Exhibit G.1
Situation Summary
June 2004

FEDERAL WATERS PORTION OF THE CHANNEL ISLANDS NATIONAL MARINE SANCTUARY – SCHEDULE UPDATE

Situation: The Pacific Fishery Management Council (Council) is scheduled to receive an update from Channel Islands National Marine Sanctuary (CINMS) about CINMS development of analytical documents and schedule for consideration of marine reserves within federal waters of CINMS. The most recent schedule revision is shown in exhibit G.1.b, Attachment 1, CINMS Marine Reserves Process Schedule as of November, 2003.

On Tuesday, June 15, the Scientific and Statistical Committee (SSC) is scheduled to review preliminary draft CINMS documents that will form a basis of a formal draft environmental impact statement (DEIS) at some point in the future. The SSC will report their initial findings and recommendations to the Council, in the context of providing information for the Council to facilitate discussion of the updated schedule proposed by CINMS. The Habitat Committee (HC) and Groundfish Advisory Subpanel (GAP) will also review information from CINMS. Similarly the HC and GAP may provide advice to the Council relative to the updated schedule proposed by CINMS. Preliminary draft CINMS documents that will be reviewed by Council advisory bodies are included under Exhibit G.1.b, Attachment 2.

Based on information provided by CINMS and the advice of the SSC, HC, GAP, the Council should consider how to coordinate with CINMS to meet their proposed schedule. This could include convening the Council's Ad Hoc Channel Islands Marine Reserves Committee in preparation for potential action at the September 2004 Council meeting. Such a meeting would consider the substantive reports of the Council advisory bodies on the CINMS draft documents (including the Coastal Pelagic Species Advisory Subpanel (CPSAS) and Salmon Advisory Subpanel (SAS) that would need to review the material after the June Council meeting) and any further information provided by the CINMS, towards a Committee recommendation on the range of proposed management alternatives at the September 2004 Council meeting.

Council Task:

1. Council Discussion and Guidance on CINMS Schedule.

Reference Materials:

1. Exhibit G.1.b, Attachment 1: CINMS Marines Reserves Process Schedule as of November, 2003.
2. Exhibit G.1.b, Attachment 2: CINMS Preliminary Draft Analytical Documents (electronic copy on CD-ROM).
3. Exhibit G.1.d, Public Comment.

Agenda Order:

a. Agendum Overview — Dan Waldeck
b. Schedule Update by CINMS Staff — Sanctuary Staff
c. Reports and Comments of Advisory Bodies
d. Public Comment
e. **Council Action:** Council Discussion and Guidance on CINMS Schedule

PFMC
06/01/04

Exhibit G.1.b
Attachment 2
June 2004

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

Donald K. Hansen, Chairman
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, OR 97220-1384

Dear Chairman Hansen - Don

In keeping with our commitment to work collaboratively with the Pacific Fishery Management Council (PFMC), please find attached for your review the *Staff Preliminary Working Draft Environmental Document For Consideration Of A Network Of Marine Reserves And Marine Conservation Areas Within The Channel Islands National Marine Sanctuary (CINMS)*. This document, which is an initial draft and does not represent the views or policies of NOAA or the Department of Commerce at this time, is an initial building block for the development of a Draft Environmental Impact Statement (DEIS). As we go forward with the development of the DEIS, we are seeking your comments on this early draft. We hope to ensure that 1) the alternatives, analyses, methodologies, and data sources under development are sound; and 2) the range of alternatives under consideration is adequate.

It is important to note that this working draft presents only an initial range of the alternatives being considered by CINMS. As developed thus far, these alternatives may contain gaps and inconsistencies and some ideas may not be fully developed. In addition, several sections of the document identify "place holders" where additional material or source information will be provided as the DEIS is developed. With your input, the CINMS will continue to refine the alternatives as it prepares the DEIS.

As such, we encourage you to read the document thoroughly and to prepare written comments for the CINMS manager. To facilitate these comments, we will provide the PFMC and the Sanctuary Advisory Council (as well as their respective designated committees and working groups) with a range of suggested review questions. In addition, public comment on this preliminary document may be taken during the respective public comment sessions at the September 12-17 meeting of the PFMC and the September 24 meeting of the Sanctuary Advisory Council (SAC).

Thank you for your continued interest and engagement in this important process. We look forward to working with you during the development of the DEIS. For further information, please contact CINMS manager Chris Mobley at (805) 884-1465 or chris.mobley@noaa.gov.

Sincerely,

Daniel J. Basta,
Director
National Marine Sanctuary Program

Enclosure

cc:
Donald McIsaac. PFMC
Patricia Wolf, California Department of Fish and Game
Russell Galipeau, Channel Islands National Park
Rod McInnis, NOAA Fisheries
Matthew Cahn, Channel Islands National Marine Sanctuary Advisory Council

Staff Preliminary Working Draft Document for Consideration of a Network of Marine Reserves and Marine Conservation Areas within the Channel Islands National Marine Sanctuary

Disclaimer
This preliminary working draft is a staff prepared document and does not represent the views or policies of NOAA or the Department of Commerce at this time. It was prepared primarily for the purpose of eliciting comments from the Pacific Fishery Management Council, Sanctuary Advisory Council and general public and should not be cited. Major portions of it are incomplete and several sections contain "place holder material." Nevertheless, we encourage those interested in this important issue to read the document thoroughly and provide written commentary to the National Marine Sanctuary Program.

For Further Information:

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Table of Contents

1. Need and Purpose for Action

1.1. Overview of the Sanctuary

1.1.1. The National Marine Sanctuary Program

Under the National Marine Sanctuaries Act as amended, 16 U.S.C. sec. 1431-1445b, (NMSA), the Secretary of Commerce (Secretary) is authorized to designate and manage areas of the marine environment as national marine sanctuaries. Such designation is based on attributes of special national significance, namely, conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or aesthetic qualities. The primary objective of the NMSA is to protect sanctuary resources.[1]

The National Marine Sanctuary System of 13 national marine sanctuaries and one coral reef ecosystem reserve comprise a federal system of marine protected areas administered by the National Oceanic and Atmospheric Administration's (NOAA) National Marine Sanctuary Program (NMSP). Their designation provides protection for sensitive marine areas, such as coral reefs and kelp forests, habitat used by important marine species, and historically significant shipwrecks and artifacts. In addition, these areas are intended to serve as valuable educational, recreational, and scientific resources.

1.1.2. The Channel Islands National Marine Sanctuary (Sanctuary)

The Sanctuary was designated in 1980 to protect the rich and diverse range of marine life and habitats, unique and productive oceanographic processes and ecosystems, and culturally significant resources. The Sanctuary area is approximately 1,252.5 square nautical miles (NM) adjacent to the following islands and offshore rocks: San Miguel Island, Santa Cruz Island, Santa Rosa Island, Anacapa Island, Santa Barbara Island, Richardson Rock, and Castle Rock (collectively the Islands), extending seaward to a distance of 6 nautical miles. The Sanctuary attracts significant human uses as well, including commercial and recreational fisheries, marine wildlife viewing, boating and other recreational activities, research and monitoring activities, numerous educational activities, maritime shipping, and nearby offshore oil and gas development.

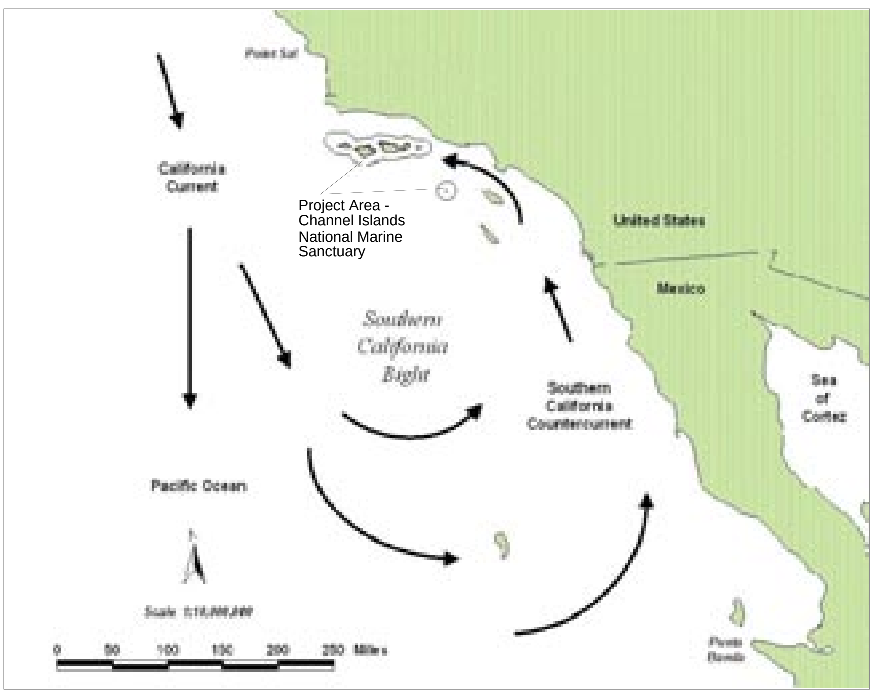
The waters surrounding California's Channel Islands represent a globally unique and diverse assemblage of habitats and species. This region is a subset of the larger ecosystem of the Southern California Bight, an area bounded by Point Conception in the north and Punta Banda, Mexico in the south (Daily et al. 1993); please see Figure 1-1. In the area between Santa Barbara Island in the south and San Miguel Island in the northwest the colder waters of the Oregonian oceanic province in the north converge and mix with the warmer waters of the Californian oceanic province. Each of these two provinces has characteristic oceanic conditions and species

[1] Sanctuary resource means any living or nonliving resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, educational, cultural, archeological, scientific, or aesthetic value of the sanctuary. (16 U.S.C. sec. 1432 (8)).

assemblages, which in turn are parts of distinct biogeographic regions. The mixing of these two provinces in the vicinity of the Channel Islands creates a transition zone within the island chain. Upwelling and ocean currents in the area create a nutrient rich environment that supports high species and habitat diversity.

This rich oceanic and island area is afforded protection at multiple levels of government. In 1980 the waters from mean high water to 6 nautical miles offshore around five of the Channel Islands (San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara islands) were designated as a National Marine Sanctuary by the Department of Commerce. Also in 1980, the islands themselves were designated a National Park by the Department of the Interior. (The Park's jurisdiction extends to one nautical mile offshore of the islands, overlapping the Sanctuary's jurisdiction.) In 1986 the United Nations Educational, Scientific and Cultural Organization (UNESCO) Programme on Man and the Biosphere designated the Channel Islands Biosphere Reserve as part of the international network of Biosphere Reserves.

Figure 1-1. Southern California Bight and the Project Area



1.2. Need for Action

In the Southern California Bight marine resources have declined under pressure from a variety of factors, including commercial and recreational fishing, changes in oceanographic conditions associated with El Niño and other large-scale oceanographic cycles, introduction or increased prevalence of disease (e.g. domoic acid), and increased levels of pollutants (e.g., Dugan and Davis 1993, PFMC 2000).

The urbanization of southern California has significantly increased the number of people visiting the coastal zone and using its resources. This has increased human demands on the ocean, including commercial and recreational fishing, and wildlife viewing and other activities. A burgeoning coastal population has also greatly increased the use of our coastal waters as receiving areas for human, industrial, and agricultural wastes (references to follow). In addition, new technologies have increased the efficiency, effectiveness, and yield of sport and commercial fisheries (references to follow). Concurrently there have been wide scale natural phenomena such as El Niño weather patterns, oceanographic regime shifts, and dramatic fluctuations in pinniped populations (references to follow).

The significant changes in ecological conditions resulting from the array of human activities in the Channel Islands region are just beginning to be understood. There have been significant shifts in the historic environmental baseline conditions that are only now being recognized. For example, many kelp beds have become urchin barrens, where urchins and coralline algae have replaced kelp as the dominant feature (references to follow). Deeper canyon and rock areas such as the Footprint region that were formerly rich rockfishing grounds are now almost devoid of larger rockfish such as cowcod and bocaccio (references to follow). The previous management approaches that focused on individual threats, such as pollution, or on individual species, such as lobster or marine mammals, have not been able to adequately account for and prevent significant changes to the area's ecosystem, including non-harvested species and their habitat.

In the Channel Islands area, commercial and recreational fisheries target more than 100 fish species and more than 20 invertebrate species (references to follow). Targeted species have exhibited high variability in landings from year to year (e.g., squid) and in several cases have declined to the point that the fishery has had to be shut down (e.g., abalone) (references to follow). Many targeted species are considered overfished and one previously targeted species (white abalone) is listed as endangered (references to follow). Many former natural refuges for targeted species, such as submarine canyons, submerged pinnacles, deep waters, and waters distant from harbors, can now be accessed due to advancements in fishing technology and increased fishing effort (Agardy et al. 2003). Bycatch has caused declines of some non-targeted species (references to follow). The removal of species that play key ecological roles, such as predatory fish, has altered ecosystem structure (references to follow). Some types of fishing gear have caused temporary or permanent damage to marine habitats (references to follow). The combination of direct take, bycatch, indirect effects, and habitat damage and destruction has contributed to a transformation of the marine environment around the Channel Islands. Additional detail on the status of marine species in the Channel Islands and the extent of human activities is provided in Chapter 4 - Affected Environment and Appendix C, Status of Human Uses.

All of the above factors play a role in contributing to the current decline in ecosystem integrity. In the regional community, there is much interest in better understanding the effects of the individual factors and their interactions, to reverse or stop trends of resource decline, and to restore the integrity and resilience of impaired ecosystems. (provide more discussion with specific examples of ongoing efforts by other sectors in research and management to address these issues).

The NMSA states that "while the need to control the effects of particular activities has led to enactment of resource-specific legislation, these laws cannot in all cases provide a coordinated and comprehensive approach to the conservation and management of special areas of the marine environment" (16 U.S.C. sec. 1431(a)(3)). Therefore, the NMSP system will improve the conservation and management of marine resources and will "maintain for future generations the habitat, and ecological services, of the natural assemblage of living resources that inhabit these areas" (16 U.S.C. sec. 1431(a)(4)(A), (C)). The NMSA charges the NMSP to take a broad and comprehensive management approach to achieve the NMSA's primary objective of resource protection. The focus of such an approach is on broad-scale, ecosystem-level (i.e., as opposed to single species or single issue) protection and management, which is essentially unique among the various agencies and laws that manage marine resources.

Like all national marine sanctuaries, the Sanctuary is mandated to both "protect…the natural habitats, populations and ecological processes" (16 U.S.C. sec. 1431(b)(3)) of the Sanctuary and "facilitate to the extent compatible with the primary objective of resource protection, all public and private uses of the resources of [the Sanctuary] not prohibited pursuant to other authorities" (16 USC 1431(b)(6)). Sanctuary staff recognize and support the fact that each year thousands of people come to the Sanctuary to work and play, and that the area's resources are an important part of individual livelihoods and recreation. Managed correctly, use and enjoyment of the Sanctuary can continue to thrive for generations to come.

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1.3. Purpose for Taking Action

Given the needs discussed above, the NMSP is considering action under the NMSA to address the following purposes:

- To ensure the long-term protection of Sanctuary resources by restoring and enhancing the abundance, density, population age structure and diversity of the natural biological communities.
- To protect, restore and maintain functional and intact portions of natural habitats, (including deeper water habitats), populations and ecological processes in the Sanctuary.
- To provide, for research and education, undisturbed reference areas that include the full spectrum of Sanctuary habitats where local populations exhibit a more natural abundance, density, diversity and age structure.
- To set aside, for intrinsic and heritage value, representative habitats and natural biological communities.

- To complement the protection of Sanctuary resources and habitats afforded by the State of California's marine reserves and marine conservation areas.
- To create models of and incentives for ways to conserve and manage the resources of the Sanctuary.

2. Background and History

2.1. Environmental Setting

The Sanctuary supports a rich and diverse range of marine life and habitats, unique and productive oceanographic processes and habitats, and culturally significant resources such as hundreds of shipwrecks and submerged Chumash cultural artifacts. This diversity, along with the busy Santa Barbara Channel, also brings significant human use and value to Sanctuary waters, including commercial fisheries, recreational fishing opportunities, marine wildlife viewing, boating and other recreational activities, maritime shipping, nearby offshore oil and gas development, research and monitoring activities, and numerous educational activities. For more details, see Chapter 4: Affected Environment.

2.2. Management Setting

In the Channel Islands region there are more than 10 local, state, and Federal management bodies that exercise some jurisdiction and authority over the natural and cultural resources, and certain human uses. Key entities include the:

- Channel Islands National Marine Sanctuary
- NOAA Fisheries (National Marine Fisheries Service; NMFS)
- Pacific Fishery Management Council (PFMC)
- Channel Islands National Park (CINP)
- California Department of Fish and Game (CDFG)
- United States Coast Guard (USCG)
- Minerals Management Service (MMS)
- California State Lands Commission
- California Coastal Commission
- Santa Barbara and Ventura Counties

Ocean managers have employed a wide array of management tools in the Channel Islands region for a variety of management purposes (conservation, utilization, etc.).

2.2.1. Federal Fishery Management

Fishery managers use fishing seasons and gear type restrictions, size and bag limits, temporary area closures and other effort control measures to manage commercial and recreational harvests. These management approaches are typically developed and targeted toward achieving maximum sustainable yield or optimal yield of a single species (e.g.. squid) or complex of species (e.g., groundfish). This has resulted in a complex fishery management system (see Appendix C for an overview of existing fisheries management). The range of stocks and species managed for harvest by the CDFG in state waters and the PFMC and NMFS in federal waters extends well beyond Sanctuary boundaries.

Under the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. sec. 1801-1883, (Magnuson-Stevens Act), the PFMC has significant authority over all species of fish from three to 200 nautical miles offshore. Generally, the Council recommends regulations only for species that have a federal fishery management plan (FMP) that has been prepared by the Council and approved by NMFS. For the west coast (Washington, Oregon and California), Federal FMPs have been reviewed for compliance with federal law and approved by NMFS for groundfish, salmon, and coastal pelagic species. The Groundfish Essential Fish Habitat EIS in draft by the National Marine Fisheries Service includes analysis of area fisheries closures as a potential management measure. An FMP for highly migratory species has recently been adopted by the Council but has not yet been approved by NMFS. For species not covered by an FMP, the Council could propose emergency regulations to be effective for up to one year, while it develops an FMP. The Council can also impose certain restrictions on the take of FMP species in non-FMP fisheries. Under the Magnuson-Stevens Act, the Council can and does recommend to NMFS fishing regulations that are also in effect within National Marine Sanctuaries, but only for FMP species. (PFMC website)

The Council's list of objectives, although focused on individual species or stocks, bears some relationship to the Sanctuary's stated purposes. These objectives are:

- Biological Productivity. Enhance long-term biological productivity.
- Insurance. Provide protection for the resource, as a hedge against the realities of management uncertainty and the effects of natural environmental variability.
- Habitat Protection. Conserve and protect essential fish habitat.
- Research and Education. Provide unfished areas for research that will serve as controls for assessment of the effects of long-term environmental variations and the potential habitat alterations due to fishing, and also increase our understanding of the role marine reserves may play in fishery management.

However, the goals and objectives for conventional fisheries management (e.g., increasing yield of stocks for harvest) may not fully encompass all of the purposes outlined in Section 1.3.

2.2.2. Sanctuary Management Plan Revision

Sanctuary regulations were proposed in the Federal Register in 1980, and the original management plan was completed in 1982. No formal review or revision of the plan has occurred since that time. Congress, however, has amended the NMSA numerous times, strengthening and clarifying the conservation principles for the program. The amended NMSA also calls upon each national marine sanctuary to review its management plan in five-year intervals and to revise the management plan and regulations as necessary to fulfill the purposes and policies of the NMSA (16 U.S.C. sec. 1434(e)). Sanctuaries are to engage in management plan review in order to:

- Evaluate substantive progress toward implementing the management plan and goals;
- Evaluate the effectiveness of site-specific management techniques and strategies;
- Determine necessary revisions to the management plan and regulations;

- Prioritize management objectives;
- Inform Sanctuary constituents, including the general public, about the Sanctuary and the management strategies that are planned for the next five years; and
- Guide Sanctuary management toward achievement of Sanctuary goals.

Additionally, significant advances in science and technology, as well as innovations in marine resource management techniques, have rendered the original 1982 Sanctuary management plan and its corresponding EIS very outdated in many respects. Furthermore, the original management plan does not contain performance indicators to evaluate the effectiveness of either the Sanctuary or the NMSP.

The management plan review is being conducted in a separate process. The draft Management Plan and accompanying EIS are scheduled for public release in Summer 2004. Please see http://www.cinms.nos.noaa.gov/marineres/manplan.html for more information.

2.2.3. Marine Zoning

2.2.3.1. Marine Zoning by the National Marine Sanctuary Program

Zoning represents an important management approach used by marine sanctuaries to:

- protect sensitive marine resources;
- separate conflicting uses;
- focus management in specific areas; and
- manage carrying capacity (human use).

Marine zones are discrete areas contained within the larger Sanctuary boundary that have special regulations for activities that differ from the regulations that apply throughout the Sanctuary as a whole. Marine zones in the sanctuary system address numerous uses. For example, marine zones are used to regulate motorized personal watercraft in Monterey Bay National Marine Sanctuary, and the Florida Keys National Marine Sanctuary has an extensive network of marine zoning to protect its ecosystem resources.

2.2.3.2. Marine Zoning By the Sanctuary

Since 1980 the Sanctuary has utilized marine zoning as a resource management tool to assist in the management of specific activities. In order to limit the potential environmental impacts of certain human activities, the Sanctuary currently contains zoned areas that provide a 1 nm buffer area around the islands prohibiting large cargo vessels, a thousand foot high area with a 1 nm buffer from island shores within which aircraft may not disturb marine mammals and seabirds, and a 2 nm buffer around the islands within which construction upon or drilling through the seabed is restricted.

2.2.3.3. Other Marine Zoning in the Channel Islands National Marine Sanctuary

Other agencies have also established marine zones wholly or partially within the Sanctuary:

In 1978, commercial and recreational fishing was prohibited in one small marine protected area of the Channel Islands, the Anacapa Island Natural Area. Within this protected area, lobsters are six times more numerous and individual lobsters are larger than in nearby fished waters (Behrens and Lafferty, unpublished manuscript). Other harvested urchin predators, including California sheephead and kelp bass, are also more numerous and larger in the protected area (Tretault, unpublished data). Predation by large lobsters and other species in the protected area caused the urchin population to decline, so that on average, the density of urchins is 7.4 times greater in fished areas than in the protected area (Behrens and Lafferty, unpublished data). Released from the intense grazing pressure from urchins, kelp in the protected area flourished, supporting a variety of associated species. On average, kelp grew five times more densely and persisted longer in the protected area as compared to fished areas nearby (NPS, unpublished data). Data from the National Park Service show that the Anacapa Island Natural Area supports some of the richest kelp forests in the Channel Islands.

In 2002, the California Fish and Game Commission authorized the establishment of marine reserves and state marine conservation areas that prohibit or limit the take and harvest of living, geological or cultural resources.

The International Maritime Organization has designated a voluntary vessel traffic separation scheme to guide large vessel traffic running through the Santa Barbara Channel.

The CINP also has several zoned areas along the island shores for different public uses, principally to protect seabird colonies and marine mammal haul outs. More recently, the CINP is instituting a new zoning approach to managing park lands, coasts and adjacent waters. (provide more details on this, including specifically why CINP is doing this.)

Due to historic lows in the stocks of certain rockfish (e.g., cow cod and bocaccio), in 2001 the PFMC took emergency action and established large area closures to rebuild these stocks. The Cow Cod Conservation Area and the California Rockfish Conservation Area overlay Sanctuary waters (see Figure 2-1). (Map and more detailed description of the closures to follow.)

Where such zoning occurs or is proposed, the Sanctuary has and will continue to work closely with relevant agencies and stakeholders to collaborate in improving resource protection and appropriate public access.

Figure 2-1: Cowcod Conservation Area/California Rockfish Conservation Area

(Figure To Be Inserted)

2.2.4. Channel Islands Marine Reserves Process, 1999-2003

In 1998, the California Fish and Game Commission (Commission) received a recommendation from a local recreational fishing group to create marine reserves[2], or no-take zones, around the northern Channel Islands as a response to dwindling fish populations. This recommendation suggested closing 20 percent of the shoreline outward to 1 nautical mile to all fishing. The recommendation led to more than one year of public discussion of the issue in the Commission forum. The Sanctuary and the CDFG developed a Federal and State partnership to consider the establishment of marine reserves in the Sanctuary, in order to respond to the proposal, to further the goals of California's Marine Life Management and Marine Life Protection Acts, and to meet the need for an open, constituent-based process. The Commission endorsed this process at their March 4, 1999 meeting.

The Sanctuary Advisory Council, a federal advisory board of local community representatives and federal, state and local government agency representatives, created a multi-stakeholder Marine Reserves Working Group (MRWG) to seek agreement on a recommendation to the Sanctuary Advisory Council regarding the potential establishment of marine reserves within the Sanctuary. The Sanctuary Advisory Council also designated a Science Advisory Panel of recognized experts and a NOAA-led Socio-economic Team to support the MRWG and the Channel Islands marine reserves process. Extensive scientific and socio-economic data were collected in support of the marine reserves assessment process. From July 1999 to May 2001, the MRWG met monthly to receive, weigh, and integrate advice from technical advisors and the public and to develop a recommendation for the Sanctuary Advisory Council on the potential establishment of marine reserves in the Sanctuary.

The MRWG reached consensus on a set of ground rules, a mission statement, a problem statement, a set of goals and objectives, a list of species of interest, and a comprehensive suite of implementation recommendations (see Appendix D for additional details). These include the following statements:

- To protect, maintain, restore, and enhance living marine resources, it is necessary to develop new management strategies that encompass an ecosystem perspective and promote collaboration between competing interests.
- To protect representative and unique marine habitats, ecological processes, and populations of interest.
- To maintain long-term socioeconomic viability while minimizing short-term socioeconomic losses to all users and dependent parties.
- To achieve sustainable fisheries by integrating marine reserves into fisheries management.
- To maintain areas for visitor, spiritual, and recreational opportunities which include cultural and ecological features and their associated values.

[2] In a California State marine reserve it is unlawful to damage, take, or possess any living, geological, or cultural marine resource, except under a permit or specific authorization from the Fish and Game Commission for research, restoration, or monitoring purposes.

- To foster stewardship of the marine environment by providing educational opportunities to increase awareness and encourage responsible use of resources.

The MRWG developed over 40 different designs for marine zoning and evaluated the ecological value and potential economic impact of each design. To do so, members of the MRWG contributed their own expertise to modify designs or generate alternatives to the designs developed by the Science Advisory Panel and utilized a geospatial tool, known as the Channel Islands Spatial Support and Analysis Tool (CI-SSAT; Killpack et al. 2000). CI-SSAT provided opportunities for visualization, manipulation, and analysis of data for the purpose of designing marine reserves.

After months of deliberation, during which the working group tried to achieve full consensus on a single preferred design, the working group ultimately selected 2 designs to represent the diverse views of the group. The composite map depicts the best effort that each MRWG representative could propose and remain true to his/her constituency (Figure D-1 in Appendix D). This composite map, along with the suite of 40 draft maps that were produced, and background scientific and economic information, were provided through the Sanctuary Advisory Council to the Sanctuary and CDFG for consideration. (Airamé, in prep.)

The MRWG considered a network of marine reserves throughout the entire Sanctuary (0-6 nm) that includes both state and federal waters. The development of ecological criteria and socioeconomic data also included the entire Sanctuary area.

As directed by the ground rules, the MRWG forwarded all areas of consensus, non-agreement and the composite map to the Sanctuary Advisory Council. The Sanctuary Advisory Council evaluated the MRWG's work and progress, deliberated over two meetings, hosted a public forum on the issue, and forwarded a recommendation to the Sanctuary Manager:

> The Channel Islands National Marine Sanctuary Advisory Council commends the Sanctuary staff, Department of Fish and Game (DFG) and all participants of the MRWG, Science and Socio-Economic Panels on their efforts over the past two years. The Sanctuary Advisory Council finds that the MRWG, in seeking consensus on marine reserves, developed scientific and socio-economic data that should be used and built upon in future consideration of such issues. The Sanctuary Advisory Council finds that the MRWG process was open, inclusive and community based.
>
> By a vote of 17 (yes), 1 (no), 1 (abstention), the Sanctuary Advisory Council agreed to:

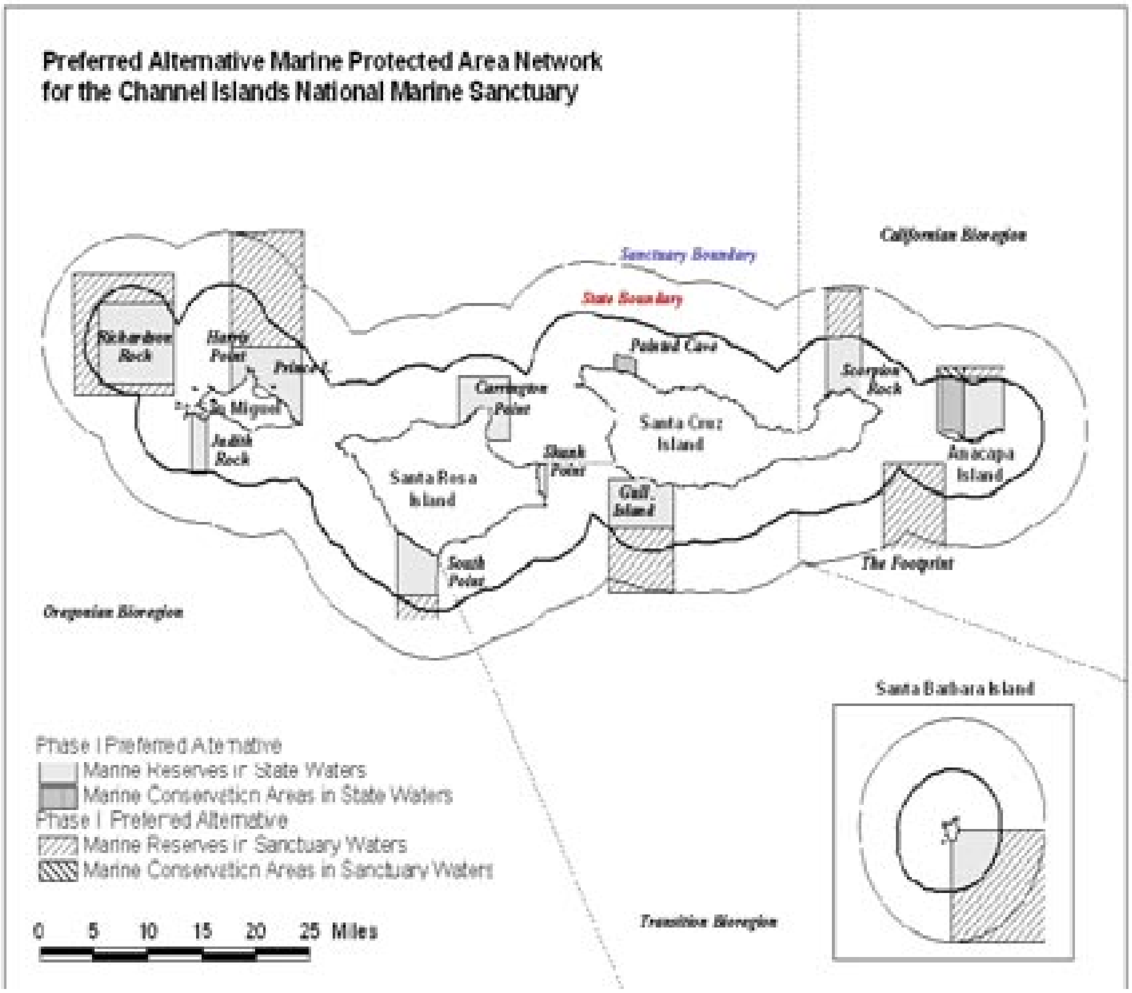
- Formally transmit the full public record of the MRWG and the Sanctuary Advisory Council regarding the development of reserves in the Sanctuary to the Sanctuary Manager;
- Charge the Sanctuary Manager and Department of Fish and Game staff to craft a final recommendation consistent with the Marine Reserve Working Group's consensus agreements for delivery to the Fish and Game Commission in August 2001;

- Request that the Sanctuary Manager and Department of Fish and Game work with the community to the maximum extent feasible in crafting this recommendation.

With this guidance, the Department and Sanctuary crafted a draft reserve network and sent it directly to the Sanctuary Advisory Council, former MRWG, Science Panel, Socio-Economic Panel members seeking further input. The draft reserve network was published in local papers and on the Sanctuary website to solicit input from the general public. Several meetings were held with constituent groups, including the Sanctuary Advisory Council Conservation Working Group, Fishing Group and Ports and Harbors Working Group to discuss the draft network. The Department and Sanctuary also met directly with former MRWG members and several written comments were received and considered.

In preparing a recommendation for the Fish and Game Commission, the Department and Sanctuary used the MRWG consensus statements as well as the MRWG Composite Map of Areas of Overlap and Non-Overlap as a foundation. Because the Composite Map was not a completed reserve network proposal agreed to by consensus of the MRWG, additional work was needed to develop the Department and Sanctuary's spatial recommendation. The recommendation proposed a network of marine reserve and marine conservation areas in the same general locations as the MRWG Composite Map. On August 24, 2001, the Sanctuary and CDFG recommended to the Commission a network of reserves and conservation areas shown in Figure 2-2, below, estimated at approximately 25% of the total area of the Sanctuary. This recommendation became the preferred alternative in the State's California Environmental Quality Act environmental review process.

Figure 2-2: The State of California's preferred network alternative.



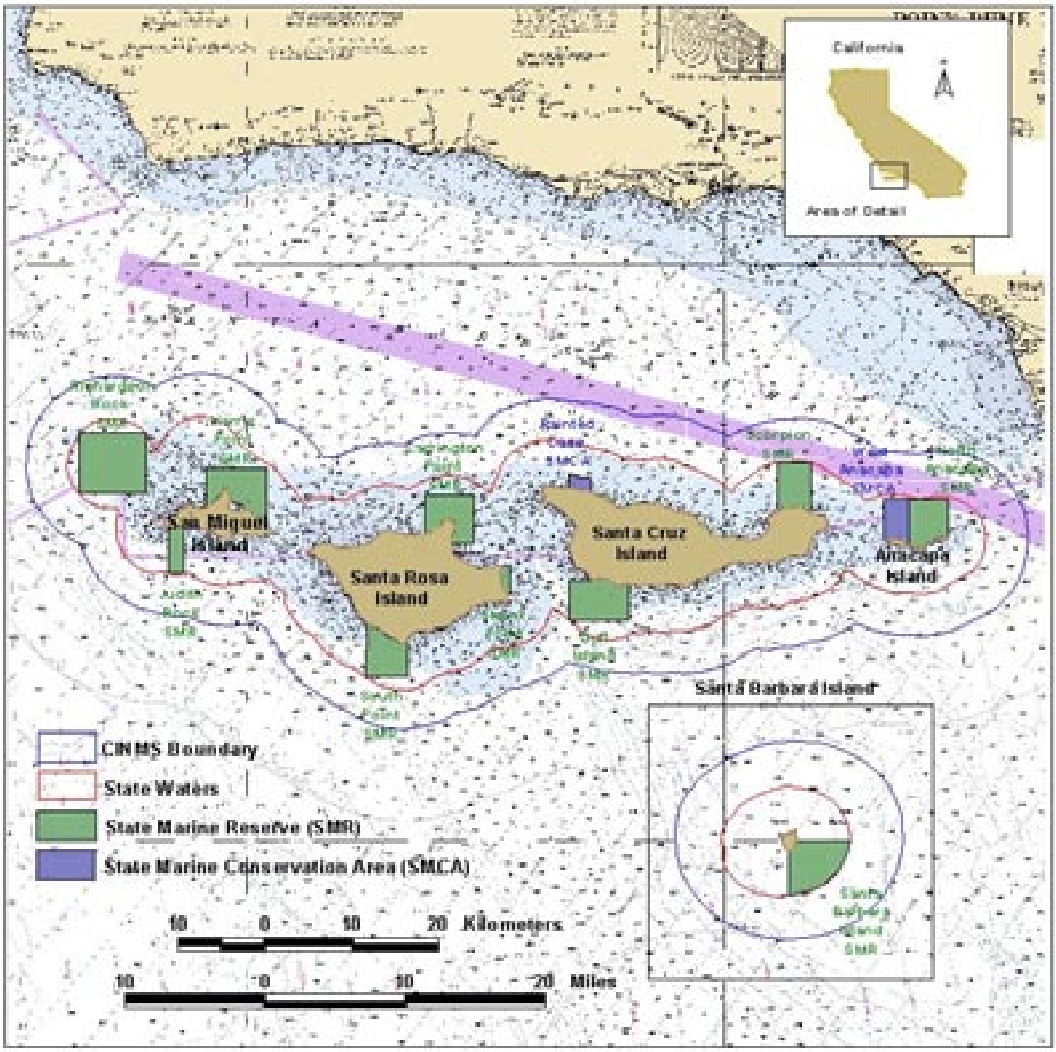
2.2.5. State Marine Reserves and Marine Conservation Areas in the Sanctuary

The CDFG prepared environmental review documents pursuant to the California Environmental Quality Act (CEQA), which included an analysis of 5 alternatives reserves networks and the no-project alternative. The reserve network developed by the CDFG and Sanctuary and shown above in Figure 2-2 was identified as the preferred alternative. On October 23, 2002, with support from NOAA and the National Park Service, the Commission approved the preferred alternative and the establishment of 10 marine reserves and 2 conservation areas[2] within State waters of the Sanctuary that encompass approximately 102 square nautical miles of the Sanctuary. The State's network went into effect on April 9, 2003.

The network alternatives analyzed in the CEQA document were split into an initial State waters phase and subsequent Federal phase. The State rulemaking process and the State environmental documents analyzed the potential cumulative effects of network alternatives in both state and federal waters of the sanctuary. The Commission's action implemented marine reserves and marine conservation areas only within the jurisdiction of the State of California. For enforcement purposes, many of the State marine reserve and marine conservation areas were "squared off," meaning that the outside boundary was drawn on a straight line of latitude, well inside the State's 3 nm jurisdiction. The Harris Point Marine Reserve off San Miguel Island and the Gull Island Marine Reserve off Santa Cruz Island illustrate this point.

The State's designated marine reserve and marine conservation areas are part of the environmental baseline that needs to be taken into account as any additional federal marine reserve and marine conservation areas are considered and proposed in the Draft Environmental Impact Statement. See Figure 2-3 below for a map of the current baseline State marine reserve and marine conservation areas in the Sanctuary. See Appendix D for a more complete discussion of the 1999-2003 state and federal Channel Islands Reserves Process. See Appendix A for a more complete description of the federal environmental process, including a flow chart outlining the steps in the process.

Figure 2-3. Existing State marine reserve and marine conservation areas.



3. Preliminary Draft Range of Alternatives

NOTE TO REVIEWER
These preliminary alternatives serve as a starting point to show the range currently being considered. As a reviewer, your input is important in assisting the sanctuary to ensure that alternatives, analyses, methodologies, and data sources are sound and the current range of alternatives is adequate for consideration in the draft environmental impact statement (DEIS) expected later this year. The alternatives may contain gaps and inconsistencies, and some ideas may not be fully developed. With your input, the planning team will continue to refine the alternatives as it prepares the DEIS.

It must be stressed that these alternatives are not exhaustive and no decision has been made on which alternative the NMSP will select as its preferred alternative in the DEIS. A preferred alternative will be developed once we have analyzed your comments and after additional analysis has been completed. The preferred alternative may be one of the alternatives presented, or it may be a new alternative.

The following four preliminary draft alternatives include the no-action alternative and three marine reserve networks of different sizes and configurations that strive to meet the purposes and need detailed in Chapter 1. Preliminary ecological and economic impact analyses for each alternative are provided in Chapter 5. The proposed marine reserve and marine conservation area network approach allows for ecosystem-based management of Sanctuary waters, including a variety of representative habitats and the species that depend on them. Differences among the spatial alternatives can be detected in deeper waters, where varying amounts of soft and hard substrate on the continental shelf and slope and pelagic habitat are represented.

3.1. Development of Preliminary Draft Alternatives

The following section provides a review of the basis for and criteria applied by Sanctuary staff to design a preliminary range of alternatives. The criteria include consideration of the following:

- The purpose and need statement articulated in Chapter 1.
- Public scoping comments submitted to the Sanctuary in writing and verbally during the public scoping period from May – July 2003. Sanctuary staff hosted several meetings in Santa Barbara and Ventura Counties and received input from the Pacific Fishery Management Council while in San Francisco, CA in June 2003. See Appendix B for a summary of scoping comments.

- Extensive input and advice from the community based Marine Reserves Working Group, Science Panel and Socio-economic Team, agency enforcement personnel and the general public received during the 1999-2003 Channel Islands Marine Reserves Process (see Appendix D).
- The Commission's environmental review process (August 2001-April 2003) and ultimate decision to implement marine reserve and marine conservation areas in State waters of the sanctuary and the suite of alternatives analyzed in the State Environmental Document, October 2002. Existing marine reserve and marine conservation areas established by the State are now considered part of the environmental baseline.
- The administrative capacity of the NMSP, the Sanctuary and partner agencies to properly monitor and enforce any of the alternatives.
- Extensive ecological criteria, developed by the Science Panel and supported by the literature. Similarly, detailed socioeconomic data on a variety of human uses. For details on the data sources and GIS-based analysis used to develop the alternatives, see Appendix D.

3.1.1. Marine Reserves: An Ecosystem Management Tool

A specific type of zoning that holds promise to address the purposes stated in Section 1.3 is a marine reserve (or "no-take" zone). Marine reserves are an ecosystem-based approach to marine resource management that protects marine species and their biophysical environments. Marine reserves are also widely recognized for their potential to: (1) to protect and enhance marine habitats (Rodwell et al. 2003), (2) to conserve biodiversity (Halpern 2003), (3) to protect or enhance ecosystem services (Dailey 1997), (4) to recover depleted stocks of exploited species (Fujita et al. 1998), and (5) to export individuals to fished areas (Kelly et al. 2002). Because of their multiple functions, marine reserves have the potential to be one of the best management tools for restoration and conservation of entire ecosystems (Rodwell et al. 2003 from Conover et al. 2000). They may also serve to expand understanding of marine ecosystems and to enhance non-consumptive opportunities such as education, outreach, and recreation.

The number of documented successful examples of marine reserves is increasing rapidly (references to follow). There is now substantial evidence to show that within areas protected from consumptive activities (e.g., fishing), rapid increases in abundance, size, biomass, and diversity of animals occur virtually regardless of where in the world reserves are sited.

Marine reserves can contribute to biodiversity, ecosystem protection, and even fisheries conservation, but they cannot succeed in the absence of complementary management approaches (references to follow). Other strategies, such as catch limits and gear restrictions in non-reserve areas, are still necessary to maintain sustainable fisheries (Allison et al. 1998). A model developed by Salomon et al. (2002) suggests that a combination of marine reserves and an overall reduction in fishing pressure contributes the greatest increase in biomass for species with both short and long-distance dispersal. Furthermore, marine reserves cannot wholly mitigate chronic and widespread problems such as input of pollutants and climate variability.

The interrelationship between conventional fishery management tools and marine reserves is complex and is stimulating considerable scientific and policy debate. Currently, a National Center for Ecological Analysis and Synthesis working group led by Alan Hastings and Louis Botsford is focused on the development of tools for the practical design of marine reserves. This group will consider a specific situation and constraints (i.e., current fishing rate, current state of the ecosystem, limited area under consideration, uncertainty in larval dispersal, fishermen behavior) in the development of scientifically sound design tools that can be used in ongoing and future implementation efforts for reserve systems; for more information see http://www.nceas.ucsb.edu. Similarly, the PFMC, NOAA National Marine Protected Areas Center and NMFS have a proposal to explore these issues as well.

In summary, the Sanctuary based Alternatives 1-3 on marine reserves and marine conservation area networks because this approach:

- Addresses the purpose and needs stated above;
- is a powerful tool for addressing local ecosystem resources, including all species and habitats, based on data from the Channel Islands and from the scientific literature;
- is within the authority of the Sanctuary under the NMSA and is consistent with the National Marine Sanctuary Program's zoning approach to resource management;
- can complement and augment other existing management approaches such as traditional fisheries management.

Note to Reviewer: During the review of the preliminary draft working document, the Sanctuary anticipates that reviewers may recommend that establishment of networks of marine reserves and marine conservation areas be done under the Magnuson-Stevens Act rather than the National Marine Sanctuaries Act. It is our understanding that the Magnuson-Stevens Act is limited to regulating only those fisheries that are managed under a Fishery Management Plan. Therefore, for example, species not listed in an FMP could still potentially be extracted in a Magnuson-Stevens act "equivalent" to a marine reserve. On the other hand, extensive closures such as the cowcod and rockfish closures may dramatically limit fishing activity in an area, and therefore have the potential to provide at least some of the benefits that would be provided by a complete marine reserve. It is the Sanctuary's expectation that specific proposals for Magnuson-Stevens Act-based marine protected areas may be submitted and considered during this review process.

3.1.2. Scoping Comments Related to Alternative Development

The Sanctuary has also taken into account scoping comments regarding the development of alternatives. The NMSP conducted three public scoping meetings during the scoping period from May 22 – July 23, 2003. See Appendix B for details. The Sanctuary received several general and some specific comments related to the development of marine reserves alternatives, including the following:

- Adjoin federal reserves with existing state reserves

- Include a "trigger" to resume fishing when marine reserve and marine conservation areas have proven their effectiveness
- Expand marine reserve areas to complete a scientifically based network to include the variety of habitats, depth ranges and species with connectivity between reserves
- Federal reserves are important to protect pelagic species and deep water species
- Apply the science panel's original size recommendation to set-aside 30-50% of each habitat type in the sanctuary
- Consider large, contiguous reserve areas
- Maximize connectivity between individual reserves, i.e., the network approach
- Include as an alternative the marine reserve and marine conservation area network developed jointly by the CDFG and the Sanctuary that the State of California implemented in state waters of the Sanctuary.

