UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
National Marine Sanctuaries Program
Monterey Bay National Marine Sanctuary

Monterey Bay National Marine Sanctuary
Final Kelp Management Report

Background, Environmental Setting and Recommendations

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"There is one marine production, which from its importance is worthy of a particular history. It is the kelp, *Macrocystis pyrifera*. This plant grows on every rock, from low-water mark to a great depth, both on the outer coast and within the channels. … The number of living creatures of all Orders, whose existence intimately depends on the kelp, is wonderful. A great volume might be written, describing the inhabitants of one of these beds of sea-weed. … I can only compare these great aquatic forests of the southern hemisphere, with the terrestrial ones in the inter-tropical regions."

- Charles Darwin (1845)

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EXECUTIVE SUMMARY

The appropriate level of kelp harvest is an ongoing issue of great interest within the Monterey Bay National Marine Sanctuary (MBNMS or Sanctuary). In 1999, the MBNMS Advisory Council identified kelp uses and management as one of its top priority topics to address. Environmental concerns, as well as multiple-use conflicts, have made this an issue of considerable public debate.

The National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), Monterey Bay National Marine Sanctuary, has authority under the National Marine Sanctuaries Act to promulgate regulations governing kelp harvesting within the MBNMS. However, NOAA recognizes the historical authority of the State of California to manage kelp resources, and prefers, at this time, to work through that authority rather than issue its own regulations. This MBNMS Kelp Management Report is the result of a year-long public process aimed at creating recommendations for the State of California regarding kelp harvesting in the Sanctuary. California plans to complete its own five-year State Kelp Management regulatory review process in the late fall of 2000.

The MBNMS has developed this document to formalize the MBNMS process for developing Sanctuary views on kelp resource issues. On January 14, 2000, the MBNMS released its first draft of the "MBNMS Kelp Management Report: Background and Environmental Setting." Written public comments on the first release of the document were sought until February 23, 2000. Additionally, the document was scheduled for discussion at a series of public meetings. On June 2, 2000, the MBNMS release a second draft of the report, the "MBNMS Kelp Management Report: Background, Environmental Setting and Draft Recommendations." Further public meetings and a public comment period followed until August 7, 2000. The final "MBNMS Kelp Management Report" is the third release of the report. It includes a final set of recommendations to the State of California from the MBNMS.

The MBNMS Kelp Management Report outlines the general environmental setting of the MBNMS, including its general meteorological, oceanographic, geological, nutrient and kelp forest characteristics. Sections of the already-completed MBNMS Site Characterization were used to provide this information. The MBNMS Kelp Management Report discusses what is known about kelp harvesting in the MBNMS, as well as the known environmental impacts from the activity. This review concludes:

- When kelp harvesting is done on a limited scale, there is generally little detectable effect on the MBNMS kelp forest resources within the Sanctuary, and
- Few long term studies exist that can determine the point at which intensive repetitious harvesting, especially in a confined space, will begin to cause significant ecological impacts.

Other interests in, and uses of, kelp resources exist, such as those important to the local tourism industry. While many of the recreational uses of kelp have never been studied extensively, or at all, to determine their environmental effects on kelp forests, other indirect anthropogenic effects have been clearly documented, such as sewage spills and coastal nearshore developments.

Use conflicts between harvesters and recreational users/interests have occurred over the past few years. One area, along Cannery Row in Monterey, has been the venue of most of these conflicts. Socio-economic studies that could help frame public discussion of this issue are lacking.

The MBNMS has been involved in kelp harvesting issues, especially those of kelp resource use conflicts since early 1996. The MBNMS is now working with the State of California to help resolve these conflicts, and address public concerns through the California kelp management process. After completing the described public process above, the MBNMS has concluded that the present management regime for kelp harvesting in the MBNMS is inadequate, and needs to be altered in several ways.

The MBNMS Kelp Management Report provides 11 recommendations to California for the management of kelp in the MBNMS. The MBNMS recommends that:

***Recommendation #1**: The MBNMS recommends that the State's kelp management process fully document and analyze the State's costs in managing kelp harvesting, including research, monitoring and enforcement, and evaluate the extent to which the revenues generated from various fees collected from the kelp harvesting industry (e.g., license fees, violation fines, business and personal taxes, tonnage fees) cover these costs.*

***Recommendation #2:** The MBNMS recommends the designation of a single no-kelp-harvest area from the City of Monterey's Coast Guard Breakwater to the north wall at the current location of the Charthouse Restaurant extending from the mean high-tide mark to a depth of 100 feet. This no-harvest area must be monitored for its effectiveness in reducing multiple-use conflicts and increasing kelp canopy to allow for proper re-evaluation in five years.*

***Recommendation #3:** The MBNMS recommends that there be no mechanical harvesting within DFG Kelp Beds #220 and #221.*

***Recommendation #4:** The MBNMS recommends the implementation of a system of limited entry for kelp harvesting in DFG Kelp Bed #220.*

***Recommendation #5:** The MBNMS recommends that no hand-harvesting (including possession) of Nereocystis be allowed in the MBNMS between April 1 and August 31 (inclusive) of each year.*

***Recommendation #6:** The MBNMS recommends that the State restrict annual harvest of any kelp bed available for harvest in the MBNMS to 50% of that bed's total maximum canopy cover.*

***Recommendation #7:** The MBNMS recommends that the State implement a more systematic method to collect, analyze and publish useful data on kelp harvesting. The MBNMS further recommends that the State resist any efforts to limit public access to kelp harvesting data.*

***Recommendation #8:** The MBNMS recommends that DFG Beds #224, 225, 226 and 301 be closed to harvesting.*

***Recommendation #9:** The MBNMS recommends that the State ensure its kelp management process evaluates the adequacy of current monitoring and enforcement of kelp harvesting activities, and strengthens them where necessary.*

***Recommendation #10:** The MBNMS recommends that the State implement an education program on kelp forest ecology and sustainable kelp harvesting for a variety of audiences, including kelp harvesters and the general public.*

***Recommendation #11:** The MBNMS recommends that the definition of "take" in the California Code of Regulations (Title 14, CCR, Chapt 1., Section 1.80) be amended to include plants.*

This report is concluded with two additional sections. The first lays out 14 areas for future research on kelp forest use and management, as well as general anthropogenic effects. The second section discusses what management resources are presently put towards kelp management by the State, and what the MBNMS believes would be adequate to properly manage the resource.

Numerous public comments were made to the MBNMS and incorporated, as appropriate, into the MBNMS Kelp Management Report. The MBNMS has responded to these comments in a "Comment and Response" document that can be requested separately from the MBNMS as a set of appendices.

1.0 Introduction

1.1 Purpose of this Kelp Report

In the winter of 2000-2001, the California Department of Fish and Game (DFG) intends, after reviewing its existing (1995) California kelp management regime and environmental documents, to prepare a new California kelp management regime for the California Fish and Game Commission (FGC) to review and act upon. The final management regime approved by the FGC will govern the harvest of kelp in California for the next five years. The DFG has already begun collecting data, holding public meetings, and reviewing the current California kelp management regime to make appropriate revisions for the FGC to review. The Monterey Bay National Marine Sanctuary (MBNMS or Sanctuary) produced this "MBNMS Kelp Management Report" to summarize information and develop recommendations focusing on kelp issues in the MBNMS. The main purpose of this report is to make recommendations to the DFG and FGC for incorporation into the California kelp management regime for the State waters area of the MBNMS. Extensive public input on these recommendations has been considered.

The appropriate level of kelp harvest is an ongoing issue of interest within the MBNMS. The MBNMS Advisory Council identified kelp use and management as one of its top priorities to address (Douros Memo, 1999). Kelp harvesting concerns in the MBNMS have been further raised recently due to plans for new abalone farms within the region. The MBNMS and its Advisory Council acknowledge that there are many legitimate uses of kelp, including, harvest for commercial purposes, kayaking, SCUBA diving, research and tourism; moreover, there is the inherent role of kelp as food and habitat for marine organisms. Therefore, another purpose of the MBNMS Kelp Management Report is to provide information to the MBNMS Advisory Council and the public about the natural history of kelp and the influences kelp harvesting may have on it.

The MBNMS recognizes kelp use to be a multi-faceted issue, with complicated components including resource use conflicts, lack of comprehensive data, adequacy of current regulations, cumulative environmental impacts, existing capital business investments, current livelihoods, and more. The MBNMS developed this report through an open public process that included the MBNMS Advisory Council, its working groups and subcommittees, and other public and private organizations (see "Public Involvement" section below).

While the MBNMS retains authority under its designation document (NOAA, 1992b) to regulate kelp harvesting (see "Regulatory Jurisdictions" section below), it also recognizes the historical authority of the DFG and FGC to manage the resource, and prefers at this time to work through those authorities rather than issue Federal regulations. The "MBNMS Kelp Management Report" is an attempt to formalize the MBNMS's process for developing Sanctuary views on kelp resource issues.

1.2 Timeline

The MBNMS followed the timeline listed below in its development of this Kelp Management Report.

June, 1999 - January, 2000: Research existing regulations, scientific literature, environmental documents, and socio-economic issues. Initial meetings with interested entities (see "Public Involvement" below) to discuss process and issues. Began writing "Draft MBNMS Kelp Management Report: Background and Environmental Setting (First Release)".
January 14 – February 23, 2000: Released Draft MBNMS Kelp Management Report: Background and Environmental Setting. Solicitation of comments.
February 24 – June 1, 2000: Revise Draft MBNMS Kelp Management Report: Background and Environmental Setting, incorporating constituency comments on background sections, and draft recommended kelp management alternatives (DFG begins scoping for its California Management Report).

June 2 – August 7, 2000: Released Draft MBNMS Kelp Management Report: Background, Environmental Setting and Draft Recommendations. Solicitation of comments.
August 8 – October 2, 2000: Writing Final MBNMS Kelp Management Report (including Final Management Recommendations for the MBNMS to deliver to the State of California as part of their management regime review).
October 3, 2000: Release of Final MBNMS Kelp Management Report (and delivery to the DFG).

1.3 Public Involvement

As stated above, the MBNMS developed this Kelp Management Report in as open a public process as possible. The MBNMS has met with representatives of numerous businesses, groups, organizations, public institutions and individuals. Moreover, the MBNMS has held numerous public meetings focusing on this issue over the past year, as well as received written comments during two comment periods. The MBNMS Kelp Management Report was discussed at three meetings of the MBNMS Advisory Council, with extensive comment and advice provided prior to the close of the most recent comment period on August 7, 2000. The MBNMS has considered all comments received (see Appendix 1 and 2).

2.0 Environmental Setting

The Environmental Setting section that follows is adapted from the MBNMS Site Characterization (1996). Some sections have been truncated for the purpose of saving space. The entire MBNMS Site Characterization is recommended reading, and can be reviewed at: http://bonita.mbnms.nos.noaa.gov/sitechar/index.html

2.1 General Meteorological Conditions (prepared for the MBNMS Site Characterization by: *Wendell Nuss, Department of Meteorology CODE MR/NU*)

2.1.1 Regional Pressure and Temperature Effects

The Monterey Bay National Marine Sanctuary is situated on the eastern edge of a North Pacific ocean high pressure system, which determines the predominant meteorological conditions for the region. The North Pacific high pressure system is the region of high sea-level pressure that occurs over the eastern North Pacific Ocean in the climatological mean as shown in Figure 1 (Mass and Bond, 1996). This region of high pressure shifts north during the summer and south during the winter and is largely a result of the large-scale subsidence that occurs over the subtropical regions of the world. This subsidence, in combination with the cool ocean surface temperatures, acts to produce a well-defined atmospheric mixed layer near the surface over the ocean. The mixed layer is capped by a very strong temperature inversion, where the temperature change across the inversion is often 10 to 20°C (Beardsley et al., 1987; Bridger et al., 1993; Brost et al., 1982; Lester, 1985; Leipper, 1994; Neiburger et al., 1961). Although the height and strength of this temperature inversion varies over space and time, it is typically located at a height between 300 and 1000 m above the ocean surface.

Within this atmospheric mixed layer, clouds, fog and temperatures characteristic of the underlying ocean surface are prevalent (Beardsley et al., 1987; Bridger et al., 1993; Elliot and O'Brien, 1977; Leipper, 1994). Consequently, the region is typified by persistent clouds and cool temperatures throughout most of the dry season (Renard, 1996; Simon, 1977). The position of the high pressure offshore in combination with lower pressure in the warm inland areas produces a relatively strong cross-coast pressure gradient, which results in west-northwest to northwesterly winds throughout much of the year (Mass and Bond, 1996; Renard, 1996). Although substantial variations from these typical conditions occur both seasonally and from day to day, the Monterey Bay coastal climate is characterized by considerable day-to-day persistence and seasonal mean temperature variations of about 5°C (Renard, 1995), typical of other maritime climates.

2.1.2 Local Meteorological Conditions

The monthly averaged winds, temperatures, rainfall, and other meteorological conditions attest to the small amplitude in the seasonal cycle and persistent weather conditions of the Monterey Bay region. The mean wind direction is from the west northwest/northwest during the dry-season months (May - October) when the North Pacific high pressure system is located at its more northern location (Halliwell and Allen, 1987). As this high pressure region shifts south during the wet-season months (November - April), the mean wind direction changes to a more westerly direction (Halliwell and Allen, 1987; Dorman et al., 1994; Dorman and Winant, 1995). The predominant west-northwest coastal winds are important in forcing and maintaining the coastal ocean upwelling (Winant et al., 1987).

The wind speed at the Monterey climate station ranges from 3.5 to 4 m/sec (8-9 knot) averages in April-June to 2-3 m/sec (4-6 knot) averages in January (Renard, 1995) due largely to the seasonal changes in the intensity of the North Pacific high pressure system. Mean temperatures range from 16-18°C during the summer/early fall to 10-13°C during the winter/early spring, although considerable day to day variations exist (Renard, 1995; Renard, 1996).

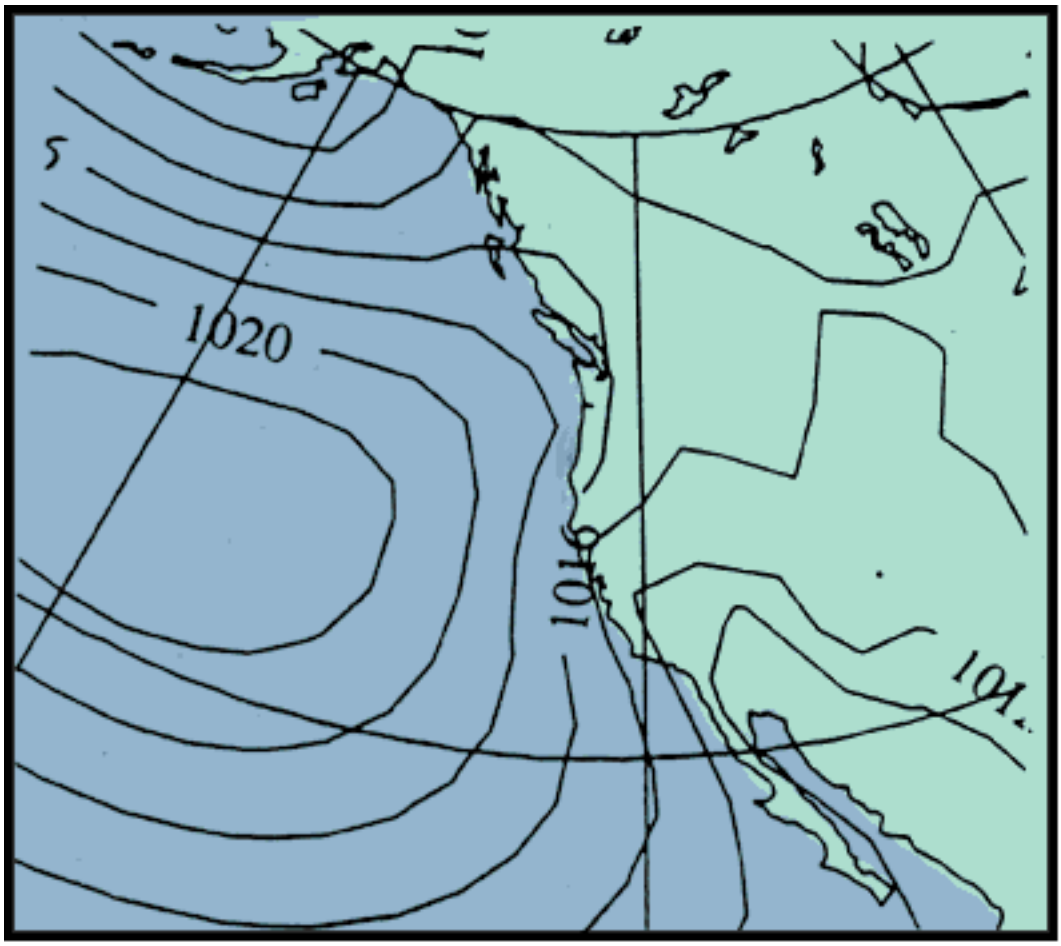

Figure 1. Thirty year mean distribution of sea-level pressure along the U.S. West Coast based on National Meteorological Center analysis. Contours area sea-level pressure every 4 mb (from Mass and bond, 1996).

Rainfall is limited almost entirely to the winter season (November - April) when midlatitude storms are prevalent. The rainfall amounts vary widely over the region due to topographic influences on the rainfall and range from near 48 cm in Monterey to over 150 cm in the Santa Cruz or Santa Lucia mountains (Madruga, 1994). Cloud cover is a maximum during the dry season when the atmospheric mixed layer is well defined (Renard, 1996; Leipper, 1994).

For a more in-depth discussion of MBNMS meteorological conditions, see the MBNMS Site Characterization at: http://bonita.mbnms.nos.noaa.gov/sitechar/clim.html

2.2 Water Masses and Hydrography
(prepared for the MBNMS Site Characterization by: *William W. Broenkow, Moss Landing Marine Laboratories*)

The surface and intermediate depth water masses in the MBNMS are a mixture of Pacific Subarctic water having low salinity and cool temperatures and the warmer, saltier Pacific Equatorial water (Sverdrup et al., 1942). For example, water at 500 m at CalCOFI Station 3 in Monterey Bay (34.25 practical salinity units [psu], 6.3°C) is nearly a 50:50 mixture of those two water types. The proportion of the water types changes as does the strength of the northward flowing California Undercurrent (Wickham, 1975). Nearshore surface temperatures vary from 8°C during winter and early spring to 17°C during fall. Nearshore surface salinities vary from 34.0 psu (practical salinity units) when upwelling is strong to 33.2 psu otherwise. Streams and rivers can have large local effects on salinity, but even during flood conditions the salinity of Monterey Bay surface waters does not fall below 31 psu (Figure 2; Broenkow and Smethie, 1978). Lynn's (1967) analysis of surface waters in the California Current 150 km offshore of Monterey Bay, showed from harmonic analysis that the seasonal variation of temperature and salinity were 12.2°C to 15.5°C and 33.1 to 33.3 psu. Both temperature and salinity maxima are reached typically in September-October, while minimum temperature occurred in February-March and minimum salinity in December-January. At a station 10 km south of Monterey Bay off Point Sur, temperature varied from 11.1°C in May to 13.8°C in November and salinity from 33.4 in January to 33.6 in July-August. Variance about the regression lines was about 1°C and 0.2 psu.

