# INTRODUCTION

## OVERVIEW

### Purpose and Need for Designation

Gulf of the Farallones National Marine Sanctuary (GFNMS) has been vested with the authority, in accordance with the National Marine Sanctuaries Act (NMSA) (1972), to provide comprehensive and coordinated conservation and management of 966 square nautical miles of nearshore and offshore waters of the eastern Pacific. A complete spectrum of marine habitats ranging from unique inland estuarine, to intertidal, pelagic, and deep oceanic environments are found within the sanctuary. These productive marine environments support an abundance of living resources including: at least 36 species of marine mammals; 54 species of birds which use the sanctuary during their breeding season; and 26 threatened or endangered species. In 1981, the National Oceanic and Atmospheric Administration (NOAA) determined that these offshore areas contain exceptional natural resources, and that these waters around the Farallon Islands and along the mainland coast of the Point Reyes Peninsula between Bodega Head and Rocky Point deserved special recognition, protection, and designation as a national marine sanctuary.

### Description of GFNMS

Located in the waters west of San Francisco, the GFNMS provides many examples of the marine life and habitats characteristic of cold temperate waters of the eastern Pacific marine region that extends from Point Conception to British Columbia. Most of the sanctuary lies in the Gulf of the Farallones between the western edge of the continental shelf and the coast of Marin and Sonoma counties. Some of the largest and most diverse eastern Pacific populations of seabirds and pinnipeds (seals and sea lions) south of Alaska occur in the Gulf. Large flocks of Cassin's Auklets, Common Murres, Western Gulls, and the endangered Brown Pelican (under consideration to be delisted) feed on the small fish and crustaceans that are abundant in the surface waters of the sanctuary. This food source also supports California's largest breeding population of harbor seals, as well as the growing population of northern elephant seals. Large numbers of whales and dolphins, including the California gray whale, the Pacific humpback whale and the blue whale are found in the area. Around the Farallon Islands is one of the world's largest seasonal congregations of white sharks. There are also many significant nearshore habitats represented within the sanctuary, such as the inland reaching Estero de San Antonio and Estero Americano; Tomales Bay and Bolinas Lagoon; and the large intertidal and subtidal reef at Duxbury Reef. See Appendix IIIE, F and G for sanctuary species list (March 2007).

*Bodega Head and Bay at the northern reach of GFNMS. Photo: NOAA*

The sanctuary also illustrates how important the ocean and its wildlife and habitats are for the economic and social well-being of the region. The area has supported large commercial fisheries, including a large percentage of the San Francisco fleet. Sport fishing also generates revenue for the party boat fleets operating out of San Francisco Bay, Half Moon Bay, and Bodega Bay. Whale watching and offshore excursions are other uses of the sanctuary that have grown in popularity. In addition, the sanctuary contains some of the West Coast's busiest shipping lanes.

**History of GFNMS**

In April 1978, NOAA held a public workshop in Mill Valley, California, to discuss a proposal to designate the sanctuary. An issue paper on possible California marine sanctuary sites, including the Point Reyes-Farallon Islands area, was circulated for review and discussion in December 1978. In March and April 1979, the California Coastal Commission (CCC) held regional and state hearings to solicit reaction to the possibility of a marine sanctuary located offshore from Point Reyes and the Farallon Islands. Based on public response and a recommendation by the CCC to develop a final environmental impact statement (FEIS), NOAA prepared a FEIS which described the proposed alternative of sanctuary designation and included draft regulations. In October 1979, NOAA distributed copies and solicited comments on a preliminary draft of the Description of Affected Environment and discussion on alternatives. A meeting was held in Point Reyes Station to discuss these sections. The FEIS was distributed for review on March 31, 1980 with public hearings in May. In response to NOAA's findings and public interest, the Point Reyes – Farallon Island National Marine Sanctuary was designated on January 26, 1981.

The original management plan, developed at the time of designation of the sanctuary, provided guidelines to ensure that all management actions undertaken in the first five years of designation were directed to resolving important issues as a means of meeting sanctuary objectives. Management objectives were considered in three areas: resource protection, interpretation, and research. The management plan also called for promulgation of six regulations or prohibitions.

**Management Plan Reviews**

The 1992 congressional legislation that reauthorized the NMSA required that each of the thirteen national marine sanctuaries engage in a management plan review process every five years to reevaluate site-specific goals and objectives, management techniques, and strategies. This management plan review process has provided GFNMS with the opportunity to: take a closer look at how the environment has changed over the past twenty years; understand the cause and effect relationship of human activity and natural perturbations on the marine ecosystem; and engage the public in the management decision making process. As a result, GFNMS is reshaping how it manages the marine ecosystem, from restructuring its program areas to reevaluating its regulations.

**Joint Management Plan Review Process (JMPR)**

In 2001, the National Marine Sanctuary Program (NMSP) began a joint review of the management plans of Gulf of the Farallones, Cordell Bank, and Monterey Bay national marine sanctuaries. These sanctuaries are located adjacent to one another, managed by the same

program, and share many of the same natural resources and issues. In addition, all three sites share overlapping interest and user groups. It has also been more cost effective for the NMSP to review the three sites jointly rather than to conduct three independent reviews. During the review, the sanctuaries evaluated management and operational strategies, regulations, and boundaries. The review process provided an opportunity to better coordinate programs between the three sanctuaries.

### Biogeographic Assessment

In support of the JMPR process, NOAA's Biogeography Program developed an assessment to identify important biological zones, time periods and ecological linkages within the three national marine sanctuaries and their encompassing biogeographic region. This geographic information systems (GIS) analysis extended from Point Arena in the north to Point Sal in the south, and identified key biological areas (e.g., areas of species richness and reproductive areas), time periods, and communities within the area of interest; focused on the continental shelf and slope. The results of the biogeographic assessment for seabirds and marine mammals have been integrated into the Final Management Plan/ Final Environmental Impact Statement (FMP/FEIS).

### The Value in Building Community Partnerships

Recognizing the challenges that lay ahead with the management plan review process, in January 2001 a GFNMS Sanctuary Advisory Council was assembled with eight members and six alternates to provide guidance and advice to the sanctuary manager on ecosystem management issues. The sanctuary advisory council included one agency and seven stakeholder representatives, with an alternate for each seat. The advisory council provides a platform for public input into the management of the GFNMS. This partnership has allowed GFNMS to make use of and build on the knowledge, roles, and resources that the private sector and other agencies have to offer. The sanctuary advisory council participated in the entire management plan review process from scoping meetings to providing input on the range of issues to be addressed in the new management plan. The sanctuary advisory council has been a vehicle for making progress through cooperation, including the community in the decision-making process, and drawing in public support.

## BUILDING A NEW MANAGEMENT PLAN

### Vision Statement

The vision, goals and objectives that follow are based on those in the original management plan. At the commencement of the JMPR process, GFNMS staff worked together to build a vision for the future of the site that reflects the current sanctuary framework and needs.

The Gulf of the Farallones is characterized by a broad extension of the eastern Pacific continental shelf. The interaction of major currents, wind, and topography creates coastal upwelling, driving the productivity of the area, creating and supporting an abundance of resident and migratory marine life. The sanctuary includes more than 400,000 breeding seabirds, the largest concentration in the contiguous United States; at least 36 species of marine mammals, including one-fifth of the California population of harbor seals; over 50 species of rockfish; one

of the world's largest seasonal congregations of white sharks; and 26 endangered and threatened species. GFNMS protects a diversity of offshore environments such as benthic and pelagic habitats and nearshore areas including bays and estuaries.

GFNMS' highest priority is ecosystem protection. The sanctuary and its partners work to protect habitats, biological communities, and ecosystem dynamics. Through the watersheds and out to the sea, GFNMS addresses current management issues and anticipates future challenges in order to maintain and protect the environment now and for future generations.

**GFNMS Goals and Objectives**

GFNMS has clearly defined goals and objectives on which to develop program areas and regulations. These goals and objectives are broad and intended to be for the site as a whole. Specific goals and objectives were also developed for each issue or program area in the management plan. In order to be consistent with the guiding legislation established in the NMSA, the mandate for the thirteen national marine sanctuaries, GFNMS has chosen the following priority goals:

Improve the conservation, understanding, and wise and sustainable use of marine resources;

Enhance public awareness, understanding, and stewardship of the marine environment;

Maintain for future generations the habitat and ecological services of the natural assemblage of living resources that inhabit these areas;

Maintain the natural biological communities to protect, and where appropriate, restore and enhance natural habitats, populations, and ecological processes;

Provide authority for comprehensive and coordinated conservation and management of these marine areas, and activities affecting them, in a manner which complements existing regulatory authorities;

Create models of and incentives for ways to conserve and manage these areas, including the application of innovative management techniques; and

Cooperate with global programs encouraging conservation of marine resources.

The strategies of the GFNMS management plan are directed to meet these goals and objectives. It should be noted that although the sanctuary goals and objectives are listed discretely, they are overlapping. Collectively, the strategies developed in the management plan address the full range of goals and objectives set forth in the previous paragraph.

**Regulations and Program Areas**

The GFNMS management plan is made up of two complementary parts: regulatory and non-regulatory. The regulatory component includes site-specific regulations or prohibitions (see Appendix III), and general regulations that apply to all thirteen national marine sanctuaries (see Appendix III). Regulations are used to control or restrict human behavior that is not compatible

with protection of sanctuary resources or qualities. The non-regulatory component of the management plan includes GFNMS' three program areas: Conservation Science; Education and Outreach; and Resource Protection. These three program areas are supported by an administrative framework which ensures that all ecosystem management activities are coordinated, and provides an appropriate infrastructure needed to help meet the goals and objectives set forth by this management plan. Collectively, the above-mentioned parts make up the whole of the management plan and are important tools for effective ecosystem management.

The regulatory and non-regulatory components of the management plan are structured to address the priority ecosystem management issues identified during the management plan review, which include the following site-specific issues and programs: Water Quality; Wildlife Disturbance; Introduced Species; Ecosystem Protection: Impacts from Fishing Activities; Vessel Spills; Education and Outreach; Conservation Science; Resource Protection; and Administration. The priority cross-cutting issues and programs identified through the management plan review process include: Maritime Heritage; Ecosystem Monitoring; Community Outreach; Administration; and Boundary Modifications. The spatial context for addressing these issues is not limited by the geographically drawn and often politically driven boundaries of just one sanctuary, but rather across all three sanctuaries included in the JMPR process, as well as areas outside of Gulf of the Farallones, Cordell Bank, and Monterey Bay national marine sanctuaries.

**Addressing Goals and Objectives within an Ecosystem Context**

The priority goals and objectives listed above led GFNMS to take an ecosystem-based approach to managing a fluid marine environment with great temporal and spatial complexity and diversity. The management plan review process has shown that the scientific community, natural resources agencies, and the public have recognized the importance of an integrated ecosystem-based approach to protect marine biodiversity and habitats. NMSP's emphasis on marine ecosystem management is consistent with other state and federal agencies' programs and initiatives.

Very early on, the NMSP took the steps to ensure an ecosystem approach for the management plan review process by identifying a study area that would be inclusive of a broader biogeographic area from Point Arena to Point Sal where biological zones, time periods, and ecological linkages could be identified irrespective of the political boundaries of the individual sanctuaries. In looking at ecological components across boundaries, human-use activities and corresponding ecosystem-based management issues were evaluated across and, as appropriate addressed across, a broader geographic boundary than that of a single sanctuary. This broad-scale ecosystem approach is carried over into the action plans in this Management Plan.

