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Research Activity Panel
Monterey Bay National Marine Sanctuary
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August 27, 2001

Kaitilin Gaffney, Co-Chair and Members of the
Monterey Bay National Marine Sanctuary
Conservation Working Group
The Ocean Conservancy
55 C Municipal Wharf
Santa Cruz, CA 95060

Dear Ms. Gaffney and Members of the Conservation Working Group:

I am writing in response to your letter to the MBNMS Research Activity Panel (RAP), dated June 29, 2001, which asked several questions related to conservation implications of marine reserves. In general, we believe the set of questions are important and the RAP is interested in working with the Conservation Working Group (CWG) in providing existing information. The questions asked are very basic and fundamental to resource management. Unfortunately, there is not an existing comprehensive characterization and monitoring program available to address all of these questions. We are, however, looking forward to the Sanctuary Integrated Monitoring Network (SIMoN) to provide this comprehensive information, and appreciate the strong support of CWG and SAC for this program. With regards to your questions, we will try to identify existing knowledge, where some information is available, or how the MBNMS is attempting to acquire the needed information. We have renumbered your questions 1 to 6 and listed your original question in italics.

1. *What is the current status of Sanctuary marine resources*
 - a. *species diversity*
 - b. *habitat diversity*

Two short papers stress how little we really know about marine biodiversity in central California and emphasize the need for more comprehensive long-term surveys in all marine habitats, increased support for museums, increased training of taxonomists, development of non-destructive survey techniques, and studies on the role of sanctuaries, refuges, and reserves in enhancing biodiversity.

- Cailliet, G.M. 1998. Marine biodiversity in central California and the role of marine sanctuaries. Pages 93-103, *In*: N. Chiariello and R.F. Dasmann (editors), Proceedings, Symposium on Biodiversity of the Central California Coast, March 3-5, 1995. Association for the Golden Gate Biosphere Reserve.
- Cailliet, G.M. 1998. What do we really know about marine biodiversity in central California? Pages 1394-1409 *In*: California and the World Ocean '97, Proceedings of the Conference, American Society of Civil Engineers, San Diego, CA.

The Sanctuary Advisory Council's Research Activity Panel is comprised of 22 representatives from government agencies, research organizations, and academic institutions concerned with the resources of the Monterey Bay National Marine Sanctuary. The Research Activity Panel advises the Council and Sanctuary Superintendent on matters of scientific and research related policies and provides a link between the community and Sanctuary management.



Information about the various habitats within the Sanctuary and the status of species is included in the Sanctuary's annual reports, Ecosystem Observations,

- Ecosystem Observations: MBNMS Annual Report 1998
<http://www.mbnms.nos.noaa.gov/Educate/newsletters/1999Eco/index.html>
- Ecosystem Observations: MBNMS Annual Report 1999
<http://www.mbnms.nos.noaa.gov/Educate/newsletters/2000Eco/index.html>
- Ecosystem Observations: MBNMS Annual Report 2000
<http://www.mbnms.nos.noaa.gov/Educate/newsletters/ecosystem2000/index.html>

as well as, information on biological communities and species lists in the MBNMS Site Characterization.

- MBNMS Site Characterization
Guerrero, J. and R. Kvitek (editors). 1996. Monterey Bay National Marine Sanctuary Site Characterization. MBNMS Technical Report.
<http://www.mbnms.nos.noaa.gov/sitechar/index.html>

In preparation for the Management Plan Review, the MBNMS is compiling a document for the general public, The State of the Sanctuary Report. This document will include the status of natural resources since Sanctuary designation in 1992, including identification of resources that have improved or degraded, and how our understanding of resources has improved or is still poorly known. Unfortunately, the detailed information you may be looking for will not be in this general document.

In addition, several of the answers to the CWG's questions listed below contain documents that apply to your first question.

2. What are the trends of exploited species and biodiversity in fished areas of the Sanctuary over the last 10-30 years?

We don't have information on trends of biodiversity. Several publications, however, do provide information on species characterizations at a point in time and recent trends of exploited species. Therefore, this question can be partially answered with information from the following publications.