The Sanctuary also received several comments that suggested alternative management approaches, including:

- Consider broad range of alternatives and management tools and not just reserves (e.g., try marine parks to test impacts of recreational fishing or allow pelagic species to be harvested recreationally from zoned areas).
- Consider traditional management tools or regimes.

3.1.3. Alternative Development Methodology

3.1.3.1. Ecological Evaluation Criteria

Ecological criteria for design of alternatives are described extensively in Appendix D. The Science Advisory Panel assembled a set of ecological criteria for the design of a network of marine reserves to meet the desired outcomes. The ecological criteria include:

- Biogeographic representation
- Habitat representation
- Vulnerable habitats
- Species of interest
- Reserve size
- Connectivity
- Monitoring sites

3.1.3.2. Socioeconomic Considerations

Cost estimates were provided for commercial fishing, kelp harvesting, recreational fishing, and consumptive diving. The analysis of potential costs was quantitative and based on baseline data gathered for the Channel Islands Marine Reserves process over two years. See Appendix E for details.

Overall, the socioeconomic analysis provides a complete list of potential costs and benefits, but because there are limited data and scientific studies related to consumptive and non-consumptive values of the project area, not all costs and benefits could be quantified. However, the data collected and generated by the Socioeconomic Panel represents an important step toward the development of baseline information and analyses.

A number of diverse data sources and methods were used to estimate both the total amount and spatial distribution of use for both the Federal and State waters of the proposed project area. These data include both existing information (e.g., catch statistics) and surveys conducted specifically for this project. The Socioeconomic Panel relied on the following sources of information:

- California Department of Fish and Game commercial fishing data showing where fish are caught and the ports where fish are landed
- 14 commercial species/species groups mapped on a 1-minute by 1-minute distributions of catch
- Socioeconomic profiles of the fishermen (e.g., experience, age, education, income, dependency on fishing, people and family members directly employed, investment/ownership of boat and equipment, place of residence and home and landing ports)
- Commercial fishermen costs and earnings
- Kelp harvesting and processing information (obtained from ISP Alginates)
- Surveys of recreational "for hire" operators (by Census)
- National Marine Fisheries Service, Marine Recreational Fishing Statistics Survey for intercept/access points for those fishing from private household boats
- Aerial flyover data for boating activities from the Channel Islands National Marine Sanctuary
- An ethnographic survey of a variety of commercial and recreational sanctuary users

3.1.3.3. Analysis

The GIS database of ecological information about the Channel Islands region (described in Appendix D) was used to determine the amount of each habitat within the proposed marine reserve and marine conservation areas.

Ten options for networks of marine reserves, developed by the Science Advisory Panel, were available to the MRWG for purposes of comparison. The Science Advisory Panel and MRWG utilized a geospatial tool, known as the Channel Islands Spatial Support and Analysis Tool (CI-SSAT; Killpack et al. 2000) to compare and contrast the alternatives. The tool also contained maps showing the distributions of major commercial and recreational activities. (Data describing the economic value of each planning unit to each fishery was not released by the fishing community for general viewing in CI-SSAT in order to protect confidential business information (prime fishing spots). However, the economic information contained within the tool and was used for impact evaluation of alternatives.)

During the Channel Islands Marine Reserve Process, the MRWG developed over 40 different designs for marine zoning and evaluated the ecological value and potential economic impact of each design. To do so, members of the MRWG contributed their own expertise to modify designs or generate alternatives to the maps originally developed by the Science Advisory Panel.

The development of Alternatives 1-3 in this preliminary draft document used the same underlying data sets and approaches that were applied during the Channel Islands Marine Reserves process. However, since the existing state network of marine reserves is in place and part of the existing baseline, all three spatial alternatives were designed to complement the existing state reserves. For example, state reserves are typically extended into federal waters along straight longitudinal or latitudinal lines for ease of location by mariners and enforcement. In addition, in order to reduce confusion and to simplify enforcement, the same management approach is proposed for contiguous areas: state marine reserves are to be adjoined by federal marine reserves, and state marine conservation areas are to be adjoined by federal marine conservation areas. Alternatives 1-3 were also designed to provide a range that includes the preferred federal/state marine reserves network identified in the state of California's final environmental document for marine reserves in the Channel Islands (see Appendix D, Figure D-2, and Figure 2-2).

3.2. Description of Alternatives

NOTE TO REVIEWER
In these alternatives, the Sanctuary is only recommending changes to management within the geographically-defined areas delineated by each alternative. Sanctuary staff welcome input on how, if at all, existing state and federal management outside of the proposed marine reserve and marine conservation areas might also be modified to improve the alternatives' ability to meet the purpose and need for this project.

3.2.1. Spatial Alternatives

3.2.1.1. No Action (Status Quo) Alternative

The no action (status quo) alternative would not add additional protected areas to the existing State marine reserve and marine conservation areas and would require no regulatory action. The existing State marine reserve and marine conservation areas and existing state and federal management of commercial and recreational activities would remain unchanged. Existing sanctuary regulations would continue to apply throughout the Sanctuary. (add map and tables for no-project alternative).

3.2.1.2. General Overview of Habitat Representation in Alternatives 1-3

Add an introductory paragraph or two that describes the kinds of habitats generally captured by extending into deeper, federal waters, and describe what their role and importance may be in the overall ecosystem. For example, what is special about deep, soft sediment areas?

Alternative 1 contains the least area of the action alternatives. The primary differences between Alternative 1 and the other alternatives occur at Richardson Rock and Santa Barbara Island, where Alternative 1 includes very little or no additional protection, whereas the other alternatives include substantial portions of deep water habitats at these locations. Of the alternatives, Alternative 1 contains the least amount of soft sediment at depths of 30-100 m, 100-200 m and >200 m and hard sediment at depths of 30-100 m. Considering the state waters in Alternative 1 that are not included in the current state marine reserves and marine conservation areas (overlap), Alternative 1 has the least amount of soft sediment at depths of 30-100 m and 100-200 m and hard sediment at depths of 30-100 m. However, the differences among alternatives in the amount of hard sediment are very small. Federal marine reserves (FMRs) proposed by Alternative 1 include the least amount of soft sediment at depths of 100-200 m and > 200 m and hard sediment at depths >200 m, compared to other alternatives.

Alternative 2 includes total area and hard sediment at depths of 30-100 m that is intermediate between Alternative 1, which is lower, and Alternative 3, which is higher. Federal marine reserves in Alternatives 1, 2, and 3 each contain 3 nmi^2 of submarine canyons. Federal marine conservation areas proposed at Anacapa Island in Alternatives 1, 2, and 3 contain 2 nmi^2 of soft sediment 30-100 m deep. Ecological data at the 1x1 sq. nm resolution were not available outside the existing Sanctuary to evaluate habitats. The area that falls outside the Sanctuary boundary is likely to include mixed soft and hard sediment at depths greater than 100 m.

Alternative 3 is the largest of the alternatives and, therefore, it includes more deep-water habitat. Of the alternatives, Alternative 3 contains the most soft sediment at depths of 30-100 m, 100-200 m and >200 m. Considering the areas in state waters that are not included in the state marine reserves or marine conservation areas, Alternative 3 includes the greatest amount of soft sediment at depths of 30-100 m and 100-200 m. State marine reserves in Alternative 3 also include substantially more soft sediment at depths of 30-100 m and 100-200 m.

3.2.1.3. Alternative 1

Alternative 1 is a modified version of an alternative submitted by Santa Barbara County commercial fishermen during the State California Environmental Quality Act Review process. Alternative 1 has been modified to fit the east and west boundaries of the existing State adopted marine reserve and marine conservation areas network. Alternative 1 would extend the following State marine reserve and marine conservation areas into deeper waters: Richardson Rock and Harris Pt., San Miguel Island, South Point, Santa Rosa Island, Gull Island and Scorpion, Santa Cruz Island, the Footprint, and Anacapa Island marine reserve and marine conservation areas.

This alternative, including the existing state marine reserve and marine conservation areas, would establish approximately 170.41 square nautical miles (nmi^2) of marine reserves and 8.6 nmi2 of marine conservation areas for a total of 179 nmi^2 of the Sanctuary (Figure 3-1). The northern boundary of the proposed Harris Pt. Marine Reserve off San Miguel Island extends slightly beyond the existing Sanctuary boundary. This alternative is smaller than the other alternatives and was originally developed to minimize the short-term potential economic impacts to commercial fisheries.

Figure 3-1: Alternative 1

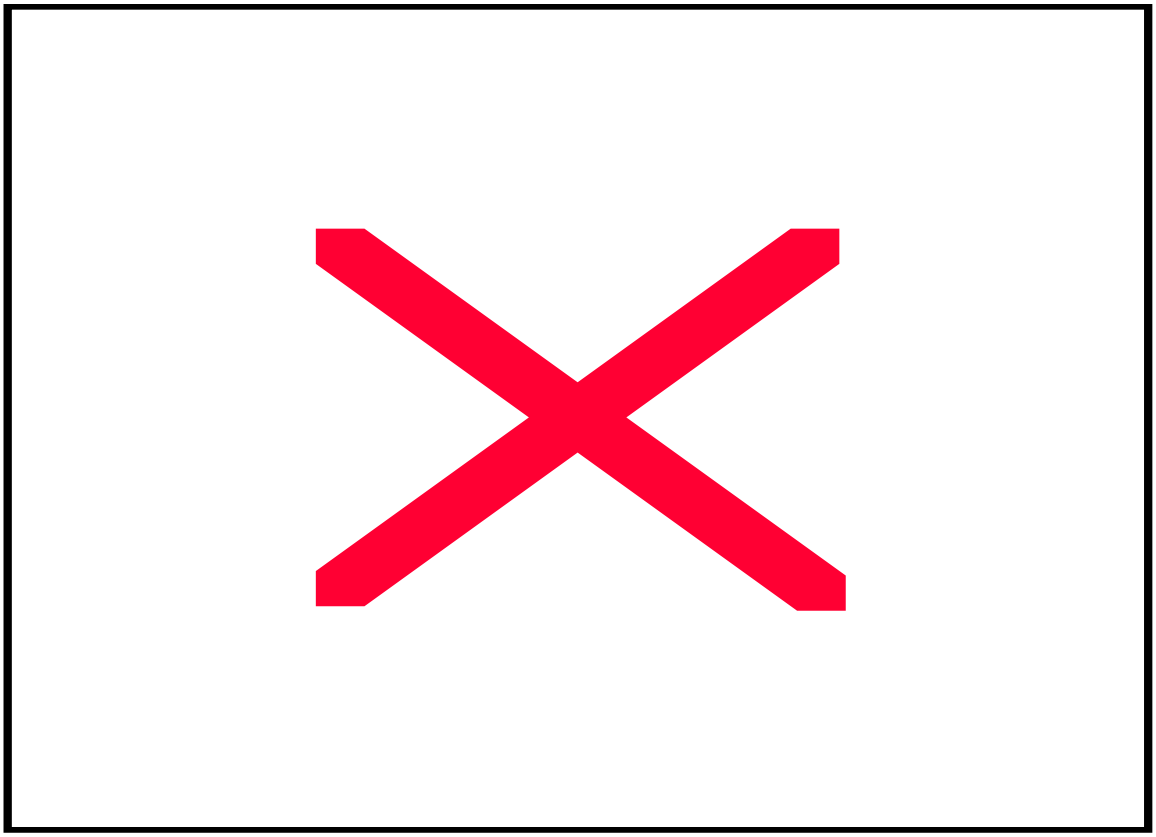


Table 3-1: Total Amount Of Each Habitat In Alternative 1

Alternative	1	1	1	1	1	1	1
Phase	Additional State Water	Federal Water MR	Federal Water MCA	Total New Proposed	Existing SMR	Existing SMCA	Total
Size (nmi2)	?	75.3	1.7	77.1	95.1	6.9	179.0
Sandy Coast	0	0	0	0	12.1	0	12.1
Rocky Coast (Protected)	0	0	0	0	12.5	3.2	15.7
Rocky Coast (Exposed)	0	0	0	0	12.3	0	12.3
SOFT (0-30)	0	0	0	0	19.4	1.8	21.2
HARD (0-30)	0	0	0	0	10.1	0.7	10.8
SOFT (30-100)	8.7	8	2	18.7	58.2	5	82.0
HARD (30-100)	0.3	0	0	0.3	6.4	0	6.7
SOFT (100-200)	8.5	13.5	0	22	31.6	0	53.6
HARD (100-200)	0	0	0	0	2.9	0	2.9
SOFT (>200)	4.4	49.9	0	54.3	13.5	0	67.8
HARD (>200)	1.6	0.6	0	2.2	2	0	4.2
Emergent Rocks (Nearshore)	0	0	0	0	114	0	114
Emergent Rocks (Offshore)	0	0	0	0	10	1	11
Submarine Canyons	2	3	0	5	9	0	14
Kelp Forest	0	0	0	0	4.6	0.03	4.7
Eelgrass	0	0	0	0	0.2	0	0.2
Surfgrass	0	0	0	0	5.6	0	5.6

3.2.1.4. Alternative 2

Alternative 2 is the original proposed action (preferred) alternative as presented in the State CEQA document and was developed by the California Department of Fish and Game and the Sanctuary in 2001. Under direction of the Sanctuary Advisory Council this alternative was based on input and advice received during the Marine Reserves Working Group process. The State waters portion of this alternative is what the Fish and Game Commission adopted in October 2002 and implemented in April 2003.

Alternative 2 would extend the State marine reserve and marine conservation areas into deeper waters in the following areas: Richardson Rock and Harris Pt., San Miguel Island, South Point, Santa Rosa Island, Gull Island and Scorpion, Santa Cruz Island, Anacapa Island marine reserve and marine conservation areas and off Santa Barbara Island. The Footprint area south of Santa Cruz and Anacapa Islands would be added as a new marine reserve zone.

This alternative, including the existing state marine reserve and marine conservation areas, would establish approximately 229.61 nmi^2 of marine reserves and 8.61 nmi^2 of marine conservation areas for a total of 238.2 nmi^2 of the Sanctuary (Figure 3-2). The northern boundary of the proposed Harris Pt. Marine Reserve off San Miguel Island and the southeast boundary of the proposed Santa Barbara Island Marine Reserve extend slightly beyond the existing Sanctuary boundary. The additional area outside the current Sanctuary boundary is approximately 12.4 nmi^2. This alternative strives to satisfy the biological criteria, while also minimizing potential economic impacts to various commercial and recreational fisheries. In order for this alternative to be fully implemented, the Sanctuary designation document would have to be amended to change the Sanctuary boundary to include the additional waters beyond the current boundary.

Figure 3-2: Alternative 2

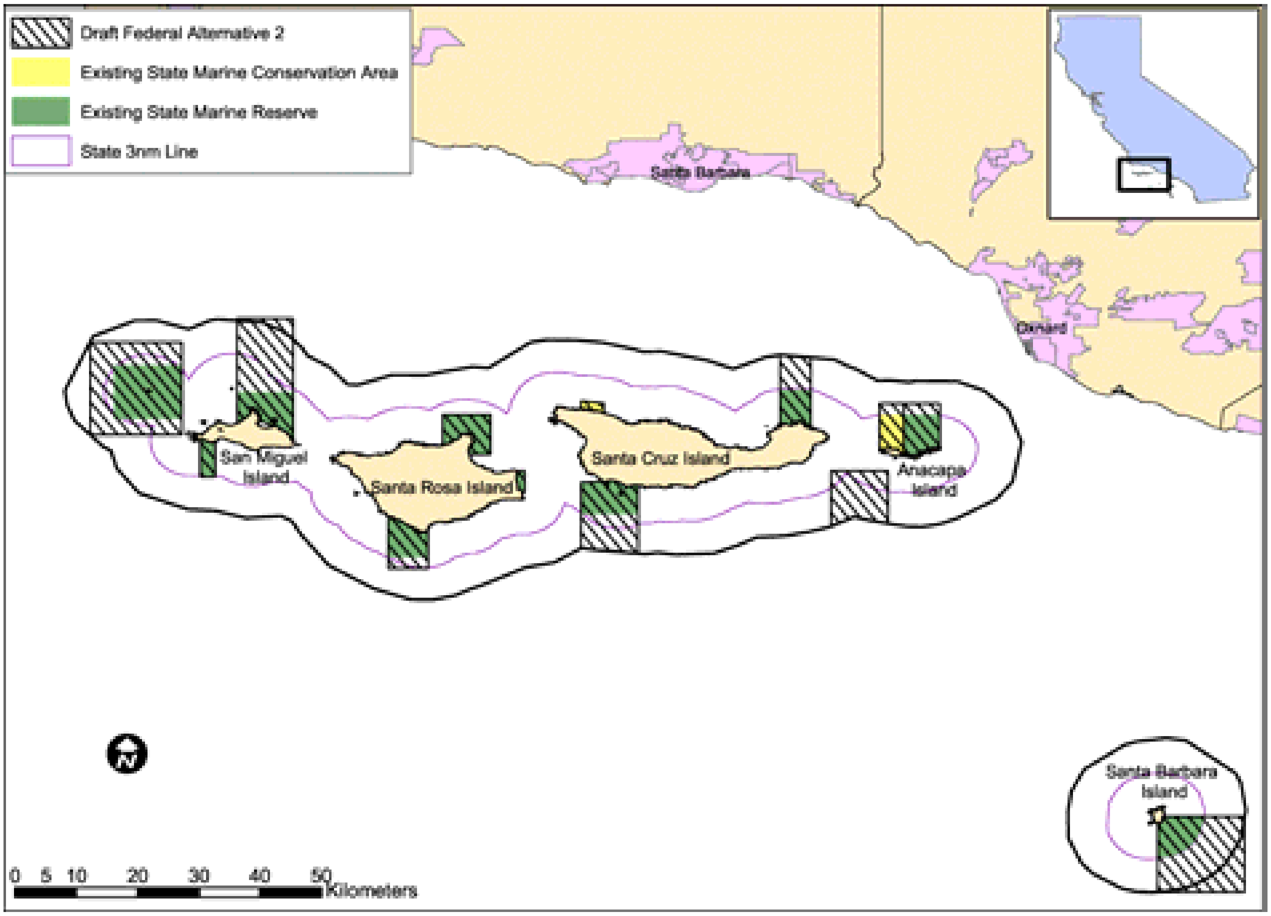


Table 3-2. Total Amount Of Each Habitat In Alternative 2

Alternative	2	2	2	2	2	2	2
Phase	Additional State Water	Federal Water MR	Federal Water MCA	Total New Proposed	Existing SMR	Existing SMCA	Total
Size (nmi2)	?	134.5	1.7	136.3	95.1	6.9	238.2
Sandy Coast	0	0	0	0	12.1	0	12.1
Rocky Coast (Protected)	0	0	0	0	12.5	3.2	15.7
Rocky Coast (Exposed)	0	0	0	0	12.3	0	12.3
SOFT (0-30)	0.6	0	0	0.6	20.0	1.8	22.4
HARD (0-30)	0.2	0	0	0.2	10.3	0.7	11.2
SOFT (30-100)	14.5	10	2	26.5	64.0	5	95.5
HARD (30-100)	0.5	0	0	0.5	6.7	0	7.2
SOFT (100-200)	12.5	31.5	0	44	35.6	0	79.6
HARD (100-200)	0	0	0	0	2.9	0	2.9
SOFT (>200)	4.4	80.2	0	84.6	13.5	0	98.1
HARD (>200)	1.6	4.3	0	5.9	2	0	7.9
Emergent Rocks (Nearshore)	0	0	0	0	114	0	114
Emergent Rocks (Offshore)	0	0	0	0	10	1	11
Submarine Canyons	2	3	0	5	9	0	14
Kelp Forest	0	0	0	0	4.6	0.03	4.7
Eelgrass	0	0	0	0	0.2	0	0.2
Surfgrass	0	0	0	0	5.6	0	5.6

3.2.1.5. Alternative 3

Alternative 3 is based on a network of marine reserves developed during the Channel Islands Marine Reserves process that was slightly modified and fully analyzed in the State CEQA Environmental Document.

For purposes of this NEPA process, alternative 3 has been modified to fit with the inshore boundaries of the existing state adopted marine reserve and marine conservation areas network. Alternative 3 extends all of the State marine reserve and marine conservation areas zones into deeper waters, except for the Painted Cave Marine Conservation Area, Santa Cruz Island and Skunk Point Marine Reserve, Santa Rosa Island, and adds the Footprint area south of Santa Cruz and Anacapa Islands.

This alternative, including the existing state marine reserve and marine conservation areas, would establish approximately 259.6 nmi^2 of marine reserves and 12 nmi^2 of marine conservation area for a total of 271.7 nmi^2 of the Sanctuary (Figure 3-3). The northern boundary of the proposed Harris Pt. Marine Reserve off San Miguel Island and the southeast boundary of the potential Santa Barbara Island Marine Reserve extend slightly beyond the existing Sanctuary boundary. The additional area outside the Sanctuary boundary is approximately 12.4 nmi^2. In order for this alternative to be fully implemented, the Sanctuary designation document would have to be amended to change the Sanctuary boundary to include the additional waters beyond the current boundary.

Figure 3-3: Alternative 3

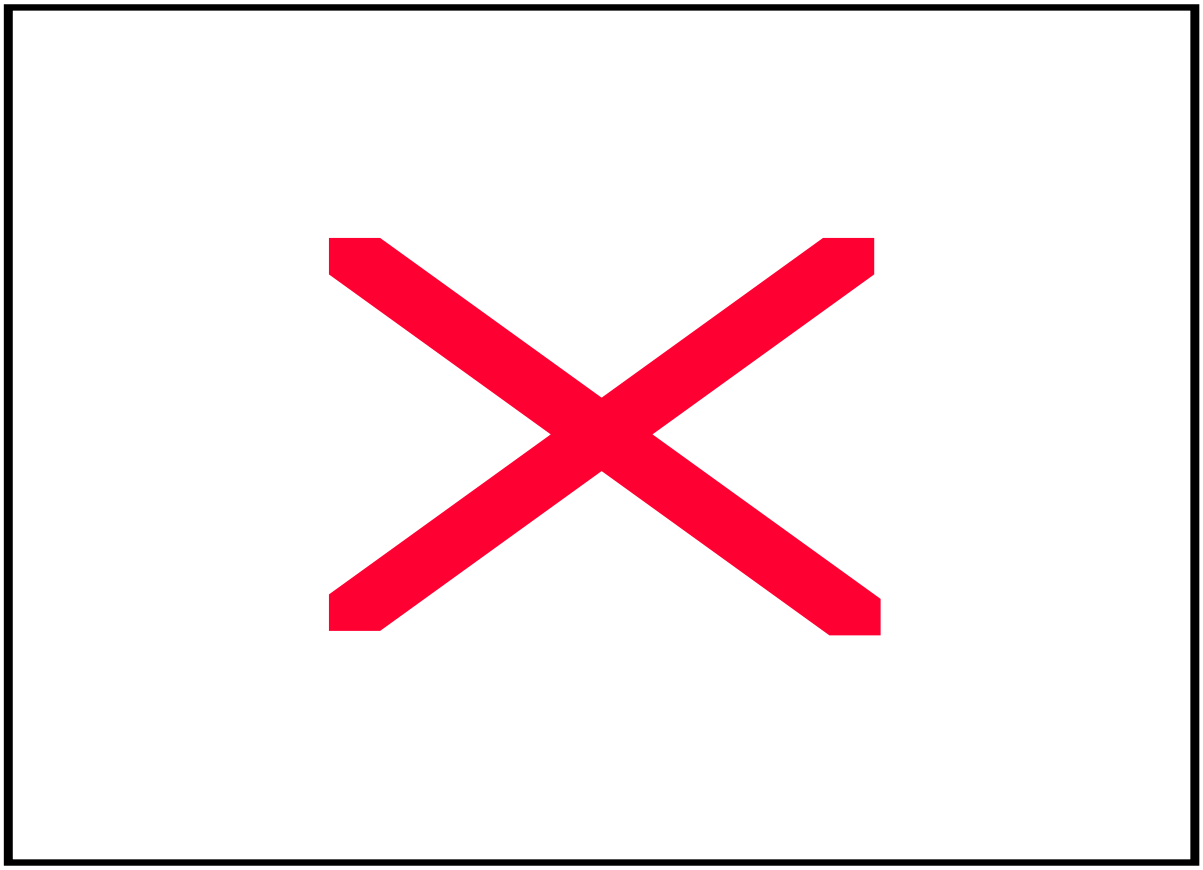


Table 3-3: Total Amount Of Each Habitat In Alternative 3

Alternative	3	3	3	3	3	3	3
Phase	Additional State Water	Federal Water MR	Federal Water MCA	Total New Proposed	Existing SMR	Existing SMCA	Total
Size (nmi2)	?	164.5	5.2	169.7	95.1	6.9	271.7
Sandy Coast	0	0	0	0.0	12.1	0	12.1
Rocky Coast (Protected)	0	0	0	0	12.5	3.2	15.7
Rocky Coast (Exposed)	0	0	0	0	12.3	0	12.3
SOFT (0-30)	0.6	0	0	0.6	20.0	1.8	22.4
HARD (0-30)	0.2	0	0	0.2	10.3	0.7	11.2
SOFT (30-100)	17.5	15	2	34.5	67.0	5	106.5
HARD (30-100)	0.5	0	0	0.5	6.7	0	7.2
SOFT (100-200)	13.5	51.5	0	65	36.6	0	101.6
HARD (100-200)	0	0	0	0	2.9	0	2.9
SOFT (>200)	4.4	105.7	0	110.1	13.5	0	123.6
HARD (>200)	1.6	4.3	0	5.9	2	0	7.9
Emergent Rocks (Nearshore)	0	0	0	0	114	0	114
Emergent Rocks (Offshore)	0	0	0	0	10	1	11
Submarine Canyons	2	3	0	5	9	0	14
Kelp Forest	0	0	0	0	4.6	0.03	4.7
Eelgrass	0	0	0	0	0.2	0	0.2
Surfgrass	0	0	0	0	5.6	0	5.6

3.2.2. Implementing Spatial Alternatives in State Waters

For each spatial alternative the Sanctuary is proposing to add additional area in Federal marine reserve and marine conservation areas, and to overlay the existing State marine reserve and marine conservation areas with Federal marine reserve and marine conservation areas regulations under the NMSA that mirror the state's regulations. Another regulatory option for each spatial alternative would be to abut rather than overlap the existing State marine reserve and marine conservation areas. Changes to certain Sanctuary regulations may subsequently involve changes to the Sanctuary designation document. The Governor of California would have the opportunity to object to such regulations before they could take effect in State waters.

Therefore, for any of the spatial alternatives, there are three potential outcomes for the final configuration of the marine protected area network:

- Federal marine reserve and marine conservation areas would overlay the existing State marine reserve and marine conservation areas with Sanctuary regulations in order to provide continuity between nearshore and offshore habitats and additional administrative capacity (such as enhanced enforcement).

- Federal marine reserve and marine conservation areas would extend into State waters in order to abut the existing State marine reserve and marine conservation areas but would not overlay them.

- If the Governor objects, the regulations would not take effect in State waters. This would create spatial gaps between existing State marine reserve and marine conservation areas and Federal marine reserve and marine conservation areas as shown below in Figure 3-4.

The ecological and socioeconomic impacts of all three possible outcomes are presented for each of the three federal alternatives in Appendix E.

Figure 3-4. Example of spatial gaps between the existing State marine reserve and marine conservation areas network and the three nautical mile State boundary if only Federal water reserves are established.

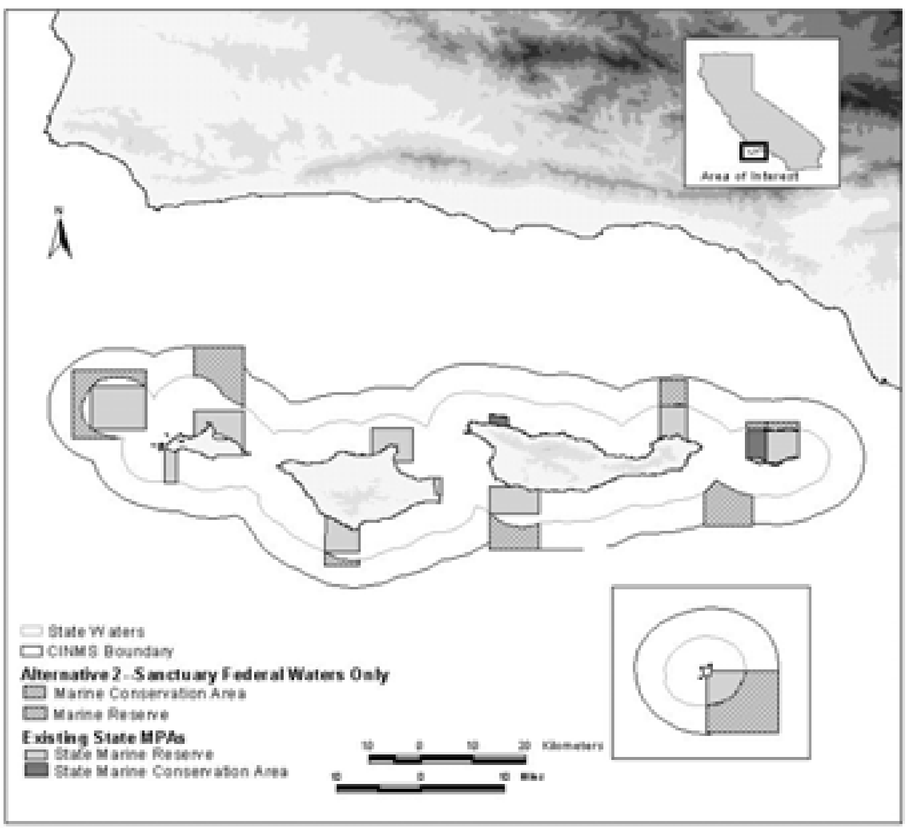


Table 3-4. Amount Of Each Habitat Type In Additional State Waters For Alternatives 1-3

Alternative	1	2	3
Phase	Additional State Water	Additional State Water	Additional State Water
Size (nmi2)			
Sandy Coast	0	0	0
Rocky Coast (Protected)	0	0	0
Rocky Coast (Exposed)	0	0	0
SOFT (0-30)	0	0.6	0.6
HARD (0-30)	0	0.2	0.2
SOFT (30-100)	8.7	14.5	17.5
HARD (30-100)	0.3	0.5	0.5
SOFT (100-200)	8.5	12.5	13.5
HARD (100-200)	0	0	0
SOFT (>200)	4.4	4.4	4.4
HARD (>200)	1.6	1.6	1.6
Emergent Rocks (Nearshore)	0	0	0
Emergent Rocks (Offshore)	0	0	0
Submarine Canyons	2	2	2
Kelp Forest	0	0	0
Eelgrass	0	0	0
Surfgrass	0	0	0

Table 3-5: Amount of each habitat type in Marine Reserves in Sanctuary federal waters (3-6 nm), Alternatives 1-3.

Alternative		1	2	3
Phase	ME	FMRs	FMRs	FMRs
Size (nmi2)		75.3	134.5	164.5
Sandy Coast	-	0	0	0
Rocky Coast (Protected)	-	0	0	0
Rocky Coast (Exposed)	-	0	0	0
SOFT (0-30)	-	0	0	0
HARD (0-30)	-	0	0	0
SOFT (30-100)	3.5	8	10	15
HARD (30-100)	-	0	0	0
SOFT (100-200)	6	13.5	31.5	51.5
HARD (100-200)	-	0	0	0
SOFT (>200)	5	49.9	80.2	105.7
HARD (>200)	-	0.6	4.3	4.3
Emergent Rocks (Nearshore)	-	0	0	0
Emergent Rocks (Offshore)	-	0	0	0
Submarine Canyons	-	3	3	3
Kelp Forest	-	0	0	0
Eelgrass	-	0	0	0
Surfgrass	-	0	0	0

Table 3-6: Amount Of Each Habitat Type In State Marine Reserves In Alternatives 1-3

Alternative		1	2	3
Phase	ME	SMRs	SMRs	SMRs
Size (nmi2)		95.1	95.1	95.1
Sandy Coast	0.9	12.1	12.1	12.1
Rocky Coast (Protected)	4.1	12.5	12.5	12.5
Rocky Coast (Exposed)	1.8	12.3	12.3	12.3
SOFT (0-30)	7.2	19.4	20.0	20.0
HARD (0-30)	2.5	10.1	10.3	10.3
SOFT (30-100)	13	58.2	64.0	64.0
HARD (30-100)	2	6.4	6.7	6.7
SOFT (100-200)	6	31.6	35.6	35.6
HARD (100-200)	-	2.9	2.9	2.9
SOFT (>200)	-	13.5	13.5	13.5
HARD (>200)	-	2	2	2
Emergent Rocks (Nearshore)	24	114	114	114
Emergent Rocks (Offshore)	-	10	10	10
Submarine Canyons	-	9	9	9
Kelp Forest	1	4.6	4.6	4.6
Eelgrass	-	0.2	0.2	0.2
Surfgrass	1.6	5.6	5.6	5.6

Table 3-7. Total amount and % of each habitat type in Alternatives 1-3

Alternative	1	2	3
Phase	Total	Total	Total
Size (nmi2)	179.0	238.2	271.7
Sandy Coast	12.1 (28%)	12.1(28%)	12.1(28%)
Rocky Coast (Protected)	15.7 (30%)	15.7 (30%)	15.7 (30%)
Rocky Coast (Exposed)	12.3 (29%)	12.3 (29%)	12.3 (29%)
Soft (0-30)	21.2 (25%)	22.4 (26%)	22.4 (26%)
Hard (0-30)	10.8 (23%)	11.2 (23%)	11.2 (23%)
Soft (30-100)	82.0 (25%)	95.5 (29%)	106.5(32%)
Hard (30-100)	6.7 (18%)	7.2 (19%)	7.2 (19%)
Soft (100-200)	53.6 (21%)	79.6 (31%)	101.6 (40%)
Hard (100-200)	2.9 (34%)	2.9 (34%)	2.9 (34%)
Soft (>200)	67.8 (12%)	98.1 (18%)	123.6 (22%)
Hard (>200)	4.2 (25%)	7.9 (47%)	7.9 (47%)
Emergent Rocks (Nearshore)	114 (22%)	114 (22%)	114 (22%)
Emergent Rocks (Offshore)	11 (61%)	11 (61%)	11 (61%)
Submarine Canyons	14 (38%)	14 (38%)	14 (38%)
Kelp Forest	4.7 (20%)	4.7 (20%)	4.7 (20%)
Eelgrass	0.2 (30%)	0.2 (30%)	0.2 (30%)
Surfgrass	5.6 (24%)	5.6 (24%)	5.6 (24%)

Modify Table 3-7 to include No-Project Alternative.

Table 3-8: Amount Of Each Habitat Type In Marine Conservation Areas In Sanctuary Federal Waters (3-6 Nm) For Alternatives 1-3

Alternative	1	2	3
Phase	FMCAs	FMCAs	FMCAs
Size (nmi2)	1.7	1.7	5.2
Sandy Coast	0	0	0
Rocky Coast (Protected)	0	0	0
Rocky Coast (Exposed)	0	0	0
SOFT (0-30)	0	0	0
HARD (0-30)	0	0	0
SOFT (30-100)	2	2	2
HARD (30-100)	0	0	0
SOFT (100-200)	0	0	0
HARD (100-200)	0	0	0
SOFT (>200)	0	0	0
HARD (>200)	0	0	0
Emergent Rocks (Nearshore)	0	0	0
Emergent Rocks (Offshore)	0	0	0
Submarine Canyons	0	0	0
Kelp Forest	0	0	0
Eelgrass	0	0	0
Surfgrass	0	0	0

Table 3-9: Amount Of Each Habitat Type In State Marine Conservation Areas In Alternatives 1-3

Alternative		1	2	3
Phase	ME	SMCA	SMCA	SMCA
Size (nmi2)		6.9	6.9	6.9
Sandy Coast	-	0	0	0
Rocky Coast (Protected)	0.6	3.2	3.2	3.2
Rocky Coast (Exposed)	-	0	0	0
SOFT (0-30)	0.8	1.8	1.8	1.8
HARD (0-30)	0.4	0.7	0.7	0.7
SOFT (30-100)	3	5	5	5
HARD (30-100)	-	0	0	0
SOFT (100-200)	-	0	0	0
HARD (100-200)	-	0	0	0
SOFT (>200)	-	0	0	0
HARD (>200)	-	0	0	0
Emergent Rocks (Nearshore)	1	0	0	0
Emergent Rocks (Offshore)	-	1	1	1
Submarine Canyons	-	0	0	0
Kelp Forest	0.01	0.03	0.03	0.03
Eelgrass	-	0	0	0
Surfgrass	-	0	0	0

3.3. Fishermen Proposals

Local Santa Barbara and Ventura commercial fishermen submitted four marine protected area proposals to the Sanctuary in late January 2004. Their proposals were to be included in Appendix F. These proposals were also presented by the fishermen to the Fish and Game Commission in February, 2004 and to the Pacific Fishery Management Council in September, 2003. The Sanctuary, in concert with the National Marine Fisheries Service and State of California, needs to review these proposals further, prior to the release of a formal DEIS. The Sanctuary does not consider these proposals to be feasible alternatives at this time. Based on an initial assessment, the Sanctuary believes that these proposals have the following problems in their current form. First, and most importantly, each proposal calls for altering or eliminating existing State marine reserve and marine conservation areas, which is beyond the jurisdiction of the Sanctuary. Second, each proposal also suggests the establishment of marine protected areas well beyond the current Sanctuary boundary, (versus the minimal boundary changes proposed in Alternatives 2 and 3, which would "square off" the federal marine reserve areas), which is also significantly beyond Sanctuary jurisdiction. Third, detailed ecological and economic data for the extensive areas beyond the Sanctuary boundary with comparable spatial resolution to available data within the current Sanctuary boundary are unavailable, which would make a quantitative comparative analysis more difficult. Finally, the proposal appears to focus on maximizing benefits to groundfish stocks rather than on addressing the purposes and needs described in Chapter 1. This January, 2004 proposal is available upon request to the Sanctuary.

The Sanctuary has discussed these issues with these fishermen as well as other fishing interests in meetings of the Sanctuary Advisory Council's Recreational and Commercial Fishing Working Groups. These groups are now developing a new proposal for Sanctuary and PFMC consideration. It is the our expectation that this proposal will be available for analysis shortly after release of this preliminary working draft document.

4. Affected Environment

This chapter is largely based on the State of California's Final Environmental Document for Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary; specifically Volume 1 Chapter 4 Environmental Settings. This document is available at http://www.dfg.ca.gov/mrd/ci_ceqa/index.html

Interested readers may also request a copy from the California Department of Fish and Game, 1933 Cliff Dr. Suite 9, Santa Barbara, CA 93109. For further details please see the Final Environmental Document.

Any persons or agencies with current data or information to update this chapter are encouraged to contact Sanctuary staff.

4.1. Ecological Setting

The waters that swirl around the five islands within the Channel Islands National Marine Sanctuary combine warm and cool currents to create an exceptional breeding ground for many species of plants and animals. Forests of giant kelp are home to numerous populations of fish and invertebrates. Every year over 27 species of whales and dolphins visit or inhabit the sanctuary including the rare blue, humpback and sei whales. On the islands, seabird colonies and pinniped rookeries flourish while overhead brown pelicans and Western gulls search the water for food.

4.1.1. Bioregions

The confluence of the California Current and Southern California Countercurrent creates three distinct bioregions in and around the Sanctuary: 1) the cold Oregonian Province; 2) the warm California Province and 3) the transition zone between the two. These provinces often overlap within the Sanctuary, which results in a high diversity of marine life as cold water species at the southern end of their range co-exist with warm water species at the north end of their range. Waters north of Point Conception and offshore and south of the Channel Islands are cool and have marine life characteristic of northern and central California.

San Miguel Island lies in the cold waters of the Oregonian Province while Anacapa and Santa Barbara Islands are in the warmer Californian Province. The eastern sides of Santa Rosa and Santa Cruz islands are in the transition zone between the two provinces (Horn and Allen 1978). Point Conception is recognized as the transition zone between the Oregonian and Californian Provinces (Horn and Allen 1978; Murray and Bray 1993; Murray and Littler 1981).

4.1.2. Habitats

There are a wide variety of marine habitats in the Sanctuary. Some of the affected habitats are summarized below. Additional details can be found in the CEQA document.
(get rid of line)

4.1.2.1. Kelp Forest Habitat

Giant kelp, a keystone species, forms extensive underwater beds on rocky substrates (except *M. angustifolia* which occurs on sand) at shallow subtidal depths (9.9 to 99 feet) throughout the Sanctuary region. These impressive, underwater forests are conspicuous features of the Sanctuary and important not only ecologically, but also recreationally and commercially. Individual kelp fronds live only about 6 months (during which they may grow 99 feet or more in length), but new fronds are continually produced during the several year life span of the plant (Rosenthal et al. 1974).

Kelp beds in the Sanctuary are highly productive habitats that provide food, attachment sites, and shelter for a myriad of invertebrates and fishes. The dense thicket of kelp in the water column and at the surface is particularly important as a nursery habitat for juvenile fishes (Carr 1989). Locations supporting kelp generally have been consistent through time, but the extent of these beds has varied considerably based on environmental conditions such as water temperature and natural predation. Greater habitat heterogeneity at the Islands has resulted in increased kelp forest species diversity compared to mainland kelp beds (Murray and Bray 1993).

4.1.2.2. Surfgrass and Eelgrass Habitat

The two types of marine flowering plants found in the Sanctuary, surfgrass and eelgrass, form dense beds on different substrate and in different conditions. Surfgrass beds are highly productive and complex microhabitats that support a wide variety of marine species. Eelgrass beds are also known to be ecologically important for primary production, nutrient cycling, and substrate stabilization (Phillips 1984). Eelgrass provides habitat and food for a unique assemblage of plants, invertebrates, and fishes (den Hartog 1970; McConnaughey and McRoy 1979; Phillips 1984). The diversity of conspicuous plant, invertebrate, and fish species was nearly twice as high within eelgrass beds as on surrounding sand habitats (Engle et al. unpublished data).

The largest beds of eelgrass in the Sanctuary occur at Smugglers Cove, Canada del Agua, and Prisoners Harbor on Santa Cruz Island and at Bechers Bay on Santa Rosa Island. Moderate beds are found at Scorpion and Forney coves on Santa Cruz Island and at Johnsons Lee on Santa Rosa Island. A few small patches of eelgrass exist at Cathedral Cove and Cat Rock on Anacapa Island and at Yellowbanks Anchorage on Santa Cruz Island. The single patch at Cathedral Cove is the only known remnant of once widespread beds scattered along the north side of Anacapa Island.

4.1.2.3. Intertidal Zone Habitats

Intertidal zones are composed of a variety of coastal habitats that are periodically covered and uncovered by waves and tides. This transition zone between sea and land is the strip of shore ranging from the uppermost surfaces wetted during high tides to the lowermost areas exposed to air during low tides. Tidal heights within the Channel Islands can be as high as 9.9 feet during full or new moon periods. On surf-swept rocky cliffs, the wave splash can extend water upward of another 17 feet or more.

Intertidal habitat within the Sanctuary includes approximately 94.5 miles of rocky coastline interspersed with approximately 47 miles of sandy beaches (CDFG 2002). Rocky shores support a rich assortment of plants and animals, including numerous green, brown, and red algae, as well as beds of surfgrass. A wide variety of sedentary invertebrates including barnacles, limpets, and mussels compete for space with the plants in the intertidal zone. Mobile invertebrates, such as snails and crabs, often hide in crevices or under rocks, then emerge to graze on plants or prey on other animals. These intertidal organisms withstand varying degrees of wave shock, dramatic temperature changes, desiccation, and attacks from terrestrial predators.

Fishes in intertidal habitats are limited to tidepools or passing through the intertidal zone at high tide. Seabirds forage in the intertidal at low tide while some roost in aggregations on cliffs just above the shore. Seals and sea lions depend on many of the Sanctuary's intertidal shores for hauling out, especially at San Miguel and Santa Rosa Islands.

4.1.2.4. Nearshore Subtidal Habitat

Subtidal habitats include those marine habitats ranging from the lower limit of the intertidal zone down to 99 feet. Nearshore subtidal habitats include mud, sand, gravel, cobble, and bedrock substrates that are subject to dynamic physical processes, including wave exposure, coastal currents, upwelling, suspended sediments and variability in temperature, salinity and nutrients.

Nearshore subtidal rocky habitats at the Islands are widespread, especially high relief volcanic reefs with walls, ledges, caves, and pinnacles. Typical shallow subtidal areas in the Sanctuary contain assemblages of plants, invertebrates, and fishes, with giant kelp dominating. However, many shallow reefs grazed by sea urchins have less giant kelp and greatly reduced species diversity. Deeper reefs have well developed invertebrate cover, including sponges, sea anemones, sea fans, plume worms, bryozoans, and tunicates. Some low-relief nearshore habitats in high current areas are dominated by large numbers of brittle stars or sea cucumbers. Low-relief sedimentary reefs exist as well, particularly on Santa Rosa Island.

Many sandy nearshore habitats in the Sanctuary have relatively steep slopes composed of coarse, shelly debris. Stable sand habitats with fine grain sediments are generally limited to sheltered coves at canyon mouths, such as those found around Santa Cruz Island. A few of these locations have well-developed eelgrass meadows. Many other sandy habitats consist of patches of shelly sand between rock reefs, forming mosaics of hard and soft substrata.

4.1.2.5. Deep Water Benthic Habitat

Beyond nearshore subtidal depths are deep-water habitats extending from 99 to greater than 660 feet deep. Well over 90 percent of deep-water benthic habitats in the Sanctuary consist of fine sands in shallower portions, grading into silt and clay-dominated sediments in deeper portions (SAIC 1986; Thompson et al. 1993). These soft-bottom particulates are derived from terrestrial runoff and decaying plankton. Coarse sediments occur near Point Conception, and north of San Miguel Island (Blake and Lissner 1993). Fine sediments occur on the sill at the western end of the Santa Barbara Channel, and in the Santa Barbara Basin.