**Tools for Effective Management Planning**

GFNMS' management plan was designed not only to protect the marine resources and biodiversity, but also to consider maintenance of economic equity, cultural integrity and human social structures. GFNMS is looking at a wide range of activities that take place in the sanctuary and evaluating them in terms of whether they are compatible with ecosystem protection and protect the structure, function, and diversity of the marine environment. In order to better evaluate human-use activities and their impacts on the ecosystem, GFNMS used three strategic

tools in the development of the management plan: science, socioeconomics and local knowledge.

**Science**

Protection of living and nonliving marine resources is the primary objective of the NMSP, and science serves an important tool for understanding, measuring, and predicting change in the status and health of the marine ecosystem. Scientific inventories, habitat characterization, research, and monitoring provide an important information base for natural resource managers to understand and evaluate effectiveness of management regimes. NOAA collected data from site programs, individual researchers and institutions throughout the region and, where possible, integrated it into GIS to spatially identify significant living and nonliving marine resources, habitats, and physical and geological features. These data were used to describe and define the ecosystem, identify areas of special significance, and locate important ecosystem support systems.

*Sanctuary researchers monitor the rocky intertidal of the Farallon Islands. Photo: NOAA*

**Socioeconomics**

In California, the total gross domestic product from the ocean economy accounted for approximately $42 billion dollars in 2000. Coastal recreation and tourism alone brings in approximately $12 billion to California annually. These numbers paint an important picture about the need to properly manage the marine resources. A sustainable community recognizes both ecosystem sustainability and economic sustainability as mutually beneficial. The NMSP not only considers the potential economic cost of management restrictions on income generating activities, but also public benefits derived from long-term protection of nationally significant resources. A cost/benefit analysis may be found in the FEIS to determine socioeconomic impacts and benefits to user groups from any proposed actions in this management plan.

**Local Knowledge**

Local knowledge represents the voice of direct experience and interaction with the marine environment over time. Many of the community partners involved in the management plan review have been linked to the waters of the sanctuary for up to half a century. Their knowledge is more extensive and long range than much of the scientific research available for the study area. GFNMS not only honors and incorporates historical knowledge, but also acknowledges that stakeholder groups have a strong connection and knowledge about their environment. These local voices also represent local interests, issues and concerns to be balanced against those from outside interests. The sanctuary advisory council members, local mariners, interest groups, and the public provided valuable input to the development of this management plan.


*Commercial fishing has long been an important industry in GFNMS. Photo: NOAA*

**Looking at the Next Five Years and Beyond**

Since its establishment in 1972, the NMSP has been building models for better marine ecosystem-based management. But even today, with better knowledge of the natural world and more experience managing human behavior, the NMSP continues to build new models to enhance ecosystem protection. This is why the GFNMS management plan is referred to as a "living document," serving as a dynamic and responsive framework to guide ecosystem-based management.

GFNMS' "living document" also serves as a proactive tool for planning a sustainable future. Instead of reacting to the symptoms of ecosystem degradation by applying panaceas, the GFNMS management plan addresses the roots of the problems, which begin and end at the point where the human community interacts with the marine community in a way that is not compatible with ecosystem protection. To ensure a sustainable future, GFNMS' "living document" will provide a framework for not only addressing ecosystem management issues of the present, but also anticipating those emerging issues of the future.

The emergence of new issues and other unforeseeable factors may affect specific aspects of sanctuary management as described in this plan. However, the overall goals, management objectives, and general guidelines will continue to be relevant. Throughout the next five years of this plan, the aim is to carefully adjust the plan to changing circumstances in light of the experience gained through actual management. Additionally, modifications to the scope and scale of the action plans may have to be made due to unforeseeable changes in levels of funding. Again, the goals and objectives of the management plan will remain unchanged.

# SANCTUARY SETTING

## ECOSYSTEM PROCESSES

### Location

Gulf of the Farallones National Marine Sanctuary (GFNMS) lies off the California coast to the west and north of the Marin, San Francisco and San Mateo Counties. Included are nearshore waters up to the mean high tide line from Bodega Head to Rocky Point in Marin County and offshore waters extending out to and around the Farallon Islands

### Geology

The GFNMS is characterized by the widest continental shelf on the West Coast of the contiguous United States. In the Gulf of the Farallones, the shelf reaches a width of 32 nautical miles (59 km). Shoreward of the Farallon Islands, the continental shelf is sandy and contains large underwater sand dunes. The shelf slopes gently to the west and north from the mainland shoreline and provides an especially large and relatively shallow (120 meters) foraging and habitat area for coastal and oceanic seabirds, marine mammals, and fish.

*Southeast Farallon Island provides a range of habitats for sanctuary inhabitants, including cliffs for seabird nesting, rocky shores for marine mammal haulouts and subtidal areas for fish and invertebrate shelter. Photo: NOAA*

The Farallon Islands are seven islands and large rocks, which lie along the outer edge of the continental shelf, between 13 and 19 nautical miles (24 and 35 km) southwest of Point Reyes and roughly 26 nautical miles (48 km) due west of San Francisco. The islands are located on part of a larger submarine ridge that extends for approximately 30 nautical miles between the Farallon Islands and Cordell Bank near the shelf break. The Farallon Islands provide secluded habitat that is essential for seabirds and marine mammals. Submarine rock outcrops surrounding the islands and extending to Cordell Bank provide rich habitat for a diverse rocky reef community.

*The esteros provide important nursery habitat for sanctuary fish species and forage habitat for local and migratory birds. Photo: NOAA*

The GFNMS coast includes sandy beaches, rocky cliffs, open bays (Bodega Bay, Drakes Bay, Bolinas Bay) and enclosed bays or estuaries (Bolinas Lagoon, Tomales Bay, Estero Americano, and Estero de San Antonio). High-energy waves typical of the winter storm season distribute sediment washed into the sanctuary by rivers and from shoreline erosion and move sand down-coast from beach to beach. The two Esteros are typically closed during summer and fall by seasonally formed sand bars, isolating the Esteros from the ocean. Tomales Bay and Bolinas Lagoon, however, remain open to the ocean year-round. Water and water-borne materials in these bays and lagoon are exchanged with the open ocean through tidal currents, although inner bay and lagoon waters may take a long time to exchange. The open bays are

sheltered from prevailing southerly currents by headlands and are important nutrient and plankton retention areas. Tomales Bay, Bolinas Lagoon and Bodega Bay lie directly on the San Andreas Fault.

**Climate and Oceanography**

Gulf of the Farallones currents are dominated by seasonal winds. Lying inshore of the large California Current, these waters are characterized by wind-driven upwelling, localized eddies and counter-current gyres, high nutrient supply and high levels of phytoplankton. The inner Gulf of Farallones is also influenced by outflow from San Francisco Bay.

During the spring-summer upwelling season (typically March 15-August 14), strong northwest winds drive surface waters offshore (due to the Coriolis effect) and cold deep waters are upwelled to the surface over the continental shelf. The California Undercurrent (also called the Davidson Current) carries cold high-salinity waters north at depth along the shelf-edge and is a source for upwelled waters. These waters are rich in nutrients and feed very high levels of primary production near-surface. The resultant phytoplankton blooms are the foundation of the rich GFNMS food webs, involving zooplankton, benthic and pelagic invertebrates, fish, birds, and mammals.

Spring-summer currents over the middle and outer shelf strongly move southeastward during upwelling, but nearshore flow patterns are mixed. San Francisco Bay and other nearshore outflows are carried both north and south by prevailing coastal currents and eddies. During brief periods of weak winds (relaxation periods), much of the inner and mid-shelf Gulf of the Farallones waters reverse direction and flow north. Phytoplankton levels peak during these relaxation periods.

In the fall, upwelling winds weaken and water temperatures increase. Sometimes known as the oceanic season, this period (typically August 15-November 15) is characterized by onshore flow of oceanic surface waters (warmer and lower salinity). Periods of upwelling winds and phytoplankton blooms do still occur during the fall.

Winter in the GFNMS is characterized by the passage of rain-bearing cold fronts, accompanied by westerly and southerly winds which drive surface currents northward and downwelling over the shelf. After the fall transition period and the cessation of the upwelling winds, the Davidson undercurrents come to the surface with a weak northeastward flow. While storm fronts characterize the months of December through March, upwelling winds are equally common and many upwelling events are also observed at this time of year (although lower levels of light in winter produce only weak phytoplankton blooms). During the downwelling events, warm oceanic surface waters move onshore and land runoff is held nearshore. Large plumes of terrestrial runoff from the mainland are also subject to the Coriolis effect, hence San Francisco Bay outflow typically remains close to shore and flows north around Point Reyes following major rain and runoff events. On occasion the influences of the San Francisco Bay outflow extend west to the Farallon Islands. Lowest surface seawater salinities are observed in the GFNMS during the winter runoff season.

Eddies are found both offshore, in the core of the California Current, and in the waters over the shelf. In the coastal waters of the GFNMS, fast flow past headlands like Point Reyes and Bodega Head may create eddies that move through the region. Eddies and open embayments partly retain nutrient-rich, upwelled waters and help explain the high levels of plankton, fish, mammals and birds observed in this region year-round. The sanctuary contains bottom features of higher rigosity (slope variability), and counter-clockwise eddies north and south of Bodega Head, Point Reyes, Pillar Point, and Pigeon Point. As a result, the sanctuary is one of the most productive areas along the California Coast, and in the world.

## SANCTUARY ECOSYSTEMS

The coast of the Gulf of the Farallones is a complex array of habitats from exposed rocky headlands to protected sandy beaches; from open bays to calm estuaries; from rocky intertidal habitats to productive mudflats; from offshore islands to submerged seamounts; and from the continental slope dissected by numerous submarine canyons to the deep sea.

### Rocky Shores

The intertidal habitat between the low and high tides is biologically rich, supporting diverse assemblages of algae, plants and animals. It is characterized by extreme conditions caused by wind, waves, and the fluctuation of tides. Organisms living in the intertidal face many challenges that are unique to living at the edge of the ocean, including threat of desiccation, physical wave action, and limited space. Rocky shores are found throughout the Gulf of the Farallones region, but particularly at Bodega Head and Duxbury Reef.

Four zones of rocky intertidal organisms are traditionally associated with different tidal heights. Species distributions are restricted according to physiological tolerance along the thermal and moisture gradient in the intertidal zone. The splash zone is almost always exposed to air, and has relatively few species. The high intertidal zone is exposed to air for long periods twice a day. The mid-intertidal zone is exposed to air briefly once or twice a day. The low intertidal zone is exposed only during the lowest tides. (See Appendix III-H for the rocky intertidal species list.)

### Splash Zone

The periwinkle, *Littorina keenae*, and the barnacle, *Balanus glandula,* can be used as an indicator of the splash zone. Microscopic algae are common in the splash zone in winter months when large waves produce consistent spray on the upper portions of the rocky shore. Black Oystercatchers and Black Turnstones are the common birds along the rocky shoreline off central and northern California. These birds are most abundant during fall and winter, and during this period, are accompanied by small numbers of Ruddy Turnstones, Surfbirds, and Wandering Tattlers. Black Oystercatchers nest along rocky coasts including the Farallon Islands (Sowls et al. 1980). A variety of species commonly considered land birds also feed along rocky shores, including Black Phoebe, American Crow, Brewer's Blackbird and European Starlings.