The vertical distributions of salinity, temperature, dissolved oxygen and inorganic nutrients were systematically characterized by the California Cooperative Fisheries Investigations (Bolin and collaborators, 1964). Monthly or biweekly hydrographic stations were occupied at Hopkins Marine Station CalCOFI Station H3 about halfway between Point Pinos and Point Santa Cruz where the canyon depth is about 900 m. A profile typical of the offshore region of MBNMS (Figure 3) shows that salinity increases monotonically from about 33.5 psu at the surface to deep North Pacific values of 34.68 psu at depths greater than 2000 m. The near-surface halocline is accompanied by a similar thermocline. It is noted that in spring and summer, the mixed layer is often absent. Conditions similar to those offshore are found at the H3 entrance to Monterey Bay so that mid-Bay waters are only slightly altered by localized warming and nutrient assimilation (Skogsberg and Phelps, 1946; Bolin and Abbott, 1963; Broenkow and Smethie, 1978). The oxygen minimum which is prevalent throughout the North Pacific is found near 600 m where oxygen concentrations are less than 0.5 ml/liter or 20 mmoles/kg and saturation levels are less than 10%.

For a more in-depth discussion of MBNMS physical oceanographic conditions, see the MBNMS Site Characterization at: http://bonita.mbnms.nos.noaa.gov/sitechar/phys2.html

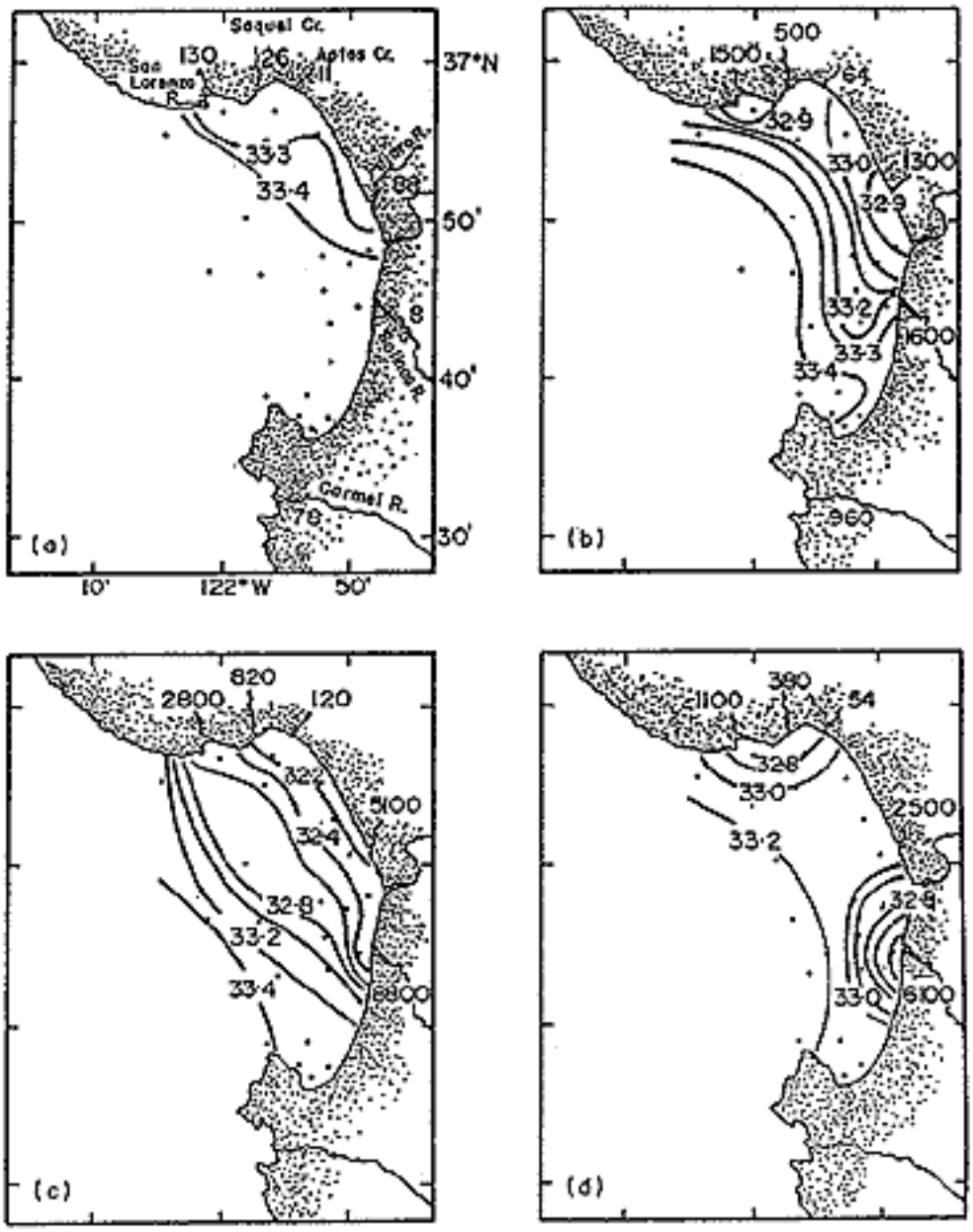

Figure 2. Near-surface salinity distributions a) 14-15 dec. 1972; b) 25-26 Jan. 1973; c) 22-23 Feb. 1973; d) 22-23 Mar. 1973 (Broenkow and Smethie, 1978).

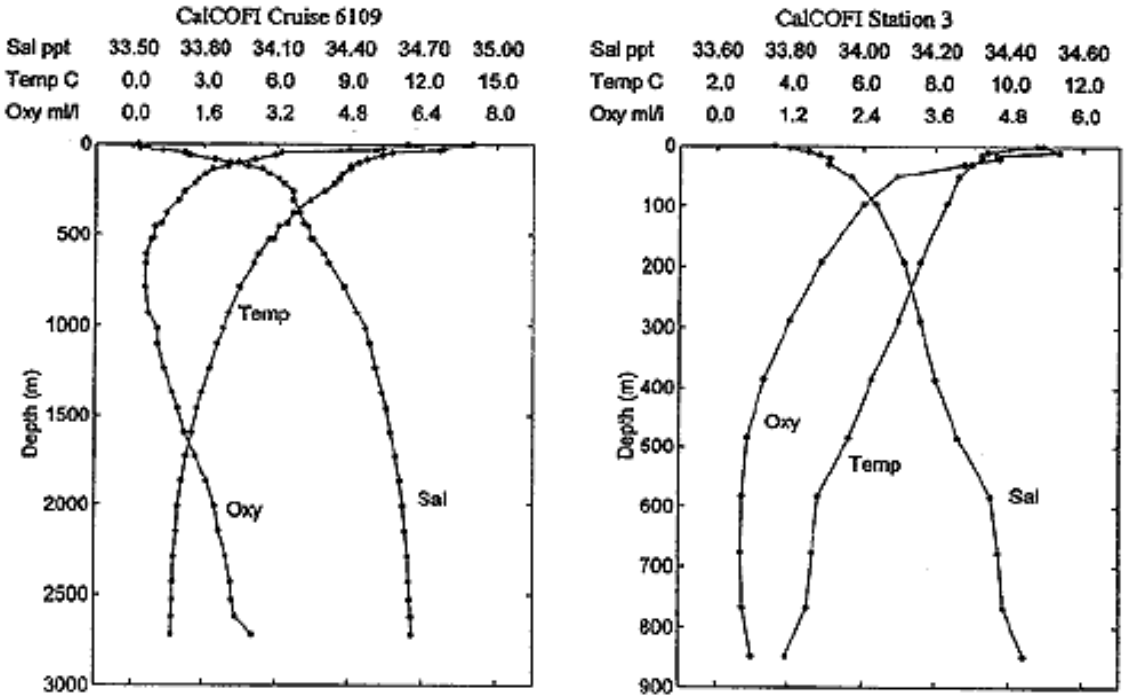

Figure 3. Vertical temperature, salinity and dissolved oxygen profiles: Left - Offshore California Current 35^0 53.5'N 122^0 24.0'W; 16 Oct. 1961; right - Hopkins Marine Station 3 in Monterey Bay 36^0 47.7'N 122^0 01.2'W; 8 May 1970 (from Broenkow and Smethie, 1978).

2.3 Water Column Characteristics and Processes: Nutrients (prepared for the MBNMS Site Characterization by: *Kenneth Coale, Debbie Colbert, Eric Kingsley and Heidi Zamzow, Moss Landing Marine Laboratories*)

Nutrients are subject to dynamic temporal variability (Figure 4; Broenkow and McKain, 1972; Shea and Broenkow, 1982). The main cause of the seasonal differences in nutrients is variation in wind-driven upwelling. When the wind blows south along the coast, an offshore transport of surface waters results. This water is replaced with cold nutrient-rich water from a depth of 25-300 m (Breaker and Broenkow, 1989; and see Physical Oceanography section of the MBNMS Site Characterization). Surface NO_3 is between 0-2 µM during non-upwelling periods, and up to 30 µM during strong upwelling. Processes which affect upwelling therefore affect surface water nutrient concentrations. For example, at a deep water station located in the middle of the Monterey Bay (CALCOFI station 3, 36°46.7'N 122° 01.3'W), Chinburg and Lasley, (1977) found a surface temperature of 14.52°C with a NO_3 concentration of 2.4 µM during a non-upwelling period. During an upwelling period they found a surface temperature of 10.12°C with a NO_3 concentration of 24.1 µM. In shallower water close to shore and over shelves, the effect of upwelling is not as pronounced. In these regions, the upwelled water comes from above the nutricline with a corresponding lower concentration of nutrients. The upwelling periods in Figure 4 (Smethie, 1973) have surface NO_3 concentrations between 1-5 µM due to the shallow bottom depth. During non-upwelling periods, internal tides can have a major effect on nutrient concentrations nearshore (Broenkow and McKain, 1972; Shea and Broenkow, 1982; and see Physical Oceanography section in the MBNMS Site Characterization). Within 10 km of the canyon head, in water depths of 100-400 m, bottom currents are aligned predominantly along the canyon axis of which the strongest component is tidal (Broenkow and McKain, 1972). The fluctuation of the tides has been observed to cause internal tide heights of 50-120 m (Shea and Broenkow, 1982). At high internal tide, nutrient-rich water from the canyon is forced over the sill into shallower parts of the Bay. At one station north of the canyon, Shea and Broenkow (1982) observed a 68% increase in the concentration of PO_4 between the periods of high and low internal tide. In northern Monterey Bay, Shea and Broenkow (1982) estimated that the transport of nutrient-rich water could result in an increased euphotic zone productivity of 0.6 g C/m^2/day. As can be seen in the examples above, nutrient dynamics in the MBNMS are influenced by a number of factors which can strongly and quickly affect nutrient concentrations and distributions, especially in Monterey Bay. These spatial and temporal changes in nutrients have profound effects on the productivity of the region. Unfortunately, these complex patterns cannot readily be resolved using conventional discrete methods of shipboard sampling and analysis. Recently, researchers at Moss Landing Marine Laboratories and the Monterey Bay Aquarium Research Institute have pioneered the development of long term in situ chemical sensors based on the principle of osmotic pumps and colorimetric analysis (Jannasch et al., 1994). These osmotically pumped submersible chemical analyzers, "Osmoscanners," have been deployed in the Monterey Bay for months at a time and reveal high frequency, dynamic trends in the temporal distribution of nitrate at the Oasis mooring site (Jannasch et al., 1994). Future deployments of such analyzers will improve our understanding of nutrient dynamics in the MBNMS.

For a more in-depth discussion of Water Column Characteristics and Processes, see the MBNMS Site Characterization at: http://www.mbnms.nos.noaa.gov/sitechar/chem.html

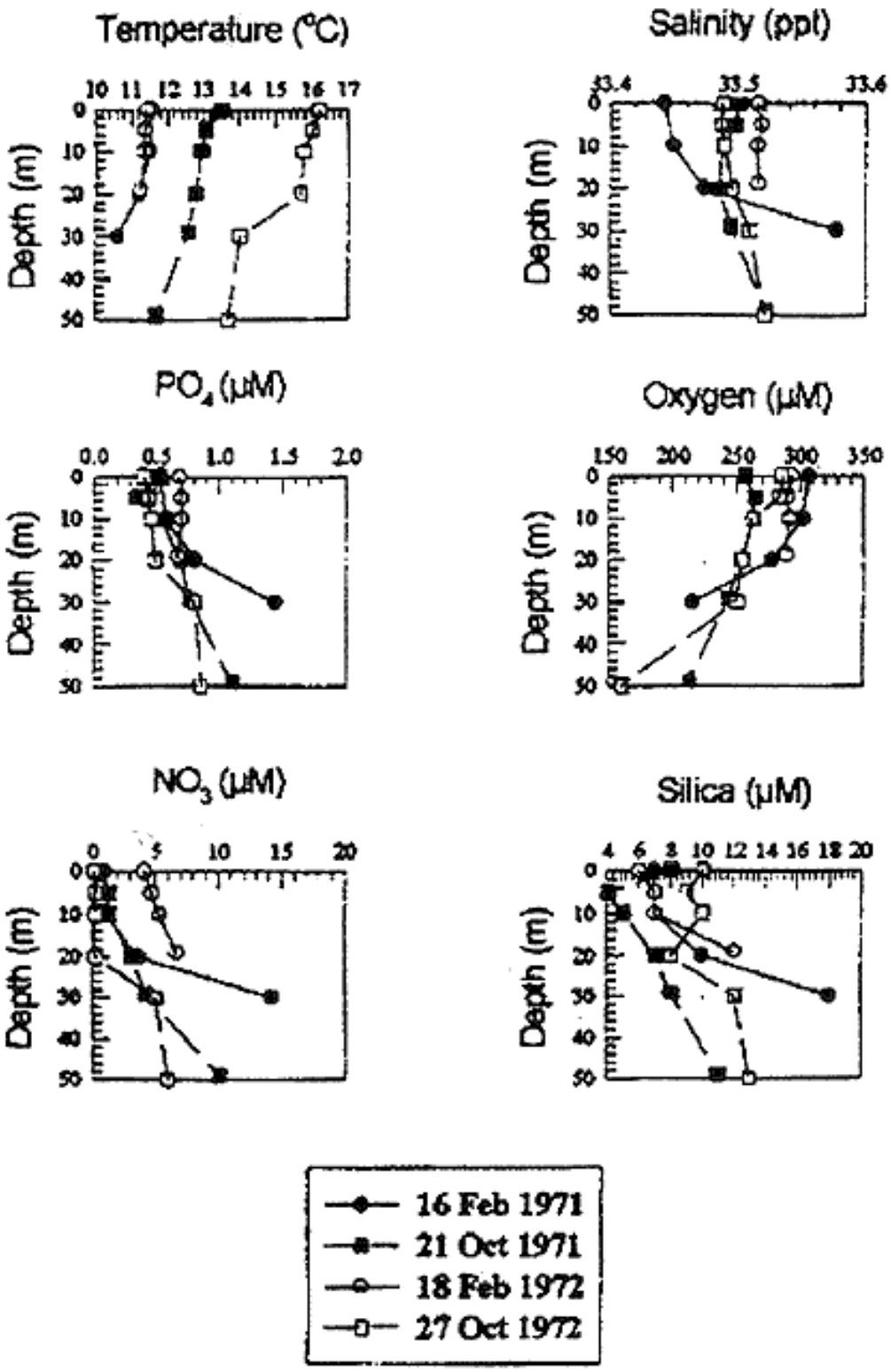

Figure 4. Vertical profiles of temperature, salinity and nutrients from Moss Landing Marine Labs' hydrographic Station 10 (36^0 45.6'N; 121^0 52.0'W) for February and October 1971 and 1972 (Created from data in Broenkow, 1972; Broenkow and Benz, 1973). The February 1971 and February 1972 profiles were reported as upwelling periods (Smethie, 1973).

2.4 Geology

(prepared for the MBNMS Site Characterization by: *H. Gary Greene, Moss Landing Marine Laboratories*)

The MBNMS spans nearly 10,000 km^2 in the central California region, and extends offshore an average distance of approximately 50 km (a maximum distance of nearly 100 km in the Monterey Bay area and a minimum distance of 15 km off Partington Point) between the Farallon Islands in the north and Morro Bay in the south. It contains one of the world's most geologically diverse and complex seafloors and continental margins. The MBNMS is located on a plate boundary which separates the North American Plate from the Pacific Plate, and is marked by the San Andreas fault system. This is an active tectonic region with common occurrences of earthquakes, submarine landslides, turbidity currents, flood discharges and coastal erosion. It is also a region of extensive natural and economic resources.

Coastal topography varies greatly, encompassing steep bluffs with flat-topped terraces and pocket beaches to the north; large sandy beaches bordered by cliff and large dune fields mid-sanctuary; and predominately steep, rocky cliffs to the south. Low- to high-relief mountain ranges and broad, flat-floored valleys are prevalent farther inland.

The Santa Cruz and Gabilan mountain ranges dominate the topography in the northern and central half of the region. Two major rivers (San Lorenzo and Pajaro Rivers) and a major creek (Scott Creek) enter Monterey Bay from these highlands through well defined valleys. Elkhorn Slough, an old river estuary that today is occupied only by tidal salt marshes, extends inland from Moss Landing for more than 10 km. The broad, extensive Salinas Valley and the northern Santa Lucia Range are the dominant topographic features in the southern half of the region; the Salinas River is the major drainage system. South of Monterey, the west flank of the Santa Lucia Range drops abruptly into the ocean. Here, the valleys of the Carmel and Little Sur Rivers are dominant topographic features. From Point Sur to Morro Bay many streams and creeks drain the southern Santa Lucias and cut the steep western face of the mountain range.

The MBNMS seafloor can be divided into three segments (northern, central, and southern) based on physiography and geology. The northern segment is composed of a relatively broad-shelfed, smooth and undissected seafloor, the central segment has a narrower shelf and highly dissected floor, and the southern segment is composed of a very narrow-shelfed, moderately dissected seafloor.