Deep rock bottoms often are located offshore from major headlands and islands, and on the highest parts of undersea ridges, banks, and pinnacles. High relief pinnacles and ridges occur in some areas, such as off the northwest end of San Miguel Island.

Because light disappears rapidly below 165 foot depths, offshore benthic habitats do not support marine plants. Invertebrates can, however, be found in these habitats and include sponges, anemones, cup corals, sea fans, bryozoans, feather stars, brittle stars, sea stars, and lamp shells. Demersal fishes are common, especially various species of rockfishes.

4.1.2.6. Water Column Habitats

Water column, or pelagic, habitats consist of discrete portions of ocean waters categorized by variation among multiple factors, such as light penetration, temperature, oxygen concentration, and density. Based on variation among these factors the water column is divided into numerous vertical and horizontal sub-habitats.

Major vertical zones within the water column begin at the ocean surface with the microlayer, a fine film of organic molecules. Next, the photic zone, from the surface to a depth of approximately 660 feet, is the portion of the water column in which there is sufficient light for photosynthesis. Within the photic zone there is an important temperature and density gradient called the pycnocline that separates warm, mixed surface water from cool, dense water below. The surface water may reach depths between approximately 130 to 330 feet or more. Below the photic zone lie the mesopelagic zone, from approximately 660 to 3,300 feet, and the bathypelagic zone, from approximately 3,300 to 11,500 feet. Water column habitats within the majority of the Sanctuary do not extend deeper than the mesopelagic zone, though the southern reaches of the Sanctuary boundary near the mouth of Santa Cruz Canyon (a submarine canyon between and offshore from southeastern Santa Rosa Island and southwestern Santa Cruz Island) approach bathypelagic depths. In general, horizontal variation in water column habitats occurs from the coast to the open ocean, within currents, at differing latitudes, and among gyres.3 (Thorne-Miller 1991).

Pelagic organisms are highly diverse and many have interesting and unique traits. Pelagic organisms that live in the water column are classified as either plankton (passive drifters that move with the water) or nekton (actively swimming organisms). Some of these organisms are found exclusively in the microlayer, while some occupy it only for a part of their life history (e.g., as eggs and larvae), and others are found in the microlayer and other water column zones. The photic zone represents the range limit of phytoplankton, microscopic marine plants that require light to synthesize their food. Many of the organisms that live in the mesopelagic and bathypelagic zones produce light biochemically for such purposes as attracting prey, or disorienting predators. In general, the mesopelagic zone has the greatest species diversity of pelagic fish. (Thorne-Miller 1991).

[3] Circular motions of water that occur in each of the major ocean basins and are centered on subtropical high-pressure regions. Gyres rotate clockwise in the northern hemisphere and counterclockwise in the southern hemisphere.

4.1.3. Plants and Animals

4.1.3.1. Plankton

Plankton, single celled marine plants (phytoplankton) and animals (zooplankton), form the base of the food web. Many species of plankton inhabit the Sanctuary and marine life is highly dependent on their growth and productivity. Their numbers, biomass, and production vary greatly both spatially and temporally. Plankton are typically classified into three size categories: very small picoplankton, medium size nanoplankton or microplankton (the most common size); and the large mesoplankton (Hardy 1993).

4.1.3.2. Marine Plants

Marine plants of the Sanctuary are made up of algae and seagrasses. Diversity of marine plants is greater in the Southern California Bight and the Channel Islands than along coastal central California. In the Southern California Bight, there are at least 492 species of algae and 4 species of seagrasses known to occur of the 673 species described for California (Abbott and Hollenberg 1976; Murray and Bray 1993).

The Channel Islands are transitional, with each island having its own ratio of southern to northern species of marine plants. Although conditions are dynamic, a general pattern emerges: Santa Barbara Island is inhabited by southern species, Anacapa Island and Santa Cruz Island are intermediate with both southern and northern components, while Santa Rosa Island and San Miguel Island are populated primarily with northern species (Murray and Littler 1981).

4.1.3.3. Invertebrates

Benthic invertebrates include species from nearly all phyla of invertebrates that live in (infauna) or on (epifauna) the sea floor during most of their lives, though most also have pelagic larvae. Benthic invertebrates may also be characterized as “sessile” (attached or sedentary) or “motile” (free-moving). They range in size from little known microscopic forms (micro-invertebrates) to the more common larger organisms (macro-invertebrates). Pelagic invertebrates (e.g., jellyfish and squid) also exist in the Sanctuary water column.

The Channel Islands support a wide variety of invertebrates due to its transitional location between cold and warm biogeographic provinces and its diversity of substrates. The substrates include sheltered and exposed coasts at depths from the intertidal to deep slopes, canyons and basins (Thompson et al. 1993). The total number of species may well be in excess of 5,000, not including microinvertebrates (Smith and Carlton 1975: Straughan and Klink 1980).

Select invertebrates in the Sanctuary include multiple species of corals, prawns, spiny lobster, crabs, sea urchins, sea cucumbers, sea star, abalone, nudibranchs, scallops, mussels, squid, clams, barnacles, snails, salps, tunicates, jellyfish, sea slugs, and anemones. White abalone is protected by the Endangered Species Act (ESA).

4.1.3.4. Fish

About 481 species of fish inhabit the Southern California Bight (Cross and Allen 1993). The great diversity of species in the area occurs for three principal reasons: 1) the ranges of many temperate and tropical species extend into and terminate in the Southern California Bight; 2) the area has complex bottom topography and a complex physical oceanographic regime that includes several water masses and a changeable marine climate (Cross and Allen 1993; Horn and Allen 1978); and 3) the islands and nearshore areas provide a diversity of habitats including soft bottom, rock reefs, extensive kelp beds, and estuaries, bays, and lagoons.

The fish species found around the Channel Islands generally are representative of fish assemblages that occur along the southern California coast, with the addition of some central California species (Hubbs 1974). Abundance of fish assemblages is greater at the northern Channel Islands than at nearby coastal regions of the southern California mainland. Regional upwelling carries nutrient-rich waters from canyons and island shelf areas to surface waters. This results in increased primary productivity and large zooplankton populations, which support exceptionally abundant populations of small schooling species, such as the northern anchovy, Pacific saury, sardine and mackerel. Larger pelagic (open water) fish prey upon these small schooling species, and together they form a significant contribution to the forage base of marine mammals and birds. Island-associated pelagic fish are commonly consumed by pinnipeds and tooth whales.

Fishes commonly found in the Sanctuary include: Albacore, anchovy (northern), barracuda (Pacific), bass (various species), bat ray, blacksmith, bocaccio, bonito (Pacific), brown smoothhound, butterfish (Pacific), California scorpionfish, cabezon, California sheephead, California moray, California flyingfish, California halibut, croaker, (various species), eel, monkeyface, garibaldi, goby (various species), greenling (various species), grunion, gunnel, hake, Pacific half moon, horn shark, jacksmelt, kelpfish (various species), mackerel (various species), northern ronquil, ocean sunfish, opah, opaleye, orangethroat pikeblenny, queenfish, reef perch, rock wrasse, rockfish (various species), ronquil, stripedfin, salmon (king), sanddab, sarcastic fringehead, sardine (Pacific), sargo, saury, Pacific sculpin, seaperch (various species), señorita, shark (various species) silversides, sole (various species), spotted cusk-eel, surfperch (various species), swordfish, thornback, topsmelt, tube snout, turbot (various species), white sea bass, whitespotted greenling, yellowfin fringehead, and zebra perch.

4.1.3.5. Sea Turtles

Four species of sea turtles have been reported in the offshore southern California region: green, loggerhead, olive Ridley, and leatherback (pers. comm. Cordaro 2003). Most information on sea turtle distribution in southern California is based on stranding data. This stranding data indicates that for the Channel Islands area all four species of sea turtle may be found within the Sanctuary at any time of year (pers. comm. Cordaro 2003). All sea turtles are protected by the ESA.

4.1.3.6. Seabirds

Over 195 species of birds use open water, shore, or island habitats in the Southern California Bight (Baird 1990). The Channel Islands region is located along the Pacific Flyway, a major migratory route for birds, and acts as a stopover during both north (April through May) and south (September through December) migrations. The months of June and July are peak months for transient shorebirds (Lehman 1994). The diversity of habitats provided both on- and offshore also contributes to the high species diversity in the region. Sandy beaches provide foraging and resting habitat for a number of shorebirds including Black-Bellied Plover, Willet, Whimbrel, Long-billed Curlew, gulls, and sanderlings. The upland potions of the beach provide kelp deposits that attract invertebrates where Black and Ruddy Turnstones, dowitchers, and other shorebird species forage. Several bird species within the Sanctuary region have special status (of concern, threatened or endangered) under Federal or State law. The Sanctuary provides important habitat for eight seabirds that have special status under federal or state law: Ashy storm-petrel, Black storm-petrel, California brown pelican, California least tern, Double-crested cormorant, Rhinoceros auklet, Western snowy plover, and Xantus' murrelet.

4.1.3.7. Marine Mammals

There are three marine mammals groups in the Sanctuary: 1) whales, dolphins and porpoises (cetaceans); 2) seals and sea lions (pinnipeds); and 3) the southern sea otter.

Cetaceans live their entire lives at sea, while pinnipeds come ashore periodically to rest, breed, bear young, or molt. Pinnepeds depend on several haulout and rookery sites throughout the Channel Islands. In California, sea otters normally spend their entire lives at sea, though some do haul out on land. All marine mammals are protected under the Marine Mammal Protection Act of 1972 (MMPA). Additionally, some marine mammals are protected under the Federal and State ESA. Species with special protected status are listed in Section 1.2.7.3 of the DEIS.

The abundance and distribution of marine mammals is an important indication of the general health and ecological integrity of the Sanctuary. Marine mammals feed on fishes and invertebrates, which feed on other marine life of the Channel Islands region. The distribution and abundance of marine mammals depend on healthy marine habitats, such as kelp forests and associated rocky reef ecosystems.

4.1.3.8. Whales Dolphins And Porpoises

At least 33 species of cetaceans have been reported in the Sanctuary region (Leatherwood et al. 1982; Leatherwood et al. 1987). Most of the reports involve live sightings although a few are known only from strandings. Common species found in the Sanctuary include: long-beaked common dolphin, short-beaked common dolphin, Bottlenose dolphin, Pacific white-sided dolphin, Northern right whale dolphin, Risso's dolphin, California gray whale, Blue whale, and Humpback whale. In winter and spring during the gray whale migrations, groups of up to 70 orcas have been reported in the region.

4.1.3.9. Seals and Sea Lions

The productive waters and relatively undisturbed environment of the Sanctuary provides vital habitat for pinnipeds, offering important feeding areas, breeding sites, and haul outs. Seven species of pinnipeds are found throughout or in part of the Sanctuary: the California sea lion (common), northern fur seal (uncommon), northern elephant seal (common), Pacific harbor seal (common), Guadalupe fur seal (extremely rare), Steller sea lions (rare), and ribbon seal (rare).

4.1.3.10. Sea Otters

Sea otters were common in the Channel Islands until prolonged periods of hunting led to local extinction at the Islands and severe depletion along the mainland California coast. In general, the California population has been slowly but steadily increasing since the discovery of a remnant colony off Bixby Creek in central California in 1937. The recovering California stock of sea otters now generally ranges from Point Conception north to Año Nuevo Island, in Santa Cruz County. From 1987 to 1990, the USFWS, which has primary jurisdiction over sea otters, translocated 139 otters to San Nicolas Island, though as of 2003 only 33 animals were reported. Following the translocation rare sightings of sea otters in the Sanctuary have been reported. Whether sea otters will become re-established within the Sanctuary remains uncertain. The southern sea otter is listed as threatened under the federal ESA.

4.2. The Human Setting

Humans have regarded the Channel Islands and its surrounding marine waters as a special place for thousands of years. Chumash Native American societies thrived for thousands of years in the Channel Islands region. Early maritime activities resulted in many ships running aground or sinking within the dangerous waters surrounding the Channel Islands, leaving us today with hundreds of historic shipwrecks, some discovered and many still lost. This rich maritime heritage of the Channel Islands region stands as a testament to the cultural importance and historic value of the Sanctuary.

In modern times, the unique nature of the Sanctuary region has attracted many commercial and recreational uses. The proximity of the northern Channel Islands and Santa Barbara Island to the mainland coast makes them uniquely accessible from Santa Barbara, Ventura, Port Hueneme, and Channel Islands Harbors as well as ports in Los Angeles County (primarily San Pedro and Terminal Island). Human use of the Sanctuary is not limited to regional residents; almost 20 percent of those who use California's coastal areas for recreation are interstate or international visitors (Resources Agency of California 1997).

Within the Sanctuary region, population growth has risen sharply over the last twenty years. The two counties adjacent to the Sanctuary, Santa Barbara and Ventura, have a combined population of over 1.1 million and the number of regional users in the Sanctuary is growing exponentially. Currently, there are more than 10 million people living in the greater Southern California Bight region. As the numbers of people increase, so do the number of Sanctuary users involved in a wide variety of activities (any references, such as Park visitation trend data, increase in shipping, increase in fishing?).

4.2.1. Recreational Activities

Recreational and tourist-related activities occur throughout the waters of the Sanctuary. Many activities are more heavily concentrated close to the islands and on the eastern half of the Sanctuary. Sportfishing, diving, whale watching, pleasure boating, kayaking, surfing, and sightseeing are all popular pastimes within the Sanctuary. In 1999, recreation and tourism businesses represented almost 480 thousand person-days of activity within the Sanctuary. (A person-day of activity is defined as one person participating in an activity for one day or any part thereof.)

4.2.1.1. Sportfishing and Consumptive Diving

Due to its relatively mild weather, the Channel Islands region is a leading year-round sportfishing (or recreational fishing) area along the West Coast. In 1999, sportfishing and consumptive diving activity in the Sanctuary generated approximately $24 million in income and supported 654 full and part-time jobs in Santa Barbara, Ventura and Los Angeles counties (Leeworthy and Wiley, 2003). Recreational (or sport) fishing is typically done with hook-and-line, nets and spearguns and may be conducted from shore, from vessels, or using SCUBA equipment (consumptive diving). Both sportfishing and consumptive diving (including SCUBA and free-diving) in the Sanctuary take place primarily from private and chartered commercial passenger fishing vessels (CPFVs).

Sportfisheries in the region access both nearshore and offshore areas, targeting bottom and mid-water fish species, primarily in the eastern half of the Sanctuary. Types of fish landed on CPFVs include kelp bass, mackerel, California sheephead, halfmoon, and whitefish. Species commonly targeted by consumptive divers, who travel from all over the world to dive in the Sanctuary, include many rockfish species and kelp bass, halibut, yellowtail and white seabass, as well as lobster and scallops. Offshore fishing focuses on mobile species like yellowtail, tuna, white seabass, barracuda, broadbill swordfish, marlin, and mako shark.

4.2.2. Commercial Activities

4.2.2.1. Fishing

The Sanctuary has extremely productive commercial fishing grounds. Commercial fishing gear used in the Sanctuary includes nets, traps, lines, and dive equipment (provide more specifics on current gear types used within boundaries). The majority of fish are caught in nearshore waters that contain giant kelp beds, an important habitat for numerous species. Key targeted species include: squid, sea urchin, spiny lobster, prawn[4], nearshore and offshore finfishes (e.g., rockfishes and California sheephead), coastal pelagic species (e.g., anchovy, sardine, and mackerel), flatfishes (e.g., California halibut, starry flounder, and sanddabs), rock crab, sea

[4] Prawn fisheries in the Sanctuary area include trawl and trap fishing for spot prawns and trawl fishing for ridgeback prawn. In 2002 the California Fish and Game Commission voted to close the spot prawn trawl fishery.

cucumber, tuna, and kelp. Live fish trapping for rockfish, California sheephead, California scorpionfish and other shallow water species occurs primarily near the coastlines of the Channel Islands. In addition, trap gear is used to take shrimp and prawns, California spiny lobster, and three types of rock crab (red, brown and yellow). Other fisheries include shark and swordfish drift netting (is this still happening today?), squid seining, urchin diving, and diving or trawling for sea cucumbers. Most of California's commercial dive sea cucumber catch is from the four northern Channel Islands (Leet et al. 2001). Abalone, once one of the most valuable fisheries in the Sanctuary (over $2.5 million harvested between 1988 and 1997 according to Leeworthy and Wiley 2003) and state, was closed to commercial harvest by the state legislature in 1997. There is a small but increasing fishery for turban snails and whelks, which is not currently regulated.

Of the Sanctuary's commercially caught species market squid, sea urchin, spiny lobster, and halibut are some of the most economically valuable, with urchin and squid exceeding the market value of all other species. Figure 2.2 shows the ex vessel value (revenue to the fishermen), adjusted for inflation and stated in year 2000 dollars, of all marine species caught in the Sanctuary between 1988 - 1999. The 1996 - 1999 average revenue from fish and invertebrates caught in the Sanctuary was ~~$20.3~~ $22.4 million (Leeworthy and Wiley 2003). In 2000, the ex vessel value of catch from the Sanctuary accounted for 15.55 percent of the ex vessel value of landings in all of California (down from 24.48% in 1999) (Leeworthy and Wiley 2003). Table 4-1 shows the ex vessel value of marine species, by group, caught in the Sanctuary and landed commercially during 1999.

4.2.2.2. Kelp Harvesting

Giant kelp harvesting occurs near Point Conception, San Miguel Island, Santa Rosa Island and near Point Mugu. Kelp is one of the Sanctuary's most valuable harvested species. In 1999, kelp harvested from the Sanctuary had a processed value of about $6 million (Leeworthy and Wiley, 2003). Presently ISP Alginates is the only company harvesting giant kelp in the Sanctuary (CDFG 2002), while several small-scale harvesters operate along the mainland coast (Ugoretz pers. comm.). With proper management the surface canopy of kelp forests can be harvested several times annually without damage to the kelp bed (Kimura and Foster 1977). However, because the kelp canopy serves as important habitat for juvenile fishes (Carr 1989) and many species of invertebrates (Watanabe 1984), harvesting kelp may have adverse effects on other inhabitants of the kelp forest community. For example, significant reductions in turban snail species were observed in harvested areas compared with unharvested areas in Carmel Bay (Hunt 1977).

Table 4-1. 1999 Ex-vessel value of commercial landings in the Sanctuary

Species Groups	1999 Value	Species Groups	1999 Value
Squid	$26,558,813	CA Sheephead	$153,147
Urchins	$5,963,876	Sculpin & Bass	$88,547
Prawn	$743,159	Roundfish	$37,318
Tuna	$53,694	Shrimp	$1,057
Spiny Lobster	$952,991	Yellowtail	$14,832
Flatfish	$324,685	Mussels, snails	$7,745
Rockfishes	$549,446	Rays & Skates	$2,283
Crab	$313,289	Salmon	$1,407
Wetfish	$608,865	Octopus	$169
Swordfish	$21,472	Surf Perch	$447
Sea Cucumbers	$267,842	Abalone	$47
Sharks	$41,638	Other	$23,728
		All species (excluding kelp)	$36,730,497

4.2.3. Research Activities

The Channel Islands are the subject of extensive scientific interest and thousands of academic and professional researchers have a myriad of Sanctuary-focused articles, academic papers, and other products. Most research falls under the following categories: physical and biological science research; socioeconomic, cultural, and historic research; and political science research. Within each of these categories research projects are typically:

- Intramural (projects are funded by the NMSP and conducted by Sanctuary staff);
- Extramural (projects are funded and conducted by outside agencies and institutions); or
- Directed (projects are conducted by outside agencies and institutions with guidance and/or support from the Sanctuary and the NMSP).

4.2.3.1. Physical and Biological Science Research

Research activities that pertain to the Sanctuary’s physical and biological setting are the most extensive. In their report Summary of Research Programs in the Channel Islands National Marine Sanctuary, Abeles et al. (2003) provide a comprehensive assessment of major physical and biological science research activities in the Sanctuary to date, with a focus on studies that include a long-term monitoring component. As shown in Table 2 below, the report categorizes 42 research projects in the Sanctuary according to ecological levels of classification: population studies (marine plants, marine invertebrates, marine fish, marine birds, marine mammals), community studies, environment studies, and ecosystem studies.

4.2.3.2. Socioeconomic, Cultural, and Historic Research

Research activities that pertain to the Sanctuary's human setting include socioeconomic studies of industries and individuals linked to the Sanctuary, as well as studies of maritime heritage resources. Socioeconomic studies in the Sanctuary have not been as extensive as other research projects in the Sanctuary. However, since the California Department of Fish and Game and the Sanctuary began the Sanctuary marine reserves process, several socioeconomic studies have been undertaken and a major socioeconomic monitoring program is being developed and implemented. Maritime heritage resource research is focused on either studies of Native American artifacts, paleontological remains, or historic studies of shipwrecks, aircraft wrecks, and material associated with wharves, piers and landings. The Sanctuary, the NMSP, and major partners, such as the CINP, the Santa Barbara Maritime Museum, the State of California, Coastal Maritime Archaeology Resources (CMAR), and the Chumash Maritime Association, conduct the majority of research on Sanctuary maritime heritage resources.

4.2.3.3. Political Science Research

Political science research focuses on the Sanctuary's operational setting. Several political scientists studying topics such as collaborative stakeholder-based processes, or consensus-based processes, have cited the Sanctuary as a case study. Political science interest in the Sanctuary primarily stems from the Sanctuary's use of its Sanctuary Advisory Council and that Council's working groups. Political science research projects tend to be extramural.

4.2.4. Educational Activities

Educational activities have been a central focus of the Sanctuary since its 1980 designation. Today the Sanctuary plays an important role in public and formal marine science education activities for all ages from K-12, to adults. Sanctuary educational activities have reached a wide variety of audiences on a local, regional, national, and international scale. Sanctuary educational activities are focused in two strategic areas: 1) community involvement, partnerships and community program development, and 2) product development.

4.2.4.1. Community Involvement, Partnerships and Community Programs

Community involvement is an essential component of the Sanctuary's Education and Outreach program. Community involvement in Sanctuary educational activities is achieved in large part through the Channel Islands Naturalist Corps, a volunteer corps of naturalists trained to provide interpretation about the Sanctuary and Park on a variety of passenger vessels, such as whale watch and dive boats, as well as at outreach and special events. Community involvement in educational activities is also achieved through the Sanctuary Advisory Council and in particular its Sanctuary Education Team. This team is made up of community members who work to address Sanctuary education needs, and to keep local educational institutions informed about Sanctuary educational opportunities. Advisory Council members at large are charged with keeping their constituents educated about the Sanctuary. Community involvement in educational activities is also achieved through participation in Sanctuary events and programs.

Together the Sanctuary and its education partners develop and implement numerous interactive educational programs including training programs, workshops, special events, and school programs, many of which are already targeted to inform and educate the public about the existing state marine reserve network.

5. Environmental Consequences Of Alternatives

Note to Reviewer
Please note that this is not a complete impact analysis and is a work in progress. Your input on the methodology and analysis is critical to taking this analysis from a preliminary review to the draft environmental impact statement.

5.1. Ecological and Socioeconomic Effects

This chapter summarizes the ecological consequences and potential socioeconomic effects of the preliminary range of alternatives. Table 5-1 below summarizes the environmental effects associated with the preliminary alternatives. For additional detail, see Appendix E.

Based on the analyses conducted to date, the extension of the state marine reserves and marine conservation areas are not expected to result in any significant adverse ecological impacts. Conversely, alternatives 1-3 are expected to have beneficial effects on the local ecosystem, resulting from the establishment of protected areas in federal waters of the Sanctuary. It is possible that displacement of effort to areas outside the proposed marine reserves and marine conservation area could potentially impact the environment through congestion of fishing into smaller areas. This could cause increases in the relative fishing pressure on certain species, which may cause a short term negative environmental impact outside marine reserve and marine conservation areas. The alternatives attempt to limit this potential impact by avoiding key fishing areas identified in the Channel Islands Reserve Process to the extent possible. Potential displacement of effort also may be offset by the potential for long term beneficial effects caused by increased production and spillover from the proposed marine reserve and marine conservation areas. In addition, existing harvest controls (e.g., size limits, bag limits, seasons) will continue to control take outside marine reserve and marine conservation areas, and other regulatory processes limiting total effort of fisheries in the area are underway.

Potential socioeconomic impacts of the alternatives would primarily involve the removal of areas of Sanctuary waters from extractive (consumptive) uses involving commercial and recreational fishing and consumptive diving (e.g., spearfishing). The estimated maximum potential impact on consumptive activities resulting from additional protection in state and federal waters ranges from $2,349,148 (2.2% of baseline level) for Alternative 1 to $3,252,903 for Alternative 3 (Table E-4). This impact is much less than the $12,565,222 estimated potential impact from the existing state marine reserves and marine conservation area (Table E-4). These maximum potential losses may be mitigated over time, since improvement in environmental health and local populations may ultimately enhance consumptive uses in the Channel Islands area over the long-term.

Non-consumptive activities (e.g., diving, kayaking, sightseeing, and eco-tourism) are generally expected to benefit or see no change economically from the establishment of marine reserve and marine conservation areas. Currently non-consumptive activities represent $1,385,756 in annual income within the project area. This income is expected to increase further over time by an unknown amount as demand for non-consumptive activities and quality of experience increase or to remain unchanged as environmental conditions improve.

As described in Chapter 3, alternatives 1-3 differ in size, connectivity, biogeographic representation, habitat representation, vulnerable habitats, species of interest, and ease of monitoring and enforcement. These differences are summarized in Table 5-1, below, and a few of these factors are discussed further in the following text.

5.1.1. Network Connectivity

Marine organisms often exhibit dispersal during at least one life history stage. Protecting multiple habitats, either in one large reserve or in several small but ecologically interconnected marine reserves, may be important for growth and reproduction of marine organisms. In the Channel Islands, the strongest currents transport organisms across the northern Channel Islands from west to east, often forming strong counterclockwise recirculation in the Santa Barbara Channel. The patterns of circulation suggest that source populations may be located in productive areas on the north sides of San Miguel, Santa Rosa, and Santa Cruz Islands. A region of low current flow, and potentially high larval retention, occurs off northeastern Santa Cruz Island. There is excellent potential connectivity among marine reserves in Alternatives 2 and 3. The probability that larvae and adults would disperse to adjacent marine reserves is relatively high because the total area covered by marine reserves is relatively large, and marine reserves are located in the predominant current across the north sides of Santa Rosa, Santa Cruz, and Anacapa Islands. Larvae and adults may disperse between marine reserves because distances between marine reserves are relatively small and individual marine reserves are relatively large.

5.1.2. Protection From Human Threats and Natural Catastrophes

It is unlikely that all of the marine reserve and marine conservation areas proposed in any of the NEPA alternatives would be impacted simultaneously by catastrophic events, such as oil spills or large storms, because marine reserve and marine conservation areas are widely distributed across the Sanctuary. The alternatives include proposals for multiple marine reserves on the north and south sides of each island in the Sanctuary, building on the State network. Catastrophic events could impact populations in one or several of the reserve areas. The impacts of catastrophic events could be reduced by adding area to sites in the existing design or by adding additional areas. The design of the alternatives did not explicitly incorporate an “insurance factor”, a multiplier required to account for the effects of catastrophic events, recommended by Allison et al. (2003). Complementary management strategies strive to prevent and respond to other threats from spills or other human catastrophes. However, the distribution of multiple protected areas in a network around the islands is designed to limit the likelihood of a single impact affecting all areas at once.

Table 5-1: Summary of Direct Ecological and Socioeconomic Effects of Each Alternative

	ALTERNATIVES			
ECOLOGICAL CRITERIA	No Action	1	2	3
Biogeographic Representation[1]		Oregon Transition Calif.	Oregon Transition Calif.	Oregon Transition Calif.
Habitat representation (Area: nmi2) Note: need to Add Pelagic and Mid water habitat	0	Soft Sediment (174.5) Hard Sediment (0.6) Pelagic (77) Submarine Canyon (3) Pinnacles	Soft Sediment (123.7) Hard Sediment (4.3) Pelagic (136.2) Submarine Canyon(3) Pinnacles	Soft Sediment (174.5) Hard Sediment (4.3) Pelagic (169.7) Submarine Canyon (3) Pinnacles
Vulnerable habitats / EFH ?	Nearshore only	Nearshore only	Nearshore only	Nearshore only
Species of Interest[2]	-	Marine Mammals Seabirds Endangered Species Rockfish overfished Sharks	Marine Mammals Seabirds Endangered Species Rockfish overfished Sharks	Marine Mammals Seabirds Endangered Species Rockfish overfished Sharks
3. Network Size (nmi2) [3]	0	77.0	136.2	169.7
Connectivity- need to add data in this row	Calculate Avg. Min Distance	Calculate Avg. Min Distance	Calculate Avg. Min Distance	Calculate Avg. Min Distance
Scientific Use	Ø to negative	+	+	+
Education Value	Ø to negative	+	+	+
Maximum potential economic impacts on aggregate consumptive uses from new protected area in state and federal waters (Table E-4)	$0 or 0% of baseline	$2,349,148 or 2.2% of baseline	$2,423,747 or 2.3% of baseline	$3,252,903 or 3.0% of baseline

Key

+ (Positive Effect)
Ø (No Effect)
[1] Chapter 4 delineates and describes the biogeographic regions within Sanctuary waters
[2] Species of interest include: (a) species of special concern (b) species with critical life-history stages (c) targeted species and (d) bycatch species
[3] Marine reserve and conservation area in additional state and federal waters of the Sanctuary

6. Appendix A: Federal Environmental Process

6.1. Implementing The Proposed Action

Under the NMSA, regulation of fishing is allowed only if that Sanctuary's designation document allows regulation of fishing. Since the Channel Islands' 1980 original designation document does not authorize the regulation of fishing, a change to the Sanctuary's designation document would be required for the Sanctuary to establish marine reserve zones under the NMSA. Any change to the designation document would be done in compliance with the National Environmental Policy Act and procedural requirements of the NMSA.

While the Council could recommend the creation of marine protected areas under its Magnuson-Stevens Act authority, it has limited ability to protect fish and habitat in the designated area from anything other than fishing impacts. For example, the Council does not control dredging, dumping, or other potentially damaging activities. Further, the Council does not have jurisdiction over other resources such as cultural and historical resources. Also, the Council is essentially limited to addressing fisheries for which there is an established Fish Management Plan (FMP). Therefore, for example, species not listed in an FMP could still be potentially extracted in a Magnuson-Stevens Act "equivalent" to a no-take marine reserve. On the other hand, extensive closures such as the rockfish and cowcod closures may dramatically limit fishing activity in an area, and therefore have the potential to provide at least some of the benefits that would be provided by a complete marine reserve.

Any recommendations made by the Council to be implemented under the NMSA must fulfill the purposes and policies of the NMSA and the goals and objectives of the particular Sanctuary.

Section 304(a)(5) of the NMSA states:

6.1.1. Fishing Regulations

> The Secretary shall provide the appropriate Regional Fishery Management Council with the opportunity to prepare draft regulations for fishing within the Exclusive Economic Zone as the Council may deem necessary to implement the proposed designation. Draft regulations prepared by the Council, or a Council determination that regulations are not necessary pursuant to this paragraph, shall be accepted and issued as proposed regulations by the Secretary unless the Secretary finds that the Council's action fails to fulfill the purposes and policies of this chapter and the goals and objectives of the proposed designation. In preparing the draft regulations, a Regional Fishery Management Council shall use as guidance the national standards of section 301(a) of the Magnuson-Stevens Act (16 U.S.C. 1851) to the extent that the standards are consistent and compatible with the goals and objectives of the proposed designation. The Secretary shall prepare the fishing regulations, if the Council declines to make a determination with respect to the need for regulations, makes a determination which is rejected by the Secretary, or fails to prepare the draft regulations in a timely manner. Any amendments to the fishing regulations shall be drafted, approved, and issued in the same manner as the original regulations. The Secretary shall also cooperate with other appropriate fishery

management authorities with rights or responsibilities within a proposed sanctuary at the earliest practicable stage in drafting any sanctuary fishing regulations.

Concurrent with the environmental review process the Sanctuary will consult with other agencies on potential changes to the terms of designation. For changes in the terms of designation to take effect in State waters the Governor of California will be afforded the opportunity to indicate if that is unacceptable.

6.1.2. Cooperating Agencies

CEQ defines the rights and responsibilities of cooperating agencies in section 1501.6 of the CEQ regulations. Upon the request of the lead agency, any other federal agency that has jurisdiction by law or that has special expertise with respect to any environmental issue shall be a cooperating agency. No federal agencies were formally requested to be cooperating agencies, nor have any federal or state agencies requested this status. Nonetheless, the NMSP has been and will continue to work closely with its resource management partners.

For this environmental review process, the Sanctuary is responsible for producing the environmental impact statement, proposed regulations, and any proposed modifications to the Sanctuary's designation document, complying fully with the National Environmental Policy Act (NEPA), the National Marine Sanctuaries Act (NMSA), the Administrative Procedure Act, and all other applicable legal requirements.

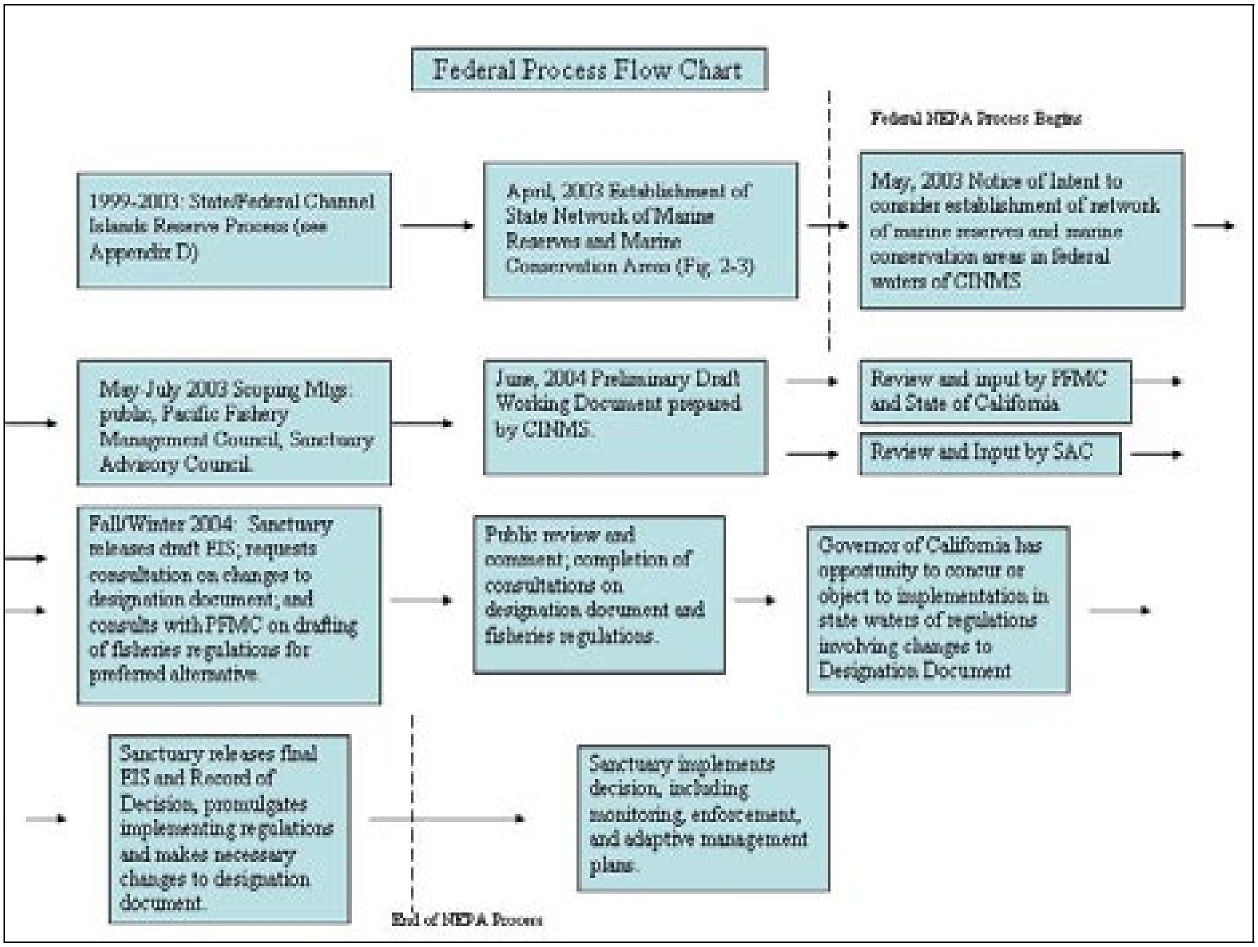
There are a number of State and Federal agencies and councils or commissions that have jurisdiction and regulatory responsibility over California coastal marine and ocean resources in the Sanctuary. The environmental review process requires close coordination and cooperation with all entities that have overlapping management jurisdiction in the Sanctuary. The NMSP has sought the input of several state and federal officials and agencies in preparing this preliminary environmental document and will continue to seek input throughout the process. Key entities include the California Department of Fish and Game, the California Fish and Game Commission, the National Marine Fisheries Service, the Pacific Fishery Management Council, and the Channel Islands National Park.

The partnership established between the State of California and Sanctuary during the Channel Islands Marine Reserves Process bodes well for the continued coordination in this federal environmental review process. As stated in the purposes for action and in the Notice of Intent (NOI) the Sanctuary intends to complement the State of California's April 2003 establishment of State marine reserve and marine conservation areas in the Sanctuary. Additionally, the Sanctuary and California Department of Fish and Game continue to work cooperatively on the implementation, education and outreach, monitoring and enforcement of the State marine reserve and marine conservation areas.

The National Marine Fisheries Service (NMFS) policy and science branches participated during the Channel Islands Marine Reserves Process. NMFS expertise and assistance in coordinating with the PFMC will be essential to moving forward with this environmental review.

The Sanctuary and Pacific Fishery Management Council (PFMC) have agreed to work closely in a spirit of partnership during this environmental review process, including consulting and cooperating fully with each other in matters regarding the conservation and management of natural resources of mutual concern and geographic authority. Further, as reviewed above, the PFMC will be provided the opportunity to prepare draft Sanctuary fishing regulations for the Exclusive Economic Zone portion of the Sanctuary for any proposal that requires NMSA fishing regulations in order to be implemented. Finally, any change to a term of designation would not apply to State waters if the Governor objects during the requisite review period.

Figure A-1: Federal Process Flow Chart



7. Appendix B: Scoping Process

7.1. Public Scoping Summary

The Council on Environmental Quality (CEQ) requires Federal agencies to conduct scoping prior to preparing an Environmental Impact Statement (EIS) for a proposed action. According to CEQ regulations (40 Code of Federal Regulations Section 1501.7), "there shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. This process shall be termed scoping."

On May 22, 2003 the National Marine Sanctuary Program published a Notice of Intent (NOI) in the Federal Register announcing its intent to consider the establishment of a network of marine reserves within the Channel Islands National Marine Sanctuary and to prepare an environmental impact statement to examine a range of management and regulatory alternatives associated with consideration of marine reserves within the Sanctuary. The NOI described the joint Federal and State partnership between the Sanctuary and California Department of Fish and Game established in 1999 to consider marine reserves within the Sanctuary and the extensive community based Channel Islands Marine Reserves Process from 1999-2001. The NOI noted that the NEPA process will build upon the Channel Islands Marine Reserves Process, including the information and analyses contained in the State's CEQA environmental documents that ultimately led to the California Fish and Game Commission's October 2002 decision to establishment marine protected areas in state waters of the Sanctuary.

The NMSP conducted three public scoping meetings during the scoping period from May 22 – July 23, 2003 to gather information and other comments from individuals, organizations, and government agencies on the scope, types and significance of issues related to consideration of marine reserves in the Sanctuary. In addition to the formally announced public scoping period, the Sanctuary Advisory Council, which is a community-based federal advisory body to the Sanctuary, allows for public participation and public comment on proposed Sanctuary actions during Sanctuary Advisory Council and Sanctuary Advisory Council working group meetings. The dates and locations of the formal and informal public scoping meetings are listed below.

Table B-1: Public Scoping Meetings

Date	Location	In attendance	Estimated Attendance
June 5, 2003	Pt. Hueneme, CA	General public	30
June 12, 2003	Santa Barbara, CA	General public	60
June 16-20, 2003	Foster City, CA	Pacific Fishery Management Council, PFMC Habitat Advisory Panel, PFMC California Delegation, PFMC Science and Statistical Committee, PFMC Enforcement Advisory Group, PFMC Groundfish Advisory Panel	100 +
June 26, 2003	Santa Barbara, CA	Sanctuary Advisory Council - Conservation Working Group	15
July 15, 2003	Carpinteria, CA	Sanctuary Advisory Council - Business Working Group	12
July 18, 2003	Ventura, CA	Sanctuary Advisory Council	50

To date the Sanctuary has received over 50 written comments and input from over 200 people. In addition, though not part of this formal federal scoping process, the California Department of Fish and Game, California Fish and Game Commission, Pacific Fishery Management Council and advisory bodies, Sanctuary and the Sanctuary Advisory Council and its working groups have hosted over 125 public meetings as part of the Channel Islands Marine Reserves Process from 1998 through 2003. Over the six years of deliberation the Sanctuary and State have received tens of thousands of comments. A complete history of the Channel Islands Marine Reserves Process including the public meetings is summarized in Chapter 2 and detailed in Appendix D.

Major constituencies represented at the federal scoping included:

- Sanctuary Advisory Council members, alternates and working group members
- Pacific Fishery Management Council members and advisory body members
- Recreational fishing organizations and individuals
- Commercial Fishing organizations and individuals
- Environmental organizations and individuals
- Congresswoman Capps' office
- State and Federal agencies
- General public

7.1.1. Range of Public Scoping Comments

The Sanctuary received a broad range of scoping comments. The comments are summarized below. The Sanctuary has attempted to address all of these comments in the relevant sections of this environmental document. We welcome comments on whether the scoping comments have been adequately addressed by this preliminary working draft.

7.1.2. Comments Regarding the Relationship of this Federal EIS Process to Other Processes

- What is the Pacific Fishery Management Council's role in this process?
- If the sanctuary designation document is revised to regulate fishing, Article 5, section 1 of the current designation document will need to be amended.
- Utilize the Marine Reserves Working Group work and address areas of consensus and non-consensus. Build on the existing State environmental process documents and information.
- Keep the marine reserves and Sanctuary management plan revision NEPA processes separate. Time is of the essence. Given four years of community process it is critical to move forward.
- The Sanctuary needs to clarify the processes required to revise the Sanctuary Management Plan, amend the Designation Document and consider marine reserves under the National Marine Sanctuaries Act

7.1.3. Comments Regarding Project Purpose and Need, or Design of Project Alternatives

- Consider values to general public and existence values
- Follow mandate of the National Marine Sanctuaries Act
- Consider findings in the Pew Ocean Report
- State goals for recreational fishing in the Sanctuary, now and in the future
- Support an ecosystem perspective
- Support species by species management
- Concern that the process pits biodiversity against game management
- Support for conservation and habitat protection
- Consider birds and marine mammals
- Reserves provide heritage and intrinsic values
- Support experimental and adaptive approach
- Support IUCN Category 4 criteria for sustainable use
- Public education and outreach is essential on marine reserve and marine conservation areas in general and the existing Channel Islands marine reserve and marine conservation areas
- Support a science-based approach
- Apply the precautionary principle
- Note overwhelming public support for marine reserves
- Adjoin federal reserves with existing state reserves
- Include a "trigger" to resume fishing when marine reserve and marine conservation areas have proven their effectiveness

- Expand marine reserve areas to complete a scientifically-based network to include the variety of habitats, depth ranges and species with connectivity between reserves
- Federal reserves are important to protect pelagic species and deep water species
- Apply the science advisory panel's original size recommendation to set-aside 30-50% of each habitat type in the sanctuary
- Consider large, contiguous reserve areas
- Maximize connectivity between individual reserves, i.e., the network approach
- Include as an alternative the marine reserve network developed jointly by the California DFG and the Sanctuary that the State implemented in state waters of the Sanctuary.

7.1.4. Comments Regarding Other Management Approaches

- Consider broad range of alternatives and management tools, not just reserves i.e. try marine parks to test impacts of recreational fishing
- Consider existing management options
- Do not address Sanctuary boundary expansion
- Allow pelagic species to be harvested recreationally from zoned areas

7.1.5. Comments Regarding Affected Environment

- Consider 1/3 of assessed stocks are overfished
- Concern with trash and debris at islands
- Concern with human use impacts on islands
- Factor in El Niño and other natural perturbations
- Consider impacts of pollution, oil slicks, sewage, nuclear and toxic wastes

7.1.6. Comments Regarding Impact Analysis

- Consider both short and long term benefits and impacts
- Analyze positive and negative impacts to consumptive and non-consumptive users
- Consider impacts on areas outside of reserves
- Consider impact to local economy
- There has been inadequate social planning for negative effects
- Job losses need to be considered
- Economic benefits of reserves should be calculated (e.g., non-consumptive uses)
- Show socioeconomic impacts to fishermen and fishing-related businesses
- Fund socioeconomic monitoring to understand fishery impacts
- Consider impacts of current regulations
- Consider long-term benefits to fisheries
- Consider federal funding of commercial buy-back programs
- Reserve size will determine the scale and timing of effects, i.e., small reserves will have a smaller effect and take longer to yield benefits versus larger reserves
- Assess Costs and benefits of phasing reserve establishment to the resources and economy over time.

- Discuss effects of the groundfish closures
- Consider existing recreational fishing impacts on resources
- Consider impacts to public access of state and federal waters
- Analyze bycatch in conservation areas or bycatch from non-rod/reel gear
- Establish socioeconomic impact thresholds of significance
- Provide analysis of yield from fisheries

7.1.7. Comments Regarding Monitoring, Evaluation and Enforcement of Marine Protected Areas

Use data from existing marine reserves.