### High and Middle Intertidal Zones

Perennial macrophytes exhibit conspicuous zonation in the rocky intertidal community. Descending into the intertidal are several zones dominated by (1) fucoid and ceramial algae in the high intertidal; (2) a dense turf of erect coralline and gigartinal algae in the mid-intertidal;

and (3) beds of rhodymenials and laminarials in the low intertidal zone. Intertidal invertebrates also exhibit conspicuous zonation. In northern California, the barnacle, *Balanus glandula*, and red algae, *Endocladia muricata* and *Mastocarpus papillatus*, are used as indicators of the high intertidal zone, but these species are also found in other areas of the rocky shore. At wave-exposed sites, the mussel, *M. californianus*, can dominate the available attachment substratum in the mid-intertidal zone. Intertidal predators generally include whelks, sea stars, sea urchins, octopus, fishes, and shore crabs.

**Low Intertidal Zone**

The low intertidal zone is subjected to nearly constant wave action and exposed only for short periods of time during the lowest tides. The presence of the seagrass, *Phyllospadix*, is a good indicator of the mean low water level.

**Sandy Beaches**

Northern California beaches exhibit classic structure: cliffs or dunes demarcate the upper boundary of the beach; the mean high tide line is generally indicated by a berm; and beach flats, troughs, or sand bars form the seaward side of the beach. Exposed sand beaches are harsh environments subjected to high wave action, wide temperature range, and periodic tidal exposure. Quiet-water beaches of estuaries and bays are protected environments subjected to less wave action.

Species distributions within the sandy beach habitat are strongly influenced by physical factors on exposed sand beaches, whereas biological factors, e.g., competition and predation, influence species distributions on protected beaches of estuaries and bays. Exposed beaches of northern California show distinct patterns of biological zonation defined by the amount of tidal inundation to each region. The biological zones of the sandy beach habitat are: upper intertidal beach zone, mid-littoral beach zone, swash zone, low intertidal beach zone, and the surf zone.

**Upper Intertidal Beach**

The upper intertidal beach is submerged for a short time and exposed to the widest range of temperatures. It is often sparsely inhabited, because the food supply on sandy beaches is unpredictable. The major sources of food on the sandy beach include plankton, macroalgae, and occasional corpses of fishes, birds, and marine mammals that are washed ashore by waves. As a result, the upper intertidal is primarily dominated by scavengers on beach wrack, such as talitrid amphipods, flies, isopods, and Coleopteran beetles (Berzins 1985). When beach wrack washes ashore, it is colonized first by the highly mobile talitrid amphipods and flies (Diptera).

Eventually, the beach wrack is colonized by terrestrial isopods and Coleopteran beetles. The pill bug, *Alloniscus perconvexus*, burrows into the sand just beneath the surface and emerges at night to feed on beach wrack. During the day, beach hoppers (genus *Megalorchestia*) are usually in shallow burrows or under piles of macroalgae. At night, the hoppers emerge to forage on algae and other detritus.

**Mid-Littoral Beach**

The mid-littoral beach zone is characterized by a moderate inundation time, but is subject to many of the same rigors as the upper zone (e.g., temperature extremes and fresh water).

The mid-littoral beach fauna is dominated by species with high mobility such as the cirolanid isopod, *Excirolana*, which are preyed upon by various shorebirds. The mid-littoral zone fauna must be highly mobile because this zone is subjected to rapid sediment removal during storms.

**Swash Zone**

The swash zone, where waves break on the beach, is characterized by the highest water movement and is submerged approximately twelve hours per day (Oakeden and Nybakken 1977). Thus, the swash zone is not subjected to extreme temperatures and salinity characteristic of the high- and mid-littoral zones. The dominant species in the swash zone is the sand (mole) crab, *Emerita analoga*, an herbivorous species that forms the basis for much of the sandy intertidal food web.

**Low Intertidal Zone**

The low intertidal zone is subjected to nearly constant wave action and exposed only for short periods of time during the lowest tides. Most of the inhabitants of the low intertidal are either rapid burrowers or protected against mechanical damage. Numerous invertebrate species burrow into superficial sediments and flourish in wave-disturbed sand bottoms (Slattery 1980).

**Surf Zone**

The surf zone is submerged continuously and experiences constant motion of waves breaking against the sea floor. Many studies suggest that sandy beach surf zones are low diversity environments, dominated by small planktivores and benthic feeding fishes and their predators (Gunter 1958, McFarland 1963, Edwards 1973a, Modde and Ross 1981, Lasiak 1983, McDermott 1983). The trophic structure of surf zone fish communities appears to be controlled primarily by three factors: (1) primary production input to the surf zone; (2) water movement; and (3) geomorphology of the sandy beaches.

Over 180 bird species were observed on beaches between Bodega Head and the northern Santa Cruz County border from October 1993 to September 1999 (Roletto et al. 2000). Sanderlings, Western Gulls, and Brown Pelicans were observed most frequently. Most of the bird species that occur in coastal wetlands (especially Sanderlings, Willets and Marbled Godwits) also occur on outer sand beaches (Davis and Baldridge 1980). Snowy Plovers, which have decreased significantly during the past two decades, nest in coastal dunes.

Breeding populations of pinnipeds are found on sand beaches off northern California. The species most commonly found along Northern California beaches, rocks and mudflats include California sea lions (*Zalophus californianus*) and harbor seals (*Phoca vitulina*).

**Estuaries Including Bays, Mudflats, and Marshes**

Bays and estuaries are among the most productive natural systems. Their physical, chemical, and biological characteristics are critically important to sustaining living resources (Mann 1982, Weinstein 1979). Bays and estuaries are important nursery areas that provide food, refuge from predation and a variety of habitats. The four main estuaries within the sanctuary are Tomales Bay, Estero Americano, Estero de San Antonio, and Bolinas Lagoon.

Tomales Bay is located between the shores of West Marin and the Point Reyes National Seashore (PRNS). Tomales Bay is an example of a fault-controlled valley along the San Andreas Fault. Lagunitas Creek, which drains into Tomales Bay, supports a run of approximately 500 Coho salmon, or 10 percent of California's current Coho salmon population. Dense seagrass meadows are found throughout Tomales Bay. Pacific herring use the seagrass beds for spawning. Tomales Bay also supports seasonal populations of salmon, steelhead, sardines, and lingcod. The shallow bay's sandy bottom attracts a variety of bottom-dwelling fish including sole, halibut, skates and rays. Leopard sharks are common in Tomales Bay and occasionally blue sharks are sighted. White sharks, although not found in enclosed bays or estuaries, do hunt for seals and sea lions that frequent the bays to haul out on the sandy beaches and rocks near the mouth of Tomales Bay. Over 20,000 shorebirds and seabirds, including loons, grebes, geese, cormorants, and ducks, spend the winter in Tomales Bay.

The Esteros Americano and de San Antonio are coastal estuaries located on Bodega Bay. Estero Americano drains into Bodega Bay at the Sonoma-Marin County line. South of Estero Americano, Stemple Creek becomes the Estero de San Antonio, also draining into Bodega Bay. Many different habitat types are found in the esteros including mudflats, marshes, rocky shore, coastal scrub, and grasslands. With the variety of habitats, the esteros support many species of plants, invertebrates, fishes, birds, and mammals. They provide essential feeding and resting areas for shore and sea birds. Some common fish species found in the esteros include Pacific herring, staghorn sculpins and starry flounder. The endangered tidewater goby breeds in the shallow waters of Estero de San Antonio.

Seagrass beds occur on the extensive mudflats in Tomales Bay, Bolinas Lagoon and within the esteros. Seagrass supports a unique and diverse assemblage of invertebrates and fishes, including snails, shrimp, nudibranchs and sea hares. The structure of seagrass beds provides protection from predation, especially for juvenile invertebrates and fishes. Pacific herring, invertebrates, and birds depend on seagrass beds in Tomales Bay to spawn and feed.

The soft bottom habitats associated with estuarine environments support large concentrations of burrowing organisms, such as clams, snails, worms, and crabs. Benthic invertebrates in estuaries have a large effect on community structure.

Willets and Marbled Godwits are among the most abundant large shorebirds in northern California estuaries whereas Sanderlings, Western Sandpipers, Least Sandpipers, Dowitchers, and Dunlins are the most abundant small shorebirds in wetlands and the outer coast beaches from Point Reyes to Bodega Bay. There are some differences within estuaries in the abundances of shorebirds. Horned and Eared Grebes, American Coots, and numerous ducks (including Buffleheads, Goldeneyes, Pintail, Mallard, and Cinnamon Teal dominate the coastal bird assemblage in shallow, tidal waters of local sloughs and estuaries while egrets and herons use brackish and salt marshes as roosting and feeding habitats during high tides [Davis and Baldridge 1980]). The time of migration and the routes of travel between breeding and wintering grounds seasonally affect the patterns in abundance of shorebird species in northern California (Ramer et al. 1991). Most species of wintering shorebirds move into California from August through March and leave wintering grounds for northern breeding grounds between late March and early May.

Fish assemblages in estuaries of the Gulf of the Farallones exhibit similar trophic structure and taxonomic structure. The most abundant estuarine fish are juvenile planktivores or low-level carnivores on infaunal invertebrates (Yoklavich et al. 1991). Fish assemblages exhibit higher abundance and species richness during the summer with the invasion of young-of-the-year marine species (Allen and Horn 1975, Hoff and Ibara 1977, Allen 1982, Onuf and Quammen 1983, Yoklavich et al. 1991). Species richness (diversity of species) and the change in species composition decline with distance from the ocean (Loneragen et al. 1986, Blaber et al. 1989, Yoklavich et al. 1991). The mouths of bays and estuaries are strongly influenced by marine hydrographic processes (Broenkow 1977), and are therefore more accessible to coastal marine species.

**Kelp Forests**

The rocky nearshore environment of northern California is characterized by dense forests of kelp growing at depths from 2 meters to more than 30 meters (Foster and Schiel 1985). The bull kelp, *Nereocystis luetkeana*, is the dominant canopy-forming kelp north of Santa Cruz to the Aleutian Islands (Foster 1982). The shallow areas inshore of kelp forests are often characterized by canopies of the feather boa kelp, *Egregia menziesii*, and other Laminarials (Foster and Schiel 1985).

Kelp forests are spatially complex communities. They alter turbulent flow patterns in the nearshore region through drag generated by their large size and frequently high densities (Duggins 1988). The biological ramifications of this type of hydrodynamic influence are potentially very important to a wide range of nearshore organisms. Disruption of flow by kelp forests is likely to have significant effects on feeding and growth (particularly in suspension and deposit feeders), dispersal and recruitment (Duggins 1988). Food and dispersal stages of many kelp forest organisms are passively dispersed, and their transport and settling characteristics will be determined largely by the movement of water in which they are suspended. Kelp beds may retain larvae released within the bed, and the strong deceleration of flow at the margins of the bed could facilitate settlement of larvae imported from outside the bed (Duggins 1988). The concentration of zooplankton at the upcurrent edge of a kelp bed, and the corresponding higher densities and feeding rates of fish in that area, are probably results of alterations of current flow by kelp (Bray 1981). Predation risk may increase the association between certain species and kelp forests because predation (by fish, birds, and marine mammals) is lower in spatially complex environments such as kelp beds (Gooding and Magnuson 1967, Wickham and Russell 1974).