- MBNMS Site Characterization
Guerrero, J. and R. Kvitek (editors). 1996. Monterey Bay National Marine Sanctuary Site Characterization. MBNMS Technical Report
<http://www.mbnms.nos.noaa.gov/sitechar/index.html>
- Fishery Resources of the Monterey Bay National Marine Sanctuary
Starr, R.M., K.A. Johnson, E.A. Laman, and G.M. Cailliet. 1998. Fishery Resources of the Monterey Bay National Marine Sanctuary. California Sea Grant College System, University of California, La Jolla. Publication No. T-042.
- MBNMS Kelp Management Report
<http://bonita.mbnms.nos.noaa.gov/research/techreports/Kelpreportfinal/index.htm>

- Marine Fishery Profiles (Volume 1: Nearshore) by the California Department of Fish and Game, Marine Region GIS lab
Wright, N., J. Kum, C. King, E. Knaggs, B. Leos, and C. Perez. 2000. Marine Fishery Profiles, Volume 1: Nearshore, Version 1. California Department of Fish and Game, Marine Region.
- numerous National Marine Fisheries Stock Assessments
- and CalCOFI Database of fish larvae (as a proxy for year class strength)
<http://www.calcofi.org/data/data.html>

In addition, several other publications or surveys are in progress

- An update to Rick Starr's Fishery Resources of the Monterey Bay National Marine Sanctuary which will include landings data from 1995-2000.
- California Living Marine Resources book by Leet et al.. This book will have additional information about the status of fishery species in California. Information from Leet et al. and Starr et al. can be used to compare trends in MBNMS with all of California.
- Stock assessments conducted by the Pacific Fishery Management Council.
- Information generated by the California Department of Fish and Game for its Nearshore Fishery Management Plan.

3. *Has there been a correlation between the decline of exploited species, unexploited species, and/or biodiversity in general within the Sanctuary and ocean productivity? With fishing activity?*

This question is based on whether there has been a change in ocean productivity. There has been a correlation between primary productivity and other marine resources. Four potential sources of information include

- Ocean climate research by the Pacific Fisheries Environmental Lab (PFEL) Research Team (including Richard Parrish, Roy Mendelsohn, Frank Schwing, and Jan Mason). The PFEL website is very informative on how fish populations (e.g. anchovy, sardine, salmon) may respond to climate variability (short-term, decadal, and long-term).
<http://www.pfeg.noaa.gov/research/climatemarine/>
http://www.pfeg.noaa.gov/research/fishery_clim/fishery_clim.html
- Ocean productivity research by Francisco Chavez and others at the Monterey Bay Aquarium Research Institute. This decade-long time series of data has allowed MBARI researchers to understand and document the interrelations between the variables that control phytoplankton production in Monterey Bay.
<http://www.mbari.org/rd/projects/2000/upperocean/biochemical.html>
- Trophic links in upwelling systems research by Don Croll and Baldo Marinovic at University of California Santa Cruz, Scott Benson at Moss Landing Marine Laboratories, and others. This study examines the relationship between foraging ecology of marine birds and mammals and coastal upwelling dynamics along the California coast.
http://www.mbnms.nos.noaa.gov/Research/techreports/TRbenson_3.html
<http://bonita.mbnms.nos.noaa.gov/research/techreports/whalereport/index.html>

- and CalCOFI Data
<http://www.calcofi.org/data/data.html>

There is an increasing amount of information available that confirms the concept that global climate change causes major changes in oceanographic conditions. These "Regime Shifts" have a direct effect on the survival of many species. The research that has been done in this area primarily discusses changes in coastal ocean productivity and resulting changes in biomass of fished species. For example, see:

- Beamish, R.J. and G.A. McFarlane (eds.). 1989. Effects of ocean variability on recruitment and an evaluation of parameters used in stock assessment models. Canadian Special Publication of Fisheries and Aquatic Sciences 108. 379 pp.
- Beamish, R.J. and D.R. Bouillon. 1993. Pacific salmon production trends in relation to climate. Canadian Journal of Fisheries and Aquatic Sciences 50: 1002-1016.
- Beamish, R.J., D. Noakes, G.A. McFarlane, L. Klayshtorin, V.V. Ivanov, and V. Kurashov. 1999. The regime concept and natural trends in the production of Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences 56: 516-526.