For a more in-depth discussion of MBNMS geological oceanographic conditions, see the MBNMS Site Characterization at: http://bonita.mbnms.nos.noaa.gov/sitechar/geol1.html

2.5 Kelp Forest Distribution and Ecology

(the original text was prepared for the MBNMS Site Characterization by: *Matt Edwards and Mike Foster, Moss Landing Marine Laboratories* - for the purposes of this MBNMS Kelp Report, the authors have allowed the MBNMS staff to edit the text as they see fit)

2.5.1 Dominant Algal Species

The rocky nearshore environment of the Monterey Bay National Marine Sanctuary (MBNMS), like the rest of central California, is characterized by dense forests of kelp growing at depths from 2 m to more than 30 m (Foster and Schiel, 1985). The giant kelp *Macrocystis pyrifera* and the bull kelp *Nereocystis luetkeana* are the dominant canopy-forming kelps in this region, and make up the major forests within the MBNMS. Giant kelp forms dense beds in the Sanctuary from Cambria to Año Nuevo except in the area between Monterey and Santa Cruz where sandy substrate is unsuitable for kelp attachment (NOAA, 1992a). The rocky coastline south of Monterey Bay is characterized by hard granite substrates with only a few sandy beaches which are limited to small coves (McLean, 1962). North of Santa Cruz, the bull kelp, which occurs from Point Conception to Unimak Island in the eastern Aleutians (Abbott and Hollenberg, 1976; Miller and Estes, 1989), becomes the dominant canopy-forming kelp (Foster, 1982a; Foster and Schiel, 1985).

Along the central California coast where the distributions of these two species overlap, giant kelp probably outcompetes bull kelp for light. Giant kelp dominates areas of relatively low water motion, and is dominant in years with relatively calm sea conditions. Bull kelp is more tolerant of high water motion and dominates areas more exposed to waves (McLean, 1962; Foster, 1982a; Harrold et al., 1988). The shallow areas inshore of these kelp forests are often characterized by canopies of the feather boa kelp *Egregia menziesii*, the intertidal giant kelp *Macrocystis integrifolia*, and the Fucalean alga *Cystoseira osmundacea* (Foster and Schiel, 1985).

Foster (1982a) observed that at Greyhound Rock, 24 km North of Santa Cruz, kelp canopies become sparse due to the combined effects of unsuitable substrate and increased water motion. This may help explain the lack of continuous kelp forests extending from Año Nuevo to the northern end of the MBNMS at Rocky Point.

2.5.2 Algal Assemblages Associated with Kelp Forests

Within the MBNMS, there are rich algal assemblages associated with the kelp forests. Subsurface canopies of the stipitate kelps *Pterygophora californica, Laminaria setchellii*, and several other species occur beneath the surface canopies (McLean, 1962; Foster and Schiel, 1985; Harrold et al., 1988). Although they occur throughout the MBNMS, these understory kelps are more characteristic of areas more exposed to wave action (Harrold et al., 1988). Other algae, such as fleshy red species, can form dense algal turfs under the canopies (Table 1; Breda and Foster, 1985; Harrold et al., 1988) and are often distributed along a depth gradient (Harrold et al., 1988) with the more robust species occurring shallower and the more delicate species occurring deeper (McLean, 1962; Devinny and Kirkwood, 1974).

Kelp canopies alone or in combination with one another can reduce the amount of light reaching the substrate to less than 1% of surface irradiance (McLean, 1962; Reed and Foster, 1984). During the winter months along the central California coast, increased water motion from winter storms removes kelp canopies thereby increasing the amount of light reaching the substrate, which in turn can have dramatic effects on the algal assemblages beneath them (Foster, 1982b; Reed and Foster, 1984; Breda and Foster, 1985). One common phenomenon occurring in areas where surface canopies have been removed is the recruitment of the brown alga *Desmarestia ligulata* (Foster, 1982a; Reed and Foster, 1984). This species forms a dense subsurface canopy which can inhibit recruitment of other algal species including giant kelp (Dayton et al., 1992).

Nongeniculate or encrusting coralline algae e.g., *Lithothamnium spp.* and *Lithophyllum spp.* and upright articulated or geniculate coralline algae e.g., *Bossiella spp* and *Calliarthron spp.* occur throughout the kelp forests and are generally more tolerant of increased water motion and thus abundant in sites more exposed to wave action (Harrold et al., 1988). They also are apparently tolerant of low light and can dominate the substrate under multiple kelp canopies. In wave-exposed areas like those at Point Santa Cruz, water motion and sand abrasion associated with storms cause an overall decrease in fleshy red algae in the winter, which then increases in the summer. This leads to an overall increase in species diversity as compared to more protected sites like those at Hopkins Marine Station in Monterey Bay (Breda and Foster, 1985).

2.5.3 Invertebrate/Vertebrate Assemblages Associated with Kelp Forests

The kelp forests of the MBNMS provide habitat for a large variety of invertebrates, fishes, birds and mammals which are distributed among three different regions of the forests; the surface canopies, the midwater and the substrate (Foster and Schiel, 1985; Figure 5).

The holdfasts of giant kelp and mats of geniculate coralline algae provide microhabitats for an abundant and species rich association of invertebrates (Andrews, 1945; Foster and Schiel, 1985; Dearn, 1987). Andrews (1945) found approximately 23,000 individuals from nine invertebrate phyla residing in five giant kelp holdfasts collected from the Monterey and Carmel Bays, the most common of which were polychaetes, amphipods, decapods, gastropods and ophiuroids.

Table 1. Common species in MBNMS kelp forests (adapted from Edwards and Foster, 1996).

Algae

Brown (Phaeophyta)	Red (Rhodophyta)	Green (Chlorophyta)
Costaria costata	*Bossiella californica*	*Cladophora graminea*
Cystoseira osmundacea	*Botryocladia pseudodichotoma* (red sea grape)	*Derbesia marina*
Desmarestia ligulata (acid seaweed)	*Calliarthron* spp.	*Enteromorpha* spp.
Dictyoneuropsis reticulata	*Callophyllis* spp.	
Dictyoneurum californicum	*Corallina* spp.	
Dictyota binghamiae	*Cryptopleura farlowiana*	
Egregia menziesii (feather boa kelp)	*Fauchea laciniata*	
Eisenia arborea (understory kelp)	*Fryeella gardneri*	
Laminaria spp. (oarweed)	*Gastroclonium coulteri*	
Macrocystis pyrifera (giant kelp)	*Gelidium* spp.	
Macrocystis integrafolia (giant kelp)	*Gigartina* spp.	
Nereocystis leutkeana (bull kelp)	*Halymenia* spp.	
Pterygophora californica	*Laurencia* spp.	
	Lithophyllum spp.	
	Lithothamnion spp.	
	Opuntiella californica	
	Pikea californica	
	Plocamium cartilagineum	
	Polysiphonia spp.	
	Prionitis lanceolata	
	Rhodymenia spp.	
	Weeksia reticulata	

Table 1 (continued). Common species in MBNMS kelp forests.

Invertebrates						
Echinoderms	***Molluscs***	***Crustaceans***	***Ascidians***	***Sponges***	***Cnidarians***	***Bryozoans***
Asterina miniata ↵ (bat star)	*Anisidoris nobilis* ↵ (sea lemon)	*Balanus* spp. ↵ (barnacles)	*Aplidium californicum*	*Acarnus erithacus*	*Agalophenia* spp. ↵ (Ostrich-plumed hybrid)	*Diaperoecia californica*
Dermasterias imbricata (leather star)	*Aplysia californica* (sea hare)	*Cancer spp.* (crabs)	*Clavelina huntsmani* (lightbulb tunicate)	*Cliona* spp.	*Anthopleura* spp. (Anemones)	*Hippodiplosia insculpta*
Henrecia leviscula	*Astrea gibberosa*	*Loxorhynchus crispatus* ↵ (decorator crab)	*Styella montereyensis*	*Hymenamphiastra cyanocrypta* ↵ (blue sponge)	*Astrangia lajollensis*	*Membranipora tuberculata*
Mediaster aequalis	*Calliostoma* spp.	*Pagurus hemphillii*	*Styletta clarella*		*Balanophyllia elegans* ↵ (orange cup coral)	*Phidolopora pacifica*
Orthasterias koehleri	*Cypraea spadicea* ↵ (top shell)	*Pugettia richii*	*Tethya aurantia* ↵ (orange puffball)		*Corynactis californica* ↵ (strawberry anemone)	*Stylaster* spp.
Pisaster spp. ↵ (starfishes)	*Cryptochiton stelleri* ↵ (gumboot chiton)	*Scyra acutifrons*			*Metridium senile* ↵ (white-plumed anemone)	*Thalamoporella californiaca*
Pycnopodia helianthoides ↵ (sunflower star)	*Hermessenda crassicornis*				*Paracyathus stearnsi*	
Strongylocentrotus spp. ↵ (urchins)	*Mitra idae*				*Stylaster californica.*	
	Navanax inermus				*Urticina* spp.	
	Octopus spp.					
	Navanax inermus					
	Tegula spp.					
	Tonicella lineata ↵ (lined chiton)					

Table 1 (continued). Common species in MBNMS kelp forests.

Vertebrates

Fish	***Mammals***	***Birds***
Brachyistius frenatus (kelp surfperch)	*Enhydra lutris nereis* (southern sea otter)	*Aechmorphorus occidentalis* (western grebe)
Chromis punctipinnis (blacksmith)	*Phoca vitulina* (harbor seal)	*Ardea herodias* (great blue heron)
Coryphopterus nicholsii (blackeye goby)	*Eschrichtius robustus* (gray whale)	*Arenaria* spp. (turnstone)
Embiotoca spp. (surfperches)	*Zalophus californianus* (California sea lion)	*Calidris alba* (sanderling)
Girella nigricans (opal eye)		*Catoptrophorus semipalmatus* (willet)
Heterostichus rostratus (giant kelp fish)		*Cepphus columba* (pigeon guillemot)
Hexogrammus decagrammus (kelp greenling)		*Corvus brachyrhynchus* (common crow)
Paralabrax clathratus (kelp bass)		*Dendrioca coronata* yellow (rumped warbler)
Myliobatis californica (bat ray)		*Gavia immer* (common loon)
Ophiodon elongatus (lingcod)		*Heteroscelus incanus* (wandering tattler)
Orthanopias triacis (snubnose scalpin)		*Larus* spp. (gulls)
Oxyjulis californica (senorita)		*Leucophoyx thula*
Aulorhynchus flavidus (tube snout)		*Lobipes lobatus*
Scorpaenichthys marmoratus (cabezon)		*Melanitta perspicullata* (surf scoter)
Sebastes spp. (rockfishes)		*Pelicanus occidentalis* (brown pelican)
Semicossyphus pulcher (California sheephead)		*Phalacrocorax* spp. (cormorants)
Medialuna californiensis (halfmoon)		*Phalaropus fulicarius* (red phalarope)
Gibbonsia spp. (kelp fishes)		*Podiceps* spp. (grebes)
		Sayornis nigricans (black phoebe)
		Sturnus vulgaris (starling)
		Thalasseus elegans
		Uria aalge (common murre)

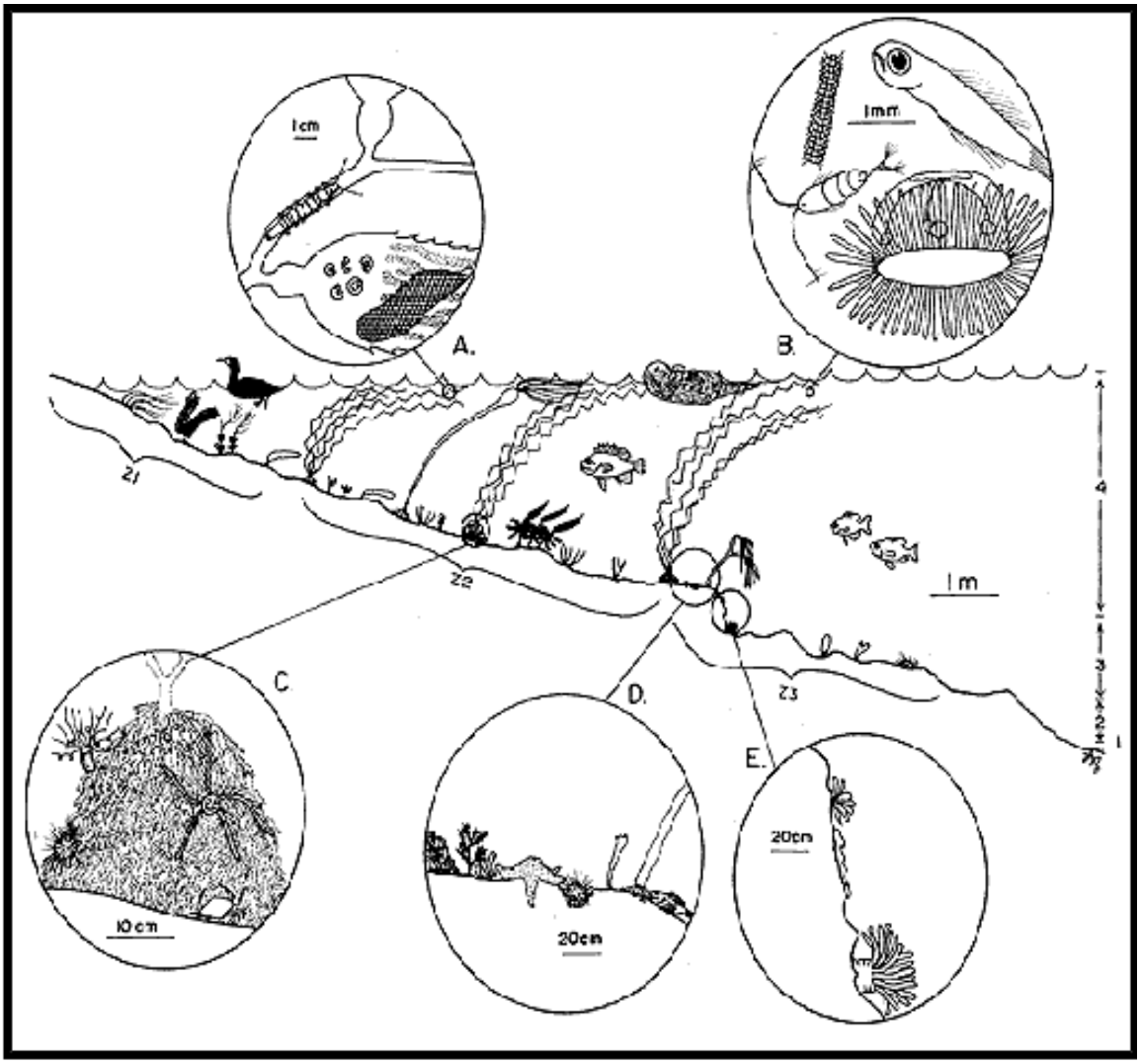

Figure 5. Cross Section of typical Central California kelp forest showing distribution of common species and microhabitats associated with the forest.

A. Canopy assemblages (isopods, tubeworms, and bryozoans).
B. Planktonic assemblages (jellyfish, fish larvae, diatoms, and crustaceans).
C. Holdfast assemblages (sea urchins, crustaceans, brittle stars, and anemones).
D. Horizontal substrate assemblages (urchins, sea stars, algae, tunicates, and bottom fish).
E. Vertical wall assemblages (coralline algae, anemones, cup corals, sponges, and byrozoans).

(Revised from Foster et al., 1983)

Outside the holdfasts, sponges, tunicates, anemones, cup corals and bryozoans are probably the most commonly occurring sessile animals within kelp forests (Foster and Schiel, 1985; Table 1). McLean (1962) observed 204 species of invertebrates living in a bull kelp forest along a wave-exposed coast south of Carmel during 30 SCUBA dives. In addition to these bottom dwelling species, a large number of invertebrates, such as the isopod *Idotea resecata* and the bryozoan *Membranipora tuberculata* occur within the canopies, while diverse assemblage of planktonic species such as jellyfish, crustaceans and fish larvae and juveniles live in the water column of the kelp forests (Figure 5).

A wide variety of motile grazers, the majority of which do not remove entire kelp plants but graze upon their tissue and other associated algae (Foster and Schiel, 1985), also occur in the forests. Some species, such as sea urchins (*Strongylocentrotus franciscanus* and *S. purpuratus*), may completely remove entire kelp plants by grazing through their holdfasts (Pearse and Hines, 1979; Foster and Schiel, 1985; Kenner, 1992). Where urchin predators are present, sea urchins may remain stationary in cryptic habitats and feed on detritus and macroalgal drift (Ebeling et al., 1985; Foster and Schiel, 1985; Watanabe and Harrold, 1991). When drift algae disappears, sea urchins are known to emerge in large numbers, form feeding fronts, and denude large areas of algae, dramatically changing the environment (Ebling et al., 1985). Other species, like the gastropods *Tegula spp*., graze along the entire thallus of the kelp plants from the substrate to the surface (Watanabe, 1984). In addition to herbivores, several species of predatory sea stars, snails and crabs inhabit the kelp forests, but comparatively little is known about the dynamics of these organisms (Foster and Schiel, 1985).

Although they are not limited to kelp forests, a variety of fish occur within them, including many of economic importance. The commercial fisheries associated with kelp forest fishes are reviewed in Leet, Dewees and Haugen (1992). In addition to the commercial fisheries, a large sport fishery is associated with kelp forests, particularly with rockfish, *Sebastes spp*. (Karpov et al., 1995).

The heterogeneous environment of the forest provides an important source of food and shelter for many fish species (Foster and Schiel, 1985; Bodkin, 1988; Table 1). These can be categorized according to where they reside in the forest (Foster and Schiel, 1985). Midwater species of the kelp canopy, such as the señorita (*Oxyjulius californica*) and the surfperch (*Brachyistius frenatus*) browse on the small crustaceans associated with both the kelp fronds and canopies. Other midwater predatory fishes including the common plankton-feeding blue rockfish (*S. mystinus*), the blacksmith (*Chromus punctipinnus*) and juveniles of the predatory kelp rockfish (*S. atrovirens*), olive *rockfish (S. serranoides*) and black rockfish (*S. melanops*). Compared to southern California kelp forests, MBNMS kelp forests have relatively few tropically-derived fish species and even fewer families, but generally host more species per family (see Foster and Schiel (1985) for a review of kelp forest fishes).

Along the central California coast, fish diversity and abundance decrease in areas where the kelp canopies have been removed (Bodkin, 1988). In addition, mass mortality of kelp forest fishes, particularly *Sebastes spp*. have been observed as a result of large waves at the southern end of the MBNMS at San Simeon (Bodkin et al., 1987). Variations in fish abundance may have significant impacts on other communities. For example, juvenile rockfishes associated with kelp forests in Monterey Bay can reduce the amount of barnacle larvae reaching the intertidal to 2% of the level found in the absence of fish (Gaines and Roughgarden, 1988).

Harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*) are common in and around MBNMS kelp forests. Harbor seals feed on shallow-dwelling kelp forest fishes, while California sea lions, which feed mainly on pelagic fishes, probably limit their use of the forests to transitory feeding (Foster and Schiel, 1985). Gray whales (*Eschrichtius robustus*) have been observed entering kelp forests to escape predation from killer whales (*Orcinus orca*, Baldridge, 1972) and also to feed on invertebrates such as midwater crustacean swarms (Nerini, 1984).

The population of sea otters found in California and the MBNMS (usually designated by a subspecific designation, *Enhydra lutris nereis*) are one of the most recognizable marine mammals associated with the kelp forests there, though are not obligate residents of kelp forests. The current

California sea otter population occupies a linear coastal range of about 280 km in central California. Most of the population occurs within the boundaries of the MBNMS. Sea otters feed on invertebrates, many of which are associated with kelp forests (Foster and Schiel, 1985 and 1988; Estes et al., 1986), and must consume 25% of their body weight per day to meet their energy needs (Costa, 1978). Otters also use kelp forests as a refuge from predation by white sharks and winter storms, and as nursery areas for females with pups (Foster and Schiel, 1985).

Sea otters can have significant impacts on sea urchin populations, which in turn may affect the kelp forests themselves (Foster and Schiel, 1988). In this respect, otters have been called a "keystone species," since they occur high in the food web and by controlling their prey species (sea urchins), they greatly alter the community as a whole (Estes and Palmisano, 1974; Estes and Duggins, 1995). As background, keystone species (Paine, 1969) are those defined as having cascading effects disproportionate to their abundance (Power, et al., 1996). While the generality of the "keystone species" role of sea otters is debatable (Foster et al., 1988; Foster 1990**;** Riedman and Estes, 1990), the effect of sea otters on a kelp forest is most probably significant.

A wide variety of birds use MBNMS kelp forests although their relationship with the forests is poorly known (Table 1). Foster and Schiel (1985) report that kelp provides three distinct habitats used by birds: the kelp forest made up of living attached plants associated with rocky substrata, drift kelp floating in the open sea, and the kelp wrack, i.e. detached kelp deposited on the beach by water motion. Kelp forests provide a large potential source of invertebrate and fish prey as well as a refuge from storms. Birds commonly observed in this habitat are gulls, terns, snowy egrets, great blue herons and cormorants (Foster and Schiel, 1985). Birds associated with drift kelp, like phalaropes, feed on the associated plankton and larvae. The kelp wrack provides an important food source and habitat for kelp flies, maggots and small crustaceans on which several species of shore birds, starlings, common crows, black phoebes and warblers feed (Davis and Baldridge, 1980).

2.5.4 Seasonal Patterns and Kelp Life Histories

The seasonal patterns in the kelp forests of central California are very different from those observed in southern California. In central California, giant kelp and bull kelp exhibit their greatest recruitment in the spring and maximum canopies in early fall (Foster, 1982a) while kelp canopies in southern California reach their maximum in the winter. Recruitment of giant kelp sporophytes in southern California is greatest during periods of low temperatures and high nutrients, called "recruitment windows" (Deysher and Dean, 1986). These conditions are nearly continuous in central California but are particularly evident during spring upwelling (McLean, 1962; Breaker and Broenkow, 1994) when light is also high because of canopy thinning by winter storms. These new kelp sporophytes grow from the substrate to the surface where they are supported by gas-filled bladders called pneumatocysts, and may form very dense surface canopies. While bull kelp has been observed to produce spores as early as February in northern California, spore production usually begins as early as June and lasts until the fall (DFG, November 1995). Bull kelp recruitment continues as late as August (DFG, November 1995).

Individual giant kelp plants can live up to seven years (Rosenthal et al., 1974), though plants in central California may be shorter lived because they are removed during periods of high water motion associated with winter storms (McLean, 1962; Foster, 1982a; Reed and Foster, 1984; Harrold et al., 1988). Additionally, individual fronds only exist for about six months before they are sloughed off to be replaced by new fronds arising from the holdfast. During these winter storm periods, giant kelp survivorship is positively correlated with the hardness of the substrate to which the plants are attached (Foster and Schiel, 1985). Another major source of kelp mortality along central California has been grazing by sea urchins (*Strongylocentrotus spp*.) (Pearse and Hines 1979, Watanabe and Harrold, 1991). The effect of urchins however, has decreased due to predation by the sea otter *Enhydra lutris* (McLean, 1962; Kenner, 1992; Watanabe and Harrold, 1991).

Although much is known about growth and survivorship of adult kelp sporophytes, relatively little is known about the ecology of their microscopic stages. These stages are probably

highly vulnerable to grazing (Leonard, 1994) and sedimentation (Devinny and Volse, 1978; Deysher and Dean, 1986) such as that from sewage discharges, which may thus be important in determining the distribution of kelp forests within the Sanctuary (see also Meistrell and Montagne 1992). Studies on microscopic stages of giant kelp suggest they are also sensitive to the toxins associated with municipal and industrial waste discharges. For example, growth and fertility are reduced when gametophytes are exposed to elevated copper concentrations in discharge effluent (Anderson et al., 1990; see also Foster et al., 1983 for a review).

2.5.5 Marine Ecological Changes Near the Monterey Peninsula (prepared entirely by MBNMS Staff)

Ecologically, the area of the Monterey Peninsula has undergone numerous changes since recorded history. The sea otter, which once populated the area, was eliminated from the habitat by man before the beginning of the twentieth century. Sea otters did not return to the Monterey Peninsula until the late 1950's (Riedman and Estes, 1990). Assuming sea otters do have a significant effect on the nearshore environment (Estes and Palmisano, 1974; Estes and Duggins, 1995), it is nearly impossible to predict what the Monterey Peninsula's nearshore "pristine" condition was like.

Historically, large nearshore abalone and kelp harvesting industries have been supported off the Monterey Peninsula (Scofield, 1959; Cox, 1962; Donnellan and Foster, 1999). The nearshore area along Cannery Row was once predominantly a *Nereocystis* community until the 1960's (Donnellan and Foster, 1999). Another previous note (Andrews, 1945) describes the area as a mix of *Nereocystis* and *Macrocystis*. Also, the intertidal "torching" of the Peninsula's intertidal areas (Bonnot, 1931: See Below) for the red algae industry may have had significant effects, at least in the short term, on the intertidal ecosystem.

Nearshore development is assumed to pose the threat of significant impacts to the nearshore environment (Foster and Shiel, 1985; also, See Below Under Section 4.2.2). As one of the most heavily populated and developed areas of the California Central Coast, onshore activities (e.g., runoff, sewage, development) most certainly have an impact on the nearshore kelp forests.

For a more in-depth discussion of the ecology of kelp forests, see "The Ecology of Giant Kelp Forests in California: A Community Profile" (Foster and Schiel, 1985), or the DFG kelp environmental document for the State of California (DFG, November 1995).

3.0 Issues: Environmental Impacts of Kelp Use and Use Conflicts

Current human interests in kelp within the MBNMS are as a harvestable resource, a recreational destination, and ecological habitat. Kelp is harvested for various purposes in the MBNMS, such as for abalone feed. Other interests in kelp use are more complicated, but include: fishing (both recreational and commercial), recreation (e.g., SCUBA diving, boating and wildlife viewing), education, and scientific investigation.

3.1 Kelp as a Harvestable Product

3.1.1 History and Existing Status of Kelp Harvesting

While little is known of pre-historic native inhabitants' lifestyles along the MBNMS, it is known that seafood contributed to their diets (Minerals Management Service, 1990). Therefore, as there are a number of local algal varieties that are edible, it is not beyond reason that some local marine algal species were consumed by them (Dawson and Foster, 1982).

The first documented historical harvest of marine algae in the MBNMS was by Chinese immigrants. As early as the 1850's, Chinese immigrants were harvesting marine algae in the MBNMS, drying it, and exporting it to China through San Francisco (Terrell, 1995). In fact, the first "mariculture" (i.e., marine aquaculture) in the area was done as early as the 19th century by Chinese immigrants who burned intertidal patches around the Monterey Peninsula to facilitate red algal recruitment, which was then harvested for food. The patches were essentially maintained like plots on a farm. In 1929, the red algae harvest totaled 135 tons dry weight (Bonnot, 1931).

The first use of kelp in California on a large commercial basis was for the purpose of producing potash (potassium carbonate) during the First World War (Figure 6). At the time, potash was a necessary ingredient in the production of gunpowder. The potash was derived from the kelp ashes after it had been burned. At that time, kelp was harvested by encircling a stand of kelp with a cable and then pulling on the cable (Foster and Scheil, 1985). This generally had the effect of ripping out the entire kelp plant, including the holdfast. By comparison, today's harvest methods are limited to crop the fronds, which are shortlived compared to the holdfast (see section 2.5.4 Seasonal Patterns and Kelp Life Histories).

By the mid-1980's, the kelp industry was worth about $40 million statewide (Tarpley, 1992). Kelp that is harvested in California today is primarily used in chemical industrial applications. Algin, which is a product that is derived from kelp, is used as an emulsifier in processed foods (Frey, 1971) and other products where a smooth texture is required (e.g., paints, cosmetics, pharmaceuticals). Other uses of kelp are as food for cultured abalone, and as substrate for the herring-roe-on-kelp fishery (exported for Sushi).

South of the Monterey Peninsula (Figure 7 and Table 2), most kelp is harvested by large vessels, between 140 and 180 feet long and capable of cutting as much as 600 tons of *Macrocystis* in a day for the chemical industrial applications mentioned above (DFG, November, 1995). These large vessels cut the kelp canopy about four feet below the surface with the use of subsurface cutting devices on their stern (similar to how a hedge trimmer cuts). This is done as the ship backs down through a kelp bed (Foster and Schiel, 1985).

ISP Alginates Incorporated (formerly known as Kelco) is almost exclusively the harvester of kelp south of the Monterey Peninsula. There are two abalone mariculture facilities, and several herring-roe-on-kelp fishermen that occasionally harvest kelp around the Cambria area, and very occasionally further north. ISP Alginates has been harvesting kelp off the coast of California for over 70 years. ISP Alginates harvests kelp to extract algin. ISP Alginates employs approximately 170 people in California, has $40 million in annual sales from California productions of $40 million, and a $20 million annual California payroll (Dale Glantz, pers. comm.).

While ISP Alginates major operations are in Southern California, it occasionally will cut kelp in the MBNMS in the late summer and early fall along the Big Sur coastline. In recent years,

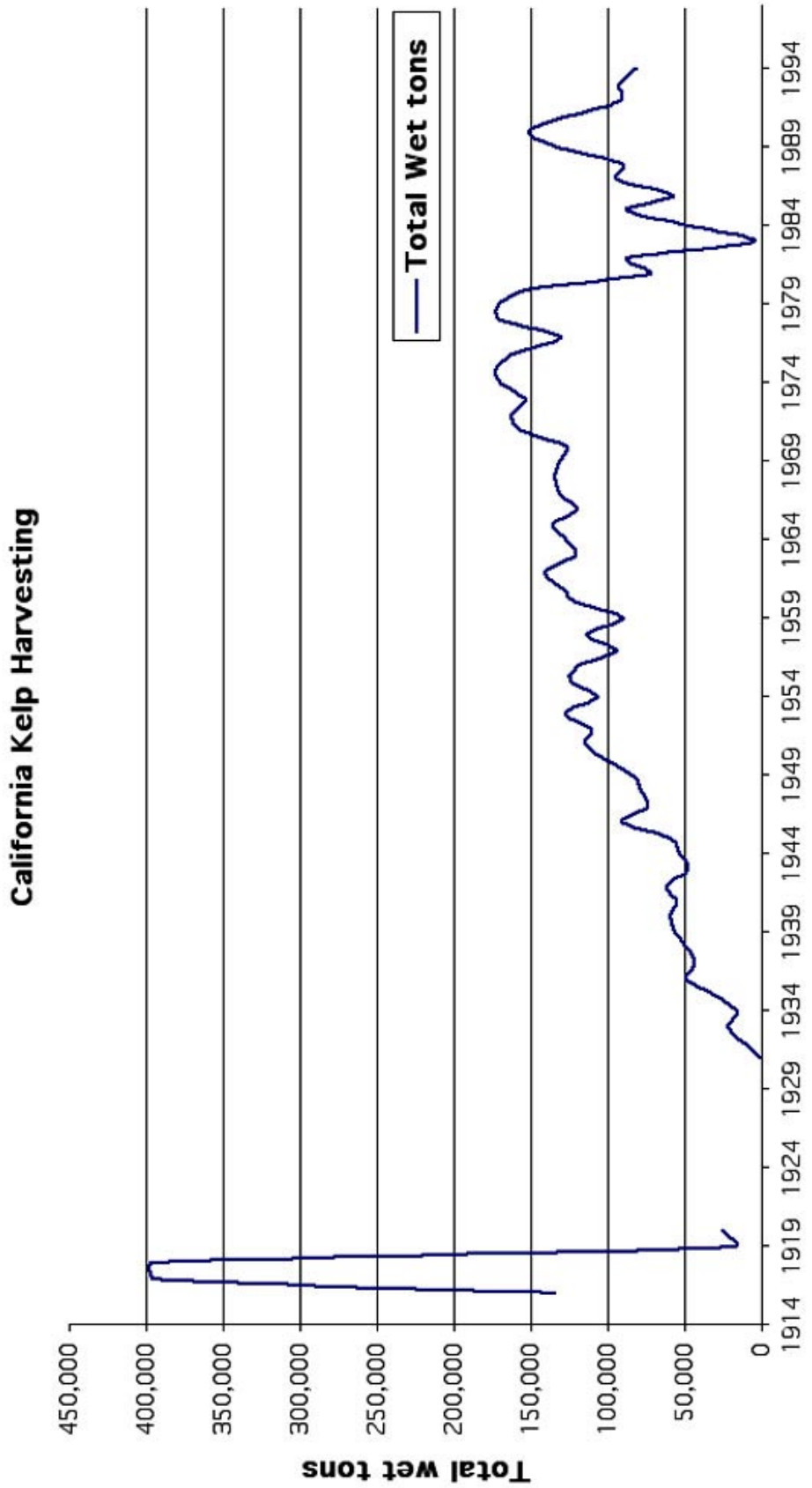

Figure 6. California kelp harvest (*Macrocystis pyrifera* and *Nereocystis luetkeana*) 1916 through 1994, in "wet" metric tons (Data courtesy of Department of fish and game (DFG), Marine Resources Divison). At the time of this document's publication, DFG had not completed a summary of the harvest levels for the state between 1995 and 1999.

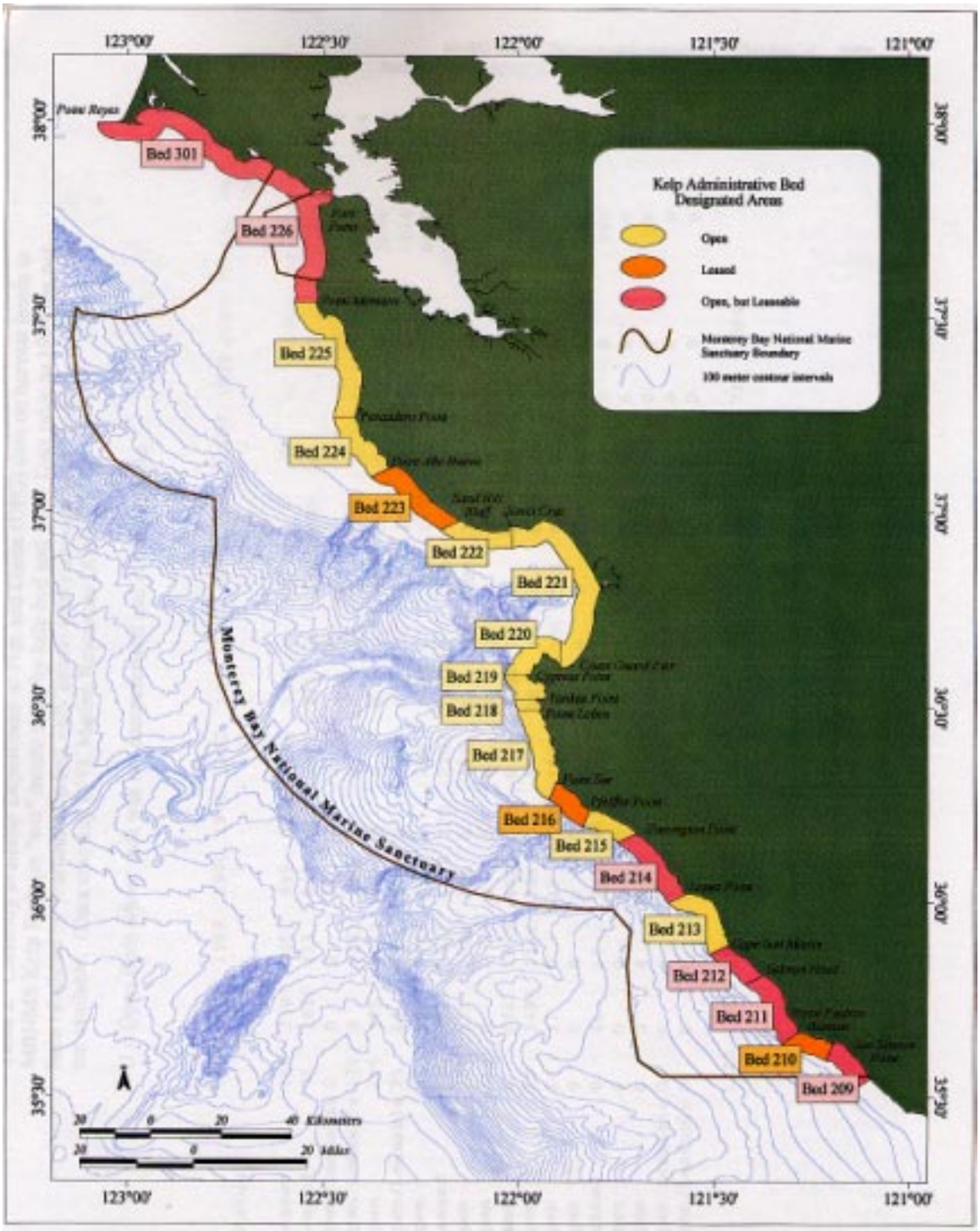

Figure 7. Map of the MBNMS showing locations and associated numbers for the areas designated as "Department of Fish and Game (DFG) Kelp Beds." Each bed is labeled as: Open - Any person with a valid DFG kelp harvesting permit may commercially harvest kelp in this bed; Leased - This bed is open to commercial harvesting only by the person or company that has leased this bed from the state of California; and, Open but Leaseable - This bed is "open" to all commercial kelp harvesting, but it can be leased according to DFG regulations.