- Evaluate if existing management is adequate and demonstrate administrative and monitoring capabilities before considering expansion of reserves.
- Funding is needed for socioeconomic monitoring to understand fishery impacts.
- Ensure management actions are enforceable and provide for adequate enforcement
- Detail explicit management plan with methods and transparent data analyses
- Mark marine reserve and marine conservation areas boundaries for those without Global Positioning Systems (GPS)

8. Appendix C: Status of Human Uses

Note to Reviewer: Much of this information is drawn from the State of California's Environmental Document for establishment of the state MPAs at the Channel Islands. We are interested in any data or information that would help us in updating this appendix.

8.1. Commercial Fishing

8.1.1. Aquaculture

Aquaculture is the practice of culturing, growing, and harvesting an aquatic species in a controlled setting. California has approximately 400 registered aquaculturists who raise products within intensive systems (enclosed, or on land; Resources Agency of California 1997). Currently Ecomar is using several of the OCS oil and gas structures near the Sanctuary to raise aquacultural products, such as mussels and other invertebrates. The bulk of the statewide mussel production (85 percent) comes from offshore oil production platforms. No other approved aquaculture activities currently occur near the Sanctuary. However, there is a proposal to develop a multi-species aquaculture operation on Platform Grace, approximately 3 miles from the Sanctuary boundary near the east end of Santa Cruz Island.

8.1.2. Commercial Harvest

Commercial fishing (by nets, traps, and lines, diving, and other methods) occurs at various locations off the coast of Southern California, including portions of the Channel Islands, an extremely productive commercial fishing area. The nearshore waters along the coast from Ventura to Santa Barbara and the waters just off the Channel Islands contain giant kelp beds that provide habitats for numerous species. The majority of fish are caught within these areas. Fishery seasons in state waters are established and regulated by the Commission and regulated by the Department of Fish and Game.

The commercial harvest of kelp and other marine vegetation near the coastline is an established industry in Southern California. Live fish trapping (e.g., rockfish, sheephead, and other nearshore species) occurs primarily in the shallower waters near the coastlines of the Channel Islands. Hook and line fisheries catch a variety of species on hand lines, longlines, rod-and-reel, and trolled gear. The main species caught in the hook and line fishery are rockfish species (Sebastes spp.). Lobsters are fished in coastal waters since they are typically most abundant in rocky areas with kelp in depths of 100 feet (30 meters) or less. The waters off the majority of the Channel Islands are conducive to this habitat since they generally have an offshore shelf that extends gradually into deeper waters. Gillnets are not allowed within 3 nautical miles of the mainland coast, or within 1 nautical mile of the offshore islands in the project area. Commercial drift gillnetting for pelagic shark and swordfish and white seabass occurs in the open waters throughout portions of the Channel Islands. This fishery, however, is only a small portion of the total industry in Southern California. The following section describes commercial fishing use of the project area.

8.1.2.1. Giant Kelp

Giant kelp was first harvested along the California coast during the early 1900s (Leet et al. 2001). Many harvesting companies operated from San Diego to Santa Barbara beginning in 1911. Those companies primarily extracted potash and acetone from kelp for use in manufacturing explosives during World War I. In the early 1920s, having lost the war demand, kelp harvesting virtually stopped. In the late 1920s, giant kelp was again harvested off California.

Giant kelp is now primarily harvested in California for extraction of alginates and other compounds and to supply food to several aquaculture companies for rearing abalones. It is also used for the herring-roe-on-kelp fishery in San Francisco Bay (Leet et al. 2001). Giant kelp is now one of California's most valuable living marine resources and in the mid-1980s supported an industry valued at more than $40 million a year. The annual harvest has varied from a high of 395,000 tons in 1918 to a low of less than 1,000 tons in the late 1920s. Such fluctuations are primarily due to climate and natural growth cycles, as well as market supply and demand. During the 10-year period 1970 to 1979, the harvest averaged nearly 157,000 tons, while from 1980 to 1989 the average harvest was only 80,400 tons. The harvest was low in the 1980s because the kelp forests were devastated by the 1982-1984 El Niño and accompanying storms, and by the 200-year storm that occurred in January 1988. In most areas the beds of giant kelp recovered quickly with the return of cooler, nutrient rich waters. Harvests in California increased to more than 130,000 tons in 1989 and to more than 150,000 tons in 1990.

In the project area, ISP Alginates is the only company harvesting giant kelp. During the 1990s, increasing international competition from Japan for the "low end," or less purified end of the sodium alginate market caused ISP Alginates to reduce harvests by about 50 percent (Leet et al. 2001). ISP Alginates anticipates California's harvest in this decade will be approximately 80,000 tons annually. The ISP Alginates Company uses specially designed vessels that have a cutting mechanism on the stern and a system to convey the kelp into the harvester bin. A propeller on the bow slowly pushes the harvester stern-first through the kelp bed, and the reciprocating blades mounted at the base of the conveyor are lowered to a depth of three feet into the kelp as harvesting begins. The cut kelp is gathered on the conveyor and deposited in the bin. These vessels can each collect up to 600 tons of kelp per day. Although the surface canopy can be harvested several times each year without damage to the kelp bed, State regulations require that kelp may be cut no deeper than four feet beneath the surface. To facilitate its harvesting operations, the company conducts regular aerial surveys. The survey information is used to direct harvesting vessels to mature areas of kelp canopy with sufficient density for harvesting.

8.1.2.2. Sea Urchin

One of the most important fisheries in California is the red sea urchin (*Strongylocentrus franciscanus*). The majority of sea urchin landings in southern California have come from the northern Channel Islands off of Santa Barbara, where large and accessible stocks once occurred (Leet et al. 2001). Red sea urchins are harvested by divers who generally use surface-supplied air delivered through a hose (hooka gear) instead of self contained underwater breathing

apparatus (SCUBA). Hooka gear consists of a low–pressure air compressor that feeds air through a hose to the diver's regulator. The hose is fed out from a reel so the diver has more maneuverability underwater. The urchins are gathered with a rake or hook and placed into large mesh bags which when full are lifted to the surface. Occasionally the bags, hoseline, and even the diver have to be freed from entangling kelp by cutting or breaking away kelp stipes.
The gonads of both male and female urchin are the object of the fishery and are referred to as “roe” or “uni” in Japanese. Gonad quality depends on size, color, texture, and firmness. Algal food supply and the stage of gonadal development affect quality and price. The highest prices are garnered during the Japanese holidays around the New Year. Sea urchins are collected by divers operating in nearshore waters. Divers check gonad quality and are size-selective while fishing to ensure marketability. In the last few years the red urchin fishery has become fully exploited throughout its range in northern and southern California. The purple sea urchin (*S. purpuratus*), which occurs over the same geographical range, is harvested in California, but only on a limited basis.

The Southern California red sea urchin fishery is relatively new, having developed over the last 30 years, and caters mainly to the Japanese export market (Leet et al. 2001). It began in 1971 as part of a National Marine Fisheries Service program to develop fisheries for underutilized marine species (Leet et al. 2001). The fishery was also seen as a way to curb sea urchins’ destructive grazing on giant kelp. Southern California urchin typically garner higher prices than Northern California urchin due to the longer market presence and consistently higher gonad quality.

There have been two periods of rapid urchin fishery expansion in California. The first culminated in 1981 when landings peaked at 25 million pounds in southern California. Contributing to this rapid escalation of the fishery was a pool of fishermen and boats involved in the declining commercial abalone dive fishery. Sea urchin landings then decreased following the El Niño of 1982-1983, when warm water weakened or killed kelp, the primary food source for sea urchins. Catches did not recover until 1985-1986, helped in part by the strengthening of the Japanese yen relative to the U.S. dollar. Urchin landings gradually increased to levels exceeding the 1981 peak and subsequently declined again during the El Niño events of 1992-1993 and 1997-1998. The latest decline was about twice the magnitude of that seen in 1982-1984, and to date the subsequent recovery in landings (and catch per unit effort or CPUE) has been far less dramatic (P. Kalvass, unpublished CDFG data).

Data on red sea urchin abundance collected by the National Park Service suggest that fishing has contributed to a general decline in the abundance of large individuals. Since 1985, abundances of harvestable size red urchins have declined by 1% per year at fished sites on Santa Rosa and San Miguel islands, (the sites contributing most to the catch), relative to non-fished reserve sites on Anacapa Island (S. Schroeter & D. Reed, unpublished analysis of NPS kelp forest monitoring data). Similar declines were not observed in the abundance of young-of-year recruits (urchins < 1” or 2.5 cm).

On the other hand, with the decline of large predators on sea urchin (including large California spiny lobster, California sheephead, and Southern sea otter), the urchin population has persisted at levels much higher than historical population sizes. High population density can contribute to the spread of disease. One study documented the spread of disease through dense urchin populations in the Channel Islands. During the study (1992-1998), urchin abundance increased over time as invertebrate predators (spiny lobsters) decreased under fishing pressure (Lafferty and Kushner 2000). Bacterial disease spread through populations with high densities of urchins. Sites with lower predator abundance had higher urchin abundance and higher incidences of the disease. An exception was the marine protected area at Anacapa Island, where urchin density was lower, due to higher predation by more abundant and larger lobsters, and the disease was nearly absent (Lafferty and Kushner 2000).

8.1.2.3. Abalone

In the 1950s and 1960s, abalone (*Haliotis spp.*) supported thriving commercial and recreational fisheries in the Channel Islands. Commercial fisheries for pink abalone and green abalone (*H. corrugata and H. fulgens*) peaked between 1950-1960, and 1971, respectively. In the early 1950s, pink abalone comprised the largest segment (about 75 percent) of the abalone fishery and was a significant component of the total abalone landings (CA DFG 2002). Pink abalone declined over 80 percent by 1999. Green abalone was common along the far southern mainland coast and at the southern Channel Islands, and occurred at the northern Channel Islands, but is now rarely encountered. Populations of green abalone appear to be extremely low (CA DFG 2002). The commercial fishery for black abalone (*H. cracherodii*) peaked in the 1970s and reached a second, lower peak in the mid 1980s. Prior to 1992, the commercial fishery for black abalone was second in pounds landed to red abalone. However, black abalone suffered significant stock declines, coincident with the spread of withering foot syndrome and continued fishing. The fishery for black abalone was closed in 1992 (Karpov et al. 2000). The commercial fishery for white abalone (*H. sorenseni*) collapsed by 1980, after heavy fishing (Tegner et al. 1996). There is no association of white abalone declines with withering foot syndrome (P. Haaker, personal communication). The white abalone fishery has been closed since 1993 but white abalone densities have continued to fall (Carlton et al. 1999; Davis et al. 1998). In 1997, white abalone was listed under the federal Endangered Species Act and a similar listing is being considered for black abalone. Red abalone (*H. rufescens*) was previously an important fishery in California, with landings peaking in 1967 and steadily declining thereafter (Leet et al. 1992). In central and southern California, red abalone had declined the least of all five species by the time the fishery was closed in 1997 (Leet et al. 2001). Red abalone is the only abalone species that remains locally common in some areas on San Miguel Island. In 1997, the area from San Francisco Bay to the California-Mexican border was closed to commercial and recreational harvest of abalone. The Department of Fish and Game determined that these species had suffered stock collapse due to overfishing. Currently, no commercial harvest of abalone is allowed in California.

8.1.2.4. Spiny Lobster

The commercial fishery for California spiny lobster (*Panulirus interruptus*), which started in the late 1800s, is one of the highest value fisheries in the Channel Islands region. Commercial fishermen use box-like traps constructed of heavy wire mesh to capture spiny lobsters. Traps of other materials, such as plastic, are allowed, but wire traps remain the most popular. About 100 to 300 traps per fisherman is common, but some may fish as many as 500 traps at the peak of the season. The traps are baited with whole or cut fish and weighted with bricks, cement, or steel to keep them on the seafloor. High-speed boats in the 20 to 40-foot size range are popular in this fishery, but everything from 15-foot skiffs to 50-foot fishing boats are used. Most trap boats are equipped with a davit and hydraulics to assist in pulling the traps (Leet et al. 2001)

The range of California spiny lobster is from Monterey Bay south to Manzanillo, Mexico. Spiny lobsters are found primarily from the intertidal zone to 43 fathoms (258 feet), in mussel beds and rocky areas with crevices, often in kelp beds. They generally hide in crevices and holes during the day and may be found on sandy bottoms at night. Commercial lobster fishing occurs in shallow, rocky areas from Point Conception to the Mexican border and off the islands and banks of the Channel Islands project area.

Sophisticated electronic equipment enables trappers to find suitable lobster habitat, and deploy and relocate traps. Traps are typically deployed along depth contours in waters less than 100 feet, or clustered around rocky outcrops on the bottom. At the beginning of the season the traps are usually very close to shore. By the end of the season they are typically deployed in 100 to 300 feet of water.

Seasonal landings in the 200,000 to 400,000 pound range rose following World War II and peaked in the 1949-1950 season, with a record 1.05 million pounds landed. A general decline followed for the next 25 years, reaching a low of 152,000 pounds in the 1974-1975 season. Landings started back up the next season, but remained between 400,000 and 500,000 pounds for nine consecutive seasons from 1979-1980 to 1987-1988. For the next nine years landings ranged from 600,000 to 800,000 pounds with a peak of 950,000 in the 1997-1998 season. Landings dropped back down after that. The peaks and valleys that have characterized this fishery are not unexpected in a fishery that is strongly influenced by the weather, El Niño and La Niña events, and the export market. About 90 percent of the legal lobsters taken in the commercial fishery weigh between 1.25 and 2.0 pounds, which produces the size of tail desired for the restaurant trade. Most of the harvest in recent years has been exported to Asian countries and France. However, depressed economies overseas have resulted in an effort to re-establish domestic markets.

The California spiny lobster fishery in southern California has persisted, in part due to persistence of suspected source populations in Mexico, but abundance and size distributions are clearly different from historical patterns (Dayton et al. 1998). The commercial fishery began in 1872, and in 1887 the average lobster taken was approximately 150 mm in carapace length (CL). By 1955, the average lobster from the commercial fishery was 119 mm CL. Average harvest in San Diego from 1976-1980 varied from 86-90 mm CL. In 1888, 260 traps yielded 231,060 lbs. By 1975, 19,000 traps were required to harvest almost the same mass (233,179 lbs; Tegner and Levin 1983). Lobster landings, although well below the peaks of the 1950s, have continued through the mid-1990s at relatively high levels.

Dramatic indirect effects of lobster fishing have been observed in the Channel Islands region. Historically, lobsters and other predators kept sea urchin populations at low levels, and kelp forests flourished. However, over time, commercial and recreational fisheries for lobster reduced the population size and average length of individual lobsters (Tegner and Levin 1983). Reduced populations of smaller lobsters were not effective predators on urchins and urchin populations increased as a result. Intense grazing by purple urchins (which were not fished) caused dramatic declines in kelp growth, leading to the formation of bare rocky reefs covered with urchins (known as urchin barrens). Crustose coralline algae, resistant to urchin grazing, became the dominant algae on rocky substrate in urchin barrens (Harrold and Reed 1985).

In 1978, commercial and recreational fishing was prohibited in one small marine protected area of the Channel Islands, the Anacapa Island Natural Area. Within this protected area, lobsters are six times more numerous and individual lobsters are larger than in nearby fished waters (Behrens and Lafferty, unpublished manuscript). Other harvested urchin predators, including California sheephead and kelp bass, are also more numerous and larger in the protected area (Tretault, unpublished data). Predation by large lobsters and other species in the protected area caused the urchin population to decline, so that on average, the density of urchins is 7.4 times greater in fished areas than in the protected area (Behrens and Lafferty, unpublished data). Released from the intense grazing pressure from urchins, kelp in the protected area flourished, supporting a variety of associated species. On average, kelp grew five times more densely and persisted longer in the protected area as compared to fished areas nearby (NPS, unpublished data). Data from the National Park Service show that the Anacapa Island Natural Area supports some of the richest kelp forests in the Channel Islands.

8.1.2.5. Prawn

The prawn fishery in the Channel Islands area includes trawl and (is there trawling today?) trap fishing for spot prawns (Pandalus platyceros) and trawl fishing for ridgeback prawn (Sicyonia ingentis). Traditionally, a number of trawl boats fished year round for ridgeback and spot prawns, targeting ridgeback prawns during the closed season for spot prawns, and fishing for spot prawn during the ridgeback closure. The California spot prawn fishery reached a peak of 800,000 pounds landed in 1998 and the (California?) ridgeback prawn fishery reached a peak of almost 1 million pounds landed in 1984 with a second peak of 1.4 million pounds landed in 1999. Live spot prawns are now taken by trap and trawl vessels and account for 95 percent of these landings. Live ridgeback prawns account for 28 to 68 percent of these landings (Leet et al. 2001).

The prawn trawling industry began in the 1965 and expanded over time. The trawler fleet operates from Fort Bragg south to the United States-Mexico border. Most vessels operate out of Monterey, Morro Bay, Santa Barbara, and Ventura, although a number of Washington-based vessels participate in this fishery during the fall and winter. The vessel length of the trawl fleet ranges from 28 to 85 feet with an average vessel length of 47 feet. Standard gear is a single-rig shrimp trawl of a semi-balloon, or Gulf Shrimp Act, design. Occasionally, double-rig or paired shrimp trawls are used. The body of the trawl net is typically composed of a single layer of 2.5- to three-inch meshes with a 36-square inch bycatch reduction device, and a minimum cod-end mesh size of 1.5 inches. Many fishermen prefer to use a double cod-end composed of two-to three-inch mesh. The introduction of roller (or rockhopper) gear in the 1990s led to the exploration of more area and the discovery of additional habitat suitable for spot prawns. The primary locations for prawn trawling occurred (or occurs?) along the upper edge of the continental shelf, which corresponds in many places with deep sandy areas near the Sanctuary boundary.

In the Channel Islands, 30 operators in the Channel Islands region were licensed to deploy trawl gear to catch spot and ridgeback prawns in 1999 (Leeworthy and Wiley 2002, and updated 2003 in Appendix C). On February 18, 2003, the California Fish and Game Commission adopted regulations prohibiting the use of trawl nets to take spot prawn. The regulations went into effect on April 1, 2003. Ridgeback trawl fishermen may land up to 50 pounds without restriction or 15 percent, by weight, of spot prawn during the open season for ridgeback prawn.

The trap fishery for spot prawns started nearly 70 years ago, when prawns were caught incidentally in octopus traps. In 1985, a trap fishery for spot prawn expanded in the Southern California Bight, with a concentration around the Channel Islands. The trap fleet operates with boats ranging in size from 20 to 75 feet. Trap designs are limited either to plastic oval-shaped traps or to the more popular rectangular wire traps. Normally, a fisherman will set 25 to 50 traps attached to a single groundline (string) with anchors and buoys at both ends. Traps are set at depths of 600 to 1000 feet along submarine canyons or shelf breaks (Leet et al. 2001).

8.1.3. Nearshore Finfishes (Including Rockfishes and California Sheephead)

The Nearshore Fisheries Management portion of the California Marine Life Management Act of 1998 defined nearshore finfish species as rockfish (*Sebastes spp.*), California sheephead (*Semicossyphus pulcher*), greenlings (*Hexagrammos spp*.), cabezon (*Scorpaenichthys marmoratus*), and other species found primarily in rocky reef or kelp habitat in nearshore waters. In the subsequent analyses in this document, the category rockfish includes all species of rockfish and cabezon. (Since the early 1990's greater emphasis has been placed on identifying individual fish species harvested from this group rather than utilizing market categories that combine multiple species.)

The development of the live or premium fishery in the late 1980’s resulted in increasing commercial catches of many species of rockfish occupying the nearshore environment in and around kelp beds. The principal goal of this nontraditional fishery is to deliver fish live to the consumer in as timely a manner as possible. Trucks or vans equipped with aerated tanks are used to transport fish directly to buyers. This fishery has increased substantially since 1988, and it continues to supply communities with live and premium quality fishes. The impetus of this fishery is the unprecedented and increasing high price paid for live fish.

Many groundfish species, including rockfish, have declined throughout their ranges and nine species are considered overfished by the Pacific Fishery Management Council. The nine overfished species are canary rockfish (*Sebastes pinniger*), cowcod (*S. levis*), yelloweye rockfish(*S. ruberrimus*), bocaccio (*S. paucispinis*), darkblotched rockfish (*S. crameri*), widow rockfish (*S. entomelas*), Pacific Ocean perch (*S. alutus*), lingcod (*Ophiodon elongatus*), and Pacific whiting (*Merluccius productus*;); (Love et al. 1998, Yoklavich 1998, Moser et al. 2000).

Recent lingcod stock assessments have concluded that lingcod is seriously depleted and that California populations appear to be less than 25 percent of their pre-1970s level (Leet et al. 2001). Rockfishes are particularly vulnerable to commercial and recreational fishing because they are long-lived (approximately 13-100 years) and have relatively slow growth, late maturity

(4-12 years), and unpredictable recruitment from year to year (Horn and Allen 1978, Cross and Allen 1993).

In the Channel Islands, 128 operators were issued commercial permits in 1999 to use handline, longline, rod & reel, and troll gear to target rockfish. In California, rockfish populations have exhibited systematic declines as a consequence of fishing pressure. There is evidence of a decline in blue rockfish stocks off southern California since the 1970s (Reilly 2001). There is clear evidence that olive rockfish have declined in abundance south of Point Conception (Love 2001). The commercial fishery for brown rockfish expanded since 1981 to a peak in 1991, and has subsequently declined. Commercial and recreational catches of brown rockfish have steadily increased during the last 40 years, while the average length and weight of brown rockfish in landings have declined by 31% and 49%, respectively (Ashcraft and Heisdorf 2001). There is compelling evidence that copper rockfish populations have severely declined in many areas and large individuals are noticeably less common than in past decades (Lea 2001). Fishery dependent surveys in 1981-1986 indicated a 23 percent decline in average weight of black rockfish compared to fish taken from 1958-1961 (Reilly 2001). The spawning population of canary rockfish has declined dramatically, with estimates of 1999 spawning population sizes of 6-23 percent of historically unfished levels (Williams and Adams 2001). Attempts to decrease fishing pressure on canary rockfish are resulting in severe restrictions for many other west coast fisheries (Williams and Adams 2001).

As a consequence of severe declines of rockfish, take of canary rockfish, cowcod, and yelloweye rockfish has been prohibited entirely. In 2001, two closures encompassing 100 and 4,200 square nautical miles were established in southern California to protect prime habitat for cowcod rockfish and other bottom-dwelling groundfish species. The larger area includes waters around Santa Barbara and San Nicolas islands. Recreational and commercial fishing for lingcod and most rockfish species is prohibited in the closures. At no time may California sheephead, lingcod, cabezon, kelp or rock greenlings, California scorpionfish, rockfish, or ocean whitefish be taken or possessed while fishing in water 20 fathoms or greater in depth in the Cowcod Conservation Areas (California Fish and Game Code Section 27.82, Title 14). Commercial bottom trawling for shrimp and prawn is also prohibited. According to a state/federal biological survey, the cowcod rebuilding period is expected to take up to 100 years. Consistent protection over a long period of time is necessary to help depleted populations of rockfishes and other vulnerable species recover from the cumulative impacts of commercial and recreational fishing.

California sheephead range from the Gulf of California to Monterey, but are rarely found north of Point Conception. This species frequents rocky areas and kelp beds from the surface to 150 feet and deeper; females are usually found in shallower depths than the males. Typical food items are sea urchins, crabs, sand dollars, mussels, abalone and bryozoans (Feder et al., 1974). While sheephead are most often observed in kelp beds and are known to venture farther from the bottom in the presence of kelp, the exact role that sheephead play, if any, in the kelp forest community is unclear (Feder et al. 1974).

The live sheephead fishery uses baited wire traps to capture small females. These traps are similar in design to those used by crab harvesters. The basic design is a 3'x2'x1.5', double compartment trap with two entrance funnels. Traps are usually constructed of 2"x2" wire mesh.

Since sheephead inhabit giant kelp beds, harvesters will set out traps adjacent to and within the kelp beds, along the southern California coast and around the Channel Islands.

There have been major changes in abundance and size distribution of California sheephead (*Semicossyphus pulcher*) in southern California. Between 1950 and 1989, the California sheephead fishery was dominated by recreational fishing. Recreational landings of California sheephead reached a peak at 230 metric tons in 1980, and subsequently decreased to 50-100 metric tons per year since 1994. Since 1989, the commercial fishery has dominated the sheephead industry. Commercial landings of California sheephead exhibited two peaks in 1987 (100 metric tons) and 1992 (150 metric tons), with a subsequent decline to approximately 60 metric tons in 2000.

ADD Rockfish Conservation Area discussion

8.1.3.1. Giant Sea Bass

Giant (black) sea bass (*Stereolepis gigas*) were once plentiful in local kelp forests in southern California (Dayton et al. 1998). There is no quantitative information on the density of giant sea bass but diver sightings of giant sea bass are fairly rare today, while historically divers reported seeing several of these fish on a single dive. Giant sea bass are known to aggregate off the north coast of Anacapa Island (De Wet-Oleson, unpublished data). Giant sea bass and other species that form aggregations for feeding or spawning are particularly vulnerable to fishers who target these area to catch large numbers of fish. Because of their large size (hundreds of kilograms) and their tendency to remain in a specific home range (possibly 2-3 ha), giant sea bass are vulnerable to spearfishers, net fishers and other anglers (De Wet Oleson, personal communication; Dayton et al. 1998).

Because of their long-term decline, in 1981, California regulations prohibited the take of giant sea bass for any purpose, with the exception that commercial fishermen could retain and sell two fish per trip if caught incidentally in a gillnet or trammel net. The law was amended in 1988, reducing the incidental take to one fish in California waters. Although this law may have prevented commercial fishermen from selling giant sea bass in California, it did not prohibit fishing over habitats occupied by this species and probably did little to reduce the incidental mortality of giant sea bass, as giant sea bass that were entangled in the nets were discarded at sea. The banning of inshore gillnets in 1994 displaced the California gillnet fishery from the majority of areas inhabited by giant sea bass, and it is reasonable to assume that this closure significantly reduced the incidental mortality of giant sea bass in California. Even so, given the slow growth and reproduction of the species, the California population of giant sea bass remains below historical highs (CA DFG 2002).

8.1.4. Coastal Pelagic Species (Anchovy, Sardine, Mackerel, and Squid)

The Coastal Pelagic Species (CPS or wetfish) category includes fisheries that generally employ purse seiners, and includes the Pacific sardine (*Sardinops sagax caeruleus*), northern anchovy (*Engraulis mordax*), and Pacific mackerel (*Scomber japonicus*). This state category closely mirrors the Pacific Fishery Management Council's management classification of the Federal Coastal Pelagic Species Fisheries Management Plan.

ADD DETAIL

8.1.4.1. Market Squid

Market squid (*Loligo opalescens*) range from British Columbia to Central Baja California (Recksiek and Frey 1978). Squid reproduction involves spawning within the water column, followed by the deposition of eggs upon the seafloor. The peak of the fishery targets the squid mating and egg laying aggregations and occurs during fall and winter in Southern California. The majority of market squid harvest is centered in the northern Channel Islands region, mainly in the project area. In general, squid harvest involves luring the animals to the surface with high wattage lamps, encircling them with purse seine nets, and pumping and/or using brail nets to remove the squid from the water, finally storing them in a fish hold. On a good net set, tons of squid may be harvested. Squid are minimally processed, mainly in San Pedro, California, and then frozen and shipped around the world, predominately to markets in the Mediterranean and China (Hastings and MacWilliams 1999). Annual squid catches can be greatly influenced by El Niño events, as shown in the following section.

Squid play a vital role in the California Current ecosystem and serve as a major link in the food chain as both predator and prey. For example, squid prey items include planktonic crustacea, mainly euphausiids and copepods, but also fish, cephalopods, gastropods and polychaetes (Karpov and Cailliet 1978). In turn, many species of marine mammals from Risso's dolphins (*Grampus griseus*) to California Sea Lions (*Zalophus californianus*), numerous fish species, including many economically important species like tuna and halibut, and numerous seabirds all depend upon squid as a key food source (Hastings and MacWilliams 1999).

Market squid have been harvested for over 100 years off the California coast from Monterey to San Pedro. The squid fishery has evolved into one of the largest fisheries in volume and economic value in California. Expanding global markets, especially in China and the Mediterranean, coupled with a decline in squid product from other parts of the world, has fueled a rapid expansion of the California squid fishery (Hastings and MacWilliams 1999).

Today, market squid is the dominant commercial fisheries in the Channel Islands, far exceeding the market value of all other species (Leeworthy and Wiley, 2002, and updated 2003 in Appendix C). In 1999, 169 operators were licensed to deploy purse seine gear to catch market squid in the Channel Islands region (Leeworthy and Wiley, 2002, and updated 2003 in Appendix C). The fishery for squid targets spawning aggregations on the nearshore shelves of the Channel Islands (Vojkovich 1998).

Squid appear to be negatively affected by El Niño events. After a peak in 1981, the squid fishery collapsed during the 1983-1984 El Niño event, and eventually rebounded to record levels in 1995-1997. The fishery declined slightly during another El Niño in 1998. The squid management plan (DFG 2001) requires reductions in the capacity of the squid fleet to limit the potential for future overfishing.

8.1.4.2. Tuna

The tuna category includes several highly migratory species that occur in the Channel Islands, including albacore, bluefin tuna, yellowfin tuna, and bonito. Tuna are caught commercially with hook and line gear. Trolling or jig vessels take the majority of albacore, with a small portion using live bait. Additionally, the wetfish fleet may target some tuna species during the summer. In some year, they may catch significant amounts of albacore (Leet et al. 2001). Commercial effort for albacore has fluctuated over the past 100 years, based primarily on market and oceanic conditions.

8.1.4.3. Pelagic Sharks

Forty operators in the Channel Islands region were issued licenses to set gill nets targeting pelagic sharks in 1999 (Leeworthy and Wiley 2002, and updated 2003 in Appendix C). In California, the fishery for shortfin mako shark began in 1978, peaked in 1986 and has declined since 1989 (Leet et al. 2001). The California fishery for thresher shark began in 1977, with a dramatic rise to a peak in 1981 and a sharp decline during subsequent years. The California fishery for blue shark begin in 1980 at a peak and dropped to almost nothing in subsequent years, with two small increases in the fishery in 1990 and 1995. The California fishery for other mackerel sharks began about 100 years ago with very low levels (Leet et al. 2001). A dramatic increase in the fishery for other mackerel sharks occurred in 1930, followed by a steep decline to extremely low levels during subsequent years. The take of white sharks is prohibited entirely. The trends in shark fisheries indicate rapid expansion and collapse of all targeted species. The significant reduction of this important predator may be affecting trophic (food chain) dynamics in the Channel Islands region.

8.1.4.4. Flatfishes

The flatfish fisheries of interest include California halibut (*Paralichthys californicus*), starry flounder (*Platichthys stellatus*), sanddabs (*Citharichthys spp*.), and other flatfish. California halibut is caught by trawl and hook-and-line, and is an important fishery in the State. Both recreational and commercial anglers prize flatfish and they are targeted from boats, piers, and the shoreline. Major fluctuations in landings of some species seem to indicate inconsistent recruitment and availability.

In the Channel Islands, 85 local operators were licensed in 1999 to deploy trawl gear targeting flatfishes (including halibut, starry flounder, and sanddabs) and California sea cucumber (Leeworthy and Wiley 2002, and updated 2003 in Appendix C). The halibut industry has declined over a period of 100 years, with peak landings of almost 5 million pounds in California in 1916 and an uneven decline to a low of several hundred thousand pounds in 1969 (Leet et al. 2001). Commercial landings of halibut have remained at about 1 million pounds during the last 20 years. The recreational (hook & line) halibut fishery in California peaked in 1947 and 1965 and the subsequent landings have remained low since 1970. Halibut landings from the recreational fishery in California are about 1.5% of the landings by the commercial fishery. Year-per-recruit analysis indicated that overall fishing effort was about twice the optimal level.

8.1.4.5. Rock Crab

The rock crab fishery is made up of three species: the yellow rock crab (*Cancer anthonyi*), the brown rock crab (*C. antennarius*), and the red rock crab (*C. productus*). Approximately 95 percent of the landings in this fishery come from southern California, although rock crabs inhabit the nearshore waters of the entire State (Leet et al. 2001). The three species are commonly found on sand near rocky reefs and within kelp beds around the holdfasts of kelp plants, where they prey on a variety of invertebrates. Rock crabs, along with several species of fish, are considered large predators associated with kelp, but the exact role that crabs play in kelp forest community dynamics is unknown (Foster and Scheil 1985).

Rock crabs are harvested using baited traps. The traps are set and buoyed either singly or as part of a string (two or more traps tied together). Trap designs and materials vary but most employ single chamber, rectangular traps of 2X4– or 2X2–inch wire mesh. Once set, the traps are left in place for 48 to 96 hours before being checked. A single harvester may use 200 or more traps at one time. Fishermen tend to replace their traps in the same location until fishing in that area diminishes. This creates pathways in the kelp canopy because of the passage of the boats along the same course. The kelp that is cut loose will either fall to the bottom to be eaten by sea urchins and other herbivores, drift out to sea, or become part of the beach litter, or a combination of these events may occur.

8.1.4.6. Sea Cucumber

Most of the State's sea cucumber catch is taken in southern California waters, with divers almost exclusively harvesting the warty sea cucumber (*Parastichopus parvimensis*) while trawlers primarily take the California sea cucumber (*P. californicus*). Divers take sea cucumbers as far south as San Diego, but most of the catch is taken off the four northern Channel Islands in depths of 6-20 fm (Leet et al. 2001).

Most of the California and warty sea cucumber harvest is shipped overseas to Hong Kong, Taiwan, China, and Korea. Domestic Chinese markets also purchase a portion of California 's sea cucumber catch. The majority are boiled, dried, and salted before export, while lesser quantities are marketed as a frozen, pickled, or live product. The processed sea cucumbers can sell wholesale for up to $20 per pound. In Asia, sea cucumbers are claimed to have a variety of beneficial medicinal or health-enhancing properties, including lowering high blood pressure, aiding proper digestive function, and curing impotency. Western medical researchers are investigating the pharmaceutical potential of various sea cucumber chemical extracts such as saponins and chondroitin sulfates (Leet et al. 2001).

At present there are few regulations on the harvest of these growing sea cucumber fisheries. In 1997, legislation was enacted to regulate the sea cucumber fishery. The major regulatory changes included requiring permits for each gear type, limiting the number of permittees based on the number of permits issued in previous years, and requiring a minimum landing of 50 pounds during 4 years (Leet et al. 2001). These regulations are unrelated to the population size of sea cucumbers and therefore may not ensure sustainability of the fishery. In the dive fishery for warty sea cucumbers there have been significant declines (i.e., 33% -83%) in population size of fished areas at the Channel Islands relative to unfished reserves (Schroeter et al. 2001).

8.2. Regulations

A variety of regulations are currently used to manage fisheries in the project area. These include total prohibitions on the take of certain species, seasonal closures, and other regulations. Tables C-1 and C-2 below summarize some of the major closures currently in place. This information is an update to the tables provided in the 2002 State of California's Final Environmental Document for Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary; specifically Volume 1 Chapter 4 Environmental Settings.

Because these tables are not a complete reproduction of all fishing regulations, (e.g., bag limits, size limits, in-season adjustments in allowable take and gear restrictions), they should not be used as guidance for legal compliance.

Table C-1: General Summary Of Existing Commercial Fishing Prohibitions In The Southern California Area As Of January 1, 2004

Insert Table C-1

Table C-2: General Summary Of Existing Recreational Fishing Prohibitions In The Southern California Area As Of January 1, 2004

Insert Table C-2

(Salmon fishing seasons are set on an annual basis. The closed season shown here was for the 2003 ocean salmon fishery and may change in 2004.)

INSERT IMAGE OF RCA AND CCA

8.2.1. Bycatch

Some fisheries have been restricted due to excessive bycatch, not because harvest exceeded the total allowable catch of the target species. Bycatch, or incidental take, can have a significant impact on non-targeted species. The highest bycatch mortality occurs in gill net, drift net, longline and trawl fisheries. In 1999, 176 commercial permits were issued to operators in the Channel Islands region to deploy trawl gear, 40 commercial permits were issued for drift gill net gear, 190 commercial permits were issued to deploy handline, longline, rod & reel, and troll gear, and 206 commercial permits were issued for purse seine gear (including 169 permits that also covered use of round haul nets). Table C-3 summarizes the number of permits issued in 1999, the type of gear used, and the target species.

Table C-3. The Number Of Commercial Permits Issued To Operators In The Channel Islands Region In 1999 (Leeworthy and Wiley, 2002/2003).

Permits	Gear	Target
85	Trawl and H&L	Flatfish
30	Trawl and trap	Prawn
61	Trawl	California sea cucumber
40	Drift gill net	Pelagic shark
37	Purse seine	Coastal pelagic species
169	Purse seine and round haul nets	Market squid
128	*H&L	Rockfish
19	*H&L	Tuna
43	*H&L and trap	Sculpin and bass

H&L includes handline, longline, rod & reel, and troll gear.

Eleven fish species are identified as bycatch in commercial and recreational fisheries in California, including sablefish, cabezon, four species of flatfish, shortspine and longspine thornyhead, yellowtail rockfish, chilipepper rockfish, and black rockfish. Commercial bottom trawl and longline fisheries take shortspine and longspine thornyheads as bycatch. Shortspine thornyhead has declined as a result of excessive bycatch by these fisheries. Commercial trawl, gill net, long line, and trap fisheries take sablefish, dover sole, and rockfish as bycatch. Calico rockfish appeared as bycatch in prawn trawls and other nearshore fisheries in southern California and are caught by sport fishers when they are fishing for other, larger benthic species (Leet et al. 2001). Cabezon, rockfish, and English sole are taken as incidental bycatch in fisheries that use handline, longline, rod & reel, troll gear, and gill nets. Horwood et al. (1998) suggest that closed areas may provide the only practical means of protecting vulnerable species caught as bycatch in the main fisheries.

Seabird bycatch in gill net and longline fisheries is one of the greatest threats to seabirds worldwide (Tasker et al. 2000). Seabirds are an important component of the Sanctuary food web. Gill nets entrap large numbers of shearwaters, auks and Xantus's Murrelet, a threatened species. Longline fisheries primarily catch shearwaters, petrels, and albatrosses (Tasker et al. 2000).

Most stocks of marine mammals in the Pacific and Atlantic experience significant mortality in gill net and drift net fisheries (Read and Wade 1999). Mortality of dolphins, porpoises and small whales often exceeds maximum allowable annual removal limits set by the Marine Mammal Protection Act because populations are often aggregated (Read and Wade 1999).

The following table summarizes west coast bycatch species incidentally taken by federally-managed fisheries of the U.S. Pacific Ocean(Table C-4).

Table C-4: Bycatch Populations Taken In U.S. Pacific Federally Managed Fisheries

Bycatch Species	Fishery	Gear Type
Sea Turtles	Tuna Swordfish Thresher shark	Surface hook and line Drift gill net Harpoon Pelagic longline Purse seine Recreational fisheries
Albatross	Highly Migratory Species	Surface hook and line Drift gill net Harpoon Pelagic longline Purse seine Recreational fisheries
Dolphins, Whales and Other Marine Mammals	Swordfish Thresher shark Tuna	Purse seine Drift gill net
Groundfish Bocaccio Canary rockfish Cowcod Darkblotched rockfish Lingcod Pacific ocean perch Pacific whiting Yelloweye rockfish	Coastal pelagic species Northern anchovy Jack mackerel Market squid Pacific sardine Pacific mackerel Swordfish Thresher shark	Purse seine Lampara nets Drift gill nets
Seabirds	Swordfish Thresher shark Tuna	Drift gillnets Purse seines
Molas	Swordfish Thresher shark Tuna	Drift gill nets
Blue and shortfin mako sharks	Swordfish Thresher shark	Drift gill nets
Invertebrates ? what inverts?	Swordfish Thresher shark	Drift gill nets

Source: Southwest Region Current Bycatch Priorities and Implementation Plan; NMFS 2003.

(Need more detail on which bycatch is significant concern for Channel Is., and why, with refs.)

8.2.2. Impacts Of Fishing Gear On Habitats

The abrasive contact of mobile fishing gear (define mobile fishing gear) with the seafloor, particularly trawling and dredging gear, can damage or destroy benthic habitats and faunas (JNCC 2004). In 1999, 176 commercial permits were issued to operators in the Channel Islands region to deploy trawl gear (Table 1.1). Check on the number of trawl permits issued (or maintained) in 2003. The intensity of the impact varies with the particular gear used and the nature of the habitat. Fishing efforts that use high energy and exert close contact with the habitat generally have high impacts on marine habitats.

Trawl doors scraped on the seafloor may penetrate sediments by up to 15 cm (JNCC 2004). Beam trawls penetrate up to 8 cm across the width of the beam (JNCC 2004). Such sediment disturbance flattens contours on the sediment surface and creates grooves by the heaviest parts of the gear. Typical trawl fisheries in California trawl the same section of sea bottom more than once per year on average (Friedlander et al. 1999).

Animals directly in the path of mobile fishing gear may be caught and subsequently die (mortality rates vary by species). Species burrowing into the seabed may be crushed. Fragile and surface-dwelling species suffer a much higher mortality than deep-burrowing or robust species. In rocky habitats, roller gear detaches and crushes organisms growing in the path of the trawl. Roller gear was introduced to the Channel Islands in the early 1990s, allowing fishers to explore and target new habitats. Long-term trawling in an area changes the marine community, both by altering benthic habitat complexity and by removing or damaging infauna and sessile organisms (Friedlander et al. 1999). Bottom-dwelling invertebrates can take up to 5 years or more to recover from one pass of the dredge (Peterson and Estes 2001).

(add more detail on which specific gear types are likely to have caused damage in Channel Islands, whether they are still being used today, and what evidence there may be for actual damage from gear use in the Channel Islands. Also clarify which gear types are not likely to cause damage to habitat.)

Although active fishing gear (define active fishing gear) can damage habitats, generally the use of the gear is controlled and the gear is removed from the ocean when the fisherman returns to port. However, lost fishing gear can continue to "ghost" fish in the environment. Ghost fishing occurs when fishing gear is lost and continues to entrap marine life and damage marine habitats. Gill and trammel nets, which are used to catch marine fishes and crustaceans, may be lost as a result of bad weather, operator error, or when they are damaged. When nets are lost, they may entrap a wide variety of marine organisms, including crustaceans, fishes, seabirds and marine mammals. After uncontrolled nets entrap a few organisms, predators and scavengers are attracted to the dead and decomposing bodies. Many of these animals also become trapped in the netting and subsequently attract other predators and scavengers. Catch rate of uncontrolled nets may decline over time as nets deplete surrounding waters or become snagged on reefs or rocks on the seafloor. One study of ghost fishing indicates that gill and trammel nets continued to catch commercial crustacean species continuously for 9 months of the study (Kaiser et al. 1996).

Static fishing gear types (define static fishing gear) have a lower impact on smaller areas of the seabed than active gear types. In the Channel Islands, traps are set for lobster, prawn, and the live fish industries. The lobster industry included 46 fishers in 1999 (Leeworthy and Wiley, 2002/2003). Include the number of traps set and lost during each season (M. Stadler, personal communication). Studies have shown that lost lobster pots may continue catching (and killing) animals for months (JNCC 2004).

Consider adding anecdotal incidents – gill net with sea lions entangled, DELTA sub reports for Footprint area, whale entanglements, etc…

8.3. Economic Overview of Commercial Activities

Table C-5 below shows the annual ex-vessel value of the commercial fisheries in the project area for years 1999 and for the average of years 1996-1999. In 1999, the top 14 species/species groups accounted for 99.7 percent of the commercial landings from the project area and for the years 1996-1999, the top 14 accounted for 98.69 percent of the commercial landings from the project area. Abalone fishing was halted in 1997, so for the years 1996-1999, the top 14 fisheries excluding abalone accounted for 99.21 percent of the value of commercial landings.

The top 14 harvested species/species groups are included in the classification and subsequent analyses in Chapter 5 and Appendix E of commercial fisheries, along with kelp. Kelp was treated differently because only one company harvests it, ISP Alginates, located in San Diego, California. Harvested value equivalent to ex-vessel value was not available. Instead, ISP Alginates supplied the processed value of kelp (1996-1999 average of $5,991,367). A separate economic impact model was created for kelp with the help of Dale Glantz of ISP Alginates. All the economic impact from kelp takes place in San Diego County where it is landed and processed.

Due to the trends in project area catch and value from 1988-1999, Leeworthy and Wiley (2002) used the average of years 1996-1999 as the most representative estimate for extrapolating future impacts. The trends in catch, value of catch and prices for the project area and for the State of California are included in Leeworthy and Wiley (2002). One can see in Table C-5 below that squid is the dominant fishery in the project area as well as the State of California. Squid catch, however, is sensitive to El Niño events. In 1998, squid catch plummeted then rebounded to a record catch in 1999. Spatial distributions of the fisheries value data for kelp, squid, wetfish and tuna are shown in Figures C-1, C-2, C-3, and C-4 below, respectively. Landing data for each fishery, separated according to port, can be found in Leeworthy and Wiley (2002).

Table C-5: 1999 Ex-Vessel Value Of Commercial Landings In the Sanctuary

Species Groups	1999 Value	Species Groups	1999 Value
Squid	$26,558,813	CA Sheephead	$153,147
Urchins	$5,963,876	Sculpin & Bass	$88,547
Prawn	$743,159	Roundfish	$37,318
Tuna	$53,694	Shrimp	$1,057
Spiny Lobster	$952,991	Yellowtail	$14,832
Flatfish	$324,685	Mussels, snails	$7,745
Rockfishes	$549,446	Rays & Skates	$2,283
Crab	$313,289	Salmon	$1,407
Wetfish	$608,865	Octopus	$169
Swordfish	$21,472	Surf Perch	$447
Sea Cucumbers	$267,842	Abalone	$47
Sharks	$41,638	Other	$23,728
		All species (excluding kelp)	$36,730,497

Insert Figures C-1, C-2, C-3, C-4: spatial distributions of the fisheries value data for kelp, squid, wetfish, and tuna.

