Sea otters are present in this subregion up to Point San Pedro (and rarely up to Point Reyes).

9.5.2 Land-Sea Interactions

Coastal watersheds: San Mateo, Big Basin

Major rivers: San Gregorio Creek, Pescadero Creek, Butano Creek,

Anadromous fish streams: Denniston Creek (steelhead), Frenchman's Creek (steelhead), Tunitas Creek (steelhead), San Gregorio Creek (steelhead), Pomponio Creek (steelhead), Pescadero Creek (steelhead, coho), Butano Creek (steelhead).

Hardened shoreline: Devils Slide (riprap), Half Moon Bay (extensive jetties, riprap, seawall), South of Pescadero Creek (riprap).

Impaired water bodies: Pacific Ocean at Fitzgerald Marine Reserve (coliform), San Vicente Creek (coliform), Pacific Ocean at Pillar Point Beach (coliform), Pacific Ocean at Venice Beach (coliform), San Gregorio Creek (coliform, sediment), Pomponio Creek (coliform), Pescadero Creek (sediment), Butano Creek (sediment).

Major point sources: Mid-Coastside Wastewater Treatment Facility

9.5.3 Socioeconomic Setting

Counties: San Mateo

Coastal towns/ports/harbors: Montara, Moss Beach, El Granada, Miramar, Half Moon Bay, Pillar Point Harbor, San Gregorio, Pescadero

Public access areas, boat ramps, piers, etc: Montara State Beach (fishing), Pillar Point Harbor (disabled access, fishing, boating), East Breakwater (campground, fishing), Francis Beach (campground, disabled access, fishing), Martins Beach (fishing), San Gregorio State Beach (disabled access, fishing), Pomponio State Beach (disabled access, fishing), Pigeon Point Lighthouse Hostel (fishing).

Commercial fisheries: Some of the major commercial fisheries landed in the Princeton and Half Moon Bay Ports are salmon, Dungeness crab, dover sole (trawl fishery), thornyheads (trawl fishery), sablefish (trawl fishery), flatfish, and California halibut. Some important areas are Pigeon Point, Half Moon Bay.

Consumptive recreational use: Major recreational fisheries occurring in subregion 5 include rockfish, lingcod, salmon, California halibut, and Dungeness crab. Some important areas are Fitzgerald, Pescadero, Pigeon Point, Colorado Reef, Bean Hollow SB, Miramontes Point, Half Moon Bay, Pillar Point, San Gregorio SB,

Non-consumptive recreational use: Pescadero, Pillar Point, Fitzgerald SMP, Bean Hollow SB, Pillar Point, San Gregorio SB, Moss Beach

9.5.4 Research and Monitoring

Research institutions: None

Existing monitoring sites: Fitzgerald Marine Reserve (PISCO intertidal), Pescadero Creek (CENCOOS), Pigeon Point (PISCO intertidal)

9.5.5 Existing MPAs, Marine Managed Areas, and Coastal Protected Areas

Existing state MPAs: James V. Fitzgerald SMP (allows recreational take of some finfish and invertebrates)

RCA and other fish closures: No overlap with RCA

Other marine managed areas: Monterey Bay NMS

Coastal protected areas: Gray Whale Cove State Beach, Montara State Beach, Fitzgerald Marine Reserve, San Francisco State Fish and Game Refuge, Half Moon Bay State Beach, San Gregorio State Beach, Pomponio State Beach, Pescadero State Beach, Pescadero Marsh Natural Preserve, Bean Hollow State Beach, Pescadero Creek County Park, Portola State Park, Butano State Park, Pigeon Point Light Station State Historic Park

9.5.6 Other Issues

Construction of new pier at Pillar Point Harbor: The San Mateo County Harbor District is exploring the possibility of replacing Romeo pier at Pillar Point Harbor.

Expansion of berths and construction of haulout facility at Pillar Point Harbor: The San Mateo County Harbor District is beginning a new project to install 71 new boat berths in the Inner Harbor. The project will include dredging a basin for the berths, placing the sediment on the perched beach behind a new bulkhead, installing the berths, constructing new access walkways, landscaping, and vehicle parking behind the bulkhead, and links to the new restrooms.

9.6 Farallon Islands (Subregion 6)

Subregion 6 is the smallest of the subregions and covers 94.3 mi² and 7.4 miles of coastline surrounding the North, Middle, West End and Southeast Farallon islands. The islands are located 28 miles west of the Golden Gate and 20 miles south of Point Reyes and oriented in a northwest to southeast, eight mile long line. The continental shelf is shallow to the east of the islands and drops steeply to the west of the islands. Prominent coastal features include Southeast Farallon Island, Maintop Island, Seal Rock, Middle Farallon, North Farallon, Noonday Rock, and the Farallon Lighthouse.

9.6.1 Ecological Setting

Shoreline: Rocky Islands in an upwelling region.

Estuaries: None.

Seagrass: None mapped (though some documented *Phyllospadix torreyi* and *scouleri*).

Kelp: None mapped.

Rock/Sand Bottom: Several rocky reefs including Fanny and Hurst Shoal. Most rock in this subregion is concentrated around the Southeast, Middle, and North Farallon Islands, as well as Noon Day Rock.