Kelp forests harbor a large potential source of invertebrate and fish prey for birds (Foster and Schiel 1985). Gulls, terns, Snowy Egrets, Great Blue Herons and cormorants are associated commonly with kelp forests (Foster and Schiel 1985). Other species (e.g., phalaropes) feed on the plankton and fish larvae associated with kelp.

Harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*) are common in and around kelp forests off northern and central California. Harbor seals feed on fishes in the kelp forest whereas California sea lions probably limit their use of the kelp forests to transitory feeding (Foster and Schiel 1985).

Gray whales (*Eschrichtius robustus*) have been observed entering kelp forests to feed on invertebrates such as mid-water crustacean swarms and to escape predation from killer whales (*Orcinus orca*).

**Open Ocean**

The habitat covering the largest area within the GFNMS is the open continental shelf and the pelagic (open ocean) habitat. This habitat is strongly influenced by the oceanographic patterns of the northern California coast (for more detail, see Climate and Oceanography section above). The strong upwelling events stimulate the productivity of organisms at all levels of the marine food web. Cool, nutrient-rich, upwelled waters support high primary productivity.

All the food that drives the biology of the deep ocean originates in the very thin, near surface layer, the euphotic zone. Therefore, the feeding conditions of the ocean floor are linked with primary production. Deep-sea communities depend on the distribution and quantity of primary production, the rate of movement of organic material to the bottom, and the conditions of deposition and transformation of the organic matter in the sediment.

Distribution and abundance of zooplankton are related to the physical dynamics of the California Current system (Reid et al. 1958, Parrish et al. 1981, Huntley et al. 1995). Zooplankton are usually most abundant in neritic and inshore regions (Colebrook 1977), as compared with waters of the offshore California Current. Large populations of zooplankton are associated with subarctic water and intense upwelling along the northern/central coast of California extending to Point Conception (Reid et al. 1958, Loeb et al. 1983a).

Crustacean larvae, euphausiids, and copepods are dominant groups in the epipelagic zone (Colebrook 1977). Euphausiid swarms often concentrate near Cordell Bank, the Farallon Islands (Rice 1977, Kieckhefer 1995) and in Monterey Bay, due to high local productivity and oceanographic characteristics of the regions (e.g., upwelling, fronts, canyons, and vertical walls). Distributions of the euphausiids, *Euphausia pacifica* and *Thysanoessa spinifera,* vary seasonally in response to both temperature and light availability. Changes in euphausiid behavior can reduce the availability of prey in surface waters to predators such as seabirds (Ainley et al. 1996, Veit et al. 1997) and rorqual whales (Schoenherr 1991, Croll et al. 1998).

California blue whales respond to the seasonal patterns in productivity in foraging areas along the west coast of North America. Blue whales exhibit strong seasonal migration feeding primarily on euphausiids in the Gulf of the Farallones and migrating to the lower latitudes where they feed on "upwelling-modified" waters (Fielder et al. 1998, Croll et al. 1998), mate and give birth (Lockyer 1981). California humpback whales follow similar migration patterns as the blue whales and primarily feed on small schooling fish and euphausiid prey in the Gulf of the Farallones and migrate to Mexican waters to mate and give birth (Kieckhefer 1992).

The composition of fish species in the pelagic zone varies throughout the year with migration and spawning and from year to year with environmental fluctuations. A small number of migratory pelagic species dominate the fisheries of central and northern California, including northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), Pacific hake (*Merluccius productus*), and jack mackerel (*Trachurus symmetricus*). These pelagic species

spawn in the Southern California Bight and migrate into waters off central and northern California. However, the composition of larval fish species off central and northern California varies with oceanographic conditions.

The deep-sea pelagic invertebrate fauna is dominated by the following Phyla: cnidarians (or coelenterates), ribbon worms (Nemerteans), ctenophores, chaetognaths, mollusks, annelids (including Polychaetes), and crustaceans. The cnidarians include hydroids, sea anemones, corals, jellyfishes, and their relatives. The mollusks include marine snails (Prosobranchia), sea slugs (Opisthobranchias and Pulmonata), clams (Bivalves), chitons (Polyplacophora), squids and octopuses (Cephalopods including the Decapods, Octopods, and Siphonophora). The crustaceans include barnacles (Cirripedia), isopods, amphipods, copepods, shrimps (Caridea), ghost shrimps (Macrura), hermit crabs (Anomura), and true crabs (Brachyura).

**Continental Shelf and Slope Communities (0-200 meters)**

The continental shelf off central and northern California is generally quite gradual, and the bottom substrate is a combination of varying amounts of sand, silt, and clay. Much of the mud and sand on the continental shelf was deposited by rivers that formed during the melting of the glaciers approximately 18,000 years ago (Eittreim et al. 2000). At water depths between about 40 to 90 meters, the continental shelf off central California is covered by a nearly continuous blanket of mud as much as 30 meters thick. In areas of high wave energy, mud and sand may be resuspended and transported away from the shore. A zone of outcropping bedrock and sands is located seaward of the mud accumulation zone, on the far outer shelf where water depth exceeds 90 meters.

**Sandy Continental Shelf Communities**

Although sandy sediments may appear less productive than rocky reefs and kelp forests, numerous organisms are adapted to the shifting environments on the sandy shelf. Some animals find shelter by living in tubes and burrows. Clams lie permanently buried with their siphons extended to the surface of the sediment. Some crustaceans and mollusks live beneath the sand, emerging at night to forage. Flatfishes are camouflaged on the sandy surface of the sea floor. Ocean shrimp (*Pandalus jordani*) are found in California from depths of 240 to 750 feet. Spot prawns are found in depths of 150 to 1,600 feet and concentrate in the regions around the Farallon Islands and offshore banks. Many species of fish prey on ocean shrimp, including Pacific hake, arrowtooth flounder, petrale sole, sablefish, and several rockfishes.

Many species of flatfishes (Pleuronectidae and Bothidae) use the soft-bottom habitats along the continental shelf. English sole (*Paraphrys vetulus*) are distributed from northwest Alaska to San Cristobal Bay, Baja California, in waters as deep as 1,800 feet. Spawning of English sole generally occurs over sand and mud-sand bottoms at depths of 200 to 360 feet from September to April (Pearson et al. 2001).

Dungeness crabs (*Cancer magister*) are commonly found in a variety of habitats, but populations are concentrated on sandy to sandy-mud bottoms from the intertidal to a depth of 300 feet. Dungeness crabs are opportunistic feeders, consuming clams, fish, isopods, and amphipods.

**Rocky Continental Shelf Communities**

Along the northern California coast, rocky reefs support extensive macroalgal growth and associated abalones, sea urchins, and rockfishes.

Juvenile red abalone settle as postlarvae on coralline algae in crevices between rocks (Haaker et al. 2001). Sea urchins are abundant subtidal herbivores that play an important ecological role in the structure of kelp forest communities. Red sea urchins (*Strongylocentrotus franciscanus*) are found on rocky shores of open coasts from the low-tide water line to 300 feet deep. Purple sea urchins (*S. purpuratus*) are found on rocky shores with moderately strong surf from the low-tide line to 525 feet deep.

Fish commonly found in the rocky habitats of the continental shelf include surfperches, rockfish (black and shortbelly), cabezon, and boccacio. The surfperches (Embiotocidae) are small abundant fishes found predominantly in temperate eastern North Pacific waters. Schools of black rockfish (*Sebastes melanops*) frequently occur 10 to 20 feet above shallow rocky reefs. Shortbelly rockfish (*Sebastes jordani*) are found in greatest abundances between the Farallon Islands. The peak abundance of adults is over the bottom at depths of 400 to 700 feet. Adults commonly form very large schools often near or on the bottom during the day. At night, aggregations of shortbelly rockfish may loosen as the fish move up in the water column. Cabezon (*Scorpaenichthys marmoratus*) are found on hard bottoms in shallow water from intertidal pools to depths of 250 feet. Cabezon are common in subtidal habitats in and around rocky reefs and kelp beds. Bocaccio (*Sebastes paucispinis*) ranges from Kodiak Island, Alaska, to central Baja California.

**Continental Slope Communities (200-2000 meters)**

At a depth of about 200 meters, the continental slope drops steeply to the sea floor. The deep waters of the continental slope are characterized by extremely low light conditions, nearly freezing temperatures, and very high pressures (Laidig 2002). Continental slope species eat less frequently, are slower at digesting their food, and move more slowly then than species in warmer waters. In order to achieve sexual maturity and successful reproduction under conditions of reduced growth, continental slope species may live longer than species in warmer waters.

The invertebrate infaunal and epifaunal communities along the continental slope include many species such as polychaete worms, pelecypod and scaphopod mollusks, shrimp, and brittle stars.

Productive commercial fisheries for deep-sea fish operate on the continental slope. The species targeted include deep-sea rockfishes such as Cowcod (*Sebastes levis*) and Blackgill rockfish (*Sebastes melanostomus*), thornyheads (genus *Sebastolobus*), sablefish (*Anoplopoma fimbria*), and Dover sole (*Microstomus pacificus*). Many of these species occupy similar habitats and generally are caught together.

**Submarine Banks, Canyons, and Seamounts**

Submarine banks and shoals are found near the shelf break along a submarine ridge that extends for approximately 30 nautical miles between the Farallon Islands and Cordell Bank. The vertical

structure of Fanny Shoal, Rittenburg Bank, and the submerged rocky outcrops surrounding the Farallon Islands provide rich habitat for a diverse rocky reef community.

To the west of the Farallon Islands and the continental shelf, the seafloor drops precipitously to depths over 6,000 feet. Submarine canyons and gullies indent the steep continental slope of the Farallones Escarpment.

Pioneer and Guide Seamounts are found west of the sanctuary. These underwater islands of volcanic origin are home to colorful, long-lived invertebrates and other marine life adapted to living in dark, deep waters. Due to the difficulty in studying these remote habitats, it is possible that these seamounts harbor marine life that is yet unknown to science.

# LIVING MARINE RESOURCES

## Marine and Coastal Birds

One of the most spectacular components of the sanctuary's abundant and diverse marine life is its nesting and migratory seabirds (see Appendix III-G for a complete species list). The Gulf of the Farallones supports the largest concentration of breeding seabirds in the contiguous U.S. These birds forage in the Gulf of the Farallones and are highly dependent on the productive waters of the sanctuary. Eleven of the sixteen species of seabirds known to breed along the U.S. Pacific coast have breeding colonies on the Farallon Islands and feed in the sanctuary. Breeding colonies include Ashy and Leach's Storm-Petrels; Brandt's, Pelagic, and Double-crested Cormorants; Western Gulls; Common Murres; Pigeon Guillemots; Tufted Puffins; and Cassin's and Rhinoceros Auklets. The Black Oystercatcher, a moderte-sized shorebird, also nest on the Farallon Islands.