8.3.1. Socioeconomic Profiles of Fishermen

(Clean up all sections below until Recreation and Tourism)

Leeworthy and Wiley (2002) surveyed two separate samples of fishermen. The first sample is sometimes referred to as the Pomeroy Sample and includes fishermen in the squid/wetfish fishery. The second sample is sometimes referred to as the Barilotti Sample and includes fishermen in all other fisheries, except squid and wetfish. It is important to note that both samples can be characterized as being involved in multi-species fisheries. Often the multiple species dependency is seasonal and important in supplying income flows over the course of a year. Small percentages of dependency on a particular species/species group may involve a week or a month of income at a time when the opportunity to catch the main species/species groups fished are not available and participation in other fisheries are the only source of income. This kind of dependency is taken into account in subsequent analyses. Leeworthy and Wiley (2002) provide a baseline profile of fishermen of the project area is provided, and compare them with some profiles of fishermen obtained from a study of Tri-County fishermen (i.e., Santa Barbara, Ventura and San Luis Obispo counties).

The commercial fishermen other than squid/wetfish or the Barilotti Sample included 59 fishermen. The squid/wetfish or Pomeroy Sample included 29 purse seine boats and 8 light boats. Profiles of purse seine boats and light boats are presented separately. Not every fisherman supplied complete information so sample size (N) or the number responding to each item is reported. Measurements included: 1) Experience (Years of Commercial Fishing and Years Commercial Fishing in the project area and Age of the fisherman interviewed), 2) Education (Years of Schooling of the fisherman interviewed), 3) Dependency on Fishing (Percent of Income from Fishing, Percent of Fishing Revenue from project area and Number of Crew and Family Members Supported by directly by the fishing operation), 4) Ownership/Investment (Boat Ownership and Replacement Value of Boats and Equipment), 5) Residence (State and City) and 6) Ports Used (Home Port, Main tie-up Port, and Main Landing Port). More detail was available from the squid/wetfish fishermen (Pomeroy Sample) than the other commercial fishermen (Barilotti Sample).

Although the samples of commercial fishermen accounted for 79 percent of the annual total ex-vessel value of catch from the project area, they represent only 13 percent of the total number of fishermen reporting catch in the project area. In 1999, there were 737 fishing operations reporting some catch from the project area. Nineteen (19) percent accounted for 82 percent of the annual total ex-vessel value, with each of these operations receiving at least $50,000 per year in ex-vessel value (141 operations). Almost 64 percent of fishing operations (469) received less than $20,000 per year and accounted for only about 6 percent of annual total ex-vessel value from the project area, and 23 percent (170 operations) earned less than $1,000 per year, which was 0.20 percent of the annual total ex-vessel value from the project area (Leeworthy and Wiley 2002).

8.3.2. Tri-County Fishermen

Leeworthy and Wiley (2002) provide additional baseline data are for Tri-Counties fishermen (Table 4-25). No difference was found between the two study samples (Pomeroy and Barilotti) for Experience, Age, or Number of Crew. The Tri-County sample had higher levels of education, a higher percentage of boat ownership, a lower proportion living in Santa Barbara and also reporting Santa Barbara as their Home Port, and our sample was less dependent on fishing for their income.

8.3.3. Baseline Relationships with Consumers

Leeworthy and Wiley (2002) also analyzed Consumer's Surplus, using 1999 data provided by the National Marine Fisheries Service, and baseline data are presented here. It appears that squid and urchins are the only species/species groups for which significant proportions of U.S. landings come from the project area. The United Nations Food and Agricultural Organization (FAO) reports a 1999 world commercial catch of squid of 3,373,463 metric tons or 7,438,486 million pounds. Project area landings were therefore about 2.15 percent of world supply, although 1999 was a record year for squid in the project area. FAO also reports the 1999 world commercial catch of urchins of 118,750 metric tons or 261,844 million pounds. Project area urchin landings were therefore about 2.24 percent of world supply.

8.3.4. Fisheries Access

For economic analysis, it is critical to understand the structure of who can enter the fishery, if there are constraints on the amount and timing of total take allowed and what is the current capacity to catch the fish stock. While most fisheries in the project area require permits, they fit into the most permissible types of permit structure. These permit types are listed below:

A permit system where there are no restrictions on the number of permits, only requirements to possess one. The fishery may have some total allowable take, but not specified by fishermen (first come first serve). In this type the economic analysis of open access fisheries applies.

A permit system where the number of permits is limited, and criteria for obtaining a permit are set. The capacity of the fleet, however, is such that they could catch an amount above the total allowable catch. One might describe this as limited entry, but the limits have no real effect economically or biologically because of the capacity of the fleet. This would still be analyzed as an open access fishery.

A permit system where the number of permits is limited, criteria for obtaining a permit are set, and the capacity of the fleet is controlled to where it cannot exceed total allowable catch. In this case there are no Individual Transferable Quotas, but there is the possibility of the participants in the fishery earning economic rents. This is likely to be a derby fishery, where participants compete for a larger share of the catch. Because of the limits on capacity, this is not analyzed as an open access fishery.

A permit system where fishermen possess Individual transferable Quotas (ITQs). A limited number of fishermen are given ITQs, which specify a certain share of the total allowable catch. This avoids the derby fishery problem and since one can buy and sell the ITQs, it solves the capacity problem and fosters economic efficiency. This is not an open access fishery.

Using the above criteria, all of the commercial fisheries in the project area can currently be characterized as open access fisheries. The squid/wetfish fishery is currently considering implementing a limited entry program in the current draft management plan. The nearshore finfish fishery has reduced its capacity, and is considering limited entry. There are no present analyses of whether these limits would lead to economic rents (define) in the fishery. Therefore, no analyses of the effects of marine reserve and marine conservation areas on economic rents are possible.

8.3.5. Recreation and Tourism

Recreational activities occur primarily in nearshore areas, particularly along the mainland and around the Channel Islands. Examples of common offshore recreational activities include sportfishing, sailing, boating, and swimming. In addition, the coastal and offshore marine environments are ideal locations for tourist activities. Tourist-related activities include sightseeing, whale watching, sportfishing, pleasure boating, and diving.

8.3.6. Consumptive Activities

8.3.6.1. Recreational / Sport Fishing And Consumptive Diving

Recreational (sport) fishing involves hook-and-line fishing from piers and docks, jetties and breakwaters, beaches and banks, private or rental boats, and commercial passenger fishing vessels. Recreational fishing also includes activities such as spear and net fishing. Recreational fisheries in the project area access both nearshore and offshore areas, targeting both bottom fish and mid-water fish species. Consumptive recreational divers use both private and rental boats and commercial passenger fishing vessels. They also SCUBA dive and free-dive from the shore in a variety of locations.

The Channel Islands project area is a leading recreational fishing area along the West Coast. Weather and sea conditions allow for year-round fishing. The coastlines around the Channel Islands are popular sportfishing areas; although the majority of kelp beds are within one nm of shore, some fishing areas extend far from shore and include lingcod and rockfish grounds west of San Miguel Island, broadbill swordfish, marlin, and mako shark waters south of Santa Cruz Island, and kelp beds offshore and surrounding portions of all the islands.

The sportfishing industry in California is composed of commercial passenger fishing vessels (CPFV), private boats, and shore anglers. The CPFV's take groups of anglers out on 1/2–day, 3/4–day, full day, and multiday trips. The majority of 1/2– and 3/4–day trips fish within or near the kelp beds, except in the summer when California barracuda (Sphyraena argentea) and Pacific bonito (Sarda chiliensis) are present (Crooke pers. comm.). CPFV dive trips are often multi-day trips going to one or more of the offshore islands. These trips focus on harvesting certain species such as lobster during their respective recreational harvest seasons. A large number of sport divers (both free divers and SCUBA divers) spearfish for many of the species caught by hook and line. Species commonly targeted by consumptive divers include many rockfish species and kelp bass, halibut, yellowtail and white seabass, as well as lobster and scallops. Divers are generally limited to the shallowest intertidal waters to depths around 130 feet.

Commercial passenger fishing vessels (CPFVs) frequently offer one-day sportfishing excursions from either Ventura or Santa Barbara harbors. Types of fish landed on commercial passenger fishing vessels include kelp bass, mackerel, California sheephead, halfmoon, and whitefish. Offshore fishing focuses on more mobile species like yellowtail, tuna, white seabass, and barracuda.

The largest numbers of fish caught for recreational purposes are caught within 3 miles of shore. Barred surfperch, California halibut, jacksmelt, pacific mackerel, kelp bass, rockfish, white croaker are a few of the species that represent the largest catch numbers.

Recreational fishing also exerts significant pressure on targeted species, including rockfish. The recreational fishery for black rockfish rapidly expanded since 1979, peaked in 1985, and declined precipitously since 1993 (Reilly 2001). The recreational fishery for blue rockfish rapidly expanded in 1979, peaked in 1982 and 1993 and exhibited a subsequent rapid decline (Reilly 2001). The recreational fishery for olive rockfish expanded rapidly in 1979, peaked in 1981, and subsequently declined (Love 2001). The recreational fishery for brown rockfish expanded since 1979, peaked in 1987, and rapidly declined in recent years (Ashcraft and Heisdorf 2001). The recreational fishery for copper rockfish exploded in 1979 to a peak in 1980, and declined steadily in subsequent years (Lea 2001). Recreational fisheries for kelp rockfish, china rockfish, black and yellow rockfish, grass rockfish, and gopher rockfish expanded rapidly in 1979 to peaks between 1981 and 1985, all exhibiting subsequent declines (Larson and Wilson-Vandenberg 2001). Although there is no comprehensive stock assessment for these populations, each species probably is subject to local depression in abundance and average size wherever recreational or commercial fishing is concentrated (Leet et al. 2001).

Schroeder and Love (2002) compared rockfish density within a de-facto marine reserve (an oil platform where recreational fishing does not occur), an area allowing only recreational fishing, and an unprotected area (where both recreational and commercial fishing are allowed) in the Channel Islands region. Rockfish density was an order of magnitude less within the recreational fishing area than in the unprotected area. Community composition also was significantly different. Cowcod densities were 8 and 32 times greater in the de facto reserve than in the recreational area or unprotected area, respectively. Similarly, bocaccio densities within the de facto reserve were 18 and 408 times greater than in the recreational area or unprotected area, respectively. The authors conclude that recreational fishing can have measurable effects on the densities of targeted species.

8.3.7. Non-consumptive Activities

8.3.7.1. Whale Watching

Whale watching in the Channel Islands is popular, due to the high frequency of sightings and diversity of marine mammals. Day trips are offered from several areas landings, including Santa Barbara, Ventura and Channel Islands harbors.

8.3.7.2. Non-consumptive Diving

The Channel Islands area is considered to have some of the most highly renowned nonconsumptive diving opportunities in California. Interest in diving in the project area is keen, due to the beautiful marine habitat, shipwrecks, and other underwater historical sites. Morris and Lima (1996) describe the history of submerged cultural resources (e.g., shipwrecks) of the Channel Islands, and systematically review the archeological sites from field work in this marine area. Over 100 vessels have wrecked in the Channel Islands National Park and National Marine Sanctuary; about 21 of these have been located. A literature survey of knowledge of the marine areas shipwrecks is also found in Howorth and Hudson (1985). Nonconsumptive divers enjoy interacting with the marine environment, exploring new habitats, and underwater photography.

8.3.7.3. Sailing

Sailing is a popular pastime in the project area. The Channel Islands are within reach of several ports for single or multiple day trips. Users who sail in the project area likely also participate in other consumptive and/or nonconsumptive recreational activities during their trips.

8.3.7.4. Kayaking/Island Sight-Seeing

Several operations offer sea kayaking excursions in the project area. Users can also take kayaks out to the islands on commercial or private vessels, and spend single or multiple days kayaking along the shoreline of the Channel Islands. Due to abundant marine life and the presence of large sea caves and rock formations, the Channel Islands are considered a primary destination for sea kayakers in California.

8.3.8. Economic Overview of Recreational Activities

This section provides the baseline economic measures for the recreation industry. Consumptive recreation includes recreational fishing from a charter/party boat, fishing from a private household/rental boat, consumptive diving from a charter/party boat and consumptive diving from a private household/rental boat. Non-consumptive recreation includes non-consumptive diving, whale watching, sailing and kayaking/sightseeing from for hire or charter/party boats. No information was found on non-consumptive activities from private household/rental boats, so non-consumptive uses are undercounted. 1999 is the baseline year used for extrapolating future impacts.

A previous assessment of recreational fishing (Leeworthy and Wiley 2000) summarized information available for years 1993 to 1998 from the National Marine Fisheries Service's Marine Fishing Statistics Survey (MRFSS). MRFSS data showed a downward trend in fishing trips and catch for Southern California over this period. Total trips had declined 26.4 percent. For the top 20 species, in terms of total number of fish caught, 10 had downward trends, 7 had no trend and 3 had upward trends. These trends were contrasted with the trends between 1991 and 1996, for all of California, based on the U.S. Fish and Wildlife Survey of Fishing, Hunting and Wildlife Associated Recreation (USFWS 1991 and 1996). This latter survey showed a slight decrease in the number of recreational anglers (-0.76 percent), but an increase in the number of angler days (27.88 percent). Although the definitions of the populations covered are different between the surveys, the differences in trends could not be reconciled because the MRFSS Northern California data also showed a downward trend.

Species like California halibut, white seabass, Pacific barracuda and yellowtail, which were not among the top 20 species between 1993 and 1998, were in the top 20 or close in 1999 and 2000 (yellowtail actually ranked 21st). In 2000, the number of trips ended the downward trend in total trips and across all boat modes, and total catch increased as well. The number of trips increased dramatically between 1999 and 2000 (55.19 percent). The number of trips rebounded to almost their 1996 level. Overall, the trend in trips is still down from the 1993 level (-6.3 percent).

Many of the top 20 species had downward trends in the number of fish caught. The top 20 species also changed fairly dramatically. In 1999 and 2000, all the rockfish species that were previously among the top 20 between 1993 and 1998 dropped out of the top 20, except vermillion rockfish and bocaccio. Vermillion rockfish were ranked 13th in 1999 and 17th in 2000 and bocaccio was ranked number 19th in 1999 and 21st in 2000. Species ranked 11th through 20th in 1993 were all out of the top 20 in 2000, even though only three of these species showed downward trends in catch between 1993 and 1998.

8.3.8.1. Person Days Of Activity

In 1999, there were an estimated 437,908 total person-days (one person undertaking an activity for any part of a day or a whole day) of consumptive recreation in the project area (Table 4-30). Fishing from a private household boat was the top activity with over 214,000 person-days (49 percent of the consumptive recreation activity) followed by about 159,000 person-days of fishing from charter/party boats (36 percent of the consumptive recreation activity). Consumptive diving accounted for the remaining 15 percent of consumptive recreation activity. In 1999, 21 percent of the private household boat fishing and about 26 percent of the charter/party boat fishing in Southern California was done in the project area. Spatial distributions of charter/party boat fishing, charter/party boat consumptive diving, private boat fishing, and private boat consumptive diving are shown in Figures C-5, C-6, C-7, and C-8 respectively.

Insert Table 4-30, Figures 4-14,15,16,17 from CEQA Document, name them Table C-5, and Figures C-5 to C-8

In 1999, there were an estimated 42,008 person-days of non-consumptive recreation from "for hire" operations in the project area. As mentioned above, an estimate of the amount of non-consumptive recreation activity from private household boats was not possible. Whale watching was the top non-consumptive recreational activity with about 26 thousand person-days (62 percent of all non-consumptive recreation activity) followed by non-consumptive diving with almost 11 thousand person-days (26 percent of all non-consumptive recreation activity). Sailing and kayaking/island sightseeing accounted for the remaining 13 percent of non-consumptive recreation activity. Spatial distributions of whale watching, non-consumptive diving, sailing, and kayaking/island sightseeing are shown below in Figures C-9, C-10, C-11, and C-12, respectively.

Insert Figures 4-18, 4-19, 4-20, and 4-21from CEQA document and name them Figures C-9 to C-12

In 1999, the recreation industry included a total of 479,916 person-days of consumptive and non-consumptive recreation. Consumptive recreation was 91.25 percent of all recreation activity in the project area. The "for hire" industry (51 charter/party boat/guide operations) accounted for almost 46 percent of all the person-days of recreation activity. This is important because the estimates of use from this industry were based on a census, not a sample, of all operators who operate in the project area (Leeworthy and Wiley 2002

8.3.8.2. Expenditure Profiles

Table C-6 below shows the expenditure profiles developed for each activity/boat mode. Low food, beverage and lodging costs would indicate a low percentage of users being overnight visitors or dominated by local users. In 1999, coastal residents accounted for 86.7 percent of charter/party boat trips and 96.86 percent of private household boat trips for fishing in southern California (NMFS, MRFSS). Not all the profiles found had consistent categories; sometimes food and beverage was reported separately and sometimes they were aggregated together. When reported separately, the separated categories were used in the impact analysis. The profiles for charter/party boat fishing and private household/rental boat fishing are from a 2000 study of Southern California marine recreational fishing (Gentner, Price and Steinback 2001). See Leeworthy and Wiley (2002) for a discussion and critique of the approach used in an American Sportfishing Association report.

Insert Table 4-32 from CEQA document, call it Table C-6

8.3.8.3. Baseline Economic Impacts of Recreation in the Sanctuary

The baseline impacts of consumptive and non-consumptive recreational activities are summarized in Tables C-7 and C-8 below.

Insert Tables 4-33 and 34 from CEQA, call them C-7 and C-8.

8.3.9. Oil and Gas

Under Federal regulations, no new offshore oil or gas activity is allowed within the project area. Oil and gas development does occur in the Santa Barbara Channel. Current onshore facilities prepare crude oil for shipment to refining centers, and produce natural gas. A characterization of onshore facilities for offshore oil and gas activities is found in California Offshore Oil and Gas Energy Resources Baseline Conditions & Future Development Scenarios (MMS 1999). Oil and gas activities would not be affected by any of the action alternatives in a manner different from the no-project alternative.

8.3.10. Vessel Traffic and Harbors

8.3.10.1. Commercial Vessel Traffic

The Los Angeles-Long Beach Harbor is the busiest on the west coast (McGinnis, 1990). Commercial vessels use the shipping lanes of the Santa Barbara Channel. To help direct offshore vessel traffic in the Santa Barbara Channel, a Traffic Separation Scheme (TSS) was designated in the project area to separate opposing flows of vessel traffic into lanes, including a zone between lanes where traffic is to be avoided. Vessels are not required to use any designated TSS, but failure to use one would be a major factor for determining liability in the event of a collision.

The most recent survey of the number of commercial vessels that use the shipping lanes of the channel is found in the County of Santa Barbara Energy Division (1989) and the National Maritime Research Center (1981). The County of Santa Barbara (1989) study reported 8,458 vessels, or 23.3 trips per day, during 1987 and projected an estimated 15,864 per year, or 43.2 trips per day, during 2000. Commercial vessel traffic is not expected to be affected by any of the action alternatives in a manner different from the no-project alternative.

8.3.10.2. Ports and Harbors

Santa Barbara Harbor, built in 1926, is a 1,068-slip harbor and is used primarily by fishing, commercial, and recreational vessels. It is a popular destination for recreational boaters, fishermen, and tourists. The harbor offers a number of boating services including maintenance, hull cleaning, repairs, and towing.

Ventura Harbor, built in 1963, is located approximately 65 miles northwest of Los Angeles. The harbor has increased in size so that it now encompasses 152 acres of land, 122 acres of water, and has 1,375 slips. This small harbor is used primarily by recreational and commercial vessels, and provides several services and outdoor activities. Its proximity to the Channel Islands makes it an excellent point of origin for day or extended trips. Although it is used primarily by recreational and commercial fishing vessels, Ventura Harbor does offer berths for some supply and work vessels that service offshore platforms (MMS 1999).

Channel Islands Harbor is located in Oxnard, halfway between Ventura Harbor and Port Hueneme. With nine marinas and four yacht clubs, the harbor is home to more than 2,800 recreational and commercial vessels. Channel Islands Harbor is the closest harbor to the Channel Islands, making it a convenient location for day or extended trips. Public facilities and services include laundry rooms, restrooms and showers, picnic areas, marine supplies, and maintenance and repair shops. Vessels associated with the offshore oil and gas industry typically do not use Channel Islands Harbor (MMS 1999).

Port Hueneme is the only deep water port between Los Angeles and San Francisco, and is used by commercial ships to load and unload goods. Port Hueneme is also used by supply and crew vessels that service offshore platforms (MMS 1999).

9. Appendix D: The Marine Reserves Working Group Process

9.1. The Channel Islands Marine Reserves Process

9.1.1. A Federal, State and Local Community Partnership

In 1998, the California Fish and Game Commission (Commission) received a recommendation from a local recreational fishing group to create marine reserves5, or no-take zones, around the northern Channel Islands as a response to dwindling fish populations. This recommendation suggested closing 20 percent of the shoreline outward to 1 nautical mile to all fishing. The recommendation led to more than one year of public discussion of the issue in the Commission forum. In response to the proposal and the need for an open, constituent-based process consistent with Sanctuary and California Department of Fish and Game (CDFG) missions and mandates, the Sanctuary and the CDFG developed a Federal and State partnership, the Channel Islands Marine Reserves Process, to consider the establishment of marine reserves in the Sanctuary. The Commission endorsed this process at their March 4, 1999 meeting.

The Channel Islands National Marine Sanctuary Advisory Council, a federal advisory board of local community representatives and federal, state and local government agency representatives, created a multi-stakeholder Marine Reserves Working Group (MRWG) to seek agreement on a recommendation to the Sanctuary Advisory Council regarding the potential establishment of marine reserves within the Sanctuary. The Sanctuary Advisory Council also designated a Science Advisory Panel of recognized experts and NOAA led a Socio-economic Team to support the MRWG and Channel Islands Marine Reserves Process. Extensive scientific and socio-economic data were collected in support of the baseline assessment and marine reserves design process. From July 1999 to May 2001, the MRWG met monthly to receive, weigh, and integrate advice from technical advisors and the public and to develop a recommendation for the Sanctuary Advisory Council on the potential establishment of marine reserves in the Sanctuary.

The MRWG reached consensus on a set of ground rules, mission statement, problem statement and goals and objectives, a list of species of interest and a comprehensive suite of implementation recommendations. The goal statements included the following:

> To protect, maintain, restore, and enhance living marine resources, it is necessary to develop new management strategies that encompass an ecosystem perspective and promote collaboration between competing interests. One strategy is to develop reserves where all harvest is prohibited. Reserves provide a precautionary measure against the possible impacts of an expanding human population and management uncertainties, offer education and research opportunities, and provide reference areas to measure non-harvesting impacts.

[5] In a California State marine reserve it is unlawful to damage, take, or possess any living, geological, or cultural marine resource, except under a permit or specific authorization from the Fish and Game Commission for research, restoration, or monitoring purposes.

- *Ecosystem Biodiversity: To protect representative and unique marine habitats, ecological processes, and populations of interest.*

- *Socioeconomic: To maintain long-term socioeconomic viability while minimizing short-term socioeconomic losses to all users and dependent parties.*

- *Sustainable Fisheries: To achieve sustainable fisheries by integrating marine reserves into fisheries management.*

- *Natural and Cultural Heritage: To maintain areas for visitor, spiritual, and recreational opportunities which include cultural and ecological features and their associated values.*

- *Education: To foster stewardship of the marine environment by providing educational opportunities to increase awareness and encourage responsible use of resources.*

9.1.2. Community Development of Alternatives

The MRWG developed over 40 different designs for marine zoning and evaluated the ecological value and potential economic impact of each design. To do so, members of the MRWG contributed their own expertise to modify designs or generate alternatives to the designs developed by the Science Advisory Panel and utilized a geospatial tool, known as the Channel Islands Spatial Support and Analysis Tool (CI-SSAT; Killpack et al. 2000). CI-SSAT provided opportunities for visualization, manipulation, and analysis of data for the purpose of designing marine reserves.

CI-SSAT provides a computer-based environment for viewing and evaluating information (Killpack et al. 2000). The interface resembles a Geographic Information System (GIS) with optional viewing of spatially explicit data. Data can be selected or hidden, by checking a box beside the data label. Once the data have been selected, the user can zoom in or out to obtain broader or more detailed views.

In the Channel Islands case, CI-SSAT contained both ecological and economic data. The map of conservation "hotspots," generated using irreplaceability analysis in Sites V.1, was included in the CI-SSAT. The ecological data, including distributions of sediments, giant kelp, seagrasses, seabirds, and marine mammals, also were included. Ten options for networks of marine reserves, developed by the Science Advisory Panel, were available for purposes of comparison. The tool also contained maps showing the distributions of major commercial and recreational activities. Data describing the economic value of each planning unit to each fishery was not released by the fishing community for general viewing by the public in CI-SSAT. However, the economic information was contained within the tool and was used for impact evaluation of alternatives.

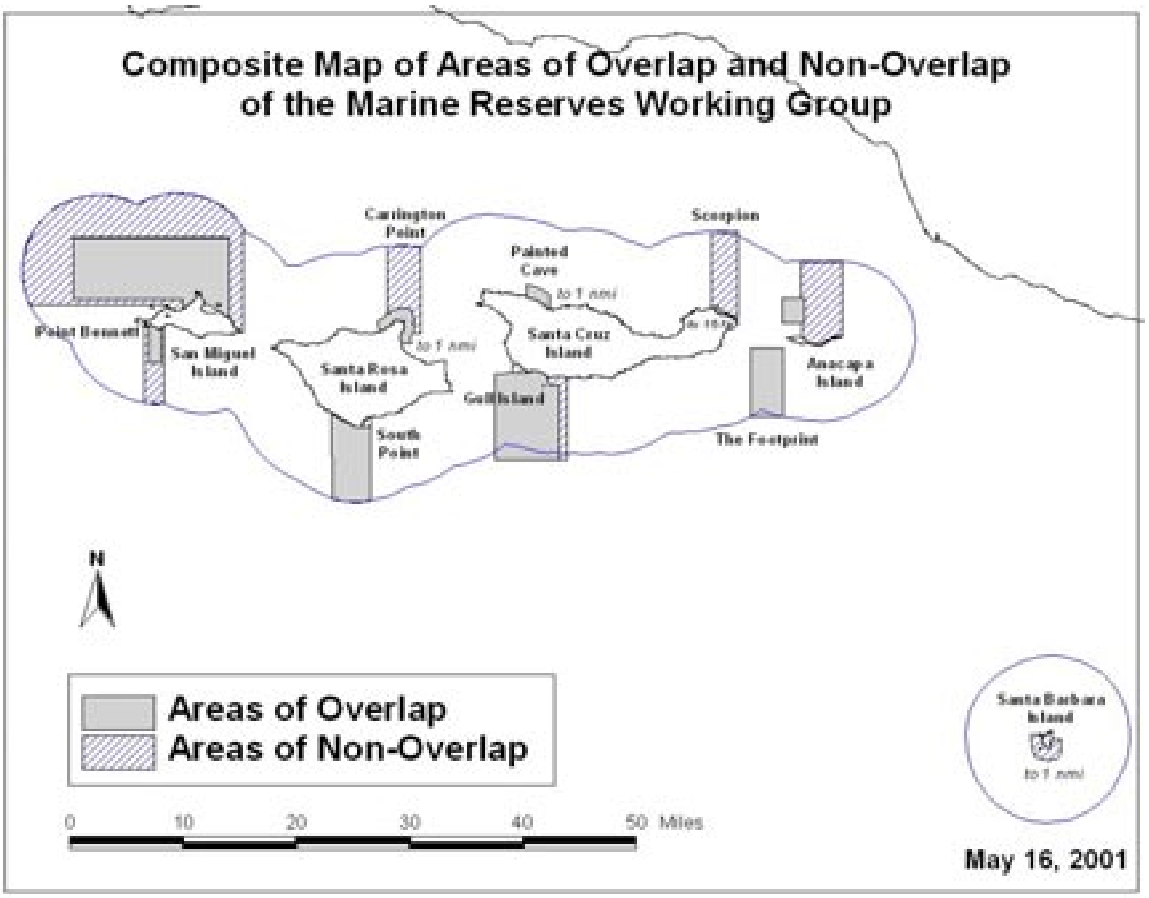
CI-SSAT is capable of performing an analysis similar to the irreplaceability analysis of Sites V.1. For any particular analysis, CI-SSAT generates a map, based on an initial weighting of ecological and economic criteria that shows how much each planning unit contributes to a design. If the user desires to produce a zoning plan based entirely on ecological criteria, the analysis will reflect only ecological data, and the biodiversity "hotspots" will be identified based on habitat heterogeneity, species diversity, and rare habitats or species. If the user desires to minimize economic impact of a zoning plan, then the CI-SSAT analysis selects the areas that have low overlap with existing commercial and recreational consumptive activities. If the user desires to balance ecological with economic criteria, the areas of conservation value will be selected in the sites that minimize economic impacts. The outcome is a compromise similar to a Sites V.1 annealing process with consideration of the economic cost of each planning unit. Once the analysis is completed, the user can work with the base map from the analysis to develop a marine zoning plan. In the Channel Islands case, the MRWG decided not to use CI-SSAT function to weight criteria. (Members of the working group agreed that the ecological and economic criteria should be weighted equally, but they were unwilling to work from a compromised map that contained incomplete socioeconomic information (due to the fishermen's desire for confidentiality of their business information).) Thus, CI-SSAT was more useful for visualization, exploration, and comparison of zoning plans developed by working group members.

CI-SSAT permits users to view or hide any ecological or economic data layer in the analysis. Simple drawing features allow users to create rectangles, circles, or odd shapes to represent potential reserves. Once the user has completed a zoning plan, a quick evaluation provides the user with (1) information about the amount of each habitat or portion of species' range captured within the reserve boundaries and (2) the potential impact of the reserve on major commercial industries and recreational activities. By adjusting the boundaries to include more of a particular habitat or species, or to reduce the impact to a particular industry or activity, CI-SSAT facilitates development of a marine zoning plan to meet the user's criteria. The tool supports rapid modification and real-time evaluation of alternatives.

After months of deliberation, the working group selected 2 designs to represent the diverse views of the group. The composite map depicts the best effort that each MRWG representative could propose and remain true to his/her constituency (Figure D-1). This composite map, along with the suite of 40 draft maps that were produced, and background scientific and economic information, were provided through the Sanctuary Advisory Council to the Sanctuary and CDFG for consideration. (Airamé, in prep.)

It is important to note that the MRWG considered a network of marine reserves throughout the entire Sanctuary (0-6 nm) that includes both state and federal waters. The development of ecological criteria and socioeconomic data also included the entire Sanctuary area.

Figure D-1. Composite Map of Areas of Overlap and Non-Overlap Marine Reserve Network Proposals



As directed by the ground rules, the MRWG forwarded all areas of consensus, non-agreement and the composite map to the Sanctuary Advisory Council. The Sanctuary Advisory Council evaluated the MRWG's work and progress, deliberated over two meetings, hosted a public forum on the issue, and forwarded a recommendation to the Sanctuary Manager:

> The Channel Islands National Marine Sanctuary Advisory Council commends the Sanctuary staff, Department of Fish and Game (DFG) and all participants of the MRWG, Science and Socio-Economic Panels on their efforts over the past two years. The Sanctuary Advisory Council finds that the MRWG, in seeking consensus on marine reserves, developed scientific and socio-economic data that should be used and built upon in future consideration of such issues. The Sanctuary Advisory Council finds that the MRWG process was open, inclusive and community based.

By a vote of 17 (yes), 1 (no), 1 (abstention), the Sanctuary Advisory Council agreed to:

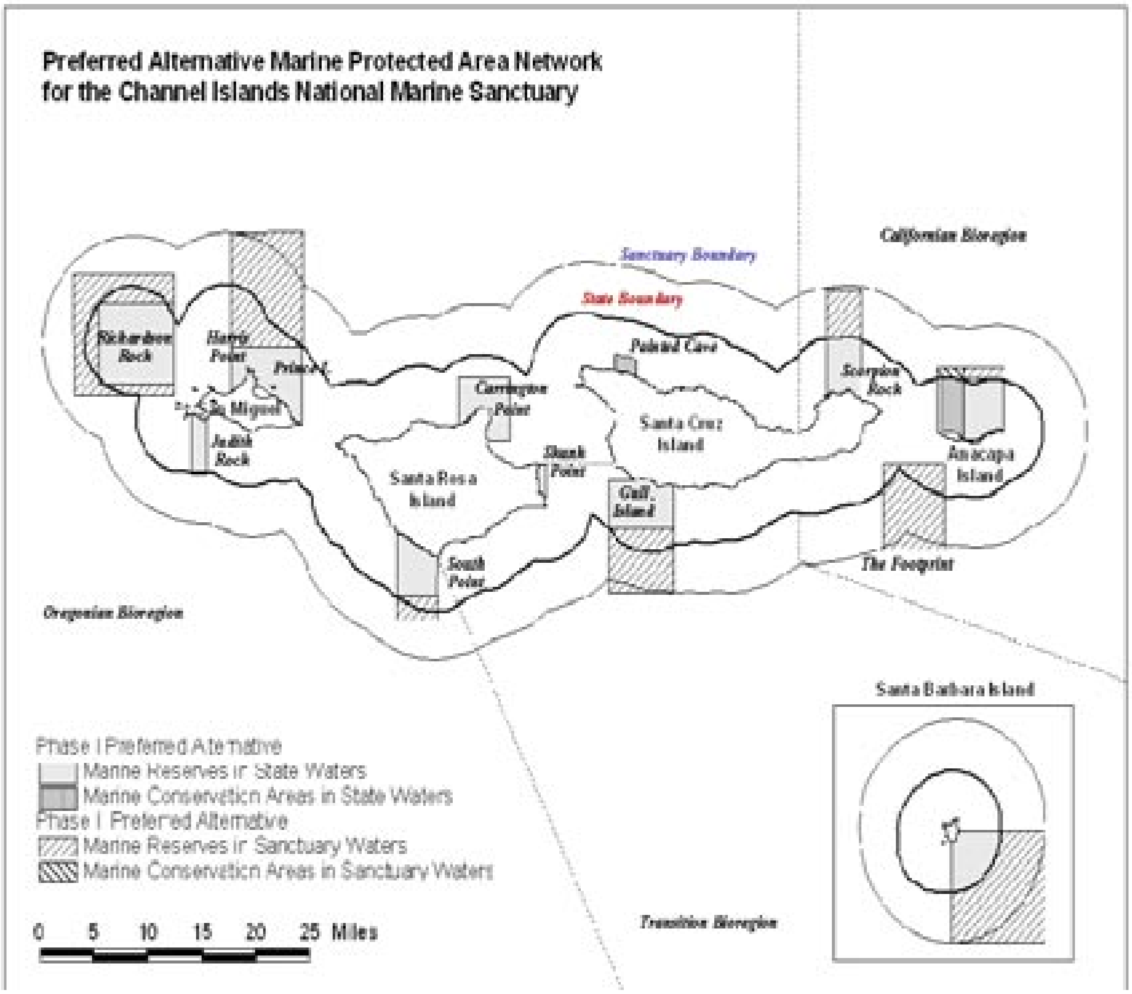
- Formally transmit the full public record of the MRWG and the Sanctuary Advisory Council regarding the development of reserves in the Sanctuary to the Sanctuary Manager;

- Charge the Sanctuary Manager and Department of Fish and Game staff to craft a final recommendation consistent with the Marine Reserve Working Group's consensus agreements for delivery to the Fish and Game Commission in August 2001;
- Request that the Sanctuary Manager and Department of Fish and Game work with the community to the maximum extent feasible in crafting this recommendation.

With this guidance, the Department and Sanctuary crafted a draft reserve network and sent it directly to the Sanctuary Advisory Council, former MRWG, Science Panel, Socio-Economic Panel members seeking further input. The draft reserve network was published in local papers and on the Sanctuary website to solicit input from the general public. Several meetings were held with constituent groups, including the Sanctuary Advisory Council Conservation Working Group, Fishing Group and Ports and Harbors Working Group to discuss the draft network. The Department and Sanctuary also met directly with former MRWG members and several written comments were received and considered.

In preparing a recommendation for the Fish and Game Commission, the Department and Sanctuary used the MRWG consensus statements as well as the MRWG Composite Map of Areas of Overlap and Non-Overlap as a foundation. The recommendation proposed a network of marine reserve and marine conservation areas in the same general locations as the MRWG Composite Map. On August 24, 2001, the Sanctuary and CDFG recommended to the Commission a network of reserves and conservation areas shown in Figure D-2, below, estimated at approximately 25% of the total area of the Sanctuary. This recommendation became the preferred alternative in the State's California Environmental Quality Act environmental review process.

Figure D-2: The State Of California's Preferred Network Alternative.



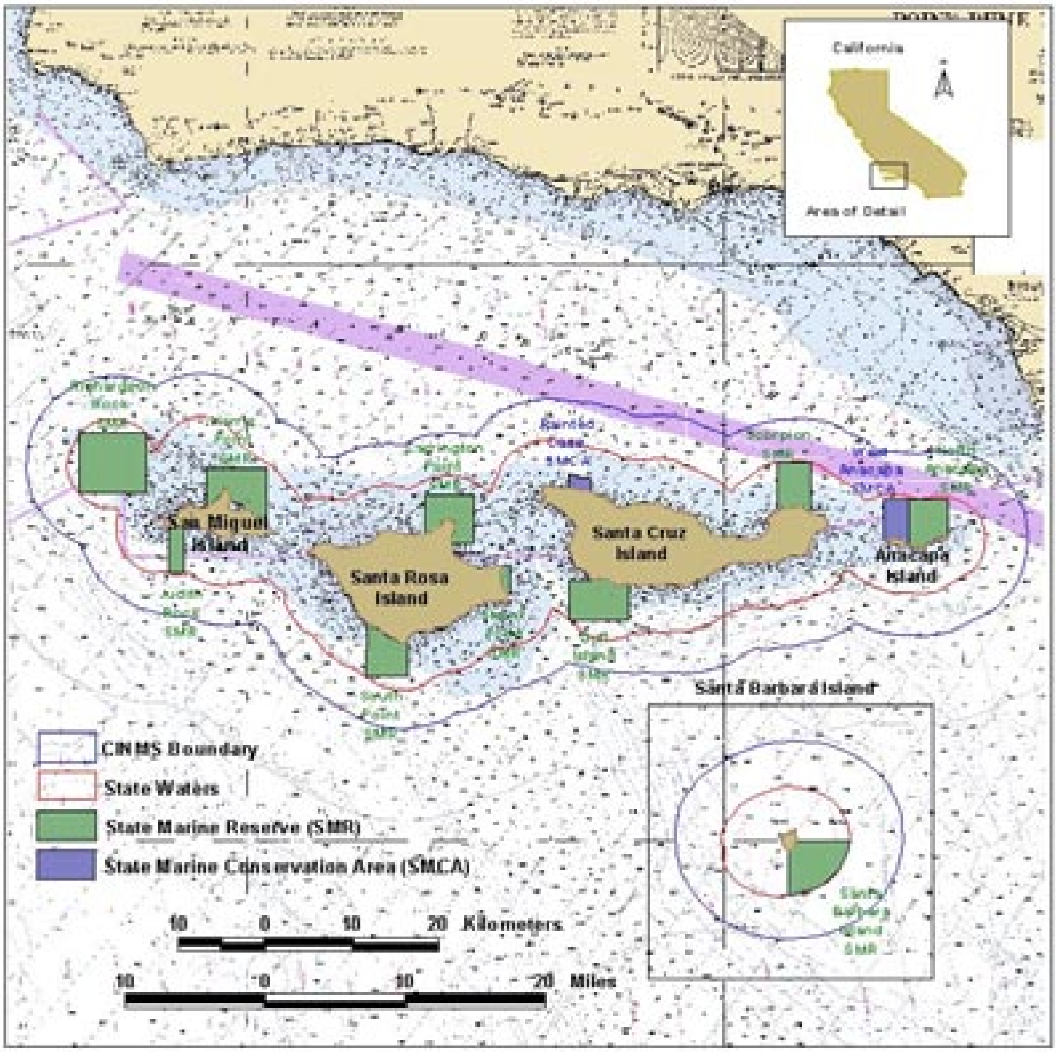
9.1.3. State Marine Protected Areas in the Sanctuary

The CDFG prepared environmental review documents pursuant to the California Environmental Quality Act (CEQA), which included an analysis of 5 alternatives reserves networks and the no project alternative. The reserve network developed by the CDFG and Sanctuary and shown above in Figure D-2 was identified as the preferred alternative. On October 23, 2002, with support from NOAA and the National Park Service, the Commission approved the preferred alternative and the establishment of 10 marine reserves and 2 conservation areas2 within State waters of the Sanctuary that encompass approximately 102 square nautical miles of the Sanctuary. The State's network went into effect on April 9, 2003.

The network alternatives analyzed in the CEQA document were split into an initial State waters phase and subsequent Federal phase. The State rulemaking process and the State environmental documents analyzed the potential cumulative effects of network alternatives in both state and federal waters of the sanctuary. The Commission's action implemented marine reserves and marine conservation areas only within the jurisdiction of the State of California. For enforcement purposes, many of the State marine reserve and marine conservation areas were "squared off," meaning that the outside boundary was drawn on a straight line of latitude, well inside the State's 3 nm jurisdiction. The Harris Point Marine Reserve off San Miguel Island and the Gull Island Marine Reserve off Santa Cruz Island illustrate this point. The State anticipated that the federal government would propose complementary reserves within the adjacent deeper waters to complete the network.

The State's designated marine reserve and marine conservation areas are considered part of the environmental baseline that needs to be taken into account as any additional federal marine reserve and marine conservation areas are considered and proposed in the Draft Environmental Impact Statement. See Figure D-3 below for a map of the State marine reserve and marine conservation areas in the Sanctuary.

FigureD-3: Existing State Marine Reserve And Marine Conservation Areas In The Channel Islands National Marine Sanctuary



9.2. Factors Considered in the Channel Islands Reserves Process and Also Considered in the Drafting of Alternatives 1-3

9.2.1. Administrative Capacity – Monitoring and Enforcement Criteria

To Be Included

A detailed biological and socioeconomic monitoring plan is provided in Appendix G.

9.2.2. Enforcement Considerations

State and Federal enforcement officers were consulted during the Channel Islands Marine Reserves Process as well as local recreational and commercial mariners who participated in the MRWG public forums. There was consistent agreement that any marine reserve proposals should be mapped with clear and discernable boundaries that match major points of land and terrestrial features, and that boundary coordinates should be set on the nearest whole minutes of latitude and longitude. In addition, "Specific to the extension of Marine Protected Areas from State waters to federal waters, the PFMC Enforcement Consultants believes rules should be consistent between the two jurisdictions. The concept of maintaining consistency in rulemaking should also apply in the development of sanctuary regulation in general" (Supplemental EC Report June 2003). This is why Alternatives 1-3 all propose to use consistent federal regulatory language to describe federal areas adjacent to established state areas.

Complementary regulations are called for in the Cooperative Enforcement Agreement between NOAA and the State of California, signed May 2002. The State of California and Secretary of Commerce agreed to promote the adoption of appropriate and complementary conservation, management and enforcement measures and regulations pursuant to the NMSA and the California Fish and Game statutes and regulations.

9.2.3. Ecological Criteria

The design of alternatives depends on the desired outcome of the management effort. One of the desired outcomes is to ensure the long-term protection of Sanctuary resources. The proposed actions to achieve the desired outcome include (1) setting aside representative habitats and natural biological communities and (2) restoring abundance, density, diversity and age structure of natural biological populations.

Ecological criteria for design of alternatives to address the desired outcomes have been described extensively in the ecological literature. The Science Advisory Panel assembled a set of ecological criteria for the design of a network of marine reserves to meet the desired outcomes of the MRWG. It is important to note that the ecological criteria were developed for the entire design process, including state and federal waters. The ecological criteria are described in more detail below and are summarized in Table D-2.

9.2.4. Biogeographic Representation

Protection of all biogeographic regions is essential for conservation of biodiversity (Roberts et al. 2003a). By definition, biogeographic regions are characterized by unique assemblages of species. Although ranges of some species may extend across several adjacent biogeographic regions, transitions between biogeographic regions are characterized by coincidence of range endpoints for many species. Reserves in one bioregion are not likely to serve an adjacent bioregion because connectivity across biogeographic boundaries is likely to be low (Roberts et al. 2003a). The transitions between major biogeographic regions are dynamic. Persistent thermoclines, which often mark the transition between biogeographic regions, may shift tens of miles or more during environmental fluctuations such as El Niño -Southern Oscillation (McGowan et al., 1998). Transition zones between biogeographic regions should be included in reserves because conservation of transitions will contribute to conservation of genetic diversity (Roberts et al. 2003a). In addition, shifts in species distributions, arising from large-scale factors such as climate change, can be detected most rapidly in a transition zone, where conditions already may be suboptimal for many species. Roberts et al. (2001) recommended an autonomous marine reserve network for each distinct biogeographic region contained within a planning region.

The Science Advisory Panel used available information on sea surface temperature (ICESS, 2001) and species distributions to identify the biogeographic regions in the Channel Islands. The Science Advisory Panel drew biogeographic boundaries in the areas of sharpest transition between large bodies of water, following the deepest bathymetric contour (under the assumption that these might provide a significant boundary to movement of some species, especially nearshore species that rarely enter pelagic waters). The Science Advisory Panel recommended one to four areas be designated within each of the three biogeographic regions, comprising approximately 30-50 percent of the area in the Channel Islands National Marine Sanctuary (CDFG 2002).