Depth Zones: Mostly hard and soft bottom in the 30-100 m depth range with some mostly hard bottom in the 0-30 m range and the only significant, though still small, area of soft bottom in the 100-200 m range. No areas deeper than 200 m.

Oceanographic Habitats: Rich productive waters with high phytoplankton content reach Farallons Islands around five days after upwelling along the coast south of Point Arena. This ready food supply fuels a productive ecosystem. It is not known how often nor how important the influences of San Francisco Bay outflow are on the islands, but it is thought to be minor or negligible. [J. Largier, pers. comm.]

Seabird Colonies: North Farallon Island (Common Murre, Brandt's Cormorant), Southeastern Farallon Island (Leach's Storm Petrel, Ashy Storm Petrel, Brandt's Cormorant, Double-Crested Cormorant, Pelagic Cormorant, Western Gull, Pigeon Guillemont, Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin, Fork-Tailed Storm Petrel). The islands include the largest seabird colony in the lower 48 states. The North Farallon Islands have over 40,000 murre and a Steller sea lion rookery. The South Farallon Islands have a great diversity of birds.

Marine Mammal Rookeries: North Farallon Island (Steller sea lion), Southeast Farallon Island (Steller sea lion (large), northern fur seal, elephant seal). There are four breeding species in the Farallon Islands. This is the only northern fur seal rookery in the study region.

Marine Mammal Haulouts: Major haulouts on Southeastern Farallon and other haulouts on North Farallon.

Other Areas for Marine Mammals: Offshore marine mammal species are found here, including blue whales, pacific white-sided dolphin, Dall's porpoise, Risso's dolphin, humpback whales, and gray whales. This area is important for foraging as it is close to the shelf break.

9.6.2 Land-Sea Interactions

Coastal watersheds: Farallon Islands

Major rivers: None

Anadromous fish streams: None

Hardened shoreline: None

Impaired water bodies: None.

Major Point Sources: None mapped.

9.6.3 Socioeconomic Setting

Counties: San Francisco

Coastal towns/ports/harbors: None

Public access areas, boat ramps, piers, etc: None

Commercial fisheries: Some of the major commercial fisheries landed in the San Francisco Port Complex are salmon, Dungeness crab, dover sole (trawl fishery), thornyheads (trawl fishery), sablefish (trawl fishery), flatfish, and California halibut..

Consumptive recreational use: Major recreational fisheries occurring in subregion 6 include rockfish, lingcod, salmon, California halibut, and Dungeness crab. Some important areas include Fanny Shoal, "North Farallon", Southern Farallon Islands, "Middle Farallon"

Non-consumptive recreational use (diving, whale-watching, wildlife viewing): Important areas include Noonday Rock, SE Farrallon Island

9.6.4 Research and Monitoring

Research institutions: PRBO Conservation Science, U.S. Fish and Wildlife Service

Existing monitoring sites: Southeast Farallon (PISCO intertidal, CENCOOS)

9.6.5 Existing MPAs, Marine Managed Areas, and Coastal Protected Areas

Existing state MPAs: Farallon Islands SMCA (some spatial closures from March to April)

RCAs and other fish closures: Some overlap with RCA (60.1 sq mi)

Other marine managed areas: Gulf of the Farallones NMS.

Coastal protected areas: Farallon Islands National Wildlife Refuge, Farallon Islands State Game Refuge

9.6.6 Other Issues

To be determined.

10.0 Conclusion

The MLPA North Central Coast Study Region is the second region to begin the MLPA planning process and builds on lessons learned during the MLPA Central Coast Project. The regional profile summarizes and provides background information on the biological, oceanographic, socioeconomic and governance aspects of the region and draws upon suggestions and information provided by regional stakeholders and the SAT. The profile serves as a foundation for evaluating existing MPAs and describing alternatives of potential new MPAs, and identifying needs for additional data and information.

The MLPA has a number of goals that includes conservation of biodiversity and health of marine ecosystems, recovery of depleted marine populations, protection of representative and unique habitats for their intrinsic value, and improvement of recreational, educational, and study opportunities. The north central coast study region is one of the most biologically productive regions in the world. Furthermore, California's marine and coastal environments form part of the State's identity and support important economies that depend on healthy ocean resources, such as fisheries and coastal tourism.

In summary, the north central coast study region has many important and unique features including:

- Globally rare and significant upwelling-driven system that supports high marine biodiversity (plankton, invertebrates fish, marine mammals, seabirds) in open waters of the Gulf of the Farallones
- Important kelp forests and rocky reefs and associated fish assemblages (such as many species of rockfish)
- Regionally important estuaries (Tomales Bay, Drakes Estero, Bolinas Lagoon) and the mouth of the San Francisco Bay (the largest estuary on the West Coast)
- Monterey Bay National Marine Sanctuary, Gulf of the Farallones National Marine Sanctuary, Point Reyes National Seashore, and the Golden Gate National Recreation Area
- Rich and productive fisheries that have supported coastal communities and provided fresh seafood to the region and the world
- Renown as a fishing, kayaking, and whale-watching and wildlife viewing destination where marine recreational activities help to support coastal tourism and coastal communities
- An abundance of marine research and educational institutions whose staff have explored and studied the region and helped to raise public awareness about marine biology

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