*Common Murres breed on the Farallon Islands and other craggy promontories within the sanctuary. They are particularly vulnerable to impacts from oil spills. Photo: NOAA*

The sanctuary also protects four estuaries, a lagoon, and one large coastal bay that provide foraging habitat for aquatic birds such as waterfowl, shorebirds, pelicans, loons, and grebes. These habitats are pristine compared to most coastal wetlands in California and provide habitat for thousands of migrating and wintering birds. More than 160 species of birds use the sanctuary for shelter, food, or as a migration corridor. Of these, over 50 species of birds are known to use the sanctuary during their breeding season.

Six marine and aquatic bird species that are federally listed as threatened or endangered can be found in the sanctuary (March 2007). These include the Marbled Murrelet, California Brown Pelican, Western Snowy Plover, and Short-tailed Albatross.

*GFNMS was designated to protect the seabirds of the Gulf of the Farallones. Here are a few examples. Northern Fulmar (left) forage within the open waters of the sanctuary, Snowy Egrets (center) inhabit the shallow estuarine waters, and Western Gulls and other birds fill the skies above the sanctuary. Photos: NOAA*

## Marine Mammals

Thirty-six species of marine mammals have been observed in the GFNMS. This includes six species of pinnipeds (seals and sea lions), twenty-eight species of cetaceans (whales, dolphins, and porpoises), and two species of otter. Many of these mammals occur in large concentrations and are dependent on the productive and secluded habitats for breeding, pupping, hauling out,

feeding, and resting during migration. The Farallon Islands provide habitat for breeding populations of five species of pinnipeds, and support the largest concentrations of California sea

*Common marine mammals of the GFNMS include California and Steller sea lions (left), gray whales (center), and longbeaked common dolphins (right). Photo: NOAA*

lions and northern elephant seals within the sanctuary.

**Fish Resources**

Fish resources are abundant over a wide portion of the Gulf of the Farallones. Because of the comparatively wide continental shelf and the configuration of the coastline, the sanctuary is vital to the health and existence of salmon (chinook and coho), northern anchovy, rockfish, and flatfish stocks. The extension of Point Reyes and the resulting current patterns tend to retain larval and juvenile forms of these and other species within the sanctuary, thereby easing recruitment pressures and ensuring continuance of the stocks. Sanctuary waters offshore of the Farallon Islands act as a location for shallow and intertidal fishes which further enhance finfish stocks.

*The rockfish group of fish (Sebastes spp.) are among the most diverse fish species in the sanctuary nearshore and deep habitats. Photo: NOAA*

*White sharks migrate to the Gulf of the Farallones in the fall to prey upon the marine mammal populations. Photo: NOAA*

The sanctuary includes many diverse habitats, thereby contributing to the region's high productivity. Bays and estuaries are especially important as feeding, spawning, and nursery areas for a wide variety of finfish. Common fish species of the major bays and estuaries include the Pacific herring, smelts, starry flounder, surfperch, sharks and rays, and coho salmon. The rocky intertidal zone supports a specialized group of fish adapted for life in tide pools, including monkey face eels, rock eels, dwarf surfperch, juvenile cabezon, sculpins, and blennies. Many of these stocks are important as forage for shorebirds and seabirds. Subtidal habitats support large populations of juvenile finfish (e.g., flatfish, rockfish, etc.). Nearshore pelagic environs are habitat to large predatory finfish such as sharks, tunas, and mackerel. Northern anchovies, Pacific mackerel, and market squid are abundant and can be commercially valuable. Pelagic fish resources in the study area generally parallel species living in the nearshore subtidal zone. At the mid-depth or meso-pelagic range over sand and mud bottoms, bocaccio, chilipepper, widow rockfish, and Pacific hake are

abundant. Kelp beds substantially increase the useable habitat for pelagic and demersal species and offer protection to juvenile finfish.

**Marine Flora**

Significant algal and plant communities within the sanctuary include kelp beds, salt marshes, and seagrass beds. The importance of these plants, algae, and microscopic phytoplankton for habitat and food cannot be overstated.

*Kelp forests in GFNMS are dominated by bull kelp (Nereocystis luetkeana). Photo: NOAA*

*The intertidal algae the sea palm is a State-species of special concern and is found in pockets along the GFNMS rocky shores*

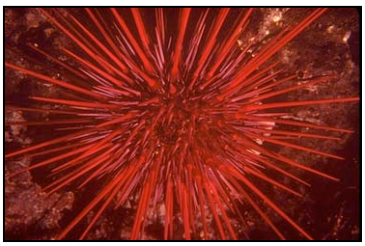
Kelp forests include the giant kelp species bull kelp. The highest concentration of kelp beds in the sanctuary occurs along the mainland coast between Point Reyes Headlands and Bolinas Lagoon. As noted above, these kelp beds provide important habitat and food for many invertebrate and finfish species.

Salt marshes offer food and protected habitat for many coastal species during vulnerable lifecycle stages. For example, some flounders breed near salt marshes to allow juveniles to develop in the marsh system. Herons, sandpipers, duck, rails, and geese are also dependent upon the marsh for feeding and breeding.

Seagrass beds are situated on subtidal estuarine flats, in bays, and coastal inlets. Seagrass beds provide important breeding and nursery habitat for organisms such as herring, which attach their eggs to eelgrass. Although some marine organisms feed directly on seagrass, the principal food chain supported by seagrass is based on detritus.

**Benthic Fauna**

Benthic fauna communities refer to invertebrates living directly on or in the seafloor. Benthic fauna communities differ according to habitat type and exist in all habitats of the sanctuary (bays and estuaries, intertidal zones, nearshore, and offshore). Generally, each habitat area supports differing benthic assemblages of most classes, e.g., worms, clams, or crabs. The most conspicuous species include abalone, crabs, and sea urchins. Hundreds of other species (including sea stars, clams, amphipods, and shrimp) are critical links in the food chains of fish, birds, and mammals.



*Sea urchins are important grazers in the intertidal ecosystem. Photo: NOAA*

# HUMAN-USE IMPACTS ON ECOSYSTEMS

A wide range of human-use activities occur in and around the waters of the GFNMS. The San Francisco Bay metropolitan area exerts considerable user influence on the scale and intensity of uses (often competitive) occurring in the area. The major near and offshore activities include commercial fishing and mariculture, commercial shipping, recreation, and research. Additional details on the extent of human-use activities in the sanctuary can be found in the introduction of each action plan.

## Commercial Fishing and Mariculture

The most important commercial harvests include Pacific herring, salmon, flatfish, albacore, tuna, and Dungeness crab. As of the date of publication, the offshore commercial groundfish fishery within the Gulf of the Farallones remains closed below 20 fathoms. Most of the commercial catches harvested in the sanctuary are landed in San Francisco, Bodega Bay, Oakland, Half Moon Bay, and Sausalito. A number of mariculture operations in Tomales Bay and Drakes Estero raise oysters, mussels, and other shellfish.

*Fishing vessels can be seen plying sanctuary waters for fish throughout the seasons. Photo: NOAA*

## Commercial Shipping

*Large cargo ships daily transit the sanctuary enroute to and from the Port of San Francisco. Photo: NOAA*

Three major shipping lanes converge in the sanctuary just west of the Golden Gate Bridge at the entrance to San Francisco Bay. The volume of traffic in and out of San Francisco Bay is large, totaling approximately 6,000 arrivals in calendar year 2003. This represents an average of over three tankers and ten other types of vessels per day. In recent years, the sanctuary is seeing an increase in cruise ship traffic. Cruise ship visitation to San Francisco Bay more than doubled in two years from 44 in 2002 to 91 in 2004.

## Recreation

The sanctuary is a popular recreation area because of its many outstanding natural features and its proximity to the San Francisco Bay metropolitan area. More than 58 coastal access points in Sonoma, Marin, San Francisco, and San Mateo Counties provide direct access and views of the sanctuary. Most of these access points are located in federal, state, county, and local parks.

*Kayaking is a popular way to experience the sanctuary, particularly on Tomales Bay. Photo: NOAA*

Sport fishing is one of the more popular activities in the sanctuary. King salmon and rockfish are the major species taken. Whale watching, Farallon Islands wildlife viewing, sailing, and oceanic birding excursions account for several thousands of visitors venturing offshore. The major onshore recreational uses include beach-related activities, bird watching,

coastal hiking, wildlife viewing, tide pooling, surfing, kayaking, canoeing, boardsailing, clamming, and surf fishing. On some weekend days, more than 1,000 clam diggers harvest geoduck, gaper, Washington, and littleneck clams.

**Research and Monitoring**

The diversity of physical and biological habitats throughout the sanctuary offers an outstanding opportunity for scientific research on marine and estuarine ecosystems. Several academic institutions, government agencies and nongovernmental organizations have ongoing monitoring and research programs in the area. Research on the Farallon Islands (Farallon National Wildlife Refuge) is coordinated by the U.S. Fish and Wildlife Service (USFWS), through a Cooperative Agreement with PRBO Conservation Science. The sanctuary collaborates with these and other institutions on conducting monitoring and research to help characterize the wildlife and habitats of the sanctuary and to help understand natural and human factors responsible for causing changes in the marine environment.

*Sanctuary scientists collect data on the rocky shores of the Farallon Islands to answer important resource management questions. Photo: NOAA*

**Cited References**

Allen, L. G., and M. H. Horn. 1975. Abundance, diversity, and seasonality of fishes in Colorado Lagoon, Alamitos Bay, California. Estuarine and Coastal Marine Science 3: 371-380.

Allen, L. G. 1982. Seasonal abundance, composition, and productivity of the littoral fish assemblage in upper Newport Bay, California. Fishery Bulletin 80: 769-790.

Ainley, D. G., L. B. Spear, and S. G. Allen. 1996. Variation in the diet of Cassin's auklet reveals spatial, seasonal, and decadal occurrence patterns of euphausiids off California, U. S. A. Marine Ecology Progress Series 137: 1-10.

Berzins, I. K. 1985. *The Dynamics of Beach Wrack Invertebrate Communities: An Evaluation of Habitat Use Patterns*. University of California, Berkeley.

Blaber, S. J. M., D. T. Brewer, and J. P. Salini. 1989. Species composition and biomasses of fishes in different habitats of a tropical northern Australian estuary: their occurrence in the adjoining sea and estuarine dependence. Estuarine, Coastal and Shelf Science 29: 509-531.

Bray, R. N. 1981. Influences of water currents and zooplankton densities on daily foraging movements of blacksmith, *Chromis punctipinnis,* a planktivorous reef fish. Fisheries Bulletin 78: 829-841.

Bray, R. N., and A.W. Ebeling. 1975. Food, activity and habitat of three "picker-type" microcarnivorous fishes in the kelp forests off Santa Barbara, California. Fisheries Bulletin 73: 815-829.

Broenkow, W. 1977. Water chemistry of the Elkhorn Slough and Moss Landing Harbor. In Nybakken, J. G. Cailliet, and W. Broenkow (eds). *Ecologic and Hydrographic Studies of Elkhorn Slough Moss Landing Harbor and Nearshore Coastal Waters*. Moss Landing Marine Laboratories Technical Publication. Moss Landing, California.

Carr, M. H. 1983. Spatial and temporal patterns of recruitment of young-of-the-year rockfishes (genus *Sebastes*) into a central California kelp forest. Thesis, San Francisco State University. San Francisco.

Colebrook, J. M. 1977. Annual fluctuations in the biomass of taxonomic groups of zooplankton in the California Current, 1955-1959. Fishery Bulletin 75: 357-368.