Table 2. Currently available Department of Fish and Game (DFG) data on harvest levels in MBNMSKelp Beds (in "wet" metric tons) by kelp bed and year. Data prior to 1987 has not been tabulated by year and kelp bed, only annual total statewide kelp harvest records are available. (Data courtesy DFG, Marine Resources Division.)

U = Open Beds whose data was not computerized and is not available.

Bed #	Status	Year														
		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Totals	Mean Harvest
209	Leased	168	2787	2951	999	2289	1260	225	0	50	0	0	0	420	11149	858
210	Leased	70	1850	413	887	679	4956	491	0	1020	936	0	0	0	11302	869
211	Open/Leasable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
212	Open/Leasable	170	0	1231	160	0	0	0	0	0	571	0	0	0	2132	164
213	Open	205	375	1022	80	0	0	0	0	597	521	0	0	0	2800	215
214	Open/Leasable	75	68	555	579	0	398	0	0	0	241	0	0	0	1916	147
215	Open	0	942	1104	417	2	214	1479	0	314	1690	0	0	284	6446	496
216	Leased	173	3214	3529	2778	128	2203	1131	0	2108	5717	0	0	325	21306	1639
217	Open	200	920	1984	304	0	612	0	0	429	300	0	0	0	4749	365
218	Open	218	0	0	0	0	0	0	0	0	0	0	0	0	218	17
219	Open	0	4321	1665	450	0	0	1488	13	0	0	0	37	0	7974	613
220	Open	19	3492	1188	202	0	3	1202	38	44	664	464	238	142	7696	592
221	Open	14	11	0	43	252	554	575	391	564	73	719	295	30	3521	271
222	Open	0	0	0	0	0	0	0	0	0	294	130	164	63	651	50
223	Leased	0	41	54	73	86	118	63	95	75	86	2	0	0	693	53
224	Open	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
225	Open	0	0	4	4	4	5	5	14	0	0	0	0	0	36	3
226	Open/Leasable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
301	Open/Leasable	U	U	U	U	U	U	U	0	0	0	0	0	0	0	U
Totals		1312	18021	15700	6976	3440	10323	6659	551	5201	11093	1315	734	1264		

ISP Alginates' operations have extended north of Point Sur. For example, in 1998, for one day, an ISP Alginates' boat did harvest as far north as Carmel Bay (Dale Glantz, pers. comm.).

Kelp harvesting on and north of the Monterey Peninsula (Figure 7 and Table 2) is primarily by hand and is utilized for abalone feed, and, to a very limited degree, recreational, educational, scientific purposes, and for the herring-roe-on-kelp fishery. Hand-harvesting of kelp is typically done from small skiffs. Hand-harvesters reach over the sides of the skiff and cut the kelp fronds just below the surface (DFG regulations state that kelp cannot be cut further than four feet from the surface). The kelp is then hauled aboard the boat. In this fashion, up to two tons can be harvested on any one trip in the typical skiff. Once cut, that particular kelp frond stops growing. The kelp plant continues growing from other fronds that have not been cut, or by starting more fronds from the holdfast.

The first abalone mariculture operations in the MBNMS, utilizing kelp as an abalone food source, were on Monterey's Cannery Row, and at Pigeon Point in San Mateo County, in the 1960's. Abalone mariculture enterprises that utilize kelp in the MBNMS today are limited to three abalone facilities: one in Davenport, and two in Monterey Harbor. Two other abalone farms lie just outside the MBNMS to the south. To hold the abalone, the facility in Davenport pumps ocean water into onshore holding pens (or "raceways"), while the two Monterey facilities rely on floating pens. The abalone in the pens are fed kelp that is harvested from nearshore kelp beds. The abalone mariculture operations in Monterey Harbor are relatively small operations (in terms of the number of abalone held) compared to the Davenport operation, or the combined operations proposed for Pillar Point Harbor (see below).

Economically, all of these operations contribute to the local general economy, particularly to the tourist industry. Many local restaurants serve abalone on their menus. Due to the recent closing of California's commercial abalone fishing industry, maricultured abalone is the only available source for these restaurants. Besides the abalone meat, the shells are utilized as curios and as jewelry. U.S. Abalone, for example, has recently marketed a line of jewelry based on cultured abalone "pearls", and is marketing them locally (David Ebert, pers. comm.).

3.1.2 Present Kelp Harvesting Levels

In California, the State may lease, through an open competitive public process, certain kelp beds to individuals or companies. The price paid for a leased bed may therefore vary. Leased beds, which can only be harvested by the tenant, enable companies to more efficiently plan and manage their kelp harvests. Open beds (i.e., unleased beds) can be harvested by any individual or company with a valid DFG kelp harvesting permit. "About 38% of the State's kelp beds have been reserved for harvest by any licensed kelp harvester. No leasing of these beds is allowed. This policy insures that the State's smaller kelp harvesters will have access to kelp, and will not be shut out by lease agreements with large companies" (DFG, November 1995). The total tonnage of kelp removed from California kelp beds in 1994 was approximately 81,006 tons (Figure 6). Of this amount, approximately 54,682 tons (67.5%) were from "leased beds", while the remainder, 26,324 tons (32.5%), was from "open beds" (DFG, November 1995).

The number of leased beds in the MBNMS, and California in general, may fluctuate from year to year as leases expire, are renewed or are newly acquired. In 1999, there were four leased beds and 16 open beds in the MBNMS (Figure 7).

The total tonnage taken from the MBNMS kelp beds fluctuates widely also. In 1992 and 1993, there were 10,323 and 6,659 tons harvested respectively (Table 2). However, due to storms in 1994 which limited access and available kelp, only approximately 551 tons were taken (Table 2). In 1995, total harvests taken from MBNMS kelp beds was back up to 5,201 tons (Table 2). Therefore, the total amount of kelp harvested in the MBNMS varies greatly due to various factors such as weather (Figure 8) or availability of kelp in other locations around California (Dale Glantz, pers. comm.).

Within the MBNMS, kelp harvesting has historically been concentrated near Cambria, Point Sur, and from Carmel Bay to Monterey Bay. However, north of Point Sur, there has historically been little to no commercial harvests of kelp (Table 2).

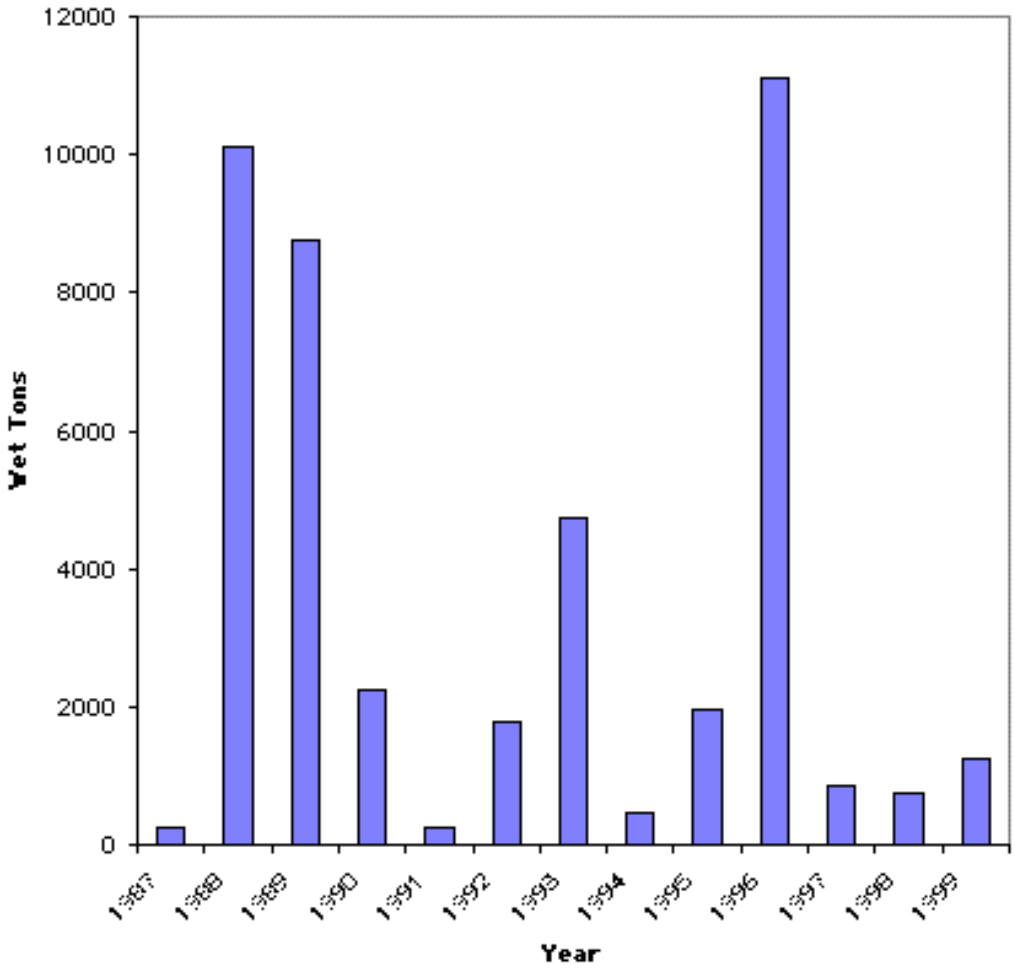

Figure 8. Kelp harvested from MBNMS kelp beds (open and closed beds) between 1987 and 1999. Data from 1987 to 1993 does not include Leased bed tonnages (Data courtesy of California Department of Fish and Game, Marine Division).

Around the Monterey Peninsula (CDFG Kelp Bed #220), kelp harvest levels have been declining from a high in 1996 (664 tons). By 1999, harvests were only 21% (142 tons) of this total. Reasons for this decline in harvests include social pressures to harvest elsewhere, oceanographic conditions, collectivization of harvesting efforts under the Monterey Kelp Cooperative, and abalone facility business failures.

Recently, the California Coastal Commission and the San Francisco Bay Regional Water Quality Control Board approved four permits to start abalone mariculture operations in Pillar Point Harbor. The MBNMS reviewed those Pillar Point abalone proposals, and wrote several comment letters to the California Coastal Commission and DFG. While the proposed new facilities are inside the harbor, and therefore outside the area jurisdiction of the MBNMS, the kelp that will be needed to sustain such operations will probably come out of the MBNMS. At full buildout, these four facilities will contain as many as 2.25 million abalone (up to 3 inches in diameter). Coastal Commission staff estimates that the amount of kelp needed to sustain this buildout, up to 1,800 tons per year*, could be of concern depending where, and how frequently, the harvests are made (see the California Coastal Commission staff reports on these four projects passed out at the July 15, 1999, Coastal Commission Public Hearing).

While concerns over some localized harvests continue to exist, MBNMS concerns about increasing harvests of kelp within the MBNMS have been greatly tempered since the first release of the MBNMS Kelp Report in January. The MBNMS has been informed by ISP Alginates that their harvest levels in the MBNMS, and California in general, have decreased by half since 1993 (Dale Glantz, pers. comm.). This is due to the fact that ISP Alginates decided to move many of its lower-grade production facilities to Scotland, and only conduct high-grade production of alginates in California. The MBNMS encouraged DFG to tabulate this recent harvest data early in its Kelp Management Report review process so that the people of California can more accurately review the status of the industry. Also, within the last year, a major kelp harvesting interest in the MBNMS, Pacific Mariculture Inc. (PMI), based in Santa Cruz, went out of business. The withdrawal of PMI from the kelp harvesting scene has reduced the number of maricultured abalone, hence harvested kelp, by nearly one-half.

3.1.3 Ecological Effects from Kelp Harvesting

Even under ideal conditions, where plenty of management funding and labor resources exist, precise human management of kelp forests is inherently difficult due to the complexity of the ecology and the highly dynamic marine environment of kelp forests (Foster and Schiel, 1985).

The question of the effect of kelp harvesting on kelp forests is of interest to the MBNMS. After an analysis of the studies that have been done, two general conclusions can be reached. The first is that when kelp harvesting is done on a limited scale, there is generally little detectable, adverse effect on the kelp forest. The second conclusion is that, while numerous expert opinions agree that overharvesting can occur (North, 1968; Miller and Geibel, 1973), and have even postulated as to the parameters for such a harvest level, few long term studies exist that can answer the question, “At what point would intensive repetitious harvesting, especially in a confined space,

* - Local abalone aquaculturalists claim this is an overestimate of kelp needed f
and believe a more accurate estimate should be about half that amount. The harves
this claim with data generated by various researchers (Godoy et al., 1992; Godoy a
McBride, 1998) as well as their own experiences. The MBNMS itself does not have s
time to provide an accurate estimate of how much kelp is actually needed by an aba
based on the size of their operations. The MBNMS believes this information is cru
discussion of the issue. The MBNMS would encourage DFG to publish such an estima
of their CEQA document so that public process can continue based on an independent
generated estimate.

begin to cause significant ecological impacts?" Such a question becomes even more complicated when non-harvesting impacts, such as storms, nearshore development, incidental effects from recreational uses of the kelp bed, and sewage discharges, such as those activities that occur in CDFG Kelp Bed #220, are factored in.

The studies that indicate little to no effect from limited harvesting are numerous, though focused on only several aspects of the kelp forest ecology. These studies address both the effects on the kelp plant/canopy itself, as well as some of the associated organisms of a kelp forest. However, further studies are needed as some aspects of kelp harvesting have only been partially studied, or not studied at all (e.g., effect on benthic invertebrates, marine mammals, sea birds).

While Miller and Geibel (1973) did find that kelp abundance declined slightly when an area's kelp canopy was repeatedly removed, they generally concluded that the effect was not significant. Other studies (Barilotti et al., 1985; Donnellan and Foster, 1999) have also found that no significant effect on the kelp canopy from harvesting could be discerned, especially when time frames of more than a year are investigated. This may be due to the highly variable nature of the environment, few data, and an inability of researchers to determine the cause of single year observations.

Removal of a kelp canopy can have significant effects on increasing growths of subsurface algae by allowing more light to penetrate the water column (Pearse and Hines, 1979; Reed and Foster, 1984; Breda and Foster, 1985; Harrold et al., 1988). Most recently, Clark et al. (in prep) showed that this phenomenon was true, but not for all algal species. While it is apparent that canopy harvesting can have an effect on growths of subsurface algae, other factors such as wave exposure (Breda and Foster, 1985; Harrold et al., 1988; Graham, 1997), Additionally, El Niño events (Dayton and Tegner, 1984; Dayton et al., 1992), and temperature/nutrient fluctuations (Zimmerman and Robertson, 1985) could all have effects on algal species composition and abundance. Kelp harvesters have argued, and some studies support the concept (Kimura and Foster, 1984; Clark et al., in prep.), that limited kelp harvesting can actually increase the amount of kelp availability in an area by allowing more light to reach the bottom (in addition to other benefits - see Section 4.3 - Use Conflicts below), and thereby increase the amount of kelp recruitment. While kelp harvesting leading to increased light penetration may increase the number of kelp recruits, the biomass of kelp may actually decrease because the recruits are much smaller, and intraspecific competition will reduce the plant density as the recruits grow toward the surface.

Invertebrates, of all the groups of species that rely on kelp forests for their habitat, may be the most affected by kelp harvesting. For motile invertebrates in the kelp canopy, previous studies estimate that from 1/4 to 1/3 of them are removed when kelp is being harvested by large scale harvesters (Quast, 1968). However, no research has conclusively determined whether or not such removals are significantly affecting those species populations within the forest, or if such removals are ecologically important. Hunt (1977) did find significant reductions in a species of turban snail in harvested areas as compared to non-harvested areas. A recent class study by students at the University of California, Santa Cruz, indicated harvests of canopy invertebrates may be higher than previously thought (Ish and Reisewitz, 1999). Virtually no studies can be found that analyzed the effect of kelp harvesting on kelp forest benthic invertebrates.

The effect of kelp harvesting on invertebrates attached to kelp fronds (e.g., gastropods, crustaceans) is poorly understood. Therefore, MBNMS staff have preliminarily begun working with University of California scientists to outline studies that better assess the potential effects of kelp harvesting on these species. It is noted that some very small, immobile invertebrates (such as bryozoans) that are harvested along with the kelp are usually consumed by the abalone as part of their diet (Dave Ebert, pers. comm.).

Quast (1968) summarized three studies that examined the effect of kelp harvesting on finfish populations. All three of the studies, each using a distinctly separate means of analysis, indicated that little to no affect could be discerned from kelp harvesting. Miller and Geibel (1973), through several experimental methods, also concluded that adult fishes were probably not affected by kelp harvesting, though they raised some concern for juvenile fish concentrations, particularly juvenile rockfish, due to harvesting. Other DFG biologists have made similar observations and relayed these to the MBNMS (Robert Lea, pers. comm.). These observations indicate that more

studies need to be conducted on this matter. The few studies that exist are many years old and concentrated in Southern California.

No experimental studies were found that have analyzed the effect of kelp harvesting on seabirds, despite the fact that birds are commonly seen foraging in and around kelp forests.

A particular issue of concern to the conservation community is the effect that concentrated kelp harvesting, as well as other activities (e.g., recreational), could be having on sea otters. This is especially true in light of recent downward trends in the California sea otter population (though this trend appears to have been reversed according to the most recent Fall and Spring sea otters counts). As stated previously, sea otters feed on various invertebrates that exist in kelp forests (Foster and Schiel, 1985; Ostfield, 1982), and utilize kelp forests as a natural refuge and as nursery areas (Foster and Schiel, 1985). No experimental studies could be located that analyzed the indirect effect of kelp harvesting (i.e., potential loss of habitat and food) on sea otters. However, it has been shown that sea otters are very adept at prey switching when a preferred food item is unavailable (Ostfield, 1982). This ability of sea otters to readily switch prey would make experimental studies difficult on the indirect effects of canopy loss. Indications are that little direct physical threat to the sea otter is likely from mechanical harvesting (Fulton and Saunders, 1985; DFG, November 1995). In a study of human disturbances to sea otters in some areas where kelp is harvested, Curland (1997) did not collect data on this activity as regarding its affect on sea otter behavior. No other studies can be found that have investigated the effect of kelp harvesting on other marine mammals that are found in and around kelp forests, such as harbor seals and sea lions.

Another environmental concern that needs to be mentioned is the importance of drift kelp and "wrack" to the ecology of various ecosystems. In the subtidal environment, drift kelp is an important food source for various organisms such as abalone and sea urchins (Foster and Schiel, 1985). On the beaches, kelp wrack is an important food source and habitat for numerous organisms (Oakden, 1996). In the deep benthic environment of areas in the Monterey Bay submarine canyon, kelp may provide an important food to the organisms found there (Harrold and Lisin, 1989; Okey, 1997; Harrold et al., 1998; Okey, in prep.). Finally, in the epipelagic zone, floating kelp masses are important habitat for juvenile fishes, such as rockfish (Foster and Schiel, 1985; Aaron King, pers. observ.).