9.2.5. Habitat Representation And Heterogeneity

For biodiversity conservation, all representative and unique marine habitats should be protected within marine reserves (Roberts et al. 2001, Jones 2002, Stevens 2002, Roberts et al. 2003a). “Each habitat type has an intrinsic functional position in marine ecosystems and thus, an inherent conservation value” (Stevens 2002). By protecting representative habitats, marine reserves conserve ecosystems, including living marine resources and ecological linkages within those systems (NRC 2001). Unless management objectives identify particular habitats for conservation, the total area set aside for the protection of each habitat should be approximately related to its relative prevalence in the planning region (Sala 2002, Roberts et al. 2003b). Protecting the same habitat type in multiple reserves reduces the risk of catastrophic loss of any of the habitat types and supports the exchange of larvae and adults among sites, contributing to the persistence of local populations and metapopulations. A network design, with multiple patches of the same habitat in different reserves, is required to measure effects of the reserve in monitoring and research programs.

Classification by habitat type often represents marine community and ecosystems characteristics better than individual species distributions (Ward 1999). The number of species in a particular area generally increases with the number of habitat types. Thus, habitat heterogeneity, or the co-occurrence of many different habitat types, acts as a proxy for the number of species (Jones 2002, Roberts et al. 2003a). Because organisms often use more than one habitat, it is important to include several habitats within a reserve (Carr and Reed 1993) and thus adjacency of habitats is an important consideration. Some consideration must be given to the size of each patch of habitat. If a small area is divided into many habitats, there is a risk that each patch will be too small to support viable populations (Roberts et al. 2003a).

The Science Advisory Panel developed a simple, multidimensional habitat classification, using depth, exposure, substrate type, dominant plant assemblages, and a variety of additional features. The Science Advisory Panel distinguished four ecological zones: (1) the euphotic zone from 0 to 30 m, (2) the shallow continental shelf from 30 to 100 m, (3) the deep continental shelf from 100 to 200 m, and (4) the continental slope below 200 m. One important reason for the proposed addition of marine reserves and marine conservation areas in federal waters is that this will generally increase network representation of habitats in the deeper ecological zones 3 and 4.

Within each ecological zone, sediment types were identified from various sources, including a Shoreline Inventory Database (MMS, 2000) that describes a variety of coastal features in Santa Barbara County, a map of over 5000 sediment grabs around the Channel Islands (Amuedo and Ivey, 1967), a database of soft sediment samples in the northern Channel Islands (USGS, unpub. data,) and a substrate map of the sea floor around Channel Islands (MMS, 1984). These sources were combined using a geographic information system (GIS) to develop a comprehensive substrate map of the Channel Islands National Marine Sanctuary, divided into soft substrate (e.g., mud, sand, gravel) and hard substrate (e.g., rock, boulder, bedrock)" (CDFG 2002). The potential distribution of giant kelp around the northern Channel Islands and Santa Barbara Island was determined from aerial photographs of the region between 1980 and 1989 (Ecoscan, 1989). To achieve the desired outcome, the Science Advisory Panel recommended setting aside at least 30 – 50 percent of each habitat type within each ecological zone.

9.2.6. Vulnerable Habitats

Consider EFH definition and application

Vulnerable marine habitats require protection from human threats and catastrophic events (Roberts et al. 2003a). To ensure that such habitats were adequately represented, vulnerable habitats including seagrass meadows and deepwater sponges and corals were considered explicitly in the design of protected areas in the Channel Islands. Intertidal surfgrass meadows were mapped for the Bureau of Land Management using helicopter surveys (Littler and Littler 1979). Eelgrass meadows were mapped at six sites on Santa Cruz Island and two sites on both Anacapa and Santa Rosa Islands (Engle et al. 1998). The scarcity and relatively small size of eelgrass meadows in the Channel Islands restricted the potential locations of reserves. Eelgrass meadows were included in Carrington SMR, Scorpion Rock SMR, and Anacapa Island SMCA. Surfgrass beds are included in the majority of State marine reserve and marine conservation areas, including Harris Point SMR, Carrington Point SMR, Skunk Point SMR, Gull Island SMR, North Anacapa Island SMR and SMCA, and Santa Barbara Islands SMR.

Qualitative discussion of submersible observations of vulnerable habitats and conditions within Sanctuary/deepwater sponges, corals

9.2.7. Physical Processes

In marine environments, the water column is a dynamic habitat, influenced by physical processes such as currents, jets, eddies, waves, and upwelling. Currents and jets influence the distribution of organisms by transporting larvae from one place to another. Eddies contribute to retention of local production. Upwelling contributes to local production by transporting nutrients from depth to surface waters where the combination of light and nutrients supports rapid growth of phytoplankton.

Marine reserves may serve different functions depending on the physical processes within and around the reserves. Because upwelling sites support high productivity, they may be good locations for reserves if management goals are to restore and protect abundance and diversity of marine organisms. Reserves placed in an area exposed to a strong and directional current are likely to receive organisms from upstream sites. Additionally, these sites may be good locations for reserves because the increased level of production within reserves will be transported to surrounding areas on regional currents. Reserves in areas with reduced or no currents serve different goals, restoring and enhancing local production, but contributing little to surrounding waters.

The Science Advisory Panel considered physical processes in the design of marine reserves. The panel recommended that some reserves should be located in areas of strong and directional currents, in order to contribute to regional production, and that other reserves be located in areas of reduced or no currents, in order to restore and enhance local abundance, density and diversity of marine organisms. The panel also recommended that some upwelling sites be included in marine reserves, given sufficient data on the locations of such sites.

9.2.8. Species of Interest

One of the desired outcomes of the proposed action is to protect and restore abundance, density and diversity of marine species in the Channel Islands. Certain marine species are particularly vulnerable to extirpation and extinction (Roberts and Hawkins 1999). Species that depend on limited, vulnerable or patchy habitats may require special consideration. Species with small geographic ranges are vulnerable to environmental shifts and catastrophic events. Low fecundity, unpredictable recruitment and slow growth also are characteristics that make species vulnerable to fishing and other activities or events that remove large proportions of reproductive adults (Jones 2002).

Species may be vulnerable to fishing during one or several developmental stages. Many species have life histories that include migration, aggregation to spawn, larval dispersal, juvenile settlement, and other habitat-specific ontogenetic transitions (Roberts et al. 2003a). Marine reserves may be used to protect habitats that support vulnerable life stages (Jones 2002, Roberts et al. 2003a). The entire life cycles of species of interest should be considered in reserve design, because placing a reserve in one location, for example, to protect a spawning aggregation, may shift fishing effort to another critical habitat, such as a migration bottleneck (Roberts et al. 2003a).

Many targeted species, particularly the nearshore groundfishes, could benefit from protection by no-take marine reserves (Yoklavich 1998, Parrish et al. 2000, NRC 2001, Shipp 2003). Marine reserves will contribute to fisheries to the degree that they protect or have the potential to protect targeted species (Roberts et al. 2003a). In addition, reserves can be a useful tool for protecting non-targeted species that are susceptible to particular fishing gears (Shipp 2003). Non-targeted species may benefit from marine reserves established for targeted species through reduced incidental damage from fishing.

The MRWG and the Science Advisory Panel identified 119 species of interest in the Channel Islands, including plants, invertebrates, fish, seabirds, and marine mammals (shown in Table D-1, below). The final species list was agreed to by consensus of all MRWG members. The Science Advisory Panel recommended setting aside representative portions of all ecologically relevant habitat types to restore and enhance all species of interest and ecological linkages.

Insert Table D-1 here: list of 119 species of interest.

9.2.9. Reserve Size

The size and spacing of marine reserves depends on the specific goals of the reserves (Botsford et al. 2003). For biodiversity conservation, larger reserves will contain a greater variety of habitats and species of interest. Thus, larger reserves afford more protection for biodiversity (Daan 1993, Clark 1996, Sumaila 1998, Roberts and Hawkins 2000, NRC 2001, Roberts et al. 2003b). An interconnected network of medium and small reserves located throughout a management area will contribute more to fisheries than a few large reserves, unless the reserves become too small to contribute to local production (Jameson et al. 2002, Roberts et al. 2003b). Ideally, reserves for fisheries will be large enough to contribute to local production and small enough to allow spillover and export functions (Guenette et al. 1998, Hastings and Botsford 2003, Roberts et al. 2003b; Halpern and Warner 2003).

Given the diversity of marine habitats and life history strategies, no simple spatial target can describe the minimum area needed to conserve biodiversity of any given ecosystem (Agardy et al. 2003). Size of reserves depends on life history and dispersal characteristics of species of interest (Botsford et al. 2003). If juvenile and adult dispersal is high, larger reserves will be needed for their conservation (Gerber et al. 2003).

Fishing mortality rates in areas outside reserves also affect the size of reserves designed for biodiversity conservation and sustainable fisheries. Modeling efforts by Gerber et al. (2003) indicate that larger reserves are needed to sustain fisheries that are subjected to high fishing effort. Similarly, Pitcher et al. (2002) determined that, even with habitat enhancement, small reserves would do little to reverse fishery declines in a reef fishery.

Large reserves almost always initially contain more species, including rare species, than small reserves (Halpern 2003). Large reserves may be necessary to protect species of interest that use more than one habitat during their lives (Halpern 2003). Large reserves are necessary if the management goal is to create refuges for species with high dispersal (Salomon et al. 2002). Because of smaller edge-to-area ratios, large reserves experience fewer edge effects than small reserves. Although reserves designed to reduce edge effects will address biodiversity conservation, small edge-to-area ratios also limit the potential for spillover and export to fisheries (Frieldlander et al. 2003).

Small reserves with large edge-to-area ratios may export a greater proportion of larvae and adults than large reserves (Roberts et al. 2003a). However, small reserves may not be effective in sustaining species that have high dispersal potential (Friedlander et al. 2003). Further, small reserves can be susceptible to catastrophic events, such as large storms or extreme low tides that could wipe out a population within a single event (Halpern 2003, Roberts et al. 2003a). If small reserves cannot sustain populations within their boundaries, they will not achieve biodiversity, fishery, or other management objectives (Roberts et al. 2003a). Small reserves may be effective if they are designed to maintain essential ecological linkages between species of interest and the habitats they require. Small reserves can be effective if they are strategically located, for example, along migratory routes or on spawning grounds (Halpern 2003).

9.2.10. Suggested Sizes

Examination of fisheries indicates that the minimum threshold population size for long-term persistence varies with the life history characteristics of the species and that the fraction of natural settlement required for persistence falls within a broad range between 20 and 50 percent (NRC 2001, Roberts et al. 2003a), and possibly up to 70 percent (Mace and Sissenwine 1993, Hannesson 1998, Lauck et al. 1998). Modeling efforts by Doyen and Béne (2003) suggest that protecting 25 percent of a fishery stock in marine reserves would ensure the sustainability of the stock. Foran and Fujita (1999) recommend protecting 25 percent in reserves to rebuild reproductive output of an overfished species (Pacific Ocean Perch) and Guenette and Pitcher (1999) recommend setting aside at least 30 percent to provide a larger spawning biomass for cod. Mangel (2000) suggested that, for stocks that are initially heavily fished, reserves of 20 to 30 percent guarantee a high level of persistence for time horizons of 20 or 100 years and provide higher levels of cumulative catch than management with no reserves. Dahlgren and Sobel (2000) modeled the percent of biomass in fished and unfished areas in the Dry Tortugas to estimate the size of the reserve needed to meet specific management objectives. Results from their model indicate that a no take reserve protecting 30 to 40 percent of the region of influence is needed to elevate overexploited stocks to sustainable target levels. A marine reserve constituting 40 percent or more of a fisheries management area, according to Nowlis and Roberts (1999), would enhance catches and reduce annual catch variability in surrounding fishing grounds for species whose young (i.e., larvae) freely cross reserve boundaries, but whose adults do not. Collectively, these models suggest that marine reserves can contribute to a sustainable fishery if the reserve area includes a substantial proportion of critical habitats.

Another approach is to determine the area needed to conserve at least a portion of all representative species and/or habitats. Numerous studies have examined the distributions of species to determine the minimum area needed for representation of all habitats and/or species of interest. Bustamante et al. 1999 developed a reserve design for protecting coastal habitats in the

Galapagos archipelago whose objective was to protect sites for tourism and sites of high biological importance. Their design included representing all coastal habitat types in each of five biogeographic zones encompassed by the archipelago in the reserve. Bustamante et al. (1999) estimated that it was necessary to protect 36 percent of the region from fishing to achieve the conservation objective. Using data from Turpie et al. (2000), Roberts and Hawkins (2000) estimated that setting aside 10 to 36 percent of the coast of South Africa would maximize long term persistence of coastal fish species. A system covering 10 percent of the South African coast could be designed to represent over 95 percent of the species. However, this system would not represent a number of narrowly distributed, endemic species. A reserve system covering 29 percent of the coast would represent all species and a reserve system of at least 36 percent would protect all species at the core regions of their ranges (a common goal for conservation). Ryers et al. (2000) found that 41 percent of locations were required for complete representation of all species, based on richness and rarity algorithms. Ward et al. (1999) found that complete representation of fish and invertebrate groups required protection of 80 percent of locations. In general, these studies indicate that substantial area must be set aside to protect the full complement of species and habitats, particularly if some species have specialized and unique habitat requirements (Gladstone 2002).

Another approach is to determine potential dispersal length of species of interest to identify necessary reserve size. Models suggest that reserves must be as large as the mean larval dispersal distance in order to sustain populations of interest (Palumbi 2003). An examination of genetic structure of marine populations indicates that reserves on the order of 10-20 km in size could sustain species that show genetic isolation by distance (Palumbi 2003). Shanks et al. (2003) determined that individual reserves, at least 4-6 km in diameter, are needed to allow larvae with short dispersal distances to settle within the reserve. Several experts have suggested that a network of medium and small reserves would encompass a broad array of dispersal potentials, contributing to biodiversity and fisheries conservation.

Although reserve size is an important component of effective design, it cannot be the sole criterion. Inclusion of representative habitats is equally important to the success of marine reserves. Further, reserves are likely to demonstrate the largest and most rapid changes in biomass in areas recently experienced high fishing effort. No matter what their size, reserves are not likely to increase production if they are placed within unproductive habitats where little fishing occurs (Gerber et al. 2003). Considering the results of fisheries models, species representation, and dispersal lengths, the Science Advisory Panel recommended that protecting at least 30 percent and possibly up to 50 percent of the representative habitats in each of the biogeographic regions of the Channel Islands would contribute to the desired outcomes of the proposed action.

9.2.11. Reserve Connectivity and Spacing

Large reserves, which contain representative habitats and sufficient larval settlement, may be used effectively to restore and enhance populations of interest (Roberts et al. 2003b, Shanks et al. 2003). However, a network of medium and small reserves may be the most efficient way to achieve objectives of conservation and fishery management (Hastings and Botsford 2003). Protecting several different sites in a network of reserves builds in the redundancy needed to include a greater proportion of representative habitats (Hastings and Botsford 2003) and prevent catastrophic and simultaneous loss of all reserves (Allison et al. 2003).

Although a small reserve may not sustain a particular population, the population may persist through recruitment of larvae produced by other reserves in a coordinated network (Palumbi 2003 and Hastings and Botsford 2003). For species with low larval retention, sustainability of the reserve population may depend on recruitment from reproductive populations in surrounding waters (Roberts et al. 2003a). If several reserves are placed within the dispersal range of species of interest, the reserves might serve as stepping-stones between populations (Roberts 1997).

The design of networks of marine reserves depends on larval dispersal distances and population connectivity (Botsford et al. 2001). Connectivity is estimated as the amount of exchange of larvae, recruits, juveniles, and adults between populations within a species' range (DeMartini 1993, Palumbi 2003).

Larval dispersal rates are influenced by time in the plankton, strength and direction of currents, and larval behavior (Palumbi 2003, Shanks et al. 2003). Species that spend a short time in the plankton tend to disperse short distances compared to species that have a longer developmental phase (Shanks et al. 2003). Larval swimming increases the probability of local retention, particularly when larvae swim down, avoiding entrainment in surface currents (Tankersley et al 1995).

When they have been estimated directly, dispersal distances for marine species range from meters to thousands of kilometers (Shanks et al. 2003). The presence of larvae of coastal marine species in the mid-ocean plankton suggests the potential for long-distance dispersal (Scheltema 1986). The spread of invasive species provides an estimate of potential annual dispersal distances (Palumbi 2003). Larval dispersal also can be estimated indirectly through population genetic structure (Kinlan and Gaines 2003). Palumbi (2003) estimated mean larval dispersal distances on the order of 25-150 km from isolation by distance comparisons.

Because of the diversity of life history strategies, no single reserve configuration will satisfy goals for biodiversity and fisheries conservation in all marine ecosystems. Reserve designs must consider the unique characteristics of the habitats and species of interest (Grantham et al. 2003).

Reserves afford the greatest amount of protection for species with low rates of dispersal, contributing to biodiversity conservation (Botsford et al. 2003). Species with intermediate rates of dispersal are likely to spend some time in reserves and some time in unprotected waters, contributing to sustainable fisheries (Botsford et al. 2003). Species with high rates of dispersal may not receive sufficient protection within a reserve or a network of reserves (Gerber et al. 2003); for species with high dispersal, other approaches to management are critical. To be sustainable, a single reserve must encompass the dispersal potential of species of interest (Grantham et al. 2003, Largier 2003). Larger reserves are needed to sustain species with longer larval distances (Botsford et al. 2003).

Reserves should be spaced at intervals less than the minimum dispersal distance of long-distance dispersers. Shanks et al. (2003) determined that the minimum dispersal distance among some species was 20 km/yr, suggesting that reserves should be spaced no more than 20 km apart. Based on larval dispersal patterns, Sala et al. (2002) determined that the distance between adjacent reserves in the Gulf of California should not exceed 100 km.

The predominant direction of dispersal also influences the spacing of reserves. In places where currents are strongly directional, reserves that are upstream are most likely to contribute to recruitment in the region (Gaines et al. 2003, Roberts et al. 2003b). If currents are strongly directional, multiple reserves are likely to contribute more than a single reserve of the same total area (Gaines et al. 2003). Protecting reserves in different locations takes advantage of high connectivity in systems with strong current patterns (Gaines et al. 2003). In places where currents are reduced or reverse directions, production in reserves is likely to contribute to local recruitment. Local eddies also may contribute to local retention of larvae (Lee et al. 1994 and Limouzy-Paris et al. 1997). If possible, marine reserves should capture some portion of local retention zones where larvae accumulate prior to settlement (Wing et al. 1998).

9.2.12. Human And Natural Threats

Human and natural threats may prevent marine reserves from achieving the desired outcomes (Allison et al. 2003). Reserves are unlikely to be effective if they are located in areas that a subjected to frequent stresses (Jameson et al. 2002, Roberts et al. 2003a). Natural threats include large storms, floods, epidemic diseases, hypoxic events, harmful algal blooms, and global climate change (Roberts et al. 2003a). Various human activities may threaten the integrity of marine ecosystems, including input of pollutants, fishing, anchoring, oil drilling, laying cable and other activities that alter the seafloor. Fishing may cause irreversible damage to habitats, rendering them unsuitable for marine reserves (Roberts et al. 2003a). Modified habitats are not likely to support the recovery of exploited species (Roberts et al. 2003a).

Planners should expect some loss of or damage to habitat within reserves due to unpredictable effects of human and natural threats. Reserves are more likely to achieve goals for biodiversity and fisheries conservation if the reserve area is not simultaneously impacted by catastrophic events (Allison et al. 2003). Increasing the number or size of individual reserves will reduce the risk of loss or damage due to human and natural threats (Allison et al. 2003, Roberts et al. 2003a). Allison et al. (2003) provide a mechanism for estimating the additional area required to buffer reserves against the effects of catastrophic events. This “insurance factor” is a function of the fraction of the coastline affected by catastrophes each year and the amount of time it takes a site to recover from the catastrophe (Allison et al. 2003).

Larger reserves will contain more species and larger populations are more likely to survive periodic disturbances (Roberts and Hawkins 2000). If possible, reserves should be spaced at sufficient distances to prevent adjacent reserves from experiencing loss from the same catastrophic event. Elimination of threats is impossible if the threats occur at the scale of marine ecosystems, such as global warming.

9.2.13. Site Monitoring

The biological diversity of the Channel Islands has attracted the attention of marine scientists for over a century. Thousands of articles, academic papers, and videos document the distributions and abundances of marine organisms and their habitats around the islands. Numerous studies document ecological processes, including interactions between species. The wealth of information about the biology of the Channel Islands region now provides an historical baseline, which can be used by management agencies to evaluate new management strategies, such as marine reserves.

Over 40 current monitoring programs investigate the ecological patterns and processes of marine populations, communities, and ecosystems in the Channel Islands region (Abeles et al. 2003). Many of these programs can provide the information necessary to assess ecological impacts of marine reserve and marine conservation areas. The Science Advisory Panel recommended locating monitoring sites inside and outside of marine reserve and marine conservation areas in order to detect the ecological impacts of marine reserve and marine conservation areas.

The state marine reserve and marine conservation areas, established in April 2003, include numerous shallow benthic monitoring sites. Six of 16 kelp forest monitoring sites are in state marine reserve and marine conservation areas. These sites are monitored annually for a variety of characteristics including algal cover, invertebrate and fish population levels and diversity. One of PISCO's historical subtidal monitoring sites is included in a state reserve and, after the marine reserve and marine conservation areas were established, PISCO conducted subtidal surveys in 7 of the 12 marine reserve and marine conservation areas during the summer of 2003. Paired monitoring sites were surveyed outside the reserves in order to detect differences between reserve and non-reserve sites.

Fewer monitoring programs exist in offshore and deep water than shallow nearshore habitats. Following the recommendation of the Science Advisory Panel, the proposed marine reserve and marine conservation areas should include some, but not all, of the offshore and deepwater monitoring sites. Midwater trawl surveys have been conducted in the Santa Barbara Channel and off of the Channel Islands since 1995 (Nishimoto, M., personal communication). Midwater trawl surveys were conducted in state marine reserve and marine conservation areas at Scorpion, Gull Island, South Point, and Anacapa Island. Midwater trawl surveys were conducted in proposed reserve areas at Harris Point, South Point, Gull Island, Scorpion, and Anacapa Island. Deepwater submersible surveys have been conducted throughout the Southern California Bight since 1995 (Love, M., personal communication). Deepwater submersible surveys have been conducted in state marine reserves at Richardson Rock, Gull Island, and Santa Barbara Island. Deepwater submersible surveys have been conducted in proposed reserves offshore of Harris Point, Richardson Rock, and Santa Barbara Island. Trawl surveys and sediment grabs were made throughout the Southern California Bight in 1998 and 2003 (Fangman, S., personal communication). Trawl surveys occurred in the areas designated as state marine reserve and marine conservation areas at Judith Rock, Harris Point, Gull Island, Scorpion, Anacapa Island, and Santa Barbara Island. Trawl surveys occurred in proposed reserves at Harris Point and Anacapa Island.

The existing monitoring programs were not designed within the context of the newly established marine reserve and marine conservation areas. As a consequence existing programs may need to be modified or expanded, and new programs may need to be developed, in order to assess the ecological impacts of protected areas. CDFG and the Sanctuary have worked together with other research and monitoring agencies, partners, and local stakeholders to develop a detailed monitoring plan, as shown in Appendix G. This monitoring plan will continue to be refined and adjusted, particularly if areas in deeper waters are added to the network.

9.3. Review of Ecological Criteria

At the June 2001 Pacific Fishery Management Council (PFMC) meeting the Science and Statistical Committee (SSC) offered to create an SSC ad-Hoc Marine Reserve Committee to review the Science Advisory Panel's size recommendation. They presented their conclusions as an independent peer review of the size recommendation in a written report to the PFMC. In this report the SSC states that "given the mandate of the Science Panel and the constraints under which they conducted their deliberations, the SSC is generally supportive of their reserve size recommendation as it relates to the biodiversity and sustainable fisheries goals...Beyond that context, however, the methodology used...will require substantial modifications and extensions to be more broadly useful to the Council..." (SSC, 2001). The SSC goes on to state that it endorses the use of reserves as a management tool, but they should be carefully integrated with traditional fishery management (SSC, 2001).

With regards to the Science Advisory Panel's conclusions that protecting representative habitats would protect biodiversity, the SSC felt it was a reasonable approach (SSC, 2001). This was particularly true given the large number and diversity of species the Science Advisory Panel was asked to consider (SSC, 2001). The Science Advisory Panel noted that biodiversity benefits increase with reserve size, and thus could not be used as an upper bound for their recommendation. Thus, the goal of limiting impacts to fisheries became the limiting factor for the upper bound.

Table D-1: Ecological Criteria For Marine Reserve Design

Ecological Criteria (Roberts et al. 2003)	Application to the Channel Islands
Biogeographic representation	Three major biogeographic regions were identified using data on biota and SST.
Habitat representation	Representative and unique marine habitats in each biogeographic region were classified using depth, exposure, substrate type, dominant plant assemblages, and a variety of additional features.
Physical processes	Currents were considered in the design of alternatives because they contribute to regional transport or retention of larvae. Areas of upwelling were considered because they contribute to high local production.
Species of special concern	Island coastlines and emergent rocks were weighted according to the distributions of pinniped haul-outs and seabird colonies. Habitats likely to support vulnerable and/or targeted species, especially rockfishes, were identified for the design process.
Size and connectivity	At least one, and no more than four, reserves were located in each of the three biogeographic regions. The distances between reserves were considered in the design process in order to maximize the transfer of organisms between protected areas.
Human threats and natural catastrophes	The reserve size recommended to achieve desired outcomes in a stable environment (30-50 percent) was multiplied by an "insurance factor" that accounts for the frequency of severe disturbances (1.2-1.8). No areas were excluded from the process because of equal risk throughout the islands.
Monitoring sites	Data from monitoring sites provide information about historical patterns and processes. Some monitoring sites were included in reserves and some remained outside reserves so that scientists will be able to determine the ecological impacts of reserves relative to natural variability.

9.3.1. Applying Analytical Data

The Science Advisory Panel used Sites V.1 to evaluate spatial data and develop options for marine reserve design. Versions of this tool have been applied to locate terrestrial reserves for The Nature Conservancy and marine reserves in Australia (Lewis et al. 2003), Canada (Ardron 2002), Mexico (Sala et al. 2003), and Florida (Leslie et al. 2003). A description of Sites and the Sites software are available on the internet at www.ecology.uq.edu.au/marxan.htm.

To generate a suite of marine reserve and marine conservation areas designs, Sites V.1 requires continuous data, a list of explicit criteria, and targets for representation of each criterion. In the Channel Islands case, scientists organized ecological data by biogeographic region. Scientists identified specific targets for different habitats and species, based on the overall abundance of these features in the study region. In different analyses, the Sites program included (in a set of potential reserve sites) 30%, 40%, and 50% of each habitat or feature in each biogeographic region.

Sites V.1 applies a process known as "simulated annealing" to identify components within the study areas that contribute to management goals (Possingham et al. 2000). The Sites program randomly generates an initial reserve system that includes the target percentage of each habitat and feature. The program then calculates an objective function based on the input parameters. The objective function consists of two main sections; the first is a measure of the cost of the reserve system (currently based on the boundary length of each planning unit) and the second is a penalty for violating various goals and objectives. For the Channel Islands case, the perimeter or "boundary length" of each 1 x 1 nmi2 planning unit was used as the cost in the ecological analysis. Sites V.1 attempts to minimize the boundary length in order to produce the most efficient solutions. The program evaluated 1,000,000 annealing iterations per run. At each iteration, a planning unit is chosen at random which might or might not already be in the reserve system. The program evaluates the change to the value of the reserve system that would occur if this planning unit were added or removed from the system. At each step, the new solution is compared to the previous solution, and the best one is accepted.

The minimum set approach does not account explicitly for the spatial relationships among the sites selected for the reserve system. Without some modification or additional constraints, the final reserve system will almost always be highly fragmented and, thus, inappropriate. Fragmentation is a problem because there are both ecological and economic reasons why reserves should be spatially contiguous with low edge to area ratios. Clustering of reserve sites can be achieved by including an adjacency constraint and minimizing the boundary length of the reserve system. The boundary length modifier was set to a value of 1, which clusters planning units into discrete potential reserve sites.

The Science Advisory Panel generated hundreds of potential options using Sites. A large number of good solutions may satisfy a single set of input criteria. Each solution is given a score equal to the conservation value minus the cost (boundary length) of the reserve. The "best" solution of all runs is the scenario with the greatest conservation value and the lowest cost. The summary details of each run include the target for each habitat or feature, whether or not the target was met, the proportion of the target met, and the actual area of the habitat or feature that was included in the best scenario. The data are grouped by biogeographic region and target percentage.

Sites V.1 provides an "irreplaceability analysis," which indicates the number of times each planning unit was included in the suite of design options. The irreplaceability analysis was converted to a list of percentages by dividing the number of times each planning unit was selected for the final scenario by the total number of planning units in the biographic region. For example, planning units that are selected in 70%, 80%, or 90% of the runs are likely to have high conservation value, whereas planning units that are selected in 5% or 10% of the runs are likely to have lower conservation value. The irreplaceability analysis is particularly valuable for advancing discussions about marine zoning because biodiversity "hotspots" can be identified from the map of irreplaceability values. In the Channel Islands process, the map of irreplaceability values provided the foundation for discussions about reserve design (See Development of Alternatives, below).

Because a large number of solutions may satisfy a single set of input criteria, it is important to understand the similarities and differences among solutions. Solutions were compared using cluster analysis in Primer v. 4, a statistical program developed by the Plymouth Marine Laboratory. The 100 top ranking solutions were selected from the total runs (which varied from

314 to 786 for each biogeographic region, depending on size of the region). For each run, planning units were assigned a value of 1 if they were included in the final solution or 0 if they were not. The Bray-Curtis similarity between solutions was calculated for the 100 top ranking solutions. The Primer statistical program created a dendrogram, or hierarchical branching diagram, showing the relationships between the 100 top ranking solutions. Similar solutions were clustered together whereas dissimilar solutions were placed more distantly from each other on the dendrogram.

Clusters of solutions were divided into groups based on Bray-Curtis similarity among clusters. For most analyses, solutions with more than 60% similarity were grouped together. However, the input criteria at 30% set-aside in the Oregonian Province and the Transition Zone produced large numbers of dissimilar solutions that exhibited high conservation value. Therefore, clusters of solutions at 30% set-aside for the Oregonian Province and the Transition Zone were grouped together above 40% similarity. Grouping based on Bray-Curtis similarity produced approximately 5 groups per analysis. If the grouping algorithm produced more than 5 groups, the group with the lowest high score was removed from the analysis. Solutions within each cluster were ranked according to conservation value. The top ranking solution in each cluster was selected for consideration by the MRWG.

9.3.2. Socioeconomic Criteria

A number of diverse data sources and methods were used to estimate both the total amount and spatial distribution of use for both the Federal and State waters of the proposed project area. These data include both existing information (e.g., catch statistics) and surveys conducted during the Channel Islands Marine Reserves Process. The following sources of information provided insight to the values and various uses of the Sanctuary:

- California Department of Fish and Game commercial fishing data showing where fish are caught and the ports where fish are landed 14 commercial species/species groups mapped on a 1-minute by 1-minute distributions of catch
- Socioeconomic profiles of the fishermen (e.g., experience, age, education, income, dependency on fishing, people and family members directly employed, investment/ownership of boat and equipment, place of residence and home and landing ports)
- Commercial fishermen costs and earnings
- Kelp harvesting and processing information (obtained from ISP Alginates)
- Surveys of recreational “for hire” operators (achieved a Census)
- National Marine Fisheries Service, Marine Recreational Fishing Statistics Survey for intercept/access points for those fishing from private household boats
- Aerial flyover data for boating activities from the Channel Islands National Marine Sanctuary
- An ethnographic survey of a variety of commercial and recreational sanctuary users

This information was provided to the MRWG and utilized in dozens of exercises to craft marine reserve proposals. Similarly, the CDFG and Sanctuary applied the same information in crafting the agency alternative for the State of California CEQA process. Sanctuary staff has relied on this data set in the development of the preliminary range of alternatives 1-3.

9.4. Biogeographic Description of the State Reserves

The following descriptions list habitats and species that are protected in the existing State marine reserve and marine conservation areas and potential additional Federal marine reserve and marine conservation areas. As noted above, the protection of habitats correlates to the protection of species and important species-habitat interactions. The following discussion applies generally to Alternatives 1-3.

9.4.1. Santa Barbara Island Marine Reserve

Santa Barbara Island SMR is located at the southeast side of Santa Barbara Island. Santa Barbara Island, Sutil Island, and Shag Rock support major seabird and marine mammal colonies. Santa Barbara Island supports breeding colonies of numerous seabirds, including the endangered California Brown Pelican, Western Gull, Black Oystercatcher, Black Storm-petrel, Leach's Storm-petrel, Brandt's Cormorant, Pelagic Cormorant, Cassin's Auklet, Pigeon Guillemot and Xantus's Murrelet. California sea lions haul out on sandy beaches on the southeastern side of Santa Barbara Island. Harbor seals and northern elephant seals occasionally haul out in the same place.

The exposed rocky shoreline along Santa Barbara Island is interspersed with occasional cobble beaches (10-12 m wide) in protected coves. The rocky intertidal habitat descends steeply to patchy reefs in large areas of sand. Patchy populations of surfgrass grow on subtidal rocks (15-20 m). Populations of giant kelp on reefs around Santa Barbara Island have declined relative to historical data. Red and purple sea urchins and brittle stars (Ophiothrix spp.) dominate the rocky subtidal habitats around Santa Barbara Island. Spiny lobsters are abundant in rocky subtidal habitats in the vicinity of South Point and large mussel beds can be found in the rocky intertidal habitats on the southeastern side of Santa Barbara Island.

The continental shelf drops to approximately 200 m less than _ mile from shore, and continues to drop to 400 m within 3 miles of Santa Barbara Island. In the past, populations of white, green, pink, and black abalone inhabited intertidal and subtidal rocky habitats. The reserve includes rocky subtidal habitats, from approximately 25-65 m, that may contribute to the recovery of the endangered white abalone. Sandy subtidal habitats support halibut populations near the northern border of the Santa Barbara Island SMR. California sheephead have been observed near South Point.

9.4.2. Anacapa Island Marine Reserve

The North Anacapa Island SMR is located on the northeast side of Anacapa Island. Historically (early 1980s) kelp beds off Anacapa Island extended offshore to approximately _ mile. Today, rocky reefs that once supported extensive kelp beds are now barren. Sea urchins and brittle stars cover rocky areas around most of northern shoreline of Anacapa Island. Where urchins and brittle stars invade rocky reefs, other species decline, including Corynactis anemones, sponges, and tunicates. Remnant populations of giant kelp occur close to shore in the Anacapa Natural Area, the only area in the Channel Islands that has been fully protected from fishing since 1978.

The Anacapa Natural Area supports a lush kelp forest and a diverse assemblage of associated species. Surfgrass is found on rocks in the subtidal, particularly in protected inlets (e.g., Cathedral Cove). Eelgrass is not currently found along the north shore of Anacapa Island, but historical records indicate that this area once supported eelgrass populations.

The protected rocky shoreline along the north side of Anacapa Island is interspersed with occasional gravel beaches (e.g., Frenchy's Cove). The rocky intertidal habitat, broken by occasional patches of coarse sand, extends to approximately 40 ft. Numerous nearshore emergent rocks provide roosting sites for seabirds and protective cover for nearshore fishes and invertebrates. Muddy sloping terrain near "Rickett's Rock" supports populations of various invertebrates and is a site for squid spawning. At approximately 60 ft, the continental shelf extends to low relief rubble and compacted sand. A large boulder field extends from approximately 80-100 ft.

Sea urchins and spiny lobsters are larger and their populations are more stable inside the Anacapa Natural Area than in fished areas (Lafferty and Behrens 2003). Pink abalone can be found in the Anacapa Natural Area, but populations are very small relative to historical sizes. In general the diversity of fishes is higher in the Anacapa Natural Area than in fished areas, but the number of large predatory fish has declined. Kelp bass, California sheephead and numerous rockfish species have declined relative to historical levels. Common fishes include blacksmith, senorita, and kelp rockfish.

Mean densities of fished species, including kelp bass and barred sand bass, are significantly larger in the Anacapa Natural Area than in fished areas nearby (Beers, unpub. data). Densities of California sheephead are greater in the Natural Area, but the differences are not significant. Similarly, the spawning biomass of some fished species is significantly larger in the Anacapa Natural Area than in fished areas. In contrast, mean densities of species that are not fished, including rock wrasse, señorita, and garibaldi, are not significantly different in fished areas and the protected Natural Area.

Size distributions of fished species, including kelp bass, barred sand bass, and California sheephead, are larger in the Anacapa Natural Area than in fished areas. In contrast, size distributions of species that are not fished, including rock wrasse, señorita, and garibaldi, are not significantly different in fished areas and the Natural Area. The data from Ancapa Natural Area suggest that this region can benefit greatly from protection within a marine reserve, in terms of density, spawning biomass, and individual size. These changes could contribute to increased production of species targeted for commercial and recreational fisheries.

Leopard sharks breed off the northern shore of Anacapa Island. The Middle Anacapa Island includes a unique aggregation of giant (black) seabass, a large-bodied, long-lived species that has declined to low numbers in the last 25 years (DeWet Oleson, unpub. data).

Harbor seals haul out on Middle Anacapa Island. Occasionally California sea lions visit the protected areas on the eastern end of the island.

Anacapa Island supports breeding colonies of numerous seabirds, including Western Gull, Black Oystercatcher, Brown Pelican, Cassin's Auklet, Pigeon Guillemot, Pelagic Cormorant, and Xantus's Murrelet.

9.4.3. Anacapa Island Marine Conservation Area

The West Anacapa Island SMCA is located on the northwest side of Anacapa Island. The conservation area is an extension of the North Anacapa SMR that provides additional habitat and species protection. Commercial lobster and recreational lobster and pelagic finfish take would be allowed in the conservation area. Pelagic finfish are defined as northern anchovy (Engraulis mordax), barracudas (Sphyraena sp.), billfishes* (family Istiophoridae), dolphinfish (Coryphaena hippurus), Pacific herring (Clupea pallasi), jack mackerel (Trachurus symmetricus), Pacific mackerel (Scomber japonicus), salmon (Oncorhynchus spp.), Pacific sardine (Sardinops sagax), blue shark (Prionace glauca), salmon shark (Lamna ditropis), shortfin mako shark (Isurus oxyrinchus), thresher shark (Alopias vulpinus), swordfish (Xiphias gladius), tunas (family Scombridae), and yellowtail (Seriola lalandi).
*Marlin is not allowed for commercial take.

The high relief rocky shoreline is increasingly exposed toward the west of Anacapa Island. The eastern shoreline of West Anacapa Island is rocky, descending to broken reef and boulder fields in the subtidal zone (approximately 80 ft). The western shoreline of West Anacapa Island is rocky, descending rapidly to a steep muddy slope. High wind and wave action on West Anacapa Island create mixing and upwelling, increasing the amount of nutrients in the water. Nearshore rocky habitats on West Anacapa support patchy populations of giant kelp and surfgrass. A steep rocky reef off the western tip of Anacapa Island supports sea fans, anemones and sponges. Large populations of spiny lobster are found in rocky reefs off northwestern Anacapa Island. Squid aggregate over the muddy slope north of west Anacapa Island. Waters around West Anacapa Island support a high diversity of fishes, including California sheephead, garibaldi, kelp bass, blacksmith damsel, and numerous nearshore rockfish species. Harbor seals haul out on West Anacapa Island, but they are more common on the south side of the island. California sea lions are attracted to northwestern Anacapa Island when squid are present.

The West Anacapa Island SMCA is adjacent to breeding sites for numerous seabirds, including the endangered California Brown Pelican, Western Gull, Black Oystercatcher, Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, Pigeon Guillemot, and Xantus's Murrelet. The conservation area encompasses one of only two Brown Pelican breeding and fledgling areas in North America.

9.4.4. Footprint Marine Reserve

The Footprint, which is located in open waters in the passage south of Santa Cruz and Anacapa Islands, is proposed as a marine reserve in each alternative. The majority of the Footprint is sand or gravel between 90-900 ft. The Footprint includes several submerged rocky features, including pinnacles and submarine canyons that once supported large population of numerous rockfish species. Today, the rockfish populations around the Footprint are severely depleted from intensive recreational and commercial fishing in the region. Although populations are depleted, the habitat supports a variety of species, including bocaccio and cowcod, both recognized as overfished by the PFMC. Fish populations in the vicinity of the Footprint are likely to respond to protection within a reserve through increased density, individual size, and reproductive potential.

9.4.5. Santa Cruz Island, Scorpion Rock Marine Reserve

The Scorpion Rock SMR is located on the northeast side of Santa Cruz Island. Rocky shoreline within the Scorpion Rock SMR extends from Cavern Point to Potato Harbor. There is a small sandy beach at Scorpion Anchorage. Some emergent nearshore rocks and caves provide breeding and roosting sites for seabirds, including Western Gull, Black Oystercatcher, Brandt's Cormorant, Pelagic Cormorant, Pigeon Guillemot, Cassin's Auklet, Leach's Storm-petrel, and Xantus's Murrelet. Scorpion Rock is one of the two primary nesting areas for Cassin's Auklets in the Channel Islands (Adams 2003).

The intertidal habitat in Scorpion SMR is primarily rocky with some mixed sand and gravel beaches. Subtidal habitats are mixed sand and gravel sediments with a few patch reefs off Cavern Point. Sandy and muddy subtidal habitats support eelgrass populations. Nearshore sandy habitats support populations of geoduck clams. Feather boa kelp and surfgrass are also found in the area. Giant kelp is found within the Scorpion area, but populations are not stable. Because kelp populations are reduced, the Scorpion area does not support large populations of kelp-associated fishes. Rocky subtidal habitats are dominated by purple sea urchins.

Tall pinnacles and high relief rocky features are associated with caves and submerged rocky cliffs along the coast. Pinnacles support populations of mussels, and attract fish, such as opaleye and perch. Spiny lobster are found in the rocky subtidal and on pinnacles around Cavern Point to Potato Harbor. Terraced reef habitats may support juvenile lobsters. Scallops and sea fans are found in deeper waters on pinnacles. California sheephead are found in deeper waters. Lizardfish, various flatfish species, and sand dabs are found in sand and gravel habitats around Scorpion Anchorage.

Harbor seals are resident and California sea lions have been observed around Scorpion Anchorage, but the area does not support large populations of marine mammals. Killer whales have been sighted frequently in the vicinity of Scorpion Anchorage.

9.4.6. Santa Cruz Island, Painted Cave Marine Conservation Area

The Painted Cave SMCA is located on the north side of Santa Cruz Island. The reserve includes 2 nmi of shoreline and an area of 1.1 nmi2 entirely within State waters. Recreational fishing for lobster and pelagic finfish is allowed in the conservation area.

Painted Cave is reputedly the largest sea cave of the coast of North America. The rocky cliffs around Painted Cave drop steeply into the ocean. There is a narrow intertidal zone and steep rocky walls characterize the subtidal habitat. The bottom of Painted Cave is mostly sand and rocky cobble. The steep rocky walls support some sea urchins, scallops and encrusting invertebrates. Pinnipeds, Risso's dolphin, and cetaceans, including gray, blue, and humpback whales are often observed on the north shore of Santa Cruz Island. The Painted Cave SMCA includes suitable breeding habitat for numerous seabirds, including Western Gull, Black Oystercatcher, Brandt's Cormorant, Pelagic Cormorant, Leach's Storm-petrel, and Pigeon Guillemot.

9.4.7. Santa Cruz Island, Gull Island Marine Reserve

The Gull Island SMR is located on the southwest side of Santa Cruz Island. Historically, Gull Island supported a diverse and abundant marine fauna. Although these populations are reduced, the habitat supports a variety of species. Fish populations in the vicinity of Gull Island are likely to respond to protection within a reserve through increased density, individual size, and reproductive potential. The existing Gull Island Marine Reserve and proposed extension into deeper waters protects a variety of different habitat types from the nearshore to the continental slope. Sand beach (Johnson's Beach) is the predominant shoreline habitat at the border of the Gull Island SMR. Endangered Snowy Plovers may occur on Johnson's Beach. The beach also supports one of the few populations of pismo clams at the islands. The remaining shoreline is covered with cobble beaches.

Subtidal habitats in the Gull Island SMR are mixed sand and rocky reefs. Red and green algae dominate inshore areas. Gull Island supports an intermittent population of giant kelp, but the kelp populations are reduced. Subtidal habitats support patchy populations of surfgrass. Rocky intertidal and subtidal habitats once supported populations of red, pink, white, and black abalone, but only a small population of red abalone, and very few black abalone have been observed recently. Large populations of purple urchins occur in the vicinity of Gull Island. Rocky subtidal habitats from Gull Island to Laguna Point support populations of spiny lobster. Purple hydrocoral (Allopora) is found in deeper rocky reefs around Gull Island.

Shallow rocky habitat extends offshore to Gull Island. Nearshore reefs support populations of various rockfish species. However, rockfish are not as diverse in this region because of physical changes associated with the mixing of warmer waters from the California Counter Current with cooler waters from the California Current. Southern species such as California sheephead and wrasses are relatively common in the Gull Island region. The region also supports spawning populations of white seabass and halibut. Thresher and mako sharks are fished in the deeper waters near stronger currents.

A number of nearshore and offshore emergent rocks, including Gull Island itself, provide roosting habitats for seabirds, and shelter for fish and invertebrates. Gull Island provides roosting sites for Western Gull, Black Oystercatcher, Pelagic Cormorant, Pigeon Guillemot, Cassin's Auklet, and Xantus's Murrelet. California sea lions and harbor seals haul out on Gull Island. Compacted sand and rubble sediments on the continental shelf drop steeply into the Santa Cruz Canyon.

9.4.8. Santa Rosa Island, Carrington Point Marine Reserve

The Carrington Point SMR is located on the north side of Santa Rosa Island. The shoreline around Carrington Point is exposed and rocky. Some protected sand beaches and rocky shoreline is found from Carrington Point to Bechers Bay. Numerous seabirds, including California Brown Pelican, Western Gull, Black Oystercatcher, Brandt's Cormorant, Pelagic Cormorant, and Pigeon Guillemot roost at the end of Carrington Point.