Croll, D. A., B. R. Tershy, R. Hewitt, D. Demer, S. Hayes, P. Fiedler, J. Popp, and V. L. Lopez. 1998. An integrated approach to the foraging ecology of marine birds and mammals. Deep-Sea Research II 45: 1353-1371.

Davis, J., and A. Baldridge. 1980. *The Bird Year: A Book for Birders with Special Reference to the Monterey Bay Area*. Boxwood Press. Pacific Grove, California.

Duggins, D. O. 1988. The effects of kelp forests on nearshore environments: biomass, detritus, and altered flow. In VanBlaricom, G.R., and J.A. Estes (eds). *The Community Ecology of Sea Otters*. Springer-Verlag, Germany. Pp. 192-201.

Ebeling, A. W., and D. R. Laur. 1985. The influence of plant cover on surfperch abundance at an offshore temperate reef. Environmental Biology of Fishes 12: 169-179.

Ebeling, A. W., D. R. Laur, and R. J. Rowley. 1985. Severe storm disturbances and reversal of community structure in a southern California kelp forest. Marine Biology 84: 287-294.

Edwards, R. R. C. 1973a. Production ecology of two Caribbean marine ecosystems. I. Physical environment and fauna. Estuarine Coastal and Marine Science 1: 303-318.

Eittreim, S. L., M. E. Field, and M. Noble. 2000. Where Does the Mud Go? Ecosystem Observations for the Monterey Bay National Marine Sanctuary.

Fiedler, P. C., S. B. Reilly, R. P. Hewitt, D. Demer, V. Philbrick, S. Smith, W. Armstrong, D. A. Croll, B. R. Tershy, and B. R. Mate. 1998. Blue whale habitat and prey in the California Channel Islands. Deep-Sea Research II 45: 1781-1801.

Foster, M. S. 1982. The regulation of macroalgal associates in kelp forests. In Srivastava, L. (ed). *Synthetic and Degradative Processes in Marine Macrophyte*. Walter de Gruyter and Co. Berlin, Germany. Pp. 185-205.

Foster, M. S., and D. R. Schiel. 1985. The ecology of giant kelp forests in California: a community profile. U.S. Fish and Wildlife Service Biological Report 85(7.2): 152 pp.

Gooding, R. M., and J. J. Magnuson. 1967. Ecological significance of a drifting object to pelagic fishes. Pacific Science 21: 486-497.

Gunter, G. 1958. Population studies of the shallow water fishes of an outer beach in south Texas. Publications of the Institute of Marine Science, University of Texas 5: 186-193.

Haaker, P. L., K. Karpov, L. Rogers-Bennett, I. Taniguchi, C. S. Friedman, and M. J. Tegner. 2001. Abalone. In Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson [Eds]. *California's Living Marine Resources: A Status Report*. California Department of Fish and Game Resources Agency. Pp. 89-97.

Hoff, J. G., and R. M. Ibara. 1977. Factors affecting the seasonal abundance, composition, and diversity of fishes in a southeastern New England estuary. Estuarine and Coastal Marine Science 5: 665-678.

Huntley, M. E., M. Zhou, and W. Nordhausen. 1995. Mesoscale distribution of zooplankton in the California Current in late spring, observed by Optical Plankton Counter. Journal of Marine Research 53: 647-674.

Kieckhefer 1995 Check in Kieckhefer, T. R. 1992. Feeding ecology of humpback whales in continental shelf waters near Cordell Bank. Moss Landing Marine Laboratories. Moss Landing.

Laidig, T. 2002. Continental slope communities. In Karl, H. A., J. L. Chin, E. Ueber, P. H. Stauffer, and J. W. Hendley II [Eds.]. *Beyond the Golden Gate: Oceanography, Geology, Biology, and Environmental Issues in the Gulf of the Farallones*. U. S. Department of the Interior and U. S. Geological Survey. Circular 1198.

Lasiak, T. A. 1983. The impact of surf-zone fish communities on faunal assemblages associated with sandy beaches. In McLachlan, A., and T. Erasmus (eds). *Sandy Beaches as Ecosystems*. Dr. W. Junk Publishers. The Hague. Pp. 501-506.

Lockyer, C. 1981. Growth and energy budgets of large baleen whales from the Southern hemisphere. Food and Agricultural Organization Fisheries Series 5: 379-487.

Loeb, V. J., P. E. Smith, and H. G. Moser. 1983a. Ichthyoplankton and zooplankton abundance patterns in the California Current area, 1975. California Cooperative Oceanic Fisheries Investigations Reports 24: 109-131.

Loneragen, N. R., I. C. Potter, R. C. J. Lenanton, and N. Caputi. 1986. Spatial and seasonal differences in the fish fauna in the shallows of a large Australian estuary. Marine Biology 103: 461-479.

Mann, K. H. 1982. *Ecology of Coastal Waters*. University of California Press. Los Angeles, California. 322 pages.

McDermott, J. J. 1983. Food web in the surf-zone on an exposed sandy beach along the mid-Atlantic coast of the United States. In McLachlan, A. and T. Erasmus. *Sandy Beaches as Ecosystems*. Dr. W. Junk Publishers. The Hague. Pp. 529-538.

Modde, T. and S. T. Ross. 1981. Seasonality of fishes occupying a surf zone habitat in the northern Gulf of Mexico. Fishery Bulletin 78: 911-922.

Onuf, C. P., and M. L. Quammen. 1983. Fishes in a California coastal lagoon: Effects of major storms on distribution and abundance. Marine Ecology Progress Series 12: 1-14.

Parrish, R. H., C. S. Nelson, and A. Bakun. 1981. Transport mechanisms and reproductive success of fishes in the California Current. Biological Oceanography 1: 175-203.

Pearson, D. E., S. L. Owen, and D. Thomas. 2001. English Sole. In Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson [Eds]. *California's Living Marine Resources: A Status Report*. California Department of Fish and Game Resources Agency. Pp. 384-385.

Ramer, B. A., G. W. Page, and M. M. Yoklavich. 1991. Seasonal abundance, habitat use, and diet of shorebirds in Elkhorn Slough, California. Western Birds 22: 157-174.

Reid, J. L., G. L. Roden, and J. G. Wyllie. 1958. Studies in the California Current system. California Cooperative Oceanic Fisheries Investigations Reports 6: 27-57.

Roletto, J., J. Mortenson, L. Grella, and D. Osorio. 2000. Beach Watch Annual Report: 1999. Unpublished report to the National Oceanic and Atmospheric Administration. Gulf of the Farallones National Marine Sanctuary, San Francisco, California.

Schoenherr, J. R. 1991. Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. Canadian Journal of Zoology 69: 583-594.

Slattery, P. N. 1980. Ecology and life histories of dominant infaunal crustaceans inhabiting the subtidal high energy beach at Moss Landing, California. M. A. Thesis, San Jose State University, California.

Sowls, A. L., A. R. DeGange, J. W. Nelson and G. S. Lester. 1980. Catalog of California Seabird Colonies.U.S. Dept Interior, Fish and Wildl. Serv., Biol. Serv. Prog. FWS/OBS 37/80.371 p.

Rice 1977 Check in Rice, D. W. 1978. Blue Whale. In Haley, D. (ed). *Marine Mammals of Eastern Pacific and Arctic Waters*. Pacific Search Press. Seattle, Washington. Pp. 30-55.

Weinstein, M. P. 1979. Shallow, marsh habitats as primary nurseries for fishes and shellfish. Cape Fear River, North Carolina. Fisheries Bulletin 77: 339-357.

ABA Consultants. 1989. Elkhorn Slough Wetlands Management Plan: Hearing Draft Report. Prepared for Monterey County and California Coastal Commission. ABA Consultants. Capitola, California.

Wickham, D. A., and G. R. Russell. 1974. Evaluation of midwater artificial structures for attracting coastal pelagic fishes. Fisheries Bulletin 72: 181-191.

Yoklavich, M. M., G. M. Caillet, J. P. Barry, D. A. Ambrose, B. S. Antrim. 1991. Temporal and spatial patterns in abundance and diversity of fish assemblages in Elkhorn Slough, California. Estuaries 14(4): 465-480.

Veit, R. R., J. A. McGowan, D. G. Ainley, and T. R. Wahls. 1997. Apex marine predator declines ninety percent in association with changing ocean climate. Global Change Biology 3: 23-28.

# OVERVIEW OF JOINT MANAGEMENT PLAN REVIEW (JMPR) PROCESS

The National Marine Sanctuary Act (NMSA) requires the National Marine Sanctuary Program (NMSP) to periodically review sanctuary management plans to ensure that sanctuary sites continue to best conserve, protect, and enhance their nationally significant living and cultural resources. Gulf of the Farallones National Marine Sanctuary (GFNMS) had not reviewed or revised its management plan since its designation in 1981. Recent scientific discoveries, advancements in managing marine resources, and new resource management issues provide the basis for the development of this new five-year management plan.

The NMSP has reviewed the management plans of GFNMS together with the Cordell Bank and Monterey Bay national marine sanctuaries. These sanctuaries are located adjacent to one another, managed by the same program, and share many of the same resources and issues. In addition, all three sites share many overlapping interest and user groups. It is also more cost effective for the program to review the three sites jointly rather than conducting three independent reviews. Using a community-based process that has provided numerous opportunities for public input, the NMSP identified priority resource management issues to be addressed in the management plans. Through the review process, management strategies, regulations, and boundaries were also evaluated.

The sanctuary's management plan describes the objectives, policies, and activities for GFNMS. It also outlines regulatory goals; describes boundaries; identifies staffing and budget needs; and sets timelines, priorities, and performance measures for conservation science and education programs. The management plan will guide the development of future management activities over the next five years.

## STAGES OF THE GFNMS MANAGEMENT PLAN REVIEW PROCESS

### Public Scoping Meetings

The GFNMS management plan review process began in Fall 2001 with a two-month public scoping period to identify specific management priority issues for the next five to ten years. As a part of the Joint Management Plan Review (JMPR), the NMSP held twenty public scoping meetings in communities throughout the north-central California coast, in Sacramento, and in Washington, D.C. Approximately 1,000 people participated in these forums and submitted approximately 4,000 comments. All comments were compiled and posted on the JMPR website.

*The management plan review included twenty public scoping meetings. Photo: NOAA*

In addition to public scoping meetings, the NMSP accepted written comments. Comments were sent to the NMSP in the form of e-mails, letters, faxes, and petitions. The program received approximately 6,500 e-mails, 300 letters, thirteen faxes, and a petition with 1,700 signatures.

From these, a *Summary Scoping Document* was prepared and distributed to each of the sanctuary advisory councils. This document organized all the comments received through early February 2002 into thirty general issue categories. Background information and summary charts were included to help the NMSP staff and three advisory councils prioritize the issues. The document is also posted on the JMPR website at http://www.sanctuaries.nos.noaa.gov/jointplan/.

**Issue Prioritization**

Four prioritization workshops were held with each of the sanctuary advisory councils to evaluate the cross-cutting and site-specific marine resource management issues identified during the public scoping process. These recommendations were given to staff for consideration in developing the final list of issues to be addressed in the JMPR.