There have been several downward trends in fish catches over the years [see Starr et al. (1998) and their new updated publication available soon]. In addition, catches (hence either productivity or availability) of such things as salmon, squid, and others change radically with El Niño and La Niña phenomena. But there are few quantitative data available to actually test the hypothesis of cause and effect. Starr et al.'s update of Fishery Resources will include landings data along with changes in fishing regulations and effort. This may provide insight into any correlation between increases or decreases in exploited and unexploited species.

A new article in Science claims that ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems, including pollution, degradation of water quality, and anthropogenic climate change. The study examines paleoecological, archaeological, and historical data, which show that time lags of decades to centuries occurred between the onset of fishing and consequent changes in ecological communities. The article notes ecological community changes around the world, including the widespread reduction in the number of trophic levels and deforestation in the kelp forest ecosystem in the northern Pacific and southern California due to population explosions of herbivores following the removal of apex predators by fishing.

- Jackson, J.B.C., et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293:629-638.

Other scientists, however, emphasize the importance of climate fluctuations and sources of species harvest besides fishermen.

4. *What are the trends of exploited and unexploited species within the Hopkins and Point Lobos marine reserves over the last 10-30 years?*

Several publications contain information of invertebrate and fish species abundance, density, and size distribution information within marine reserves in the Monterey Bay area.

- Intertidal species composition studies at Hopkins Marine Life Refuge

Barry, J.P., C.H. Baxter, R.D. Sagarin, and S.E. Gilman. 1995. Climate-related, long-term faunal changes in a California Rocky Intertidal Community. *Science* 267:672-675.

Between the period 1931 to 1933 and the period 1993 to 1994, there has been an increase in the relative abundance of warmer water invertebrate species on the rocky intertidal community at Hopkins Marine Station, consistent with the predictions of change associated with climate warming.

Sagarin, R.D., J.P. Barry, S.E. Gilman, and C.H. Baxter. 1999. Climate-related change in an intertidal community over short and long term scales. *Ecological Monographs* 69:465-490.

Between the period 1931 to 1933 and the period 1993 to 1996, the abundance of macroinvertebrates changed in a rocky intertidal community at Hopkins Marine Station, consistent with the predicted effects of climate warming.

- Kelp forest fish population surveys at Hopkins Marine Life Refuge, Point Lobos State & Ecological Reserve, and Big Creek Marine Ecological Reserve

Paddock, M.J. and J.A. Estes. 2000. Kelp forest fish populations in marine reserves and adjacent exploited areas of central California. *Ecological Applications* 10:855-870.

Density and size distribution of ten species of kelp forest fishes were compared between three marine reserves and adjacent exploited areas. The average length of four rockfish species was significantly greater within Hopkins and Point Lobos reserves, as well as the proportion of larger fish.

- SCUBA diver surveys of rockfish at Big Creek Ecological Reserve

VenTresca, D.A., M.L. Gingras, J. Ugoretz, A. Voss, S. Blair, J. Plant, R. Hornady, and C. Yoshiyama. 1998. The potential of marine reserves to enhance fisheries. Pages 400-411 In O.T. Magoon, H. Converse, B. Baird, and M. Miller-Henson, eds. *California and the World Ocean '97. Taking a Look at California's Ocean Resources: An Agenda for the Future*. ASCE, Reston, Virginia.

Densities of rockfishes and length frequency of gopher rockfish were significantly greater within Big Creek Marine Ecological Reserve than in adjacent areas

- SCUBA diver surveys of rockfish at Point Lobos conducted by a high school teacher and students, in collaboration with Sustainable Seas Expedition

Carmel High School teacher, Michael Guardino, and students conducted 200 research dives inside and adjacent to the Point Lobos Reserve in Carmel Bay. They created a database that describes the abundance, diversity, and age structure of resident fish populations. The students found significant differences between the assemblage of fishes at Whalers Cove and South Monastery Beach after completing site characterizations and analyses of sessile invertebrate life.