As stated above, when the MBNMS first began investigating this issue several years ago, it was apparent that no studies have been successfully completed that would help indicate when (or if) intensive and repetitive harvesting in a confined space would begin to be ecologically significant. A 1998/99 study funded by the MBNMS, as well as the cities of Monterey and Pacific Grove, was attempted using existing data, and looking at the long term effect of kelp harvesting in a small confined space (the area along the Monterey Peninsula coastline from the Coast Guard Breakwater to Lover's Point) on the kelp canopy. This study, by Michael D. Donnellan and Michael S. Foster (Donnellan and Foster, 1999; Appendix 3), utilized aerial photos and harvest records dating back to 1972. The study indicated that kelp harvesting had little to no effect on the kelp canopy at or near peak canopy cover months. However, the study was inconclusive because low sample sizes and high variability in kelp abundance limited the statistical power of the study design. Further aerial surveys being conducted by the MBNMS (see below) will add to this database and allow follow-up on this study to eventually produce more conclusive results. In particular, the MBNMS is looking for more conclusive results regarding effects during seasons when kelp canopies are lower and "competition" for kelp by other users is more pronounced.

During the comment period for the first release of the MBNMS Kelp Report, the issue of *Nereocystis* utilization by kelp harvesters was raised. As stated above, north of Santa Cruz, the bull kelp, which occurs from Point Conception to Unimak Island in the eastern Aleutians, becomes the dominant canopy-forming kelp. However, none of the *Nereocystis* beds in the MBNMS appear to be of any great size (Van Wagenen, 2000).

The effects of *Nereocystis* harvesting on the abundance and distribution of *Nereocystis* have been studied in British Columbia (Foreman, 1984). These studies can find little effect from harvesting at the site scales investigated, though Roland (1985) found that harvesting fronds can impede plant growth and reproductivity. However, *Nereocystis* is an annual plant (*Macrocystis* is a perennial plant), is limited in its MBNMS distribution, spore production is seasonal (late spring to

the death of the plant in winter), and harvesting of *Nereocystis* removes the reproductive tissue (unlike with *Macrocystis* harvesting) (DFG, November 1995). Therefore, there is a valid issue regarding the effect of localized, concentrated harvests of *Nereocystis* in the MBNMS. Such concerns would be particularly realized if such harvests occurred prior to spore release. California restricts harvests of *Nereocystis* north of Point Arguello (California Code of Regulations: Title 14, Section 165(c)(4)), because the beds are too important to the ecology in those areas. They also outright bans harvests in certain kelp beds north of San Francisco (DFG Kelp Beds #303, 304, 305, 306 and 307) because their production is too variable to allow harvest (Robson Collins, pers. comm.).

As part of developing a long-term kelp canopy monitoring program, and building on previous work by DFG and the Monterey Bay Aquarium, the MBNMS funded aerial mapping surveys of kelp canopies in the early fall of 1999 (Van Wagenen, 2000). In 1999, with the return of cooler waters during the recent La Niña conditions, tremendous kelp canopy cover was found along the MBNMS. These 1999 data from the overflight were compared to data from a similar overflight project conducted by the same contractor for DFG in 1989. Visually, the size, shape and extent of the kelp beds along the MBNMS were very similar between the 1989 and the 1999 overflights. One very obvious similarity between the two datasets was the near complete lack of kelp beds north of Año Nuevo, with large beds occurring just south of that point. This is noted even though these overflights occurred at (or near) the peak of the kelp canopy height. Also, in the case of 1999, kelp production was very high along the central California coast.

The total Sanctuary-wide kelp resource canopy decreased from 16.918 square miles in 1989 to 14.053 square miles in 1999. The greatest loss in kelp canopy extent between the two inventories was observed within the Monterey Bay itself (DFG Beds #222, 221 and 220), and the greatest gain in kelp resource extent was noted in DFG Bed #217, between Yankee Point and Point Sur (Van Wagenen, 2000). [NOTE: Caution must be used in reviewing and comparing these data, which actually only represent two data points, separated by a ten year period. These data do not necessarily reflect long-term trends in kelp resource extent and distribution (Van Wagenen, 2000). Caution must also be extended to the idea that deciding on a point in time when kelp is at its maximum extent BEFORE the overflight occurs is challenging.]

The MBNMS plans to continue the aerial surveys each fall to document canopy maximums, and potentially each late winter/early spring when kelp canopy cover is typically at its minimum. It would also be useful to study short-term canopy variability. After annual overflights have been done for a long enough period of time, these data are expected to reveal long-term trends in kelp canopy extent. Canopy data will be integrated with other kelp community surveys being conducted by regional scientists and institutions.

As stated in the beginning of this section, a need exists for an answer to the question, "At what point would intensive repetitious harvesting, especially in a confined space, begin to cause significant ecological impacts?" Abalone mariculturalists need kelp on a ongoing basis. They need kelp during the winter (when kelp supplies are low), as much as they need it during the summer (when kelp supplies are high). During times of low kelp abundance (e.g., winter, after storms, and during El Niños), it stands to reason that any environmental effect that may be occurring is most likely compounded by harvesting larger percentages of the kelp canopy during these times. Any management strategy should have a consideration about protecting areas that could be potentially overharvested in times of reduced kelp canopy cover.

It should also be noted in this section that there may be distinct differences in environmental effects caused by mechanical harvesting versus hand-harvesting. Many of the studies mentioned above, such as Miller and Geibel (1973), investigated kelp harvesting situations that more closely resemble effects that mechanical harvesters create. Hand-harvesters generally do not cut as deep or in as distinct a pattern as mechanical harvesters (Aaron King, pers. obs.; David Ebert, pers. comm.). No studies are known that describe any environmental effect differences between the two methods of harvest.

The effect of kelp harvesting on the environment must also be placed into perspective as it compares to natural events. Storms, and other natural events, can have a significant effect on the amount of kelp available in an area over a very short period of time (Miller and Geibel, 1973; Foster

and Schiel, 1985). El Niño conditions can aggravate the low kelp abundance after winter storms by reducing the growth of kelp (DFG, November, 1995). Finally, along the area of CDFG Bed #220, it has been estimated that as much as 200,000 tons of wet weight drift kelp are generated per year (Harrold et al., 1998). Considering the hand-harvested area from Point Pinos to the Coast Guard Breakwater accounts for about 1/6 of this area (33,000 tons of kelp), the kelp harvesting community along Cannery Row harvests about 2% (1987 to 1999 average harvest = 592 tons) of this production per year (Table 2). Additionally, a portion of this harvest (it is unknown how much since records are not maintain with this information) is collected as drift kelp by the harvesters, which may come from other areas.

For further reading, two reports are recommended that provide an introduction to the present state of knowledge regarding harvesting effects on a kelp forest's general ecology. These are: the "DFG California Kelp Plan" (DFG, November 1995, Sections 4.1 to 4.8.2); and, "The Ecology of Giant Kelp Forests in California: A Community Profile" (Foster and Schiel, 1985).

3.2 Other Uses of Kelp

3.2.1 History and Existing Status of Other Kelp Uses

The first records of western exploration of the Pacific indicate that early European sailors used kelp as a navigational aid to help identify both nearshore rocks and, further out at sea, the proximity to land through the sightings of floating kelp plants (North, 1971). The first published information on kelp biology was by Charles Darwin (1860) after his *HMS Beagle* voyage.

In recreational fishing (for fish, crustaceans, molluscs, etc.), kelp itself is not utilized, but the species associated with kelp forests have long been sought by fishermen. Traditionally, kelp forests have not been heavily targeted in commercial fisheries. However, in the last few years, commercial fishing in kelp forests has been increasing to supply the "live fish" market. In the live fish fishery, fish are either caught on hooks or in traps, and then held live for sale. Live fish can bring several times the ex-vessel price (up to $9 per pound) than does the same fish sold dead (about 30 cents per pound) (Griffith, 1998). While these prices reflect extremes in the market, the concept is that the "Live Fish Fishery" adds a tremendous amount of value to the commercial prices for nearshore fish. In this respect, the non-harvested use of kelp forests may be very important and economically relevant.

Major industries have arisen over the past 30 years which can be directly tied to the influx of tourists to the MBNMS. In 1992, for example, the counties along the MBNMS had a tourism industry that generated about $634.9 million in tourism spending (State Resources Agency, 1995). Many of these tourists are attracted to the MBNMS area because of the area's beautiful scenic shoreline. Kelp beds are an important component of this nearshore attraction.

Restaurants and hotels located on the coast are particularly popular. Kelp beds, especially ones that contain numerous seabirds, sea otters and other marine animals, provide a pleasant atmosphere for dining or lounging. In general, "The beauty of the environment has become the cornerstone of the region's visitor-serving economy" (Knight, 1997).

Other more active uses of kelp beds include SCUBA diving, kayaking, and other sports. Kelp beds provide the environment that attracts many of these recreational users to the sport. Most of these "ecotourism" type industries are on the increase in the MBNMS area. One business in the area that rents and sells kayaks, as well as gives lessons on kayak use, has stated that between 1989 and 1999, kayak use from its shops has increased ten-fold (Cass Schrock, pers. comm).

Likewise, the economic importance of recreational diving in the MBNMS is undeniable. The following paragraph by Weinstein (1996), puts this into perspective:

> The Northern California Diver's Association estimates that the number of divers in the central coast rose 10-20% in the 1980's (R. Gallagher pers. comm.). Dive shops from Monterey Bay to Santa Rosa (north of MBNMS) made $14 million in retail sales in 1994, plus about $5 million in associated revenues such as lessons and boats. An estimated 95% of this revenue was generated in the Monterey Bay area (R. Gallagher pers. comm.). This value complements the findings of another study estimating SCUBA and snorkeling revenue at $13.2 million dollars in 1988 for San Mateo, Santa Cruz, and Monterey counties (Meyer Resources, 1990).

Further, the owner the Aquarius Dive Shops in Monterey stated that business has increased about thirty percent over the past ten years (Harrold Toberman, pers. comm.).

3.2.2 Ecological Effects from Other Uses of Kelp

Generally speaking, other uses of kelp resources, while not directly tied to the "take" of kelp, could have an impact on the kelp forest and its ecology. Detrimental impacts of increased visitation in recreational areas is documented for some systems, though such documentation is limited for temperate reefs. A contributed papers session at the 1997 Western Society of Naturalists focused largely on this general issue of increasing visitations in recreational areas. The topic for eco-tourism and rocky shores in particular, was addressed at the *Sanctuary Currents* Symposium in 1998. Of late, this issue of increasing visitation in recreational areas has received significant attention at Yosemite National Park. Locally, concerns about the over-use by humans of rocky shores has spawned a recent petition drive in Pacific Grove, California, to place new restrictions on use of its intertidal areas. The Florida Keys National Marine Sanctuary also considered this issue recently in the development of its management plan. Finally, boating, powered and non-powered, is well documented as having the potential for ecological damage (Dornbusch & Co., 1994). Curland (1997) found that human recreation activities (e.g., boating, kayaking, diving) in the kelp forest along Cannery Row can have impact (though perhaps not significantly) on the behavior of sea otters. For a further discussion of this issue, see the MBNMS Site Characterization section on "Human Uses" at:

http://bonita.mbnms.nos.noaa.gov/sitechar/human.html

As stated above, other uses of kelp forests include the take of other species associated with the kelp forests ecology, such as fish and invertebrates. While a discussion of this topic is beyond the scope of this report, it should be noted that this use of kelp forest, such as recreational/ commercial fishing, and commercial/scientific/educational collecting, can also have impacts on the kelp forest systems. For example, intensive removal of certain kelp forest inhabitants (sea otters, sea urchins, etc.) may have significant effects on the distribution of the kelp forest itself (for a discussion of this issue, see Foster and Schiel, 1985).

Although the Monterey Peninsula is a common destination for SCUBA divers, and gets a high level of use every year, little information exists on the potential influence of divers to temperate reef systems. At Point Lobos Reserve in the MBNMS, where resource harvesting (including kelp harvesting) is banned, recreational use (including SCUBA diving) is also strictly limited by the State of California. Studies have not been done at that site to evaluate how limitations have, or have not, influenced kelp forests. A wealth of information exists on diver influences on coral reefs (e.g., Hawkins and Roberts, 1992 and 1993; Rouphael and Inglis, 1997) and associated organisms (e.g., Cole, 1994). In 1998, the MBNMS partially funded a study focused on potential diver impacts to kelp forests (Schaefer and Foster, 1998). While the study observed some diver impacts, the report states that determining the ecological effects of these disturbances would be difficult due to the natural spatial and temporal variability of these systems. Thus, the study did not determine if such

effects were ecologically important. Neither the 1998 MBNMS diving study, nor any other study that can be located, has demonstrated that SCUBA diving is actually producing significant and long-term impacts on temperate reefs, including impacts on kelp forests.

A goal of the Monterey Bay National Marine Sanctuary is to enhance visitor experience while avoiding negative impacts to resources. A significant MBNMS focus, program-wide, is on including education in recreational activities. For example, the MBNMS has recently initiated the "MBNMS Diver Partnership Program" to welcome divers to the MBNMS and enlist their support to protect resources. For more information on this project, please see the MBNMS website at:

http://bonita.mbnms.nos.noaa.gov/Educate/divered.html

Finally, other human uses of the marine environment in general may have effects on kelp forests (Foster and Schiel, 1985). Boating traffic can cause visible effects on a kelp canopy by cutting surface fronds. Coastal construction can cause changes in localized oceanographic conditions, as well as turbidity and sedimentation (Foster and Shiel, 1985). Finally, and perhaps most important, water quality degradation via point source and non-point source pollution can have significant impacts on the ecology of a kelp forest. Experts generally agree that sewage discharge from the Los Angeles area lead to the complete destruction of the Palos Verdes area kelp forests starting in the 1940's. Only after water quality improvement mandates were imposed did the kelp forest begin to reappear (Wilson, 1982).

With regard to the areas along Cannery Row, Santa Cruz and Pillar Point, the recent accidental releases of raw sewage could lead to temporary impacts on the local kelp forests and related industries.

The regulatory agencies must also consider nearshore development projects on kelp beds, such as desalination plant discharges, point and non-point pollution, and large ship (e.g., military and cruise ships) traffic, ensuring that no inappropriate waste releases occur.

3.3 Use Conflicts

Future socio-economic studies are needed to help the public determine how it best would like to manage kelp resources managed in the future. Such studies are, by and large, lacking. As Dr. Caroline Pomeroy (Researcher, UCSC) stated in her comments on the first release of this document:

> Socio-economic studies can identify and accurately describe user groups, nature and extent of their activities, perceptions, attitudes and opinions regarding the kelp resource, its use, and the conflict. Socio-economic studies can evaluate the potential costs and benefits, and impacts (positive and negative, within and across groups) of management alternatives. But only society through the policy making process) can make the value judgment to determine "the wisest use" of this resource.

Increased harvesting of kelp in certain limited areas has led to a number of use conflicts with other users who also have been increasingly utilizing these same areas. Two different industries, harvesters and recreational users, utilize these same areas for similar reasons. These reasons include: easy access, relative safety from open-ocean conditions, and lingering kelp availability in winter months when large waves remove plants at more wave-exposed sites.

One area where pronounced use conflicts have arisen recently is along the Monterey and Pacific Grove coastline, part of DFG Kelp Bed #220 in the DFG management regime. This bed stretches from Cypress Point to the Monterey Coast Guard Breakwater (Figure 9). Local kelp harvesters have annually removed an average of about 377 tons in this area since 1996 (Table 2), with the amount decreasing over that time frame. The kelp harvesters are particularly interested in harvesting from this spot during the winter months, when kelp supplies on other, more wave-exposed coastlines, are low. Additionally, because of the sheltered nature of this coastline, harvesters and other users alike are generally safer from the winter waves and other sea conditions.

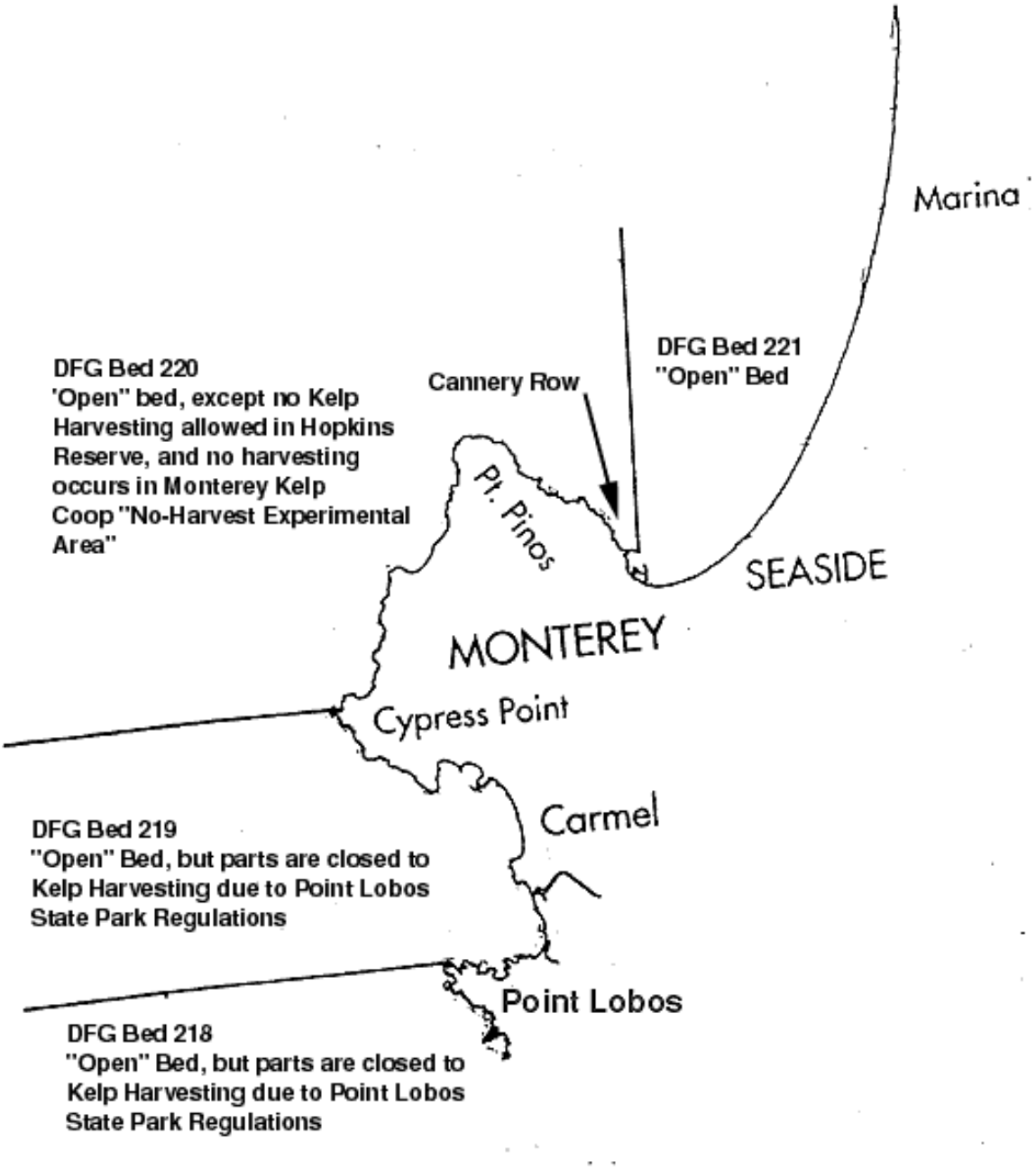

Figure 9: Map of the Monterey Peninsula showing locations and associated numbers for the areas designated as "DFG Kelp Beds.'