Rocky reefs with a few patches of sand characterize the intertidal habitat within the Carrington Point SMR. Red and brown algae grow on rocky intertidal sites in Bechers Bay. Purple and red sea urchins dominate the rocky habitats around Carrington Point.

Low relief rocky reefs mixed with sand extend into the subtidal habitat. The Carrington Point SMR includes rocky subtidal habitat around Beacon Reef and part of Rodes Reef. Giant kelp occurs in the rocky subtidal around Carrington Point, but populations are not stable. Several rock crab species and spiny lobster also live in the rocky subtidal habitats. Historically, the region supported a large black abalone population and a smaller population of green abalone. Rocky subtidal habitats on the southeast side of Carrington Point once supported red (and possibly pink) abalone. The abalone populations are now very low.

Sandy subtidal habitats southeast of Carrington Point support patchy populations of surfgrass and populations of Pachythione cucumbers, and sand castle worms (Phragmatopoma spp.). A productive eelgrass population in Bechers Bay provides protection and nutrients for juvenile fish and invertebrates. Waters around Carrington Point support a diverse assemblage of fishes, including various species of nearshore rockfish, white seabass, California sheephead, and shark species. Sandy subtidal habitats support populations of halibut. Harbor seals, California sea lions, and blue whales are often found in waters around Carrington Point.

9.4.9. Santa Rosa Island, Skunk Point Marine Reserve

The Skunk Point SMR is located on the east side of Santa Rosa Island. Onshore, the region between Skunk Point and Abalone Point supports the only lagoon in the northern Channel Islands. Lagoons are known as important habitats for juvenile fishes. Several endangered plant species are found on the beaches around the Santa Rosa Island Lagoon, including Dudleya blockmanii, Dudleya gnoma and Gilia hoffmanii. The shoreline between Skunk Point and Abalone Rock is sandy. These sand beaches support the largest populations of breeding snowy plovers in the Channel Islands. Populations of Pismo clams are also known to occur here.

Shale ridges extend out from east Santa Rosa Island to form scattered rocky reefs separated by large patches of sand. Persistent populations of giant kelp are found in the rocky subtidal habitat between Abalone Point and East Point. There are extensive populations of surfgrass south of Skunk Point toward East Point.

Surfgrass provides nursery grounds for fish and invertebrate species, including grass rockfish, halibut and crab. Sand castle worms (Phragmatopoma spp.) are found in localized patches in approximately 10-15 ft of water. Pachythione sea cucumbers are common in some areas from Skunk Point to East Point. Rocky reefs support dense and stable populations of red urchins, but populations are skewed toward smaller sizes. Rocky reefs once supported populations of scallops, but these populations have declined under fishing pressure.

The rocky subtidal habitat from Abalone Point to East Point supports populations of several nearshore rockfish species. White seabass populations can be found in waters off of east Santa Rosa Island at approximately 60 ft deep. Halibut are found in sandy subtidal habitats around Skunk Point.

Harbor seals haul out on the rocks around Abalone Point. South of Abalone Rocks, the subtidal habitat is mostly hard bottom.

9.4.10. Santa Rosa Island, South Point Marine Reserve

The South Point SMR is located on the south side of Santa Rosa Island. A rocky coastline with isolated sandy coves dominates the southwest coast of Santa Rosa Island. The coast is moderately exposed and may receive strong surge in summer months. Northern elephant seals recently have expanded their range to include sandy beaches along the southwestern coast of Santa Rosa Island (especially China Camp). In the past, the protected sandy beaches on the southwestern side of Santa Rosa Island supported breeding and wintering Snowy Plovers. No recent sightings have been made. In the intertidal zone, rocky reefs are interspersed with sandy alleys. The subtidal habitat is mixed rocky reef with sand.

The South Point SMR supports healthy and stable populations of giant kelp. Rocky subtidal habitats support a variety of algal species, including Eisenia, Pterygophora, and Laminaria. Surfgrass is found in the subtidal habitats around South Point and a patchy population of eelgrass grows in Johnson's Lee. Giant kelp forests support a diverse assemblage of nearshore rockfish. White seabass occur in the vicinity of South Point.
Crevices in the reefs provide natural refuges for invertebrates. Red sea urchins are abundant in rocky subtidal habitats. Rocky intertidal and subtidal habitats once supported populations of black abalone. Rocky subtidal habitats support remnant populations of red abalone which have low recruitment potential. The nearshore shelf drops off to sandy plateaus at approximately 70 ft. There are two deeper reefs off of South Point, at 90 ft and 120 ft.

9.4.11. San Miguel Island, Harris Point Marine Reserve

The Harris Point SMR is located on the north side of San Miguel Island. The subtidal habitat off Simonton Cove is mostly sandy, with a few offshore reefs. These sand beaches and intertidal habitats may support a population of pismo clams. During the summer months, spiny lobsters move inshore toward Simonton Cove. Halibut are found in the sandy subtidal habitats to the northwest of Harris Point. The shoreline from Harris Point to Bat Rock is predominantly exposed rocky habitat with a few sandy coves. The subtidal habitat from Harris Point to Bat Rock is expansive rocky bottom with a few high relief rocks and pinnacles. Giant kelp persists around Bat Rock and inside of Harris Point, but populations are smaller in recent years. The rocky subtidal habitat from Harris Point to Bat Rock is dominated by red sea urchins.

There is heavy recruitment of red abalone in the rocky subtidal, but few adults. The rocky habitat between Harris Point and Bat Rock once supported populations of black abalone, but these populations are now depleted. Subtidal rocky features support numerous invertebrate species, including kelp corals, anemones, and worms. The rocky subtidal habitats from Harris Point to Bat Rock and around Prince Island support populations of cold-water rockfish species, including copper, gopher, black and yellow, blue, black, and vermilion rockfish. Lingcod and cabezon also are common in these rocky subtidal habitats.

The shoreline of Prince Island is rocky and exposed. Prince Island and the rocky shoreline from Harris Point to Bat Rock provide breeding and roosting habitats for numerous seabirds, including Western Gull, Black Oystercatcher, Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, Ashy Storm-petrel, Black Storm-petrel, Leach's Storm-petrel, Cassin's Auklet, Common Murre, Pigeon Guillemot, Rhinoceros Auklet, Tufted Puffin, and Xantus's Murrelet. The rocky intertidal around Prince Island descends quickly to a rocky subtidal habitat. Persistent populations of giant kelp and surfgrass are found around Prince Island. Red and purple urchins also are abundant in this region. Waters offshore from Prince Island support substantial populations of white seabass and halibut.

9.4.12. San Miguel Island, Richardson Rock Marine Reserve

The Richardson Rock SMR is located in open waters around Richardson Rock to the northwest of San Miguel Island. Richardson Rock is the most remote exposed offshore pinnacle in the region. The rock is located in the highly productive region southeast of the major upwelling center near Point Conception. Cool, nutrient rich waters in the region support high local productivity, attracting a diverse assemblage of fishes, marine mammals and seabirds. A few emergent offshore rocks provide roosting habitats for seabirds, and shelter fish and invertebrates below the water's surface. The subtidal habitat is mixed sand and rock. Richardson Rock supports populations of vulnerable species, including black and red abalone, and numerous cold-water rockfish species.

9.4.13. San Miguel Island, Judith Rock Marine Reserve

The Judith Rock SMR is located on the southwest side of San Miguel Island. The shoreline from Adams Cove to Judith Rock is mixed rock and sand with moderate to high exposure. Judith Rock provides some protection from surge and wind. California sea lions, harbor seals, and northern elephant seals haul out on beaches around Point Bennett, including the region adjacent to the Judith Rock SMR. The reserve is adjacent to breeding and roosting sites of numerous seabirds including Western Gull, Black Oystercatcher, Brandt's Cormorant, Pelagic Cormorant, Cassin's Auklet, and Pigeon Guillemot.

The rocky intertidal habitat in Judith Rock SMR is highly productive. The subtidal habitat is mixed rock and sand with moderate relief. Rocky reefs are interspersed with sand alleys. Rocky reefs provide suitable habitat for red and purple sea urchin. Rock crab live in sheltered areas along the sand alleys. The Judith Rock SMR includes populations of red abalone, but red and black abalone have been depleted in nearshore habitats. Giant kelp populations between Adams Cove and Judith Rock are healthy and stable. Laminaria is found in deeper waters (approximately 70-90 ft). Patches of surfgrass grow in the subtidal. The lush kelp forest habitat supports diverse populations of nearshore rockfish.

10. Appendix E: Ecological and Socioeconomic Analyses

10.1. Description of Analyses By Alternative

10.1.1. Ecological Impact Analysis- the No Action Alternative

Given the increasing resource demands by the human population, it is likely that the health of marine ecosystems will continue to deteriorate without a change in management strategies (Agardy et al. 2003). Without action, the Sanctuary would have to primarily rely on species-specific fisheries management to attempt to achieve desired outcomes for ecosystem management. Existing fisheries management includes size and catch limits, gear restrictions, and seasonal closures as well as more drastic measures to restore declining fisheries, such as the Cowcod closure, which protects certain species below 300 ft in the area around Santa Barbara Island and the groundfish closure, which is a temporary management measure in the effort to restore groundfish fisheries. The Sanctuary would also rely on the existing state marine reserve and marine conservation areas, but they would not include the full suite of habitats in the Sanctuary, including deeper waters.

10.1.2. Alternatives 1-3

Alternatives 1-3 consist of networks of marine protected areas, including no-take marine reserves and limited-take marine conservation areas. Marine reserves, together with conventional fisheries management strategies, can have significant ecological benefits. Protection afforded by reserves may allow targeted species to rebound, increasing local recruitment and contributing to spillover of adults and export of larvae into fished areas (Guénette et al. 1998, Jones 2002). Additionally, reserves may protect critical life stages and spawning aggregations of targeted species (Shipp 2003). Reserves may provide insurance and resilience in an uncertain world with unpredictable environmental fluctuations (NRC 2001). Finally, reserves can serve as reference areas for research to determine the effects of fishing on marine ecosystems (NRC 2001).

Although it is difficult to predict the ecological impacts of establishing a particular reserve, a wealth of information is available on the ecological impacts of reserves worldwide and, more specifically, within the State of California and around the Channel Islands. Studies of other marine reserves were reviewed to provide an estimate of expected ecological impacts within and around reserves. These studies were conducted primarily in long-established reserves and provide estimates of what might occur in the Channel Islands over the long term. Particular emphasis has been placed on impacts of reserves in California and around the Channel Islands. However, because no two reserves are exactly the same, these results provide guidelines for what may occur and the proposed alternatives may not have exactly the same results.

10.1.2.1. Local Ecological Impacts

There is abundant evidence to demonstrate that protecting areas from all extractive activities leads to rapid increases in abundance, size, biomass, and diversity of targeted animals, regardless of where in the world reserves are located. Halpern (2003) reviewed 76 studies of reserves that were protected from at least one form of fishing. He derived aggregate measures of reserve performance, by combining responses of all the organisms studied for each of four variables: abundance, total biomass, average body size, and species diversity. Across all reserves, abundance (measured as density) approximately doubled. Biomass, or the weight of all organisms combined, increased 2.5 times in reserves as compared to fished areas. Average body size of organisms protected in marine reserves increased by approximately 30%. The increase in size contributes to greater reproductive potential (Béné and Tewfik 2003). In addition to changes in biomass, abundance, size, and reproductive potential, the number of species in each sample increased by 30%.

Ecological changes have been detected rapidly (within 1 year) in regions of high nutrient input due to upwelling (Fisher and Franks 2002, Witman and Smith 2003). Responses documented by Halpern (2003) occurred, on average, 3-5 years after reserves were established.

The time to detect ecological changes in marine reserves and the magnitude of those changes depends, in part, on the intensity of historical fishing effort in the region (Coté et al. 2001). Changes will occur rapidly in areas that recently experienced high fishing intensity. In the Channel Islands region, ecological changes are expected to occur more rapidly in the eastern islands (Anacapa and Santa Cruz Islands), where commercial and recreational fishing has been concentrated for a long period of time. Ecological responses are likely to be more subtle around the western islands (Santa Rosa and San Miguel Islands), where the intensity of recreational fishing has been lower. One exception may be certain commercial fisheries, including sea urchin, crab, and rockfish, that are concentrated around the western Channel Islands. Additionally, ecological responses are likely to be more rapid in shallow waters near shore, where fishing is concentrated in the highly productive euphotic zone. Ecological responses may be more subtle in deep waters offshore where fishing effort is limited by production and access. Certain unfished or very lightly exploited species are not expected to show changes within reserves.

Increases in abundance and density of targeted species have been detected in marine reserves in California. Paddack and Estes (2000) found mean densities for a variety of rockfish and other species 12-35% greater (all species combined) within three central California reserves (Hopkins Marine Life Refuge, Pt. Lobos Ecological Reserve, and Big Creek Marine Resources Protection Act Ecological Reserve) than adjacent fished areas, although their results were not significant due to lack of statistical power. In their study, average densities for kelp rockfish, gopher rockfish, cabezon, and lingcod were 31%, 83%, 22% and 100% greater inside the marine reserves than outside, respectively. California sheephead were much more abundant within one reserve in the study, but very infrequent or not seen at all in other areas. Central California is the northern edge of the geographic range of California sheephead, so results are likely not comparable to southern California.

Paddack and Estes (2000) also reported mean sizes for all rockfish species combined in their study. In two of the three reserves mean size was greater and in the third reserve (which had been established the least amount of time) mean size was nearly equal. On average over all three reserves mean size of rockfishes was about 14% greater within the reserves than outside.

Increases in abundance and density of targeted species also have been detected in marine reserves in the Channel Islands. Limited data were reviewed from surveys inside and outside the Catalina Marine Science Center reserve. Sheephead and kelp bass were 48% and 29% greater inside the reserve compared to outside, respectively (Caselle, unpublished data). In 2000-2001, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) compared sites inside the Anacapa Island Ecological Reserve Natural Area with one site outside the reserve at Middle Anacapa Island (Caselle unpublished data). For estimates of density, the site inside the reserve with similar habitat was compared to the site outside the reserve, whereas all sites were used for estimates of average size. Sheephead and kelp bass densities were 137% and 103% greater inside the marine reserve compared to outside, respectively. Sheephead and kelp bass average sizes were 13% and 9% greater inside the marine reserve compared to outside, respectively.

The National Park Service compared relative densities and sizes of invertebrate species inside the Anacapa Ecological Reserve Natural Area and areas nearby (Kushner unpublished data). In all cases, data was analyzed from particular sites only if the focal species were present in more than 2 out of the most recent 10 years of data. In this analysis, average spiny lobster and warty sea cucumber densities were 592% and 141% greater inside the reserve, respectively. In contrast, average red urchin densities were 13% less inside the reserve. Although red urchins are less dense inside the reserve, individual urchins are significantly larger inside the reserve. Red urchins are approximately 60% larger inside the reserve compared to areas outside. In addition, while nearly 60% of red urchins were larger than the minimum legal commercial size inside the marine reserve on average, only about 11% were outside. Table E-1 below shows average densities and sizes of targeted species in marine reserves within the State of California as compared to fished areas nearby.

Table E-1. Average Densities And Sizes Of Targeted Species In Marine Reserves Within The State Of California As Compared To Fished Areas Nearby

Species	Status	Average Density	Average Size
Kelp bass[1]	Targeted	103% greater	9% larger
Kelp bass[2]	Targeted	29% greater	
California sheephead[1]	Targeted	137% greater	13% larger
California sheephead[2]	Targeted	48% greater	
California sheephead[3]	Targeted	More abundant within range	
Kelp rockfish[3]	Targeted	31% greater	14% larger
Gopher rockfish[3]	Targeted	83% greater	14% larger
Cabezon[3]	Targeted	22% greater	14% larger
Lingcod[3]	Targeted	100% greater	
Cowcod[4]	Targeted	32 and 8 times greater	
Bocaccio[4]	Targeted	408 and 18 times greater	
Spiny lobster[5]	Targeted	592% greater	
Warty sea cucumber[5]	Targeted	141% greater	
Red urchin[5]	Targeted	13% less	60% were larger than legal size

Key

[1] Data provided by PISCO from the Anacapa Ecological Reserve Natural Area.

[2] Data provided by PISCO from the Catalina Marine Science Center reserve.

[3] Data from Paddack and Estes (2000) from Hopkins Marine Life Refuge, Pt. Lobos Ecological Reserve, and Big Creek Marine Resources Protection Act Ecological Reserve.

[4] Data from Schroeder and Love (2002) showing the density of populations in a de-facto reserve (Platform Gail) as compared to a recreational fishing area and an unprotected area.

[5] Data provided by NPS from the Anacapa Ecological Reserve Natural Area.

10.1.3. Bycatch

Bycatch, or incidental take, can have significant, direct, ecological impacts on non-targeted species (Shipp 2003). Worldwide, scientists estimate that fishermen discarded about 25 percent of their catch during the 1980s and the early 1990s (Alverson et al. 1994, Alverson 1998 from Pew 2003). Gill net, drift net, longline, and trawl fisheries have some of the highest bycatch mortality among fisheries. By prohibiting fishing within their boundaries, marine reserves can eliminate bycatch of non-targeted species and undersized individuals of targeted species within reserve boundaries. Protection can improve productivity of targeted and non-targeted species and maintain structure and function of marine communities (NRC 2001). Protection in marine reserves can enhance spawning biomass of species that experience high discards and mortality of young fish (Horwood et al. 1998). Marine reserves may provide the only practical means of protecting vulnerable species caught as bycatch in the main fisheries (Horwood et al. 1998).

10.1.4. Non-Targeted Species

If non-targeted species are insulated ecologically from the impacts of fishing, then establishing a reserve is not likely to affect the abundance, density and size distribution of the non-targeted species. However, establishing a reserve may impact non-targeted species if strong ecological linkages (e.g., predation or competition) exist between non-targeted species and others that are fished. The range of ecological responses of non-targeted species to protection within reserves demonstrates the importance of indirect effects.

In 2000-2001, PISCO investigated the differences between non-targeted species in the Anacapa Ecological Reserve Natural Area and fished areas nearby. Rock wrasse, garibaldi, and black surfperch densities were 173%, 79%, and 398% greater inside the reserve at Anacapa Island compared to outside, respectively. Rock wrasse average size was 3% greater inside the reserve compared to outside, respectively. Garibaldi and black surfperch average sizes, however, were 4% and 24% smaller inside the reserve compared to outside, respectively.

National Park Service data (Kushner unpublished data) were examined to compare relative densities and sizes of invertebrate species inside the Anacapa Ecological Reserve Natural Area compared with areas nearby. Average purple urchin, bat star, and giant-spined star densities were 91%, 66%, and 77% less inside the reserve, respectively. Purple urchins were larger on average (26%) inside the reserve.

Table E-2: Average Densities And Sizes Of Unfished Species In The Anacapa Ecological Reserve Natural Area As Compared To Fished Areas Nearby.

Species	Status	Average Density	Average Size
Rock wrasse1	Unfished	173% more	3% larger
Garibaldi1	Unfished	79% more	4% smaller
Black surfperch1	Unfished	398% more	24% smaller
Purple urchin2	Unfished	91% less	26% larger
Bat star2	Unfished	66% less	
Giant-spined star2	Unfished	77% less	

Key
1 Data provided by PISCO.
2 Data provided by NPS.

The differences between ecological responses in the reserve as compared to surrounding waters indicate that indirect effects of reserves impact non-targeted species, sometimes in unexpected ways. Declines in abundance, density, or size of non-targeted species within a reserve may indicate that one or several predators have been released from fishing pressure and now exert predation pressure, causing the non-targeted species to decline. Increases in abundance or density of non-targeted species within a reserve may be a result of reduced competition for resources as production within the reserve increases over time. Complex indirect interactions, resulting from fishing and the subsequent establishment of a no-take marine reserve, have been documented in the Channel Islands region.

10.1.5. Indirect Ecological Effects

Historically, lobsters and other predators kept sea urchin populations at low levels and kelp forests flourished. However, lobster fishing has occurred throughout the Channel Islands for over 100 years (Leet et al. 2001). Over time, commercial and recreational fisheries for lobster reduced the population size and average length of individual lobsters (Tegner and Levin 1983). Reduced populations of smaller lobsters were not effective predators on urchins and, as a result, urchin populations increased. Intense grazing by purple urchins (which were not fished) caused dramatic declines in kelp growth, leading to the formation of bare rocky reefs covered with urchins (known as urchin barrens). Crustose coralline algae, resistant to urchin grazing, became the dominant algae on rocky substrate in urchin barrens (Harrold and Reed 1985).

In 1978, commercial and recreational fishing was prohibited in one area of the Channel Islands, the Anacapa Ecological Reserve Natural Area. Within the reserve, lobsters are six times more numerous and individual lobsters are larger than in nearby fished waters (Behrens and Lafferty, unpublished manuscript). Other targeted species, including California sheephead and kelp bass, also are more numerous and larger in the reserve (Tretault, unpublished data). Predation by large lobsters and other species in the reserve caused the urchin population to decline. On average, the density of urchins is 7.4 times greater in fished areas than in the reserve (Behrens and Lafferty, unpublished data). Released from the intense grazing pressure from urchins, kelp in the reserve flourished, supporting a variety of associated species. On average, kelp grew five times more densely and persisted longer in the reserve as compared to fished areas nearby (NPS, unpublished data). Data from the National Park Service show that the marine reserve supports some of the richest kelp forests in the Channel Islands.

In addition to greater density and diversity in the reserve, the protected kelp forests are more resilient to natural perturbations than those in fished areas. Kelp grows throughout the Channel Islands under good conditions, when upwelling of cool waters brings nutrients to the region. During El Niño events, low-nutrient warm water inhibits growth of kelp. Reduced growth of kelp combined with the effects of grazing by urchins can lead to decimation of the kelp forest in areas that are fished. At some point during the past 20 years, each kelp forest monitoring site in fished areas became an urchin barren for a period of time and urchin barrens have persisted some sites (Behrens and Lafferty, unpublished manuscript). In contrast, kelp forests protected in the Anacapa Ecological Reserve Natural Area were resilient to natural perturbations associated with El Niño during a period of twenty years since the reserve was established (Behrens and Lafferty, unpublished manuscript).

The high population density of organisms, released from predation pressure through the indirect effects of fishing, can contribute to the spread of disease. One study documented the spread of disease through dense urchin populations in the Channel Islands. During the study (1992-1998), urchin abundance increased over time as invertebrate predators (spiny lobsters) decreased under fishing pressure (Lafferty and Kushner 2000). Bacterial disease spread through populations with high densities of urchins. Sites with lower predator abundance had higher urchin abundance and higher incidences of the disease. An exception was the marine reserve at Anacapa Island where urchin density was lower, due to higher predation by lobsters, and the disease was nearly absent.

It is clear from this example that the effects of fishing may be carried beyond the target species to affect abundance and diversity of other marine organisms and weaken their resilience to natural perturbations, such as El Niño cycles and the spread of disease. The marine reserve at Anacapa Island, established in 1978, restored and enhanced populations of predators and kelp. These ecological changes increased the resilience of kelp populations to climate variation and increased the resilience of urchin populations to the spread of disease. These ecological changes are likely to occur in other reserves that contain suitable habitat around the Channel Islands.

10.1.6. Local Impacts on Marine Habitats

The abrasive contact of mobile fishing gear with the seafloor, particularly used in trawling and dredging, can damage or destroy benthic habitats and faunas (Rodwell et al. 2003, JNCC 2004). In 1999, 176 commercial permits were issued to operators in the Channel Islands region to deploy trawl gear. Typical trawl fisheries in California trawl the same section of sea bottom more than once per year on average (Friedlander et al. 1999). In 2002, the federally managed groundfish fishery was closed from 3-200 nautical miles off California, with the exception of sanddabs. Within that area, commercial fishing was closed for federally managed groundfish in waters from 0-150 fathoms and commercial trawl fishing was closed from 0-200 fathoms. Commercial fixed-gear sanddab fishery is open in all waters. Although regulations currently prohibit the use of mobile fishing gear throughout a large portion of the project area, the regulations were imposed only 2 years ago and they are not permanent closures. It is anticipated that the groundfish closure area will be opened to trawl fishing once the fishery recovers. Fully protected marine reserves may provide the only long-term means of protecting marine habitats from the destructive impacts of mobile fishing gear.

Static fishing gears have a lower impact on smaller areas of the seabed than active gears. In the Channel Islands, traps are set for lobster, prawn, and the live fish industries. The lobster industry included 46 fishers in 1999 (Leeworthy and Wiley, 2002/2003). Studies have shown that lost lobster pots and other traps may continue catching (and killing) animals for months (JNCC 2004). It is unlikely that traps, lost from unprotected areas, would have significant ecological impacts in marine reserves, unless the traps are transported on strong currents or storm-generated waves into the reserve areas.

10.1.7. Regional Ecological Impacts

Effective reserves may support a greater biomass of targeted species and larger individuals than areas that are managed using conventional methods (Shipp 2003). The benefits to fisheries depend on the degree of connectivity between targeted populations in the reserve and surrounding waters. Reserves will not contribute to increased yield unless reserves export individuals to unprotected waters where they can be fished (Gaines et al. 2003).

Increased densities of adults in reserves may contribute to spillover into surrounding non-reserve areas (Roberts and Polunin 1991, DeMartini 1993, Russ and Alcala 1996, McClanahan and Mangi 2000), particularly if population dynamics are controlled by density-dependent habitat use (Jennings 2000). Many temperate groundfish populations are likely to exhibit spillover from reserves because they exhibit density-dependent habitat use (Jennings 2000 from Fisher and Frank 2002).

Several studies have documented the movement of individuals from reserves to surrounding areas (Attwood and Bennett 1994, McClanahan and Kaunda-Arara 1996, Johnson et al. 1998, Davis and Dodrill 1980). Increases in biomass of target species outside marine reserves provide indirect evidence for spillover and export (Russ and Alcala 1996b, Ratikin and Kramer 1996, Murawski et al. 2000, Roberts et al. 2001, Fisher et al. 2002). Shifts in the distribution of fishing effort provide additional indirect evidence for spillover (Alcala and Russ 1990, Yamaski and

Kuwahara 1990, Polunin and Roberts 1993, Ramos-Espla and McNeill 1994, McClanahan and Kaunda-Arara 1996, Roberts et al. 2001). In some cases, fishermen have shifted their effort to the edges of marine reserves, a phenomenon known as "fishing the line." A shift in fishing effort may indicate that (1) targeted species are more abundant near the reserve and (2) the reserve is contributing to the fishery through spillover.

Marine reserves may contribute to fisheries through the increased production of eggs within reserves and the subsequent dispersal of larvae to areas outside of the reserve (Bohnsack 1996, Sladek Nowlis and Roberts 1997, Béné and Tewfik 2003). The ability of reserves to contribute larvae to areas outside the reserve depends on several variables, including the dispersal ability of larvae, the direction of current-mediated transport, and the size and spacing of reserves (Gerber et al. 2003). Although it is difficult to track larvae during dispersal, estimates of larval dispersal have been made using population genetics (Kinlan and Gaines 2003) and duration of the larval phase (Shanks et al. 2003). Small reserves are not likely to contribute to sustainable fisheries because small populations of targeted species within reserves are not likely to export substantial quantities of larvae (Halpern 2003).

Detecting spillover may be difficult if source populations within reserves are small relative to the surrounding fished waters. The ecological benefits of larval export from reserves are not likely to be detected until the combined area of reserves reaches a substantial fraction of the project area. Models of fisheries (summarized in Chapter 2) suggest that reserves may contribute to spillover of adults and export of larvae if the combined area of reserves protects between 20 and 50 percent of the targeted stock. The cumulative impacts of Alternatives 2 and 3, combined with the existing state marine reserves and marine conservation areas, may contribute to spillover of targeted populations in the Channel Islands. However, within the context of the Southern California Bight, none of the alternatives includes more than 0.02% of the total area. Therefore, it may be difficult to detect spillover from the reserves into surrounding waters.

10.1.8. Ecological Impacts of Marine Conservation Areas

Marine conservation areas (which allow limited recreational and/or commercial fishing) can contribute to conservation and fisheries objectives (Agardy et al. 2003). However, multiple uses may be allowed at the expense of primary conservation objectives (Jones 2002). When marine protected areas allow multiple uses, they often provide mainly for exploitation rather than conservation (Prideaux et al. 1998 from Jones 2002). When socioeconomic criteria are given equal or greater weight than ecological criteria, decision-makers may choose marine protected areas with little biological value that may fail to meet many of the desired objectives (Roberts et al. 2003a). Targeted populations may decline and habitat may be degraded, even with low levels of fishing in conservation areas (Rodwell et al. 2003).

Schroeder and Love (2002) compared rockfish density within a de-facto marine reserve (an oil platform where fishing does not occur), an area allowing only recreational fishing, and an unprotected area (where both recreational and commercial fishing are allowed) in the Channel Islands region. Rockfish density was an order of magnitude less within the recreational fishing area than in the unprotected area. Community composition also was significantly different. Cowcod densities were 8 and 32 times greater in the de facto reserve than in the recreational area or unprotected area, respectively. Similarly, bocaccio densities within the de facto reserve were 18 and 408 times greater than in the recreational area or unprotected area, respectively. The authors conclude that recreational fishing in a marine conservation area can have measurable effects on targeted species.

10.1.9. Monitoring and Evaluation

Needs to include some information from the monitoring sites criterion and the summary of monitoring programs and the DFG and Sanctuary monitoring programs.

The Channel Islands National Park (CINP) Kelp Forest Monitoring Program has studied 16 monitoring sites for the past 20 years (Davis et al., 1994). These sites are monitored annually for a variety of characteristics including algae cover and invertebrate and fish population levels and diversity. These data provide a baseline against which to evaluate MPAs. Other monitoring efforts (e.g., Department abalone surveys) will also provide baseline data to compare with future monitoring inside and outside MPAs. The Science Advisory Panel recommended that some monitoring sites be included both inside and outside marine reserve and marine conservation areas to allow researchers to track changes associated with protection over time (CDFG 2002).

The MRWG recommended adaptive management of marine reserves, so that we can learn from the initial network of reserves and adjust management strategies as appropriate. Many scientists encourage a responsive and flexible management framework for marine reserves so that new information can be incorporated and management can accommodate shifts in socioeconomic conditions (Salomon et al. 2002, Agardy et al. 2003).

We know enough about coastal and marine ecosystems to improve their management. With better information we could do much more. Public and private institutions need to work together to fill gaps in our knowledge to ensure that decision-makers have timely access to the information they need to protect the public interest. In addition, scientists need to provide the public with understandable information about the structure and functioning of coastal and marine ecosystems, how ecosystems affect our daily lives, and how we affect ecosystems (Pew Oceans Commission 2003).

Monitoring and evaluation, also recommended by the MRWG, are critical components of the marine reserve strategy. Ecological monitoring can gather the data necessary to detect the effects of marine reserves on marine habitats and species of interest. The effects of fishing, which are poorly understood, can be detected by comparing reserve and fished areas, assuming adequate enforcement. Socioeconomic monitoring is essential to gauge effects on local economies, and to detect shifts in fishing effort and changes in the spatial distribution of activities in response to the reserves. Changes within reserves depend, in part, on the intensity of historical fishing effort (Wilen et al. 2002). Areas that experienced high levels of fishing are likely to respond to protection more rapidly than areas that are not heavily impacted. See Monitoring Plan And Recommendations In Appendix G.

Table E-3: Summary of The Alternatives' Ecological Impacts

ALTERNATIVES				
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3
IMPACT WITHIN NETWORK				
Abundance of species				
Intensity of Impact1	N	B (PA for some species)	B (PA for some species)	B (PA for some species)
Impact Duration2	-	Long-term	Long-term	Long-term
Impact Target3	-	Direct	Direct	Direct
Context4	-	Local	Local	Local
Individual size of species				
Intensity of Impact	N	B (PA for some species)	B (PA for some species)	B (PA for some species)
Impact Duration	-	Long-term	Long-term	Long-term
Impact Target	-	Direct	Direct	Direct
Context	-	Local	Local	Local
Density of species				
Intensity of Impact	N	B (PA for some species)	B (PA for some species)	B (PA for some species)
Impact Duration	-	Long-term	Long-term	Long-term
Impact Target	-	Direct	Direct	Direct
Context	-	Local	Local	Local
Diversity of species				
Intensity of Impact	N	B (PA for some species)	B (PA for some species)	B (PA for some species)
Impact Duration	-	Long-term	Long-term	Long-term
Impact Target	-	Direct	Direct	Direct
Context	-	Local	Local	Local
Biomass				
Intensity of Impact	N	B (PA for some species)	B (PA for some species)	B (PA for some species)
Impact Duration	-	Long-term	Long-term	Long-term
Impact Target	-	Direct	Direct	Direct
Context	-	Local	Local	Local
Community Structure				
Intensity of Impact	N	B	B	B
Impact Duration	-	Long-term	Long-term	Long-term
Impact Target	-	Direct/Indirect	Direct/Indirect	Direct/Indirect
Context	-	Local	Local	Local
Habitat Quality				
Intensity of Impact	N	PB	PB	PB
Impact Duration	-	Long-term	Long-term	Long-term
Impact Target	-	Direct	Direct	Direct
Context	-	Local	Local	Local

ALTERNATIVES				
	No Action Alternative	Alternative 1	Alternative 2	Alternative 3
IMPACT OUTSIDE NETWORK				
Larval Dispersal				
Intensity of Impact	N	N	PB	PB
Impact Duration	-	-	Long-term	Long-term
Impact Target	-	-	Direct	Direct
Context	-	-	Regional	Regional
Adult Spillover				
Intensity of Impact	N	PB	PB	PB
Impact Duration	-	Long-term	Long-term	Long-term
Impact Target	-	Direct	Direct	Direct
Context	-	Regional	Regional	Regional

<u>Key</u>

1) Intensity of Impact Ratings: Rating is based on empirical and theoretical studies conducted in the study area and/or literature review of marine reserve performance.
Potential Adverse (PA): Potential adverse ecological impact. Potential Adverse is assigned when some information indicates that a negative ecological impact may occur, but the probability, intensity and significance is undetermined.
2) Impact Duration: Period of time over which the ecological impact is expected to persist
3) Impact Target: A direct ecological impact is one that will exhibit a direct, observable effect as a result of implementation of the alternative. An indirect ecological impact is one that occurs to a non-targeted species through ecological linkages such as predation and competition
4) Context: The geographic region over which the ecological impact is expected to be detected.
(N) No Impact: No ecological impact
(PB) Potential Benefit: Potential beneficial ecological impact. Potential Benefit is assigned when some information indicates that a positive ecological impact may occur, but the probability, intensity and magnitude is undetermined
(B) Significant Benefit: Beneficial ecological impact.

10.2. Socioeconomic Criteria and Impact Analysis

The following sections provide a description of the potential impacts on the human environment based on socioeconomic information gathered and analyzed on the range of impacts associated with the use of the natural resources and non-consumptive uses of the project area. Cost estimates were provided for commercial fishing, kelp harvesting, recreational fishing, and consumptive diving. The analysis of potential costs was quantitative and based on baseline data gathered for the Channel Islands Marine Reserves process over two years. A Socioeconomic Panel report to the MRWG focused on the potential costs associated with alternatives developed during the Channel Islands Marine Reserves Process (Leeworthy and Wiley 2002 and revised per reviews Leeworthy and Wiley 2003). A qualitative characterization of potential benefits for non-consumptive users (sports divers and wildlife viewers), non-users and passive users, scientific and education values, and consumptive users of the project area was also provided in the report.

The Socioeconomic Panel analytical approach is based on an economic impact model that uses baseline information for 1996-1999 for the commercial fishing industry and kelp harvesting (Leeworthy and Wiley 2002 and revised per reviews Leeworthy and Wiley 2003). Also provided is a profile of fishermen of the Tri-county area from data collected from contractors, Dr. Barlotti and Dr. Pomeroy, and ethnographic data collected and described by Kronman et al. (2000). The Tri-county area includes San Luis Obispo, Santa Barbara, and Ventura counties. The analysis included consumptive recreational activities based on data collected for 1999 (Leeworthy and Wiley 2002 and revised per reviews Leeworthy and Wiley 2003). The recreational analysis uses an economic impact and valuation model that includes expenditure profiles. In addition, the Socioeconomic Panel included brief overviews of consumer's surplus, ethnography, and a characterization of baseline estimations. Profiles of the direct recreational users and all the suppliers of recreational services were not available.

Overall, the socioeconomic analysis provides a complete list of potential costs and benefits, but because there are limited data and scientific studies related to consumptive and non-consumptive values of the project area, not all costs and benefits could be quantified. However, the data collected and generated by the Socioeconomic Panel represent an important step toward the development of baseline information and analyses.

A description of the socioeconomic setting is provided in Chapter 3 (Affected Environment). As noted above, the Socioeconomic Panel was not able to quantify all cost and benefits that may be associated with the establishment of marine reserve and marine conservation areas within the project area. As a consequence, the socioeconomic analysis is limited by a degree of uncertainty with respect to the potential social and economic costs and benefits of MPAs.

A number of diverse data sources and methods were used to estimate both the total amount and spatial distribution of use for both the Federal and State waters of the proposed project area. These data include both existing information (e.g., catch statistics) and surveys conducted specifically for this project. The Socioeconomic Panel relied on the following sources of information:

California Department of Fish and Game commercial fishing data showing where fish are caught and the ports where fish are landed;

- 14 commercial species/species groups mapped on a 1-minute by 1-minute distributions of catch;
- Socioeconomic profiles of the fishermen (e.g., experience, age, education, income, dependency on fishing, people and family members directly employed, investment/ownership of boat and equipment, place of residence and home and landing ports);
- Commercial fishermen costs and earnings;
- Kelp harvesting and processing information (obtained from ISP Alginates);
- Surveys of recreational "for hire" operators (achieved a Census);
- National Marine Fisheries Service, Marine Recreational Fishing Statistics Survey for intercept/access points for those fishing from private household boats;
- Aerial flyover data for boating activities from the Channel Islands National Marine Sanctuary; and

- An ethnographic survey of a variety of commercial and recreational sanctuary users

10.2.1. Analytical Approach

The socioeconomic analyses are based on a two-step approach. The Step 1 Analyses describes the potential impacts of each alternative and a comparison of impacts of alternatives for commercial fisheries and fishermen, and for consumptive recreational activities for the project area (Leeworthy and Wiley 2002 and as revised in Leeworthy and Wiley 2003). The analyses also provide an aggregate consumptive impact assessment for Step 1 Analyses. Step 2 analyses are less quantitative. The Step 2 Analyses qualitatively describe factors that contribute to potential costs and, when possible, the benefits of the establishment of marine reserve and marine conservation areas within the project area (Leeworthy and Wiley 2002 and as revised in Leeworthy and Wiley 2003). The Socioeconomic Panel could not forecast all the factors such as human responses, the ecological-biological responses, or the interaction of the human and ecological/biological systems that may result from the network of marine reserve and marine conservation areas and change Step 1 estimates. All the benefits and costs of marine reserve and marine conservation areas cannot be quantified, and so a formal benefit-cost analysis was not conducted.

The Step 1 analyses are very quantitative and include an aggregation of all the activities displaced from marine reserve areas, with the assumption that all is lost, because there is no mitigation or offsets through behavioral responses. Substitution or relocation of activities to another area, replenishment effects (biological effects such as spillover), the effects of other regulations, the current and future status of fishing stocks, and the potential benefits of marine reserve and marine conservation areas are not addressed in Step 1 analyses. The Socioeconomic Panel labeled the Step 1 analyses as “maximum potential loss”. In cases where congestion effects occur due to displacement and relocation of fishing effort, actual losses could exceed estimates of maximum potential loss. On the other hand, losses may be overestimated where offsetting factors such as effort reduction are instituted.

It is rare that there would not be possibilities for substitution and relocation to mitigate impacts. Human beings have proven to be quite ingenious, adaptive and resilient in the face of change and often develop surprising solutions. Step 2 analyses are by their nature less quantitative. The Socioeconomic Panel was simply not able to forecast all the human responses as well as the ecological-biological responses, and the interactions of these systems that will result from a network of marine protected areas.

The Step 2 Analyses focus on the potential costs of each alternative for commercial fishing and kelp harvesting and consumptive recreational activities. The analyses also include a general qualitative overview on potential benefits to non-use or passive use values associated with the project area, such as wilderness, natural, scientific, and education values, as well as long-term benefits to consumptive users. A number of diverse theoretical models from socioeconomic literature are used to guide the Step 2 analyses and to identify future costs and benefits associated with the reserve alternatives.

Overall, the analyses provides extensive profiles of the potential economic costs to commercial and recreational fishermen, measures of their dependency on Sanctuary resources, the extent of potential impacts on individual fishermen surveyed, and information relevant to assessing the ability of users to adapt to change.

10.2.2. Economic Rent

Another measure listed as a possible benefit or cost was economic rent. Economic rent is a return on an investment over and above a normal rate of return on investment. A normal rate of return on investment is that rate of return in which incentives are such that capital will neither outflow or inflow into the industry. To estimate economic rents requires detailed information on the costs and returns and investment by fishermen. The Panel attempted to obtain this information in both the commercial fishing and squid-wetfish samples but was only partially successful. Fishermen were reluctant to reveal their full costs and earnings. This prevented the Panel from evaluating the existence or extent of potential impact on economic rents.

10.2.3. Ethnographic Data Survey

The Sanctuary conducted an ethnographic data survey in 1999 (Kronman et al. 2000). Forty-three mariners were surveyed, fifteen of whom were professional fishermen interviewed about their opinions on the current status of various species and habitats, whether the status of the species and habitats have changed, environmental cycles observed, changes in climate, changes in equipment used for fishing, changes in regulations and when and/or if they affected their operations, changes in domestic and/or export markets for their products or changes in distributions of boats and fisheries and when and/or if these changes affected their operations. This ethnographic information was used in developing some of the Panel's catch distributions.

10.2.4. Commercial Fishing Operations

The information and analysis generated during the socioeconomic investigation represents an important baseline study of the various use values associated with the project area. The Socioeconomic Panel gathered and synthesized available social and economic information from a number of current programs, studies, and sources (Leeworthy and Wiley 2001; Leeworthy and Wiley 2002 and Leeworthy and Wiley 2003). Socioeconomic information and analysis were generated over a two-year time period from a number of other surveys described below that was funded as part of the Channel Islands Marine Reserves process.

Two contractors were selected by NOAA to gather information for the commercial fisheries in the Sanctuary. Dr. Craig Barilotti of Sea Foam Enterprises, Inc. collected information from all commercial fisheries, except squid and wetfish (e.g., anchovies, sardines, and mackerel). Dr. Caroline Pomeroy of the University of California, Santa Cruz analyzed squid and wetfish data gathered for a California Sea Grant research project.

Fourteen maps developed from the fisheries and kelp harvesting are used in the socioeconomic impact analyses. Because of restrictions placed on the Socioeconomic Panel by the Commercial

Fishermen's Data Committee, only the maps for squid, wetfish, tuna, and kelp were released during the Channel Islands Marine Reserves process. All maps compare ex-vessel value from specific sites within the project area. Maps (1996-1999 annual averages) and tables summarizing a comparison of the 1999 population and sample distributions for each fishery, in terms of fishing operations (vessels) and annual ex-vessel value of catch, are provided in Leeworthy and Wiley (2003).

The commercial fishing sample included 59 fishermen. The squid and wetfish sample included 29 purse seine boats and 8 light boats. Profiles of purse seine boats and light boats were presented separately. Fishermen were asked to provide information including experience (years of commercial fishing and years fishing in the Sanctuary, age, years of education, percent of income from fishing, percent of fishing revenue from Sanctuary waters, number of crew and family members supported directly by the fishing operation, ownership/investment value of boats and equipment, residence (state and city), and ports used (home port, main tie-up port, and main landing port). Not every fisherman supplied complete information. More detail was available from the squid and wetfish fishermen than the other commercial fishermen. The sample did provide a broad range of types of fishermen and represented fishermen responsible for the majority of the catch in Sanctuary waters. This sample was used for assessing potential adverse impacts and difficulties of adapting to change.

The commercial fishing sample, other than squid and wetfish, accounted for 25 percent of the 1996-1999 average annual ex-vessel value of catch from the Sanctuary. Together with the squid and wetfish sample, the analysis included 96 fishing operations which represent 13 percent of the fishing operations that fished in the Sanctuary, but accounted for 79 percent of the total ex-vessel value of catch from the Sanctuary.

In addition, the Socioeconomic Panel obtained summary tables of information from a study done by Utah State University researchers (Ron Little and Joanna Endter-Wada) under contract to the U.S. Department of the Interior, Minerals Management Service. In 1996, the Utah State University researchers conducted a survey of 248 commercial fishermen who live in the Tri-County area: 95 of the 248 fishermen fished in the Sanctuary, and 60 of the 96 fishermen in the samples lived in the Tri-county area. Very few of the squid and wetfish fishermen from the samples lived in the Tri-County area.

A characterization of the ex-vessel value of the commercial fisheries in the Sanctuary for 1999 and for the average of years 1996-1999 is provided in Chapter 3. In 1999, the top 14 species/species groups accounted for 99.7 percent of the commercial landings from the Sanctuary, and for the years 1996-1999 the top 14 accounted for 98.7 percent of the commercial landings from the Sanctuary. As a result the top 14 species/species groups were included in the socioeconomic analyses for the commercial fisheries along with kelp.

Kelp was treated differently because only one company, ISP Alginates, located in San Diego, California, harvests it. Harvested value equivalent to ex-vessel value was not available. Instead, ISP Alginates supplied the Socioeconomic Panel with the processed value of kelp (1996-1999 average of $5,991,367). The Panel constructed a separate economic impact model for kelp with the help of Dale Glantz of ISP Alginates. All the economic impact from kelp occurs in San Diego County where it is landed and processed.