<http://www.mbnms.nos.noaa.gov/Research/currents00.html#highschool>

There are several studies in progress that are attempting to answer questions of long-term changes or trends within these areas

- A subtidal kelp community structure survey by Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) at Hopkins Marine Life Refuge and Point Lobos State Reserve
<http://www.piscoweb.org/research/community/index.html>
- A comparative intertidal study and user survey of Point Piños tidepools in Pacific Grove by TENERA Environmental, LLC. Study sites will be compared to similar sites at Point Lobos and Hopkins
- The Sanctuary is providing funding for a review of the effectiveness of several marine reserves within the Sanctuary, written by Rick Starr (California Sea Grant) and others. This report is scheduled for completion in October 2001.

In addition, there are several sources of data that may be useful to determine species trends (including exploitation).

- US Geological Survey California Sea Otter Surveys
<http://www.werc.usgs.gov/otters/ca-surveys.html>
- Diver fish counts (including Great American Fish Count)
<http://www.reef.org/data/pac/surveys/index.shtml>
- Poaching records at the Pacific Grove Police Department

5. *What caused these trends?*

Long-term trends at these two areas are still under investigation, as well as, their causes. Global warming, water quality, fishing, regime shifts, and natural variability can all be factors causing changes in species diversity, abundance, and composition; but the precise cause(s) are not yet determined. Changes in species trends, however, have been correlated with changes in ocean climate.

- Changes in invertebrate species abundance and species ranges at local sites (full citations provided in answer #4)
 - Sagarin et al. 1999
 - Barry et al. 2000
- Decadal regime shifts: Expansion and collapse of sardines and anchovies in response to changes in ocean climate (info on PFEL website)
<http://www.pfeg.noaa.gov/research/climatemarine/cmffish/cmffishery4.html>
- Long-term climate variability and fisheries fluctuations (sardines and anchovies): Historical variability of fish populations from sediment records in the Santa Barbara basin (info on PFEL website)
<http://www.pfeg.noaa.gov/research/climatemarine/cmffish/cmffishery8.html>

6. *What are the potential management measures to reverse adverse trends?*

This is not a question that the RAP can answer, but more of a management resource protection issue. The focus of the RAP is increasing our understanding of the ecosystem of the MBNMS. Management measures are controls on human activity, which is outside the scope of RAP discussions.

In your letter you note the need for marine reserves as “control” sites for assessing potential impacts of human activities on marine ecosystems. The optimal experimental design would require establishing more than one study site within an area that will be designated as a marine protected area, AND more than one study site in an area as similar as possible to the marine protected area but without the restrictions on human activity. These study sites would need to be set up prior to the designation, so that baseline data could be gathered on trends in both sites before human activity is controlled in one of the sites. Data gathering would continue in both sites with the establishment of protective measures in the marine protected area. Data analysis would follow a form of the B.A.C.I. (Before After Control Impact) experimental design to determine effects of controlling human activity.

The concept of setting up control sites to evaluate the potential impacts of human activities on ecosystems is just one component of research needed to evaluate the effects of a particular management action such as marine reserves. There is a large body of literature that discusses the science and management of marine reserves. For a summary, see

National Research Council. 2001. Marine Protected Areas: Tools for sustaining ecosystems. Committee on the evaluation, design, and monitoring of marine reserves. National Academy Press, Washington, D.C. 272 pp.

In summary, your letter broadly asked if there is evidence for changes in species and habitat diversity and abundance in the MBNMS, and asked if any observed changes could be linked to either natural variation or human activities. Such broad questions are difficult to answer. Differentiating anthropogenic changes from changes caused by natural variation usually requires long-term, interdisciplinary studies that are focused on a narrow topic. Long-term monitoring programs are difficult to fund and keep intact. The MBNMS research staff, with the help of the RAP, developed a broad scale strategy (the SIMoN project) for monitoring that combines new funding with existing long-term data collection programs that are currently in place. We are hopeful that increased monitoring of sanctuary resources will provide information useful for evaluating differences between anthropogenic and natural change.

Sincerely,



Chris Harrold, Ph.D.
Chair

Sub-Committee members

Erica J. Burton
Gregor M. Cailliet
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