At this same time, though it is during the off-season for tourism, this area continues to attract a large number of tourist and other recreational use of the kelp forest resources. For example, there are five recreational dive shops in the area, three of which are new in the past ten years.

While the kelp harvester can legally remove the kelp canopy down to just four feet in depth, the effect can be an appearance that no kelp has been left in an area. However, new kelp fronds can be just below the surface, and, due to its rapid growth (up to 2 feet per day – Clendenning, 1960), can reappear quickly. The ecological effects of harvest has been discussed previously (see Section 4.1.3). However, even if such removals are not ecologically important, they could have a financial effect on kayak and dive shop businesses. This is especially true during the winter months, when low kelp abundance due to storms and other environmental factors is compounded by slow kelp growth due to reduced sunlight.

During times of winter storms, it has been suggested that the trimming of the kelp plants actually reduces drag, and may save plants from being torn out by waves (Rosenthal, 1974; Graham 1977). Some researchers report finding large balls of many kelp plants, including holdfasts, entangled in each other. According to this theory, when one kelp plant is ripped out from waves, it may snowball into other kelp plants, increasing their drag from the waves, and causes them to rip out also (Rosenthal et al., 1974).

One observation (Miller and Geibel, 1973) suggested the opposite effect from harvesting. This study found that repeated harvesting may have the effect of weakening the kelp holdfast, thereby making the plant more susceptible to being removed by storms. However, the simulated harvests from which this observation was derived were much more intense than what is even legally allowed today in California.

No socio-economic studies are available to help determine the wisest use of a kelp resource that may, in certain areas, be limited or confined.

4.0 Regulating Kelp Use in the MBNMS

4.1 Regulatory Jurisdictions

Two agencies have unquestionable legal authority to regulate kelp harvesting in the MBNMS; these are DFG/FGC and MBNMS/NOAA. These two authorities, as do many authorities at various levels of government, have overlapping jurisdiction. Other authorities may exist.

4.1.1 California Department of Fish and Game/Fish and Game Commission (DFG/FGC)

The DFG/FGC is provided by California State law with management authority over the State's kelp resources. DFG/FGC conducts its management authority largely through development of a State-wide California Environmental Quality Act (CEQA) Environmental Document containing a regulatory regime. This regime incorporates the use of kelp harvesting permits, closure of certain areas, leasing of kelp beds, and determining allowable harvest methods (DFG, November 1995). For a complete description of California laws regarding kelp harvesting, please see the website at:

http://www.leginfo.ca.gov/calaw.html

For a listing of DFG regulations regarding kelp harvesting, please see the website at:

http://www.dfg.ca.gov/title/d1_c6_hr.html

4.1.2 Monterey Bay National Marine Sanctuary (MBNMS)

The National Oceanic and Atmospheric Administration, National Ocean Service, has authority under the National Marine Sanctuaries Act (NMSA) to promulgate regulations governing kelp harvesting in the MBNMS (through a notice-and-comment rulemaking process) provided there is adequate basis for such regulations. No amendment of the designation document is necessary, as kelp harvesting is already listed in the designation document as an activity subject to regulation (NOAA, 1992b):

"Article IV. Scope of Regulations
Section 1. Activities Subject to Regulation

...The following activities are subject to regulation, including prohibition, to the extent necessary and reasonable to ensure the protection and management of the conservation, ecological, recreational, research, educational, historical and esthetic resources and qualities of the area:. . .

Aquaculture or kelp harvesting within the Sanctuary; "

4.1.3 Other Authorities

The City of Monterey has asserted a position that it may regulate kelp harvesting along its coastline out to the 60 foot depth contour. The City of Monterey's legal argument for this is derived from the Treaty of Guadalupe-Hidalgo which granted certain land rights to the City of Monterey, including control of the submerged lands along its coastline out to a 60 foot depth. In 1998, the City of Monterey passed an ordinance creating the Ed Ricketts Underwater Park from the Monterey Coast Guard Wharf to the City's boundary with Pacific Grove. According to the City of Monterey, "…the City's actions were based on its concerns that a strong conservation-based policy be in place for the kelp beds within the City limits, and that this conservation-based policy

would continue to allow for moderate multiple uses of the kelp beds." (City of Monterey comments on the first release of the Draft MBNMS Kelp Management Report). Within the underwater park, the City restricted kelp harvesters from cutting without a permit issued by the City. In a recent court ruling (Appendix 4), the Municipal Court of California, Monterey County Judicial District, ruled against the City of Monterey, stating, in part, "...the regulation of commerce (kelp) falls within the obligation of the State of California...", and that regulation of kelp, "...is beyond the City's granted powers...". This ruling was later upheld by a Superior Court bifurcated trial ruling (Appendix 4), which stated, in part, "...Kelp harvesting is a field and a subject which are preempted by State law, as evidenced by the history, extent, and application of State regulations, and the City's regulation is invalid accordingly...". At the time of the release of this final report, Monterey City officials assert that they have the legal authority to regulate kelp harvesting in the area in question, and are considering further legal action. The MBNMS will respect and work with whatever State jurisdiction(s) the California courts eventually recognize as having the authority to issue natural resource regulations in that area.

4.2 MBNMS Review of Kelp Harvesting

Long term planning, and establishment of regulatory regimes for individual National Marine Sanctuaries are done through the establishment of Management Plans and regulations (NMSA Section 304).

At the time of the Sanctuary's designation, NOAA did not regulate kelp harvesting, finding that, "There is little data available to show whether current levels of activities are negatively impacting the Sanctuary area." (MBNMS Final Management Plan, Section II, C - See NOAA 1992a). NOAA stated in the Final Environmental Impact Statement (FEIS) that existing authorities were adequately overseeing kelp harvesting activities and determined there was no need to supplement such authorities at that time (NOAA, 1992a, at III-75, Response to Comments at F-33). Further, NOAA stated that, "NOAA will work with the DFG and kelp harvesting and aquaculture industries if new activities are proposed, or increases in current levels to determine the impacts, if any, of the activity on the resources and qualities of the Monterey Bay area" (NOAA, 1992a, at III-80).

However, unlike traditional fishing activities, NOAA did list kelp harvesting as an activity subject to regulation in the designation document for the Sanctuary. Thus, if NOAA opted at any time to regulate kelp harvesting in the Sanctuary, it would not be required to go through the entire NMSA designation process to change the designation document before promulgating such a regulation.

In January, 1996, representatives of some recreational kelp use businesses and interests (e.g., divers, kayakers), who depend upon the kelp forests for their livelihoods, approached the MBNMS, DFG, marine scientists, conservation group representatives and local kelp harvesters to discuss the issue of increased kelp harvesting activity along Cannery Row in Monterey and Pacific Grove (Figure 9). At that time, a particularly intensive harvest of kelp had just occurred along Cannery Row, and concerns were raised in these meetings that too much kelp was being harvested. While it was feared that potential environmental damage was being done, the recreational industry interests also felt that aesthetic damage from kelp harvesting was affecting their activities. After discussing the issue of kelp harvesting along Cannery Row with several kelp ecology experts and the MBNMS Research Activity Panel (RAP), the conclusion of the Sanctuary was that the issue was essentially one of user conflicts, and no evidence that significant effect on the kelp or other Sanctuary resources (e.g., the surrounding ecosystem) was imminent. However, Sanctuary staff also concluded that if kelp harvests increased dramatically from historical levels (such as if a large flux of new harvesters were to enter the business, or growth in existing farms), significant ecological impacts could become a reality. The MBNMS initiated this Kelp Management Report process to evaluate this issue, provide public information about the natural history of kelp and the influence of harvesting, and, if necessary, issue recommendations to the State to resolve any problems.

Due to public concerns regarding kelp harvesting, the MBNMS staff began discussions with the kelp harvesting community and the DFG to ensure harvest levels and methods would not lead to overharvesting, and to help avoid the user conflicts that had marked the issue up to that time. At one point, on February 24, 1997, a group of the kelp harvesting and recreational industry interests met with an independent moderator (Mr. Mark Silberstein, Executive Director, Elkhorn Slough Foundation) arranged by the MBNMS. Unfortunately, the group was neither able to agree on any issues, or even agree to a common statement that could be publicly released (Mark Silberstein, pers. comm.).

The kelp harvesters, with help from the MBNMS and DFG, continued to explore several different legal and management options (e.g., leasing, special State Legislation) and finally concluded that they would like to establish a Kelp Harvest Cooperative, and to either self-regulate themselves, or seek special State regulations recognizing them as the sole entity allowed to harvest kelp within the area along Cannery Row. This desire by the harvesters was relayed to the MBNMS Advisory Council at its April, 1996, meeting in Montara, and at its December 1997, meeting in San Francisco. The MBNMS Advisory Council was supportive of the Kelp Harvesters' efforts to form a Cooperative, and at self-regulation, and encouraged the MBNMS to allow the harvesters a chance to do so before resorting to any type of regulations.

On September 22, 1998, all the kelp harvesters utilizing the kelp in the area along Cannery Row signed an agreement to form a cooperative (the Monterey Kelp Cooperative). The goal of the Cooperative is for the members to work among themselves, and with other users, for the benefit of all interests, and to help ensure the sustainability of kelp harvesting in that area (Appendix 5).

Finally, on July 27, 1999, at the behest of the MBNMS Business and Tourism Activity Panel (BTAP), representatives of the Monterey Kelp Cooperative met with representatives of the recreational industry interests and agreed on a set of recommendations (Appendix 6) for resolution of the user conflicts.

4.3 NOAA/MBNMS Authority to Regulate

As stated above, when the Monterey Bay National Marine Sanctuary was designated in 1992, NOAA identified kelp harvesting in the designation document as an activity that could be regulated in the future (NOAA, 1992b). While the MBNMS retains authority under its designation document to regulate kelp harvesting, it also recognizes the historical authority of the DFG and FGC to manage that issue, and prefers, at this time, to work through those authorities rather than issue its own regulations.

The primary purpose of the NMSA is resource protection and generally all sanctuary regulations are based on this purpose. The NMSA does provide NOAA with broad authority for comprehensive ecosystem-based management and conservation of sanctuaries, and activities affecting them. Areas designated as sanctuaries are done so because of their national significance due to their conservation, recreational, ecological, historical, research, educational, or aesthetic qualities. Sanctuaries such as the Monterey Bay allow multiple uses, such as kelp harvesting, but also kayaking, SCUBA diving and snorkeling, provided these activities are consistent with the primary mandate of resource protection. Therefore, the broader authority of the MBNMS, relative to DFG/FGC, means that the Sanctuary may address issues different than DFG/FGC. Whereas DFG/FGC may only be interested in biological resources, the MBNMS may be concerned with that plus additional issues, including use conflicts.

If there were an adequate basis of concern regarding the conduct of kelp harvesting in the Sanctuary, as one option, NOAA could pursue issuing a regulation under the NMSA to address the issue. Further, prior to developing a proposed rule, NOAA would first consult with DFG and other relevant authorities, as well as the MBNMS Advisory Council. The MBNMS would follow the National Environmental Policy Act, and determine at the time whether an Environmental Impact Statement was necessary, or an Environmental Assessment leading to a Finding of No Significant Impact.

5.0 Recommendations to the State of California

Recognizing DFG's historical expertise in researching and managing kelp harvests, as well as the FGC's historical authority to regulate the practice, the MBNMS would like to make the following recommendations to these public bodies. The MBNMS has arrived at these recommendations through an in-depth public process including public hearings, public comment periods, consultation with the MBNMS Advisory Council, consultation with numerous experts in various related fields, and an exhaustive scientific literature review. This process lasted over a year. The MBNMS believes these recommendations reflect both a median public opinion on how it would like to utilize kelp as a public resource, and the best available science on how to manage it.

Recommendation #1*: The MBNMS recommends that the State's kelp management process fully document and analyze the State's costs in managing kelp harvesting, including research, monitoring and enforcement, and evaluate the extent to which the revenues generated from various fees collected from the kelp harvesting industry (e.g., license fees, violation fines, business and personal taxes, tonnage fees) cover these costs.*

Discussion: Throughout this process, the MBNMS has learned of numerous gaps in the knowledge base necessary to most effectively manage kelp forests in California waters. There is a general lack of awareness about the environmental facts of kelp harvesting and about the social and economic ramifications of the activity.

The MBNMS makes this recommendation to ensure that funding for proper kelp management is being generated by the harvesting industry. Alternatively, other sources of funding could perhaps be used to meet these management needs, such as other sources of taxpayer funds (Federal, State or local), or private grants from charitable organizations. However, the MBNMS believes that it is socially more acceptable and justifiable to utilize the public funds generated from the use of a public resource to manage the extraction of that public resource.

The MBNMS requests this analysis because DFG may find that a surplus or deficit exists relative to that level needed by DFG for a proper level of kelp harvesting management. If a deficit exists, DFG should consider raising the permitting or tonnage fees. To the extent there is a surplus, the State should use these funds to complete necessary research, education or enforcement for kelp harvesting.

The MBNMS believes the no-action alternative to this recommendation is undesirable, as the general public may be subsidizing a natural resource exploitation that should be supported wholly by funds generated from that activity.

Recommendation #2: *The MBNMS recommends the designation of a single no-kelp-harvest area from the City of Monterey's Coast Guard Breakwater to the north wall at the current location of the Charthouse Restaurant, extending from the mean high-tide mark to a depth of 100 feet. This no-harvest area must be monitored for its effectiveness in reducing multiple-use conflicts and increasing kelp canopy to allow for proper re-evaluation in five years.*

Discussion: The purposes for this no-kelp-harvest area (Figure 10) are three-fold. The area's primary purpose is to separate two user groups, harvesters and recreational users. This area is heavily used for recreation, especially by kayakers and SCUBA divers. By restricting kelp harvesting in that area, those recreational users are guaranteed a year-round "natural" kelp canopy cover. Additionally, the no-harvest area can be used for scientific research on the effects of kelp harvesting. Since there exists an additional, similar sized, no-kelp-harvest area near Cannery Row, at the Hopkins Marine Life Refuge, these two areas would complement each other as replicate control sites. Finally, if harvest levels elsewhere along Cannery Row became ecologically significant, this area would provide an additional refuge for associated species, such as fish, invertebrates, and sea otters.

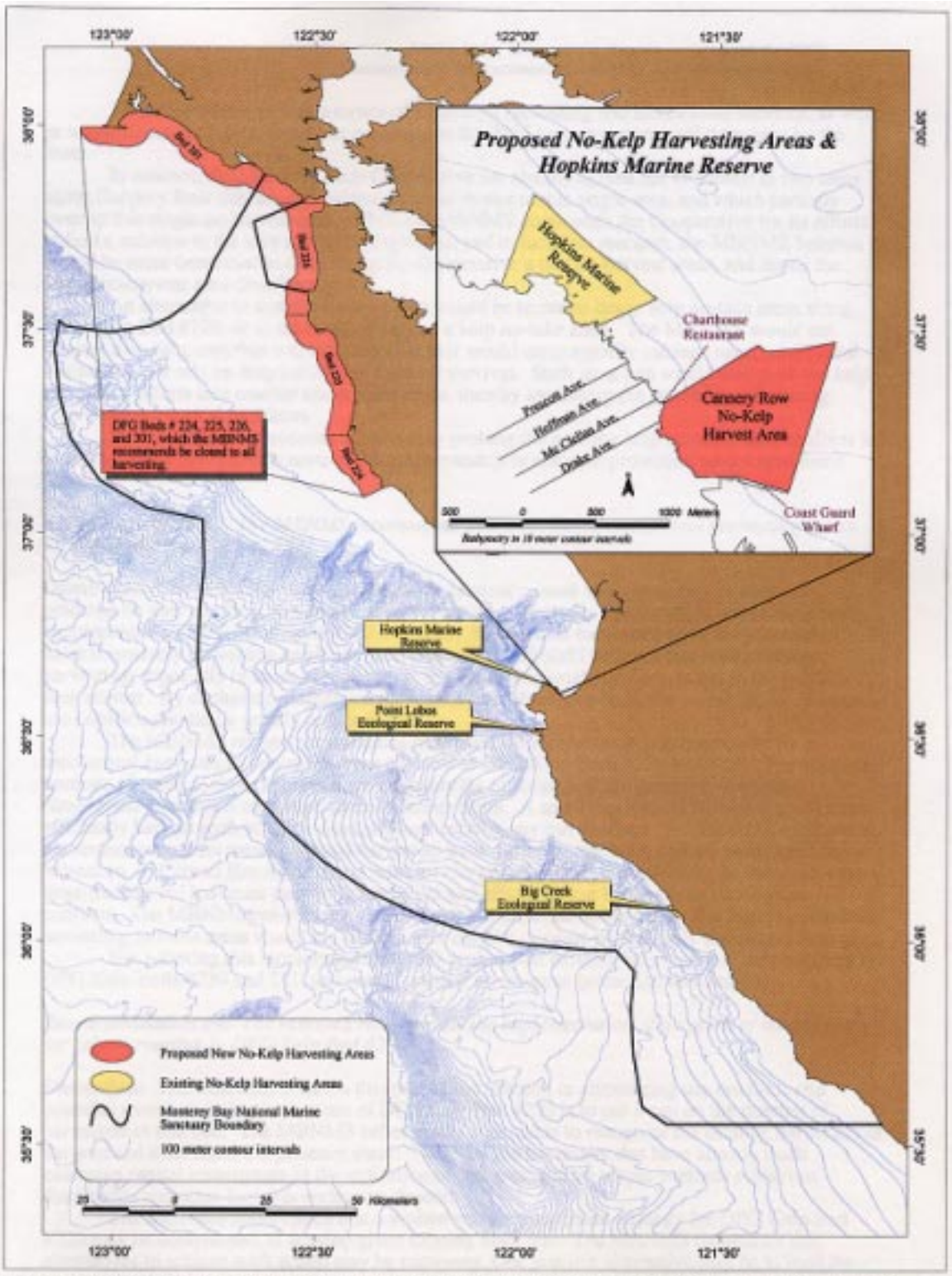

Figure 10. Map of the MBNMS showing locations of all existing areas where kelp harvesting is presently prohibited (in yellow). The MBNMS is recommending new no-kelp harvesting areas (in pink), one along Cannery Row, and another inclusive of DFG beds 224-226, and 301.