The first workshop, held in April 2002 in Half Moon Bay, involved all three sanctuary advisory councils to prioritize the cross-cutting issues raised during the scoping process. Cross-cutting issues were defined as any issue that applied to two or more sanctuaries. Following this joint workshop, individual sanctuary advisory councils met to prioritize site-specific issues raised during the public scoping process. The results from these workshops were distributed to advisory council members in a document entitled *Report on Sanctuary Advisory Council Prioritization Workshops*. The document is posted on the JMPR website at http://www.sanctuaries.nos.noaa.gov/jointplan/.

The *Report on Sanctuary Advisory Council Prioritization Workshops* summarizes the results from four prioritization workshops held with members of the Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuary Advisory Councils. One workshop was held jointly with all three advisory councils to prioritize the cross-cutting issues. The three advisory councils also met individually to prioritize site-specific issues raised during scoping. This document includes the actual ranking the councils gave to each issue based upon the following criteria: Site Benefits, Urgency, and Feasibility.

NMSP staff (from all three sanctuaries and the NMSP headquarters) met to determine the final list of priority cross-cutting and site-specific marine resource management issues to address in the management plan reviews. This group developed the final list of management plan issues using the advice of the advisory council and sanctuary staff, including the *Report on Sanctuary Advisory Council Prioritization Workshops*. The final list was released to the public in the document entitled, *National Marine Sanctuary Program Selection of Priority Issues to Address in the Joint Management Plan Review*. This document is posted on the JMPR website at http://www.sanctuaries.nos.noaa.gov/jointplan/.

The *National Marine Sanctuary Program Selection of Priority Issues to Address in the Joint Management Plan Review* report presented the priority issues the NMSP planned to address in the JMPR process. The cross-cutting and site-specific priorities are presented in a summary chart as well as a text explanation of the rationale behind the decision to address or not address each issue.

**Issue-Based Working Groups**

Issue-based working groups were established to recommend specific actions for the sanctuary to undertake to address the priority issues identified during the public scoping and prioritization phases. The working groups met an average of eight times over a seven-month period from December 2002 to June 2003. Members of the groups included sanctuary advisory council representatives, nominated experts from the community, and sanctuary staff. The groups heard from technical advisors, reviewed published documentation, and used this information to recommend specific management actions for the sanctuary to use in developing the revised management plan.

GFNMS created six working groups, two internal teams, and participated in five cross-cutting working groups. The GFNMS site-specific working groups were: Water Quality; Wildlife Disturbance; Introduced Species; Ecosystem Protection: Impacts from Fishing Activities; Vessel Spills; and Education and Outreach. The site-specific internal teams were Administration and Boundary Modifications. The cross-cutting working groups (including representatives from all three sanctuaries and advisory councils) were: Ecosystem Monitoring; Maritime Heritage; and Community Outreach. The cross-cutting internal teams were Boundary Modifications and Administration. The recommendations that came out of these working groups were prioritized and the highest ranked activities were compiled in a document entitled, *Gulf of the Farallones National Marine Sanctuary Recommendations*. The document is posted on the JMPR website at http://www.sanctuaries.nos.noaa.gov/jointplan/.

The *Gulf of the Farallones National Marine Sanctuary Recommendations* report details the goals, objectives, and strategies recommended by each working group. The report includes background information; an overview of the working group participants and process; a detailed description of each proposed strategy; and how each strategy was ranked according to the criteria of: Site Benefits; Complexity; Short-term Feasibility; Long-term Feasibility; Improved Coordination Between Sites; and Urgency.

**Review of Working Group Recommendations**

The recommendations from the issue-based working groups underwent several rounds of review in preparation for creating the draft management plan. The recommendations were sent to the sanctuary advisory council members, who reviewed the document as a whole and forwarded it with their comments and priorities to the sanctuary manager. The sanctuary advisory council considered overlap or gaps within the recommendations, the feasibility and value of each proposed activity, and any suggestions or comments they had. The sanctuary advisory council also prioritized each activity as a high or low priority based on six criteria: Site Benefits; Complexity; Short-term Feasibility; Long-term Feasibility; Improved Coordination Between Sites; and Urgency (the same criteria used by the working groups).

The sanctuary staff then reviewed the sanctuary advisory council's recommendations, comments and priorities using the same considerations and criteria as the sanctuary advisory council had used. The sanctuary manager considered both the staff and advisory council comments and made the final decision regarding those activities to be included in the draft management plan.

**Draft Management Plan**

A draft management plan (DMP) was released to the public for review and comment. It contained a series of strategies and action plans that addressed the priority resource management issues and general management of the sanctuary. It also included detailed timelines and budgets along with proposed regulatory changes. The DMP was written based on the results of the first four stages of the JMPR process described above.

The sanctuary accepted written comments (letters, e-mails, faxes) and hosted a series of public hearings to hear oral comments on the draft management plan. A supporting final environmental impact statement (FEIS) supports any changes, provides an environmental and socioeconomic analysis of proposed regulatory actions, and is packaged and reviewed with the DMP. After the close of the public comment period, the sanctuary reviewed and responded to comments and made necessary changes before issuing the final management plan (FMP).

**Final Management Plan**

Following the DMP public comment period, sanctuary staff revised the DMP, as appropriate, based on comments received. From this, the FMP was created along with a final environmental impact statement (FEIS). The FMP/FEIS was released to the public and submitted to Congress and the Governor for review. Following a 45-day review period and completion of any necessary changes, the new management plan and accompanying regulations became effective.

# STRUCTURE OF THE ACTION PLANS

This management plan is constructed around a set of functionally based action plans that outline how Gulf of the Farallones National Marine Sanctuary (GFNMS) will be managed for the next five years. Each action plan outlines how different strategies will be conducted; presents the costs that might be incurred for each strategy; sets a coordinated timeline for carrying out all strategies; and proposes performance indicators as a measure of management effectiveness.

## DEVELOPMENT OF ACTION PLANS

Through the extensive community-based management plan review, priority resource management issues to be addressed in the management plan were identified. Working groups were formed to address each of these issues. Working groups consisted of sanctuary staff, members of the sanctuary advisory council, experts, agency representatives, and the public, who worked together to identify the priority issues the sanctuary faced and the outcomes that should be sought for each issue. The working groups developed the goals and objectives; strategies; and activities to achieve those outcomes. The following issues and program areas are addressed in this management plan:

A. Water Quality

B. Wildlife Disturbance

C. Introduced Species

D. Ecosystem Protection: Impacts from Fishing Activities

E. Impacts from Vessel Spills

F. Education and Outreach

G. Conservation Science

H. Resource Protection

I. Administration

## OUTLINE OF ACTION PLANS

Each action plan is structured so that sanctuary staff and constituents may quickly and easily reference this document. Each action plan is divided into eight sections that are described in detail below.

**Issue Statement/ Program Statement**

The issue (or program) statement clearly and concisely provides an introduction about "why" this is an issue to be addressed by the sanctuary in the management plan. It may include a brief description of the current situation or problem, and areas that need attention.

**Issue Description/ Program Description**

The issue (or program) description provides a general background on what the sanctuary currently knows or understands about an issue. Program descriptions explicitly describe the types of actions already undertaken by the sanctuary and the general direction it would like to move in the future. It includes the status of natural resources, related human-use activities occurring in the sanctuary, and jurisdictional authorities pertinent to the specific issue.

**Goals**

The goal states "what" is the desired future state of the sanctuary ecosystem and management relevant to the specific resource management issue or program area. The goal is a broad statement about a long-term desired outcome that may or may not be completely obtainable.

**Objectives**

The objectives are measurable outcomes for evaluating progress and success in moving toward the future desired condition. Objectives will be achieved in a specific time frame to help accomplish the desired goal.

**Strategies**

This section is a description of how the objectives will be accomplished for the particular issue or program area. Each strategy addresses one or more objectives and is divided into specific activities for the sanctuary staff to carry out. Activities are developed and implemented to achieve the goals and objectives of the issue or program area.

Where applicable, the potential partners, products, and complementary strategies are listed. The potential partners are only those organizations that the sanctuary has identified as possible partners on the particular activity and that have shown interest in contributing to the effort. This list does not limit the partners the sanctuary may work with, but merely serves as a guide when implementing the activity. The sanctuary may partner with other organizations as work on the particular activity progresses. Likewise, the products listed are projected, but additional or altered products may become more appropriate as the strategy is completed. A list of acronyms used in this plan is found in Appendix IIIC.

Many activities within this management plan complement each other by providing the groundwork for other activities to take place or by being similar such that efficiencies can be achieved by working on them together. Where this is the case, the complementary strategies are listed beneath the activity.

**Timeline**

A general timeline is included for each action plan and presents the projected calendar for initiating and completing each strategy over the next five years. The timeline shows the planning, implementation, and where appropriate, the completion stage for each strategy. These timelines are based upon staff workload, coordination with related strategies, and the assumption that funds will be available. Timelines of strategies by program area are also included with program area action plans.

**Budget**

The budget table for each action plan presents the estimated costs per year for conducting the activities and strategies contained in this management plan. These budget numbers represent the sanctuary's best estimate of what it will cost to conduct the programs and projects described over a five-year period. However, each year the sanctuary will prepare an annual operating plan (AOP) that will determine that year's priorities and costs in the context of not only the overall revised management plan, but current issues facing the site and general national priorities as well. Therefore, costs as estimated in this management plan may be somewhat different than determined by the AOP each year. These estimates are also subject to a number of other caveats:

- The sanctuary's base budget is available each year from appropriated funds;
- There are both availability of and opportunity to receive additional funding from appropriated funds;
- The estimates do not take into account increasing personnel costs each year or inflation; and
- The estimates do not take into account unexpected events or emergencies or unforeseen projects.

**Performance Measures**

Each action plan includes a chart presenting the outcomes expected and the performance indicators that will be used to measure progress toward the outcome. This effort is being undertaken to measure the sanctuary's management effectiveness (e.g., the achievement of a planned effort or activity). The methodology to be used to assess the effectiveness of each strategy in achieving the desired goal is detailed below. The definitions for the performance measure terminology follow.

| | |
|---|---|
| *Strategy* | The management action taken by the sanctuary to address a particular issue. |
| *Performance Goal* | The over-arching, very broad target for the action plan. |
| *Desired Outcome (Objective)* | The more specific outcomes we want to achieve with our activities within the scope of the performance goal. |
| *Outcome Measure* | A specific amount or degree of the indicator that shows progress towards a desired outcome. This could contain temporal (by year) and range targets (e.g., percentage or fraction). |

| | |
|---|---|
| *How Measured* | Describes exactly how the outcome measure will be measured. |
| *Who Measures* | Identifies the staff or outside partner who will measure the outcome measure. |
| *Output Measure* | A specific product or tool that results from the activities. Its production demonstrates a completed objective. |

## OVERVIEW MATRIX OF PROGRAM AREA STRATEGIES

From a manager's perspective, every strategy in the management plan is a task for staff in one or more of the program areas. The Program Area Overview Matrixes (Appendix II) organize all strategies and activities into the four program areas: Administration; Education and Outreach; Conservation Science; and Resource Protection. The overview matrix lists the Strategies, Activities, Objectives, and Complementary Strategies under each program area.

## IMPLEMENTATION OF THE MANAGEMENT PLAN

This plan is designed to guide management of the marine resources of GFNMS for the next five years. Implementation of this new management plan will require cooperation and coordination among many federal, state, and local government agencies, as well as private organizations and individuals. Information exchange, sharing facilities and staff, and the coordination of policies and procedures within an ecosystem context are features of this management plan and each of its program areas. As this plan is being implemented, the sanctuary will work to facilitate all public and private uses of those resources that are compatible with the primary objective of resource protection.