The value of this area as a means of separating harvesting and recreational interests, as well as scientific research plot, should be evaluated in the 2005 kelp environmental document by the State.

In essence, the Monterey Kelp Cooperative has already agreed not to harvest in two areas along Cannery Row that are approximately equal in size to this single area, and which partially overlap this single no harvest area. While the MBNMS commends the Cooperative for its efforts to find a solution to the user conflicts in this area, and to facilitate research, the MBNMS believes it would be more beneficial to discontinue the Cooperative's two no-harvest areas, and install the single no-harvest area described herein.

An alternative to this recommendation would be to create larger kelp no-take areas along DFG Kelp Bed #220, or to make all of the bed a kelp no-take zone. The MBNMS would not support a no-take area that was too extensive as it would unnecessarily infringe upon small, local businesses that rely on kelp harvesting for their survival. Such an action would also push the kelp harvesting efforts into smaller and smaller areas, thereby increasing the possibility of causing significant ecological problems.

Not adopting this recommendation may prolong the existing kelp resource user conflicts in that area, and would provide none of the other research or resource protection advantages listed above.

Recommendation #3: *The MBNMS recommends that there be no mechanical harvesting within DFG Kelp Beds #220 and #221.*

Discussion: The MBNMS believes, due to the generally small size, proximity to shore and potential for user conflicts, that mechanical harvesting is generally incompatible within the areas encompassed by DFG Kelp Beds #220 and #221. Mechanical harvesters have the potential of more intensively harvesting small confined areas. The MBNMS believes that such intensive harvesting, especially in areas of high public use for recreational purposes, is not in the public's best interest. By excluding mechanical harvesters from these two beds, the possibility of resource use conflicts should be greatly reduced.

The MBNMS recognizes situations may exist at times wherein it is reasonable for a mechanical harvester to operate in areas adjacent to DFG Kelp Beds #220 and #221. For example, portions of some of these kelp beds are relatively far offshore, and are generally lower in *Nereocystis* abundance compared to areas farther north. A small mechanical harvester could more efficiently harvest such offshore areas, without causing any use conflicts. Additionally, mechanical harvesters can access areas that hand harvesters have difficulty reaching, and are rarely used for recreation. In Carmel Bay the beds are relatively large and sufficiently offshore. In that case, even a large mechanical harvester can easily maneuver and efficiently cut kelp without causing use conflicts. The MBNMS believes, given the amount of information available, that some mechanical harvesting in these areas would not create a user conflict or cause ecologically significant damage.

Not adopting this recommendation may prolong the existing kelp resource user conflicts in DFG Kelp Beds #220 and 221, and would provide no resource protection advantages.

Recommendation #4: *The MBNMS recommends the implementation of a system of limited entry for kelp harvesting in DFG Kelp Bed #220.*

Discussion: The MBNMS believes that part of the solution to eliminating use conflicts and potential over-harvesting in portions of DFG Kelp Bed #220 is to put a cap on the number of harvesters in that bed. The MBNMS believes it is reasonable to recognize the existing harvesters of the area and their historical presence there. These are the harvesters that have already made extensive capital investments in the utilization of that area, and on whose business numerous livelihoods and other business endeavors depend.

The MBNMS understands that a limited entry management strategy for DFG Kelp Bed #220 may be complicated to develop given existing State law. The MBNMS recognizes that alternatives to achieve such action may be numerous. One possible alternative may be to limit the harvest in DFG Kelp Bed #220 to only those individuals who presently possess State kelp

harvesting licenses. All future licenses issued to new businesses would contain a clause that prohibits harvests in DFG Kelp Bed #220. The MBNMS is willing to work with the State to find the most acceptable legal solution to this issue.

Not adopting this recommendation leaves the potential for future harvesters to set up businesses and become dependent on DFG Kelp Bed #220 for their kelp. Such an action is undesirable.

Recommendation #5: *The MBNMS recommends that no hand-harvesting (including possession) of Nereocystis be allowed in the MBNMS between April 1 and August 31 (inclusive) of each year.*

Discussion: The MBNMS is concerned about the limited amount of *Nereocystis* that exists as a minor portion of some of the MBNMS's kelp beds. Although *Nereocystis* does not make up a large percentage of a kelp harvester's annual harvest, it can be actively targeted by some kelp harvesters who believe that it is a better abalone food than *Macrocystis*. The MBNMS believes that intensive repetitive harvesting of *Nereocystis* could lead to localized elimination of this annual plant by reducing its recruitment potential. Additionally, since the plant is an annual, and where *Nereocystis* comprises a significant portion of a bed, any harvesting can immediately eliminate the kelp canopy from an area for the rest of the recruitment year. Such actions would have significant affects upon the kelp bed ecology. California already restricts the harvest of *Nereocystis* north of Point Arguello by means of leasing and percentage limits for these reasons (Fred Wendell, pers. comm.). In those areas, lease owners are required to conduct intensive surveys of their *Nereocystis* beds to justify their harvest levels.

Nereocystis can be important to an abalone farm during the winter as drift kelp resource. In the winter, bull kelp dies off, just like much of the giant kelp is thinned in Central California. Harvesting it after it reproduces will not harm the production of sporophytes. Therefore, the MBNMS believes it is unnecessary to totally restrict *Nereocystis* harvests thoughout the year, but rather protect it before it has had a chance to reproduce. Once reproduction has occurred, the MBNMS believes allowing *Nereocystis* take is acceptable. For these reasons, the MBNMS is proposing a seasonal restriction of *Nereocystis* harvest during its peak reproductive period**.**

Presently, California limits *Nereocystis* harvests through a clause in its kelp bed leases that allows for only a 5% ratio of *Nereocystis* to *Macrocystis*. This allowance is reasonable in that a mechanical harvester cannot completely avoid every *Nereocystis* plant within a cutting swath. Therefore, the MBNMS is not concerned with small by-catch harvests of *Nereocystis* by mechanical harvesters. Because *Nereocystis* is not highly desirable for its alginate content and is difficult to harvest mechanically, the MBNMS believes the only harvests of *Nereocystis* that will occur will be below the existing 5% limit restricted in DFG kelp bed leases.

Alternatives to the MBNMS *Nereocystis* no hand-harvest recommendation would be to allow a different percentage (0-5%) of *Nereocystis* harvest to occur. The MBNMS believes such a regulation would be difficult to enforce. The MBNMS would like to see this activity stopped unless and until further research can demonstrate no significant effect from the limited harvesting.

Not adopting this recommendation would continue to allow hand-harvesters to take reproductive blades of *Nereocystis* plants during its peak reproductive season. Given the uncertainties to the ecology of the plant, such action is undesirable to the MBNMS. The MBNMS would like to see more research done on how localized harvesting of *Nereocystis* might affect this plant's distribution and abundance before agreeing to no limitations on its harvest.

Recommendation #6: *The MBNMS recommends that the State restrict annual harvest of any kelp bed available for harvest in the MBNMS to 50% of that bed's total maximum canopy cover.*

Discussion: The MBNMS believes that, given the uncertainties regarding the long-term ecological effects from intensive localized harvesting, some form of upper cap to the harvesting of a bed's canopy cover should exist. Determining what any particular bed's maximum cover could be accomplished using datasets from overflight studies. Given the canopy cover area and relative

density of a kelp canopy, a kelp tonnage figure could be estimated. The MBNMS proposes using this method to determine a bed's total allowable harvest level.

At the present time, there appears to be confusion in the public about the existing, so-called "50% Rule". The 50% rule is not in the state regulations or code, but appears in the language of most (if not all) kelp bed leases. However, the wording of the lease language may not be unambiguous enough to dissuade multiple interpretations. ISP Alginates presently interprets the language of their Central California kelp bed leases to mean that no bed can be harvested for more than 50% of its maximum canopy cover per year (Dale Glantz, pers. comm.). For open beds, where there is no lease language, several harvesters could, in multi-harvests, take more than 50% of a bed's canopy cover per year.

In order to reduce confusion on the issue, as well as to protect the open beds in the MBNMS in the same manner as Leased Beds, the MBNMS recommends that the FGC adopt regulatory language that forbids the annual harvest of a kelp bed's canopy in excess of its 50% maximum canopy cover. This rule will require closer ongoing harvest monitoring by DFG, especially in the case of open beds. However, the MBNMS believes the extra resource management effort would be worthwhile. When DFG determines that 50% of a kelp bed's maximum canopy cover has been reached (by converting 50% maximum canopy cover to a harvest tonnage, then comparing that figure to harvester reports), DFG should have the authority to close that kelp bed to harvesting for the rest of the harvest year. Based on kelp growth cycles, such a year is more properly from June to June, rather than January to January in central California.

There are numerous other alternatives to limit canopy harvests, such as setting a quota per DFG Kelp Bed, or per acre of canopy. Such alternatives would be difficult to specify, monitor and enforce.

One alternative recommended many times during the comment period process was to establish a lower limit percentage (e.g., 10%) of a kelp bed's maximum canopy cover, and then not allow harvest below that level. For example, a kelp bed may have a maximum harvestable canopy cover in August of 10,000 metric tons. In March of the following year, if the canopy was reduced to or below 1,000 (10%), all kelp harvesting in that bed would have to cease, regardless of the cause of the decline (natural or anthropogenic). The problem associated with such an alternative would be that it could stop all kelp harvesting during certain years along the entire coast. Such an action would be catastrophic to the kelp harvesting businesses, such as abalone mariculturalists, who have a need for a steady flow of abalone feed throughout the year.

Not adopting this recommendation would continue to allow for potential abuse, such as repetitive harvests that could affect a kelp bed's health.

Recommendation #7: *The MBNMS recommends that the State implement a more systematic method to collect, analyze and publish useful data on kelp harvesting. The MBNMS further recommends that the State resist any efforts to limit public access to kelp harvesting data.*

Discussion: DFG interpretation of existing State law is that all kelp harvesting data may be released to the public. Such information is vital for a full public discussion of how best to utilize and manage a public resource. Private companies may wish to have such information kept confidential for the purposes of competitive business dealings. However, where a publicly owned natural resource is concerned, the MBNMS believes the public's right to review such information takes precedence over such business concerns.

Additionally, if the public is going to be capable of discussing the best utilization of its kelp forests, it is incumbent upon the resource management agencies to disclose relevant information in a form that is useful and available to the public. The MBNMS believes that the information systems available in the last five years enables public agencies to make such efforts in a relatively inexpensive manner. Over the Internet, it is both possible to collect and disseminate kelp harvesting and other natural resource utilization information almost instantaneously. The MBNMS has committed itself to fully utilizing this technology where available, and believes other agencies should also. If necessary, DFG needs to ensure personnel resources are properly allocated so that those kelp harvesting data are released to the public in a timely manner.

Alternatives to a system where the kelp resource harvest data are not released, conditionally released, or released in a manner that is both functionally and temporally unusable, would limit an informed public decision making process, and is undesirable.

Recommendation #8: *The MBNMS recommends that DFG Beds #224, 225, 226 and 301 be closed to harvesting (Figure 10).*

Discussion: California retains the authority to totally close certain kelp beds that are either too small to sustain harvests, or contain a high percentage of *Nereocystis*. For these reasons, California presently bans harvest in several northern California beds (Beds #303, 304, 305, 306 and 307).

A review of the 1999 MBNMS overflight data and the 1989 DFG overflight data, lead the MBNMS to believe the beds near Pillar Point Harbor, where new abalone facilities are proposed, are not large enough to sustain any kelp harvesting. Although 1999 was an exceptional year for high kelp growth due to state-wide coastal upwelling, there were very sparse kelp canopies in these kelp beds. This observation is confirmed by the 1989 DFG data.

Not adopting this recommendation leaves a possibility that future harvesters may set up businesses and become dependent on kelp beds not suitable for long-term kelp harvesting operations. Such an action is undesirable.

Recommendation #9: *The MBNMS recommends that the State ensure its kelp management process evaluates the adequacy of current monitoring and enforcement of harvesting activities, and strengthens them where necessary.*

Discussion: The MBNMS believes the State should more regularly enforce kelp harvesting laws and regulations. From discussions with kelp harvesters, the MBNMS felt that harvesting operations are rarely checked for conformity to the management program. While the MBNMS does not know if there is any widespread disregard for the laws and regulations governing kelp harvesting, it is concerned that a large segment of the public believes that there is.

One example of the public's perception being different from the State's records is in regard to kelp harvest in DFG Bed #220. The State records only 142 tons of kelp were taken from this bed in 1999. However, much public testimony was received by the MBNMS stating that much more kelp is being harvested from that bed than is being reported. A more vigilant monitoring program could settle this disagreement.

Recommendation #10: *The MBNMS recommends that the State implement an education program on kelp forest ecology and sustainable kelp harvesting for a variety of audiences, including kelp harvesters and the general public.*

Discussion: The MBNMS was surprised in this process to learn about numerous misconceptions by the public of the natural history of kelp forests, and on the beneficial aspects of kelp harvesting as a sustainable industry. Public misconceptions about kelp forests, such as ecologically equating them to old-growth terrestrial forests, abound. Also, the public should recognize that kelp harvesting makes a significant contribution to California's and the nation's economy. Viewed as a form of agriculture that utilizes a renewable resource, the kelp harvesting industry can be perceived as environmentally friendly, which contributes to our local tourist industry, the reducation of the nation's trade imbalance (through abalone, sashimi and sodium alginate exports), and to our generally high standard of living.

Likewise, a sensitivity must exist on the part of the kelp harvesting industry. It needs to recognize the importance of the aesthetic value that kelp has for certain other industries, such as tourism, and take responsible action where necessary.

Finally, kelp harvesters and recreational users alike need to be more fully aware of the issues of "species of special concern," such as the sea otter. Anecdotal reports of sea otter harassment by harvesters, scientific investigators and recreational users may lead to regulations if it cannot be addressed through educational programs.

Recommendation #11: *The MBNMS recommends that the definition of "take" in the California Code of Regulations (Title 14, CCR, Chapt 1., Section 1.80) be amended to include plants.*

Discussion: This is a technical refinement of the regulations that would specify harvest and cutting of kelp as a "take," similar to catching or killing a fish.

6.0 Recommended Research Topics

The MBNMS recommends that the State of California, other public agencies, organizations and interested individuals work with the MBNMS to conduct regional research, or continue existing research on the following kelp resource management issues. Where appropriate, these recommended research items may be considered for funding by the MBNMS, and included in research and monitoring plans:

1) Effects of kelp harvesting on kelp forest systems, particularly on canopy fish species, and species of special concern, such as sea otters. Studies conducted on these species need to describe how kelp harvesting may be affecting various aspects of the sea otters' utilization of kelp forests at various stages of their life history. For example, how may kelp harvesting be affecting sea otters use of kelp forests for reproduction, foraging, transiting and resting;

2) Effects of nearshore development projects and other terrestrial activities on kelp forests;

3) Monitoring programs, including continuation of current aerial surveys, as well as underwater transect surveys, to assess natural temporal fluctuations of kelp beds along the MBNMS, as well as any effects being caused by harvesting;

4) Geographical Information System (GIS) datasets on the nearshore geology in the MBNMS;

5) Different effects associated with different methods of kelp harvesting;

6) Alternative harvesting techniques that minimize environmental impacts;

7) Effects of non-extractive human activities (e.g., water pollution, diving, boating) on kelp forests;

8) Effects of kelp harvesting on kelp holdfasts;

9) Localized effects of intensive *Nereocystis* harvesting;

10) Artificial abalone feeds;

11) Kelp forest enhancement projects, including the possibility of artificial reefs and no-take zones;

12) Socio-economic studies on the different human uses of kelp resources;

13) Resource stress criteria for determining kelp bed closures; and,

14) A published estimate on the amount of kelp needed by an abalone mariculture facility operating in California given a certain number of abalone of various size classes.

7.0 Recommended Allocation of Agency Resources for Management

It is important that any management regime have a adequate allocation of management resources to fulfill the mandate. The MBNMS is concerned that, due to other pressing resource management issues, the State has not, to date, allocated sufficient resources to kelp management.

It is the understanding of the MBNMS that DFG presently allocates less than one FTE (full time equivalent) employee to ongoing kelp resource management. This part-time FTE is generally responsible for data input. When issues arise in kelp management, or when it is time to review the management regime every five years, DFG brings in biologists from other programs to review and update the management regime.

Additionally, DFG monitors the kelp resource with the use of kelp bed overflight information (harvest independent data), and collection of harvest data (harvest dependent data). DFG conducted a kelp bed overflight in the fall of 1999. Previous to that, DFG conducted an overflight of the kelp beds in 1989. These overflights, similar to the overflight study conducted by the MBNMS in the fall of 1999, give the resource manager information on maximum kelp canopy cover. This information is useful and necessary to determine whether kelp beds are changing significantly. If kelp beds do change over time, the changes could be due to natural fluctuations (e.g., El Ninos), or anthropogenic causes (e.g., overharvesting, pollution and sedimentation). If changes are observed, investigations should be initiated to determine the cause.

On an ongoing basis, the MBNMS believes that DFG needs to allocate at least two, and perhaps as many as three, Full-Time Employees (FTEs) to the issue of kelp management for the entire State's coast. One of these positions can continue to be responsible for data management (both harvest dependent and independent data). It would be desirable for this person to have experience in html, and close access to an internet server so information on kelp harvesting could be made public in a useful and timely manner. Another FTE should be a kelp ecologist responsible for conducting and managing contracted studies on kelp harvesting impacts; both ecological and social impacts. Finally, a third FTE could be a manager of the other two FTEs, assisting and overlapping the other two FTEs, ensuring proper regulatory compliance by enforcement personnel, conducting public kelp forest education and outreach efforts, and coordinating with other resource management units in the nearshore environment.

The MBNMS believes that more needs to be done on kelp bed monitoring. Within kelp beds, the MBNMS believes DFG should initiate long-term monitoring studies that will provide information on the effects of kelp harvesting on the kelp bed's overall ecology. With regard to overflights, at a minimum, there should be two state-wide kelp bed overflights per year. One overflight should be made during the kelp maximum (Summer-Fall) and the other at the kelp minimum (Winter-Spring). The MBNMS also encourages DFG to assess the utility of a new overflight imaging technology called "hyperspectral analysis." By assessing reflected light, this method may be able to assess subsurface kelp canopies, other submerged algae, and plant health.

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