### Limitations

Although this five-year management plan for GFNMS details the action plans for the four program areas, how these strategies are implemented may be affected by multiple factors. These include: (1) funding – the primary source of funding comes from congressional appropriations that may fluctuate from year to year; (2) GFNMS' ability to forge new partnerships in which staff, facilities and financial resources may be shared; (3) GFNMS' need to be responsive to the ever changing impacts on the sanctuary's marine resources from both natural perturbations and human activities; (4) an increased understanding of the complexity of the ecosystem, habitats and living marine resources; and (5) learning better ways to manage the resources through experience, experimentation, and the sharing of knowledge. Sanctuary staff, the sanctuary advisory council, the public, and GFNMS' partners will, as appropriate, provide oversight and guidance for redirecting any management plan strategies. A summary of the estimated cost for each action plan is included in Table 1.

### Incremental Funding Scenarios

Table 2 provides an outline of how the various strategies in the management plan will be implemented. The implementation of the strategies depends on various factors including:

1. Status of strategy implementation

2. Priority of strategy implementation

3. Coordination level necessary with partners for implementation, and

4. Funding source for strategy implementation

The status of the strategy indicates the amount of work completed or the level of implementation of a strategy at the time of the management plan review. Certain strategies and activities have been partially or wholly implemented prior to or during the management plan review. Other strategies are new as part of the updated management plan or may not be initiated until the future.

The priority of a strategy or action plan is indicated by the level of implementation based upon the funding or resources available. As stated previously, full implementation of the management plan exceeds the resources available to the GFNMS therefore requiring some prioritization of the action plan or strategies. As resources become available, a greater level of implementation is possible. Table 2 outlines how much implementation could occur with the existing amount of resources and how increases in resources would affect the amount of implementation possible for each strategy or action plan.

Implementation of most of the strategies in this management plan will require some input or coordination from partners, particularly other government agencies, research institutions and non-government organizations (NGOs). Table 2 outlines the level of involvement expected from partners to achieve full implementation of each strategy. Many action plans and strategies are completely dependent on involvement from other agencies or dependent on research conducted by a research institution.

Funding for implementation of many of the strategies will require a mix of internal National Marine Sanctuary Program (NMSP) funds as well as funding from external sources such as grants, the Farallones Marine Sanctuary Association (FMSA), or in-kind work from partner agencies. Table 2 highlights the probable source of funding as primarily internal or external or a mix of funding sources.

*Table 1: Estimated Cost for Action Plans*

| Action Plan | Estimated Annual Cost (1000's)* | | | | | Total Est. ,5-Year Cost (1000's) |
|---|---|---|---|---|---|---|
| | YR 1 | YR 2 | YR 3 | YR 4 | YR 5 | |
| **Issue-Based Action Plans** | | | | | | |
| **Water Quality** | $10.5 | $230 | $210.7 | $210.9 | $205.3 | $867.40 |
| **Wildlife Disturbance** | $131.7 | $280.5 | $342 | $442 | $209 | $1405.20 |
| **Introduced Species** | $12 | $87 | $151.5 | $208.5 | $216 | $675 |
| **Ecosystem Protection: Impacts from Fishing Activities** | $679 | $354 | $361 | $321 | $375 | $2090 |
| **Impacts from Vessel Spills** | $145 | $218 | $191 | $219 | $185 | $958 |
| **Program-Based Action Plans** | | | | | | |
| **Education and Outreach** | $1237 | $1029 | $1223 | $1,578 | $1,492 | $6559 |
| **Conservation Science** | $1703 | $1301 | $1374 | $1525 | $1507 | $7410 |
| **Resource Protection** | $268 | $2708 | $457 | $332 | $332 | $4097 |
| **Administration** | $549 | $4094 | $4394 | $4644 | $1894 | $15575 |
| **Cross-Cutting Action Plans** | | | | | | |
| **Administration and Operations** | $288 | $276 | $264 | $264 | $264 | $1356 |
| **Community Outreach** | $144 | $180 | $180 | $180 | $216 | $900 |
| **Ecosystem Monitoring** | $381 | $525 | $567 | $531 | $471 | $2475 |
| **Maritime Heritage** | $237 | $237 | $246 | $270 | $270 | $1260 |
| **Northern Management Area Transition Plan** | $526 | $518 | $613 | $692.5 | $680 | $3,029.50 |
| **Total Estimated Annual Cost** | $6,311.2 | $12,037.5 | $10,574.2 | $11,417.9 | $8,316.3 | $48,657.10 |
| The sanctuary's base budget is available each year from appropriated funds. | | | | | | |
| There is both availability of and opportunity to receive additional funding from appropriated funds. | | | | | | |
| The estimates do not take into account increasing personnel costs each year or inflation. | | | | | | |
| The estimates do not take into account unexpected events or emergencies or unforeseen projects. | | | | | | |

*Table 2: Incremental Funding Scenarios*

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Funding Scenarios and Implementation of Action Plan Strategies** | **Activity Status:** | **Implementation Level Funding: Scenario 1** | **10% per year Increase: Scenario 2** | **20% per year Increase: Scenario 3** | **Partnership Coordination** | **Primary Funding Sources** |
| Issue Area Action Plans | | | | | | |
| Water Quality | | | | | | |
| WQ-1: Water Quality Monitoring Coordination | ○ | L | M | M | ● | ◗ |
| WQ-2: Harbor and Marina Water Quality | ○ | M | M | H | ● | ◗ |
| WQ-3: Land-based Discharges | ○ | L | M | M | ● | ◗ |
| WQ-4: ASBS Water Quality | ○ | M | M | H | ● | ◗ |
| WQ-5: Mussel Watch Monitoring Program | ○ | M | M | H | ● | ● |
| WQ-6: Water Quality Working Group | ○ | M | H | H | ● | ○ |
| WQ-7: Water Quality Staff Support | ○ | M | H | H | ○ | ○ |
| WQ-8: Water Quality Bibliography | ○ | M | H | H | ◗ | ○ |
| WQ-9: Nonpoint Education for Municipal Officials (NEMO) | ○ | L | M | H | ● | ◗ |
| Wildlife Disturbance | | | | | | |
| WD-1: Web-Based Database | ○ | M | M | H | ◗ | ○ |
| WD-2: Volunteer Monitoring Programs | ○ | M | H | H | ◗ | ○ |
| WD-3: Agency Monitoring Programs | ○ | M | H | H | ● | ◗ |
| WD-4: Interpretive Enforcement | ○ | M | M | H | ● | ◗ |
| WD-5: Wildlife Viewing Guidelines | ◗ | H | H | H | ● | ◗ |
| WD-6: Outreach and Media | ◗ | H | H | H | ◗ | ◗ |
| Introduced Species | | | | | | |
| IS-1: Introduced Species Database | ○ | H | H | H | ● | ● |
| IS-2: Estuarine Detection and Monitoring | ○ | M | M | H | ◗ | ◗ |
| IS-3: Intertidal Detection and Monitoring | ○ | M | M | H | ◗ | ○ |
| IS-4: Pelagic Detection and Monitoring | ● | H | H | H | ● | ● |
| IS-5: Early Detection Outreach Program | ○ | L | M | M | ◗ | ◗ |
| IS-6: Technical Advisory Council | ○ | L | M | M | ● | ◗ |
| IS-7: Rapid Response Plan | ○ | M | M | M | ● | ◗ |
| IS-8: Regulatory Actions | ○ | H | H | H | ○ | ○ |
| IS-9: Outreach to Prevent Introductions | ○ | M | M | H | ◗ | ◗ |
| Ecosystem Protection: Impacts from Fishing Activities | | | | | | |
| FA-1: Resource Characterization | ◗ | M | H | H | ◗ | ◗ |
| FA-2: Socioeconomic Profile of Fishing Activities | ○ | H | H | H | ● | ◗ |
| FA-3: Develop Compatibility Index | ○ | M | H | H | ◗ | ○ |
| FA-4: Address Impacts from Fishing Activities | ○ | M | H | H | ◗ | ◗ |
| FA-5: Develop Maritime Heritage Model | ○ | M | H | H | ● | ○ |
| FA-6: Sanctuary Representation At Fisheries Management Meetings | ○ | H | H | H | ● | ○ |
| FA-7: Krill Harvesting Ban | ○ | H | H | H | ● | ◗ |
| EP-1: Evaluate Marine Zoning | ○ | M | H | H | ● | ○ |
| EP-2: Living Resource and Habitat Protection Working Group | ○ | H | H | H | ● | ○ |

| | | Funding Scenarios and Implementation of Action Plan Strategies | A<br>Activity Status: | B<br>Implementation Level Funding: Scenario 1 | C<br>10% per year Increase: Scenario 2 | D<br>20% per year Increase: Scenario 3 | E<br>Partnership Coordination | F<br>Primary Funding Sources |
|---|---|---|---|---|---|---|---|---|
| | | EP-3: Estero Marine Reserves | ❍ | M | H | H | ● | ❍ |
| | | Impacts from Vessel Spills | | | | | | |
| | | VS-1: Expand Drift Analysis Model | ◗ | M | M | M | ● | ● |
| | | VS-2: Refine Spill and Drift Model | ◗ | M | M | H | ● | ◗ |
| | | VS-3: Profile Vessel Activity | ❍ | M | H | H | ◗ | ❍ |
| | | VS-4: Evaluate Vessel Routing Changes | ◗ | M | H | H | ◗ | ● |
| | | VS-5: Refine Resources At Risk Model | ◗ | H | H | H | ● | ◗ |
| | | VS-6: Participate in Regional Response Team | ◗ | H | H | H | ● | ◗ |
| | | VS-7: Revise Internal Emergency Response Plan | ◗ | H | H | H | ❍ | ❍ |
| | | VS-8: Integrate Beach Watch Data Into Area's Contingency Plan | ◗ | M | H | H | ◗ | ◗ |
| | | VS-9: Mariner Outreach | ❍ | M | H | H | ◗ | ◗ |
| | | VS-10: Maritime Trade Advisory Council Seat | ❍ | M | M | M | ◗ | ❍ |
| | | VS-11: Sanctuary Representation At Vessel Traffic Forums | ❍ | H | H | H | ◗ | ◗ |
| | | VS-12: Vessel Spills Working Group | ❍ | H | H | H | ● | ❍ |

## Legend

| Column A | Column B, C, D | Column E | Column F |
|---|---|---|---|
| **Strategy Status:**<br><br>● – Existing w/o significant modification<br>◗ – Existing w/ significant modification<br>❍ – New (since '05) or future (not yet implemented) | **Implementation* (w/ NMSP Funding):**<br><br>**H** - High<br>**M** - Medium<br>**L** - Low<br>* Implementation ranking considers the priority of each strategy as well as the percentage of activities that could be initiated, maintained, and/or completed under differing funding scenarios. | **Necessary Partnership Coordination:**<br><br>● - Not possible w/o partners<br>◗ - Significant reliance on partners<br>❍ - Little reliance on partners | **Primary Funding Sources (e.g., grants, Foundation):**<br><br>● - External (e.g., grants)<br>◗ - Internal/ External<br>❍ - Internal |