After reviewing the trends in catch and value from 1988-1999, the Socioeconomic Panel decided that the average of years 1996-1999 would be the most representative estimate for extrapolating future impacts. The trends in catch, value of catch and prices for the project area and for the entire State are included in the analysis (Leeworthy and Wiley 2002 and the revised version in Leeworthy and Wiley 2003).

The commercial fishery economic impact model translates annual ex-vessel value of landings into total annual income and employment impacts on local economies. Distributions of catch by species/species group from the Sanctuary and port where landed were multiplied by figures from the Fishery Economic Assessment Model (FEAM) that translate annual ex-vessel value of landings by species/species groups at a given port to total annual income generated in the local county economy (Leeworthy and Wiley 2002 and Leeworthy and Wiley 2003).

10.2.5. Commercial Consumer's Surplus

The Socioeconomic Panel also described the possibility of losses to consumers if the supply of commercial seafood products were reduced enough to have impacts on prices to consumers or a gain to consumers, if marine reserve and marine conservation areas resulted in increased supplies and lower prices to consumers. To estimate consumer surplus requires access to econometric demand and supply models for each of the fisheries. The Panel was not able to find any such research for California seafood products, except sea urchins (Reynolds 1994). As a result the Panel was not able to provide estimates of potential impacts on consumers from possible price changes. However, an assessment was conducted on percent of supply provided from the Sanctuary and the Socioeconomic Panel concluded that the proportions of supply that would be impacted by any marine protected area would not significantly impact supply nor impact prices, thus no changes in consumer surpluses are expected.

10.2.6. Recreational Uses

Recreation was divided into consumptive activities and non-consumptive activities for the purposes of the socioeconomic analysis. Consumptive recreation includes recreational fishing from a charter/party boat, fishing from a private household/rental boat, consumptive diving from a charter/party boat and consumptive diving from a private household/rental boat. Non-consumptive recreation includes non-consumptive diving, whale watching, sailing and kayaking/sightseeing from for hire or charter/party boats.

Non-consumptive recreational users are potential beneficiaries of marine reserve and marine conservation areas. Because the Panel was not able to obtain existing information on non-consumptive activities from private households and rental boats, non-consumptive uses are undercounted. A comprehensive benefits analysis was not part of the Panel's assessment and was beyond the scope of the Panel's investigation. Recreational consumptive users may potentially experience both costs and benefits of marine reserve and marine conservation areas under various conditions. As described earlier, the potential benefits from marine reserve and marine conservation areas are determined by the size and location of marine reserve and marine conservation areas, which vary among alternatives. Because data on non-consumptive users accessing the Sanctuary from private household and rental boats are not available, non-consumptive benefits of marine reserve and marine conservation areas are underestimated.

The Socioeconomic Panel included an analysis of information for years 1993 to 2000 from the NMFS's Marine Recreational Fisheries Statistics Survey (MRFSS) (Leeworthy and Wiley 2002 and Leeworthy and Wiley 2003). MRFSS data show a downward trend in fishing trips and catch for southern California over this period. Total trips had declined 39.6 percent from 1993 to 1999. In 2000, there was a significant increase in the number of trips. So the decline for 1993 to 2000 was reduced to 6.3 percent. In the 1993 to 1998 period, the top 20 species, in terms of total number of fish caught, 10 had downward trends, 7 had no trend and 3 had upward trends. In 1999 and 2000, all the rockfish species previously among the top 20 between 1993 and 1998 dropped out of the top 20, except Vermillion Rockfish and Bocaccio. Species ranked number 11 to 20 in 1993 were all out of the top 20 in 2000, even though only three of these species showed downward trends in catch between 1993 and 1998. These trends were contrasted with the trends for the years 1991 and 1996, for all of California, based on the U.S. Fish and Wildlife Survey of Fishing, Hunting and Wildlife Associated Recreation (USFWS 1991 and 1996). This latter survey showed a slight decrease in the number of recreational anglers (less than one percent), but an increase in the number of angler days (27.88 percent). Although the definitions of the populations covered are different between the surveys, the Panel was not able to reconcile the differences in trends because the MRFSS Northern California data also showed a downward trend.

The Socioeconomic Panel's recreational data included information organized into consumptive and non-consumptive activities and within each of these categories whether the activity was done from a charter/party boat or guide service (for hire operation) of from a private household owned boat. The charter/party boat or guide service activity was obtained through a contract with Dr. Charles Kolstad of the University of California, Santa Barbara. Dr. Kolstad was able to conduct a census, or contact all charter/party boat or guide services that operated in the Sanctuary in 1999. Information obtained included person-days of activity, by activity type along with revenues, operating and capital costs and profits associated with each activity. Person-days of activity, by type of activity, were mapped in 1-minute by 1-minute cells for all the cells in the Sanctuary. Private household boat use data were obtained from multiple sources explained below.

10.2.7. Charter/Party Boat or Guide Service – For Hire Operations

A total of 51 operators of charter/party boat or guide services were identified as having operated in the Sanctuary in 1999. Operators often engaged in providing multiple activities, sometimes both consumptive and non-consumptive activities. Therefore, the addition of the number of operators across activities will add to more than 51. Person-days of activities, revenues, costs and profits are not double counted across activities.

NOAA provided nautical charts with the 1-minute by 1-minute cell grid overlaid to the Kolstad team. Person-days of activity, by type of activity, were mapped for each operation and entered into spreadsheets and a Geographical Information System (GIS) database. The GIS database allowed various alternatives to be compared on in a spatial and graphical format. Person-days of activity, by type of activity, were then summed across operations. Since a census of operations was achieved, the sum of the sample represents the population estimate. Information on the recreational fishing industry by type of activity is found in Chapter 3.

10.2.8. Economic Impact and Valuation Model for Recreational Fishing Operation

The model used person-days of activity for each of the consumptive and non-consumptive recreation activities for 1999. The person-days were mapped in 1-by-1 minute grid cells for the area within the Sanctuary. The mapped data were included in the GIS database.

10.2.9. Expenditure Profiles

The next step in the economic impact model was the development of expenditure profiles for each recreation activity. The Panel reviewed the literature and most of the studies found were related to fishing in southern California with one study for all of California party boat fishing (NMFS 1980; Wegge et al. 1983; Rowe et al. 1985; Hanemann et al. 1991; and Thompson and Crooke 1991).

The Panel supplemented this information with a visitor's study for Santa Barbara County (Santa Barbara County Conference and Visitors Bureau and Film Commission 1999) for lodging and food and beverage expenditures, and a study on diving in Northwest, Florida for some dive related costs (Bell et al. 1998). Also, from the charter/party operations the Panel derived the boat fee per person-day. From all this information the Panel constructed expenditure profiles. Because the Panel relied on mostly regional studies, the expenditure profiles do not differ by county, except the charter/party boat fees.

Later, the Socioeconomic Panel received a recently released study by NOAA's National Marine Fisheries Service entitled "Marine Angler Expenditures in the Pacific Coast Region, 2000" (Gentner et al. 2001). This study provided updated spending profiles for charter/party boat fishing and private household/rental boat fishing in Southern California. The new expenditure profiles were incorporated into the analysis. The new estimates are lower than those previously used in analyses by Leeworthy and Wiley (2001) for the MRWG. The derivation of the spending profiles is provided in Leeworthy and Wiley 2002 and Leeworthy and Wiley 2003.

The next step for calculating potential economic impact was to multiply the person-days of activity by the expenditures per person-day to get total direct sales impact. These direct sales estimates by expenditure category were mapped into the appropriate standard industry categories in the 1997 Economic Census of Business for each county. Direct sales estimates were translated into direct wages and salaries impact by multiplying the direct sales estimate by the appropriate wages-to-sales ratio specific to each category in each county. Estimated direct wages and salaries were divided by the wages-to-employment ratios specific to each category in each county to get an estimate of the direct number of full and part-time employees directly supported.

Direct wages and salaries were translated into total direct income by multiplying direct wages and salaries by the ratio of total income to wages and salaries income specific to each county. This adjustment accounts for proprietor's income. The ratio of proprietor's income to proprietor's employment was used to derive proprietor's employment (this doesn't make sense-check) , which was added to wages and salaries employment to get total direct employment supported.

The final step was to calculate the multiplier impacts. Because the Panel did not have estimates of the proportion of local residents to nonresidents in each activity in each county, they used a range of 2.0 to 2.5 for income multipliers and 1.5 to 2.0 for employment multipliers. These ranges of multipliers are consistent for economies in the impact area. Direct income and direct employment applied to the multipliers yields estimates of the total income impacts. Only direct impacts are counted for residents, but much of these impacts are double counted because they represent part of the multiplier impacts of other basic or export industries. Leeworthy and Wiley 2002 and Leeworthy and Wiley 2003 use the import substitution argument to justify including direct impacts of residents. The net effect is to overstate the impacts of recreational consumptive users.

When the Panel reports only one estimate for annual income or employment, it is the upper range estimate, which was used to develop a maximum potential loss estimate in Step 1 analyses of marine reserve alternatives.

10.2.10. Consumer's Surplus

The Panel also conducted a review of literature for studies that estimated the consumer's surplus values for the various recreational uses in the Sanctuary. Five studies were obtained for California or southern California: however, only two of these provided enough information on values that could be used (both were for fishing). The average value for all studies was $11.58 per person-day (Leeworthy and Wiley 2002). However, after receiving the review comments from the Pacific Fishery Management Council, Science and Statistical Committee, one study was dropped (Rowe et al 1985) and all values were converted to 1999 dollars. The resulting estimate increased to $34.75 per person-day. The Panel used this value as a rough approximation for all consumptive and non-consumptive recreation activities. There is no differentiation between consumptive and non-consumptive recreation activities for this measurement. In Appendix I (table I.1) of Leeworthy and Wiley (2003) a comparison of consumptive and nonconsumptive recreation consumer's surplus numbers is presented from Rosenberger and Loomis (2001). There was no significant difference between fishing and wildlife viewing. Non-motorized boating did have significantly higher values.

10.2.11. Thresholds Of Significance - Socioeconomic Impacts

A threshold is a quantitative or qualitative standard or set of criteria for a particular resource. This standard is used to compare the environmental setting of the resource or consumptive use with or without the project impact to determine whether the impact is significant.

Determining the character of economic and social impact is predicated on the scale used in analysis. One way to look at significance is to consider administrative definitions: for example, Presidential Executive Order 12866 defines a significant impact for Federal Regulations as, among other things, any impact on the economy of $100 million or more annually. When the impact of a Federal Regulation is expected to have impacts of $100 million or more, then the requirement is that the Federal agency proposing the regulation must conduct a benefit-cost analysis of the regulation.

Another way to examine impact is to view the impact with respect to the total economy of the region. As the Socioeconomic Panel showed, if marine reserve and marine conservation areas were to result in the elimination of 100 percent of the current uses in the Sanctuary, then a full benefit-cost analysis would be required (Leeworthy and Wiley 2002). However, none of the alternatives being proposed for marine protected areas would reach the $100 million level of impact. Although the Panel estimated a baseline impact of $172 million to annual personal income, this is less than four one-hundredths of one percent (a small fraction of one percent) of the entire seven-county area (Leeworthy and Wiley 2002 and Leeworthy and Wiley 2003). If all the activities in the Sanctuary were prohibited, it would not have a significant impact on the total economy of the seven-county region. Here the use of significant impact is limited to the relationship between the activities in the entire economy of the region. The highest impact is in Ventura County, which depends on about eight-tenths of one percent of its employment from activities in the Sanctuary.

The Socioeconomic Panel noted that they were not able to conclude that there would or would not be significant impacts on certain individuals or groups. The Panel had no basis for judging significance at the personal scale and context. The Socioeconomic Panel did conclude that there would be no significant macroeconomic or fiscal impacts from marine reserve and marine conservation areas in the Sanctuary (Leeworthy and Wiley 2002 and Leeworthy and Wiley 2003). Judgments of significance of individual or group impacts are normative or value judgments that are best left to a representative political body, not the purview of social scientists. Social scientists can only measure impacts on individuals and groups; it is not part of social science to make value judgments as to significance of the impacts.

10.3. Potential Economic Impacts

NOTE TO REVIEWER
Because this is the Step 1 analysis and does not take account for potential mitigating circumstances, what is presented simply adds the data available in each 1x1 cell and calculates the potential impact to commercial and recreational consumptive and non-consumptive users. The next level of analysis (Step 2) will factor in recent regulatory actions including fisheries closures (i.e., Rockfish Conservation Area and prawn trawling). One anticipated analytical challenge is the lack of finely scaled (1x1 minute resolution) data for certain fishing gear types in the Sanctuary.

Following are summary tables the detail potential impacts to commercial and recreational consumptive activities for each alternative broken down by additional state and federal water marine reserve and marine conservation areas and the total cumulative impacts (including the existing State MPAs). Commercial fishery impacts tables detail potential impacts by county, ex-vessel value by port and species group, and total employment impacts by county. Recreational fishing impacts are measured in person-days, income and employment and by industry (charter boat fishing and diving and private boat fishing and diving). Table E-4 below shows potential impacts for all consumptive activities for each alternative.

Table E-4: Potential Impacts For All Consumptive Activities For Each Alternative

Aggregate Consumptive Activities: Summary of Impacts by Alternative - Step 1 Analysis

	Additional State		Federal		Total: New Proposed		Existing State		Cumulative Total	
Alternative	Amount	% [1]	Amount	%	Amount	%	Amount	%	Amount	%
					Income [2]					
1	$1,332,904	1.2%	$1,016,243	0.9%	$2,349,148	2.2%	$12,565,222	11.7%	$14,914,370	13.9%
2	$786,534	0.7%	$1,637,213	1.5%	$2,423,747	2.3%	$12,565,222	11.7%	$14,988,969	13.9%
3	$934,206	0.9%	$2,318,697	2.2%	$3,252,903	3.0%	$12,565,222	11.7%	$15,818,125	14.7%
					Employment [3]					
1	37	1.2%	27	0.9%	64	2.2%	360	12.2%	425	14.3%
2	22	0.7%	45	1.5%	67	2.3%	360	12.2%	427	14.4%
3	27	0.9%	64	2.1%	90	3.0%	360	12.2%	451	15.2%

1. Percents are the percent of total baseline amounts from the aggregate data.
2. Total income, including multiplier impacts, is equal to $107,600,471 (Baseline Study Area Total).
3. Total employment, including multiplier impacts, is equal to 2,961 jobs (Baseline Study Area Total).

Additional analysis on impacts to recreational consumptive activities for the existing State marine reserve and marine conservation areas is provided in Appendix E.

10.3.1. Step 1 Analysis - Impacts to Commercial Fishing, Alternative 1

The establishment of marine reserve and marine conservation areas would eliminate all commercial fishing activities within marine reserves, unless they are conducted as part of an approved scientific research program, and most commercial fishing activities within marine conservation areas.

10.3.1.1. Step 1 Analysis

Alternative 1 would potentially impact $493,167 in annual ex-vessel revenue or 1.75 percent of ex-vessel revenue within the deeper waters of the Sanctuary (Table E-5). The cumulative impacts might result in a maximum potential impact of approximately $3.6 million in annual ex-vessel revenue, or 12.86 percent of all ex-vessel revenue in the Sanctuary. All of the potential impact on harvest of kelp and catch of urchins, spiny lobsters, crab, California sheephead, and sea cucumbers are in the State waters portion of the Sanctuary. Most of the potential impact on tuna and wetfish, and about half the potential prawn impact, are in the deeper waters of the Sanctuary.

The socioeconomic analysis is constrained to potential economic impacts. As a percent of total Sanctuary catch, the highest maximum potential impacts to fisheries in the additional state water and federal water reserves are to squid and prawn. Cumulative impacts are highest for squid and urchin at approximately $1.7 million and $879,761 respectively.

Table E-5: Commercial Fishing - Summary of Impacts on Ex Vessel Value By Species Group

Commercial Fishing: Summary of Impacts of Alternatives on Ex Vessel Value by Species Group

	Alt. 1									
	Additional State		Federal		Total: New Prop.		Existing State		Total: Cumulative	
Species Group	Value	%	Value	%	Value	%	Value	%	Value	%
Squid	$ 132,343	1.01	$ 12,807	0.10	$ 145,150	1.11	$ 1,596,682	12.24	$ 1,741,831	13.35
Kelp	$ 70,010	1.17	$ -	0.00	$ 70,010	1.17	$ 328,568	5.48	$ 398,578	6.65
Urchins	$ 82,574	1.57	$ 2,687	0.05	$ 85,261	1.62	$ 794,500	15.09	$ 879,761	16.71
Spiny Lobster	$ 12,150	1.32	$ -	0.00	$ 12,150	1.32	$ 143,343	15.55	$ 155,493	16.86
Prawn	$ 65,642	9.33	$ 60,384	8.59	$ 126,026	17.92	$ 21,436	3.05	$ 147,462	20.97
Rockfish	$ 4,204	0.77	$ 8,458	1.54	$ 12,662	2.31	$ 66,740	12.15	$ 79,402	14.45
Crab	$ 2,890	0.84	$ -	0.00	$ 2,890	0.84	$ 48,675	14.17	$ 51,565	15.01
Tuna	$ 3,384	1.11	$ 10,910	3.57	$ 14,294	4.68	$ 4,546	1.49	$ 18,840	6.16
Wetfish	$ 6,437	2.14	$ 6,186	2.05	$ 12,623	4.19	$ 22,074	7.32	$ 34,697	11.51
CA Sheepshead	$ 296	0.13	$ -	0.00	$ 296	0.13	$ 38,326	16.24	$ 38,622	16.37
Flatfishes	$ 2,625	1.43	$ 2,325	1.26	$ 4,950	2.69	$ 20,027	10.89	$ 24,977	13.58
Sea Cucumbers	$ 1,740	1.04	$ -	0.00	$ 1,740	1.04	$ 26,512	15.81	$ 28,252	16.85
Sculpin & Bass	$ 1,534	2.54	$ 2,487	4.12	$ 4,021	6.67	$ 5,331	8.84	$ 9,352	15.50
Shark	$ 536	1.54	$ 558	1.61	$ 1,094	3.15	$ 4,456	12.82	$ 5,550	15.97
Total	$ 386,366	1.37	$ 106,802	0.38	$ 493,167	1.75	$ 3,121,215	11.10	$ 3,614,382	12.86

1. Percents are the amount of each species/species groups ex vessel value impacted by an alternative divided by the Study Area Total for the species/species group.

Step 1 Analysis - Impacts to Recreational Consumptive Uses, Alternative 1

Table E-6 below shows the aggregate maximum potential loss to annual income for all recreational consumptive activities in alternative 1 is approximately $1.03 million dollars or 4.2 percent of the $24.7 million in annual income generated by recreational consumptive activities in the project area. The cumulative impact when including the existing state marine reserve and marine conservation areas is potentially $3.99 million or 16.2 percent, of the $24.7 million in annual income.

Table E-6: Recreational Consumptive Activities – Step 1 Analysis

Summary: Recreation Consumptive Activities - Alternative 1 - Step 1 Analysis

	Additional State		Federal		Total: New Proposed		Existing State		Cumulative Total	
Person-days	4,435	1.0%	11,561	2.6%	15,996	3.7%	58,451	13.3%	74,447	17.0%
Market Impact										
Direct Sales	$ 386,497	1.1%	$ 1,022,292	2.9%	$ 1,408,788	4.0%	$4,383,967	12.5%	$ 5,792,755	16.5%
Direct Wages and Salaries	$ 161,661	1.1%	$ 429,498	3.0%	$ 591,159	4.2%	$1,690,233	12.0%	$ 2,281,391	16.2%
Direct Employment	5	1.1%	13	3.0%	18	4.1%	53	12.3%	71	16.4%
Total Income										
Upper Bound	$ 282,906	1.1%	$ 751,622	3.0%	$ 1,034,528	4.2%	$2,957,907	12.0%	$ 3,992,435	16.2%
Lower Bound	$ 242,491	1.1%	$ 644,247	3.0%	$ 886,738	4.2%	$2,535,349	12.0%	$ 3,422,087	16.2%
Total Employment										
Upper Bound	7	1.1%	19	3.0%	27	4.1%	80	12.3%	107	16.4%
Lower Bound	6	1.1%	16	3.0%	22	4.1%	67	12.3%	89	16.3%
Non-Market Impact										
Consumer's Surplus	157,109	1.0%	409,854	2.7%	$ 566,963	3.7%	$2,056,480	13.3%	$ 2,623,443	17.0%
Profit[1]	5,244	1.2%	14,045	3.3%	$ 19,289	4.6%	$45,943	10.9%	$ 65,232	15.5%

1. Profit is used as a proxy for producer's surplus.

10.3.2. Step 1 Analysis - Impacts to Commercial Fishing, Alternative 2

10.3.2.1. Step 1 Analysis

Alternative 2 would potentially impact $353,089 in annual ex-vessel revenue or 1.26 percent of ex-vessel revenue within the deeper waters of the Sanctuary (Table E-7). The cumulative impacts might result in a maximum potential impact of approximately $3.5 million in annual ex-vessel revenue, or 12.36 percent of all ex-vessel revenue in the Sanctuary. All of the potential impact on harvest of kelp and catch of urchins, spiny lobsters, crab, California sheephead, and sea cucumbers are in the State waters portion of the Sanctuary. Most of the potential impact on tuna and wetfish, and about half the potential prawn impact, are in the deeper waters of the Sanctuary.

The socioeconomic analysis is constrained to potential economic impacts. As a percent of total Sanctuary catch, the highest maximum potential impacts to fisheries in the additional state water and federal water reserves are to squid and prawn. Cumulative impacts are highest for squid and urchin at approximately $1.7 million and $799,874 respectively.

Table E-7: Commercial Fishing – Summary of Impacts of Alternatives on Ex Vessel Value By Species Group

Commercial Fishing: Summary of Impacts of Alternatives on Ex Vessel Value by Species Group

	Alt. 2									
	Additional State		Federal		Total: New Prop.		Existing State		Total: Cumulative	
Species Group	Value	%	Value	%	Value	%	Value	%	Value	%
Squid	$ 25,614	0.20	$ 51,230	0.39	$ 76,843	0.59	$ 1,596,682	12.24	$ 1,673,525	12.83
Kelp	$ -	0.00	$ -	0.00	$ -	0.00	$ 328,568	5.48	$ 328,568	5.48
Urchins	$ -	0.00	$ 5,374	0.10	$ 5,374	0.10	$ 794,500	15.09	$ 799,874	15.19
Spiny Lobster	$ 1,266	0.14	$ -	0.00	$ 1,266	0.14	$ 143,343	15.55	$ 144,609	15.68
Prawn	$ 65,642	9.33	$ 65,991	9.38	$ 131,633	18.72	$ 21,436	3.05	$ 153,069	21.77
Rockfish	$ 23,347	4.25	$ 29,653	5.40	$ 53,000	9.65	$ 66,740	12.15	$ 119,740	21.80
Crab	$ 38	0.01	$ -	0.00	$ 38	0.01	$ 48,675	14.17	$ 48,713	14.18
Tuna	$ 3,872	1.27	$ 31,991	10.47	$ 35,863	11.73	$ 4,546	1.49	$ 40,409	13.22
Wetfish	$ 6,103	2.02	$ 33,162	11.00	$ 39,265	13.02	$ 22,074	7.32	$ 61,339	20.35
CA Sheepshead	$ 296	0.13	$ -	0.00	$ 296	0.13	$ 38,326	16.24	$ 38,622	16.37
Flatfishes	$ 975	0.53	$ 3,075	1.67	$ 4,050	2.20	$ 20,027	10.89	$ 24,077	13.09
Sea Cucumbers	$ -	0.00	$ -	0.00	$ -	0.00	$ 26,512	15.81	$ 26,512	15.81
Sculpin & Bass	$ 1,221	2.02	$ 3,267	5.42	$ 4,488	7.44	$ 5,331	8.84	$ 9,819	16.28
Shark	$ 234	0.67	$ 738	2.12	$ 972	2.80	$ 4,456	12.82	$ 5,428	15.62
Total	$ 128,608	0.46	$ 224,480	0.80	$ 353,089	1.26	$ 3,121,215	11.10	$ 3,474,304	12.36

1. Percents are the amount of each species/species groups ex vessel value impacted by an alternative divided by the Study Area Total for the species/species group.

10.3.3. Step 1 Analysis - Impacts to Recreational Consumptive Uses, Alternative 2

Table E-8 shows the aggregate maximum potential loss to annual income for all recreational consumptive activities in alternative 2 is approximately $1.4 million dollars, or 5.9 percent, of the of the $24.7 million in annual income generated by recreational consumptive activities in the project area. The cumulative impact when including the existing state marine reserve and marine conservation areas is potentially $4.4 million or 17.8 percent, of the $24.7 million in annual income.

Table E-8: Recreational Consumptive Activities – Alternative 2 – Step 1 Analysis

Summary: Recreation Consumptive Activities - Alternative 2 - Step 1 Analysis

	Additional State		Federal		Total: New Proposed		Existing State		Cumulative Total	
Person-days	7,391	1.7%	14,572	3.3%	21,963	5.0%	58,451	13.3%	80,414	18.4%
Market Impact										
Direct Sales	$ 644,484	1.8%	$ 1,321,253	3.8%	$1,965,737	5.6%	$4,383,967	12.5%	$ 6,349,704	18.1%
Direct Wages and Salaries	$ 269,134	1.9%	$ 557,151	3.9%	$ 826,285	5.9%	$1,690,233	12.0%	$ 2,516,517	17.8%
Direct Employment	8	1.9%	17	3.8%	25	5.7%	53	12.3%	78	18.0%
Total Income										
Upper Bound	$ 470,985	1.9%	$ 975,014	3.9%	$1,445,998	5.9%	$2,957,907	12.0%	$ 4,403,905	17.8%
Lower Bound	$ 403,701	1.9%	$ 835,726	3.9%	$1,239,427	5.9%	$2,535,349	12.0%	$ 3,774,776	17.8%
Total Employment										
Upper Bound	12	1.9%	25	3.8%	37	5.7%	80	12.3%	118	18.0%
Lower Bound	10	1.9%	21	3.8%	31	5.7%	67	12.3%	98	18.0%
Non-Market Impact										
Consumer's Surplus	261,788	1.7%	516,971	3.3%	$ 778,759	5.0%	$2,056,480	13.3%	$ 2,835,240	18.3%
Profit[1]	8,680	2.1%	18,497	4.4%	$ 27,177	6.5%	$45,943	10.9%	$ 73,120	17.4%

1. Profit is used as a proxy for producer's surplus.

10.3.4. Step 1 Analysis - Impacts to Commercial Fishing, Alternative 3

10.3.4.1. Step 1 Analysis

Alternative 3 would potentially impact $542,191 in annual ex-vessel revenue or 1.93 percent of ex-vessel revenue within the deeper waters of the Sanctuary (Table E-9). The cumulative impacts might result in a maximum potential impact of approximately $3.7 million in annual ex-vessel revenue, or 13 percent of all ex-vessel revenue in the Sanctuary. All of the potential impact on harvest of kelp and catch of urchins, spiny lobsters, crab, California sheephead, and sea cucumbers are in the State waters portion of the Sanctuary. Most of the potential impact on tuna and wetfish, and over half the potential prawn impact, are in the deeper waters of the Sanctuary.

The socioeconomic analysis is constrained to potential economic impacts. As a percent of total Sanctuary catch, the highest maximum potential impacts to fisheries in the additional state water and federal water reserves are to squid and prawn. Cumulative impacts are highest for squid and urchin at approximately $1.8 million and $797,187 respectively.

Table E-9: Commercial Fishing – Summary of Impacts of alternatives on Ex Vessel Value By Species Group

Commercial Fishing: Summary of Impacts of Alternatives on Ex Vessel Value by Species Group

	Alt. 3									
	Additional State		Federal		Total: New Prop.		Existing State		Total: Cumulative	
Species Group	Value	%	Value	%	Value	%	Value	%	Value	%
Squid	$ 81,112	0.62	$ 85,381	0.65	$ 166,493	1.28	$ 1,596,682	12.24	$ 1,763,175	13.51
Kelp	$ -	0.00	$ -	0.00	$ -	0.00	$ 328,568	5.48	$ 328,568	5.48
Urchins	$ -	0.00	$ 2,687	0.05	$ 2,687	0.05	$ 794,500	15.09	$ 797,187	15.14
Spiny Lobster	$ 2,532	0.27	$ -	0.00	$ 2,532	0.27	$ 143,343	15.55	$ 145,875	15.82
Prawn	$ 65,642	9.33	$ 169,337	24.08	$ 234,979	33.42	$ 21,436	3.05	$ 256,415	36.46
Rockfish	$ 16,966	3.09	$ 27,501	5.01	$ 44,467	8.09	$ 66,740	12.15	$ 111,207	20.24
Crab	$ 3,329	0.97	$ -	0.00	$ 3,329	0.97	$ 48,675	14.17	$ 52,004	15.14
Tuna	$ 4,188	1.37	$ 30,686	10.04	$ 34,874	11.41	$ 4,546	1.49	$ 39,420	12.90
Wetfish	$ 6,771	2.25	$ 31,082	10.31	$ 37,853	12.56	$ 22,074	7.32	$ 59,927	19.88
CA Sheepshead	$ 296	0.13	$ -	0.00	$ 296	0.13	$ 38,326	16.24	$ 38,622	16.37
Flatfishes	$ 1,941	1.06	$ 4,800	2.61	$ 6,741	3.67	$ 20,027	10.89	$ 26,768	14.56
Sea Cucumbers	$ -	0.00	$ -	0.00	$ -	0.00	$ 26,512	15.81	$ 26,512	15.81
Sculpin & Bass	$ 1,493	2.47	$ 5,061	8.39	$ 6,554	10.86	$ 5,331	8.84	$ 11,885	19.70
Shark	$ 234	0.67	$ 1,152	3.32	$ 1,386	3.99	$ 4,456	12.82	$ 5,842	16.81
Total	$ 184,505	0.66	$ 357,687	1.27	$ 542,191	1.93	$ 3,121,215	11.10	$ 3,663,407	13.03

1. Percents are the amount of each species/species groups ex vessel value impacted by an alternative divided by the Study Area Total for the species/species group.

10.3.5. Step 1 Analysis - Impacts to Recreational Consumptive Uses, Alternative 3

Table E-10 shows the aggregate maximum potential loss to annual income for all recreational consumptive activities in alternative 3 is approximately $1.7 million dollars or 6.9 percent, of the of the $24.7 million in annual income generated by recreational consumptive activities in the project area. The cumulative impact when including the existing state marine reserve and marine conservation areas is potentially $4.7 million or 18.9 percent, of the $24.7 million in annual income.

Table E-10: Recreational Consumptive Uses – Alternative 3 – Step 1 Analysis

Summary: Recreation Consumptive Activities - Alternative 3 - Step 1 Analysis

	Additional State		Federal		Total: New Proposed		Existing State		Cumulative Total	
Person-days	5,925	1.4%	19,201	4.4%	25,127	5.7%	58,451	13.3%	83,578	19.1%
Market Impact										
Direct Sales	$ 517,009	1.5%	$ 1,777,051	5.1%	$2,294,061	6.5%	$4,383,967	12.5%	$ 6,678,028	19.0%
Direct Wages and Salaries	$ 216,232	1.5%	$ 755,134	5.4%	$ 971,367	6.9%	$1,690,233	12.0%	$ 2,661,599	18.9%
Direct Employment	7	1.5%	23	5.2%	29	6.7%	53	12.3%	83	19.0%
Total Income										
Upper Bound	$ 378,407	1.5%	$ 1,321,485	5.4%	$1,699,891	6.9%	$2,957,907	12.0%	$ 4,657,799	18.9%
Lower Bound	$ 324,349	1.5%	$ 1,132,701	5.4%	$1,457,050	6.9%	$2,535,349	12.0%	$ 3,992,399	18.9%
Total Employment										
Upper Bound	10	1.5%	34	5.2%	44	6.7%	80	12.3%	124	19.0%
Lower Bound	8	1.5%	28	5.2%	37	6.7%	67	12.3%	103	19.0%
Non-Market Impact										
Consumer's Surplus	209,903	1.4%	681,813	4.4%	$ 891,716	5.8%	$2,056,480	13.3%	$ 2,948,196	19.1%
Profit[1]	7,015	1.7%	25,371	6.0%	$ 32,386	7.7%	$45,943	10.9%	$ 78,329	18.6%

1. Profit is used as a proxy for producer's surplus.

10.3.6. Step 2 Analysis

Step 2 Analysis is a discussion of the results of the Step 1 analysis and the factoring in of changing conditions and possible mitigating and offsetting factors over short and long time frames.

10.3.6.1. Step 2 Analyses of Commercial Fisheries and Kelp

To be included.

10.3.6.2. Step 2 Analysis of Recreation Consumptive Activities

To be included.

10.3.6.3. Step 2 Analysis of Recreation Non-Consumptive Users

The establishment of marine reserve systems is expected to result in benefits to non-consumptive recreational users. These increased benefits take the form of increases in diversity of wildlife, viewing opportunities from increased abundance of fish and invertebrates, water quality, etc. Benefits may also be derived from the decrease in the density of users or in the reduction in conflicts with consumptive users. There is no data currently available to directly estimate the magnitude of these benefits. In light of this fact a simulation is conducted for each alternative using a range of increases in quality and of quality elasticities. Quality elasticities show the percentage change in consumer's surplus for a percentage change in quality. In a paper by Freeman (1995), 13 studies were summarized on marine recreation, which contained enough information to calculate quality elasticities. Catch rate was the quality variable in all the studies in Freeman (1995). In a paper by Bockstael et al. (1989) there was enough information to calculate quality elasticities for swimming, boating and fishing in Chesapeake Bay. These quality elasticities are in Appendix I of Leeworthy and Wiley (2003). Using the range of quality elasticities and the assumption of a 10%, 50% and 100% increase in quality, benefit estimates were calculated for each alternative. To avoid skewed results from outliers, the highest and lowest elasticities were dropped from this range (Leeworthy and Wiley 2003).

The summary tables below show the extent of activity, measured in person days, aggregated for all non-consumptive uses for each alternative, and the associated income and employment generated by this activity.

Table E-11: Economic Impact Associated with Non-consumptive Activities – Alternative 1 – Summary

Economic Impact Associated with Non-consumptive Activities - Alternative 1 - Summary

	Additional State		Federal		Total: New Proposed		Existing State		Cumulative Total	
Person-days	209	0.5%	556	1.3%	765	1.8%	6,670	15.9%	7,435	17.7%
Market Impact										
Direct Sales	$ 34,413	0.5%	$ 95,237	1.3%	$ 129,650	1.8%	$1,145,310	16.1%	$ 1,274,960	18.0%
Direct Wages and Salaries	$ 16,763	0.5%	$ 46,229	1.3%	$ 62,992	1.8%	$555,828	16.2%	$ 618,821	18.0%
Direct Employment	1	0.5%	2	1.3%	2	1.7%	19	15.8%	21	17.5%
Total Income										
Upper Bound	$ 29,335	0.5%	$ 80,901	1.3%	$ 110,237	1.8%	$972,700	16.2%	$ 1,082,936	18.0%
Lower Bound	$ 25,144	0.5%	$ 69,344	1.3%	$ 94,488	1.8%	$833,743	16.2%	$ 928,231	18.0%
Total Employment										
Upper Bound	1	0.5%	2	1.3%	3	1.8%	28	15.8%	31	17.6%
Lower Bound	1	0.5%	2	1.3%	3	1.8%	23	15.9%	26	17.7%
Non-Market Impact										
Consumer's Surplus	7,532	0.5%	20,070	1.3%	$ 27,602	1.8%	$240,761	15.9%	$ 268,363	17.7%
Profit[1]	856	0.4%	2,372	1.1%	$ 3,227	1.4%	$30,645	13.7%	$ 33,873	15.1%

1. Profit is used as a proxy for producer's surplus.

Table E-12: Economic Impact Associated with Non-consumptive Activities – Alternative 2 – Summary

Economic Impact Associated with Non-consumptive Activities - Alternative 2 - Summary

	Additional State		Federal		Total: New Proposed		Existing State		Cumulative Total	
Person-days	427	1.0%	603	1.4%	1,030	2.5%	6,670	15.9%	7,700	18.3%
Market Impact										
Direct Sales	$ 70,551	1.0%	$ 103,308	1.5%	$ 173,858	2.4%	$1,145,310	16.1%	$ 1,319,169	18.6%
Direct Wages and Salaries	$ 34,153	1.0%	$ 50,209	1.5%	$ 84,362	2.5%	$555,828	16.2%	$ 640,190	18.6%
Direct Employment	1	1.0%	2	1.4%	3	2.4%	19	15.8%	22	18.1%
Total Income										
Upper Bound	$ 59,767	1.0%	$ 87,866	1.5%	$ 147,633	2.5%	$972,700	16.2%	$ 1,120,333	18.6%
Lower Bound	$ 51,229	1.0%	$ 75,314	1.5%	$ 126,543	2.5%	$833,743	16.2%	$ 960,285	18.6%
Total Employment										
Upper Bound	2	1.0%	2	1.4%	4	2.4%	28	15.8%	32	18.2%
Lower Bound	1	1.0%	2	1.4%	4	2.4%	23	15.9%	27	18.3%
Non-Market Impact										
Consumer's Surplus	15,402	1.0%	21,778	1.4%	$ 37,181	2.5%	$240,761	15.9%	$ 277,942	18.3%
Profit[1]	1,690	0.8%	2,550	1.1%	$ 4,241	1.9%	$30,645	13.7%	$ 34,886	15.6%

1. Profit is used as a proxy for producer's surplus.

Table E-13: Economic Impact Associated with Non-consumptive Activities – Alternative 3 – Summary

Economic Impact Associated with Non-consumptive Activities - Alternative 3 - Summary

	Additional State		Federal		Total: New Proposed		Existing State		Cumulative Total	
Person-days	433	1.0%	1,818	4.3%	2,251	5.4%	6,670	15.9%	8,921	21.2%
Market Impact										
Direct Sales	$ 70,761	1.0%	$ 303,726	4.3%	$ 374,487	5.3%	$1,145,310	16.1%	$ 1,519,797	21.4%
Direct Wages and Salaries	$ 34,555	1.0%	$ 148,045	4.3%	$ 182,599	5.3%	$555,828	16.2%	$ 738,428	21.5%
Direct Employment	1	1.1%	5	4.3%	6	5.4%	19	15.8%	25	21.2%
Total Income										
Upper Bound	$ 60,471	1.0%	$ 259,078	4.3%	$ 319,549	5.3%	$972,700	16.2%	$ 1,292,249	21.5%
Lower Bound	$ 51,832	1.0%	$ 222,067	4.3%	$ 273,899	5.3%	$833,743	16.2%	$ 1,107,642	21.5%
Total Employment										
Upper Bound	2	1.1%	8	4.4%	10	5.4%	28	15.8%	38	21.2%
Lower Bound	2	1.1%	6	4.4%	8	5.4%	23	15.9%	32	21.3%
Non-Market Impact										
Consumer's Surplus	15,630	1.0%	65,602	4.3%	$ 81,232	5.4%	$240,761	15.9%	$ 321,993	21.2%
Profit[1]	2,519	1.1%	11,417	5.1%	$ 13,937	6.2%	$30,645	13.7%	$ 44,582	19.9%

1. Profit is used as a proxy for producer's surplus.

10.3.7. Evaluating Displacement and the Potential for Congestion

The following section is excerpted from the State's CEQA Document (2002).

It has been suggested that congestion of fishing effort and the resulting impacts on populations outside marine reserve and marine conservation areas may have negative environmental impacts. This possibility has not been documented in other areas where marine reserve and marine conservation areas have been established. Even so, the potential impacts of congestion outside marine reserve and marine conservation areas should be considered.

Fishing effort may become concentrated around reserves for several reasons. One concern is that establishment of reserves will displace and concentrate existing fishing effort into surrounding waters. Alternately, effort may be attracted to the edges of reserves in order to benefit from potential increases in catch or catch per unit effort. It is suggested that either of these types of congestion could lead to negative population and habitat impacts outside the reserve boundary.

The key question regarding congestion is whether the expected increase in export from reserves can compensate for the increased fishing pressure in non-reserve areas. If it does, fishery yields will show a net increase or remain the same despite the displaced effort. Moreover, populations of fished species may be more abundant outside the reserve boundary despite the concentration of fishing effort.

A simple calculation estimates how much fishing effort will increase from a closure of a given size. If R is the fraction of area in reserves, then fishing intensity outside the reserve will increase by a factor 1/(1-R) if there is no reduction in effort. For example, if 25% of the habitat is closed to fishing in reserves, the intensity of fishing outside would increase by 1/(1-.25) = 1.33. If the same number of users were fishing in the remaining 75% of the habitat, the fishing intensity would be 33% higher than before. In the short term, this displacement would increase mortality rates outside the reserve. If, however, reserves enhance populations beyond their boundary either through movement of adults or young, these increases can be offset or eliminated by reserve benefits. The increased production within the reserve boundary necessary to counter the increased fishing intensity outside is 1+ [1/(1-R)]. For the example above, this equals 2.33. This means that production inside the boundary of the reserve must increase by a factor of 2.33 to just balance the added losses outside the reserve. The comprehensive reviews of reserve impacts by Halpern (2002) and Palumbi (2002), suggest that production increases inside reserves are considerably larger. Solely using increases in biomass, which underestimates increases in total production, existing reserves worldwide show a four fold increase (a factor of 4.00) in average production. These empirical data suggest that enhanced production within reserves can more than compensate for the effects of congestion outside for reserve areas as high as 50%.

These conclusions are supported by empirical data outside existing reserves. There is increasing evidence that models accurately predict the direction of change in fisheries yields associated with marine reserves. As the number and biomass of individuals increase within reserves, many species will move out of reserves into fishing grounds, enhancing stocks in fished areas through spillover of adults and export of larvae. Biomass of five commercially important species doubled in fishing areas adjacent to the Soufriere Marine Management Areas off Saint Lucia within a few years after reserve establishment (Roberts et al. 2001). Scientists documented the movement of four species of sport fishes from the Merritt Island National Wildlife Refuge to adjacent fished areas (Stevens and Sulak 2002). The movement of these fishes from the refuge to adjacent areas has been identified as primary factor responsible for the increase in numbers of catches of world record fishes in the vicinity of Merritt Island. Since 1985, all new Florida records for black drum, and most records for red drum, have been won for fish caught adjacent to the Merritt Island refuge (Roberts et al. 2001). Four years after closed areas were established on the Georges Bank, scallop (Placopecten magellanicus) biomass increased 14-fold within the closed areas (Murawski et al. 2000). Satellite tracking shows that scallop fisheries are now concentrated near reserves, and total landings are 150% of 1994 levels. McClanahan and Kaunda-Arara (1996) found a 110% enhancement of catch per unit effort in fishing grounds close to the Mombasa Marine National Park in Kenya. Ratikin and Kramer (1996) found highest catches and catch per unit effort inside the Barbados Marine Reserve and catches increased outside the reserve along a gradient approaching the boundary from both the north and the south. Russ and Alcala (1996b) found a gradual increase in densities of fish outside Apo Island reserve in the Philippines.

Data from existing reserves show that, in spite of the increased effort around reserves, the abundance of targeted species is highest in reserves and declines in proportion to distance from reserves. If the concentrated fishing effort around reserves caused local declines, the abundance of targeted species would be high within and distant from reserves, but low at the edges of reserves. Numerous reserves have been studied worldwide and this pattern has not been detected (e.g., Roberts and Hawkins, 2000). Thus, the positive effects of reserves on abundance appear to counteract potential negative effects of displacement or concentration of boats around reserves. Displaced or concentrated fishing effort at the edges of reserves also could impact habitat quality around reserves. If concentrated fishing at the edges of reserves reduces habitat quality, one would expect a corresponding decrease in abundance and diversity of species adjacent to reserves. As indicated above, this trend is not observed at the edges of reserves, which consistently support higher abundance and diversity of fishes and invertebrates than other sites distant from reserves. No published data on existing marine reserve and marine conservation areas have shown negative environmental impacts. Therefore, the Sanctuary does not anticipate any project-related negative environmental impacts.

In addition, ongoing fisheries management processes may reduce the total effort in the project area. Examples include the Nearshore Fishery Management Plan (which suggests reducing overall effort), the Squid Fishery Management Plan (which suggests reducing overall fleet size from 236 permitted vessels and light boats to 52 vessels and 52 light boats), the spot prawn trap fishery (which is reducing total effort) need update on the groundfish fishery management plan, coastal pelagic FMP, highly migratory species FMP. These long-term management plans are combined with short-term harvest reductions in current regulations. These reductions include shortened fishing seasons (e.g., rockfish and lingcod closure from November - February, inclusive, in this region), reduced bag limits, and other restrictions. The net effect of reducing effort, while closing some areas to fishing, should limit the possibility for congestion outside or marine reserves and marine conservation areas.

10.3.8. Monitoring Displacement and Accounting for Potential Congestion

NOTE TO READER
The following section is in development and provides some examples of pre and post State marine reserve and marine conservation area establishment and evaluates one of the proposed preliminary alternatives.

The Sanctuary Aerial Monitoring and Spatial Analysis program is designed to monitor and analyze the physical and anthropogenic phenomena within the Sanctuary such as sanctuary users, commercial and recreational vessel traffic, effects of shore runoff, oil spill emergencies, and collect data on both marine mammals and the kelp forest using a GIS and aerial GPS collection strategy. Photography and video are used to record sightings. Position information can be downloaded instantly to register the location of objects in Sanctuary waters. The aerial monitoring program allows near-real time collection of data vital to management and resource protection. Data collected on flora and fauna are used to monitor kelp distribution, marine mammal populations and migration patterns, and general resource health within the Sanctuary. Surveys of vessel traffic and vessel type allow anthropogenic use patterns to be studied, e.g., displacement of fishing effort due to marine reserves and marine conservation areas. Data downloaded into the Sanctuary's GIS are used to analyze historical trends and detect correlations across data types.

Following are preliminary consumptive use statistics within the Sanctuary for the 9 month period April 2003 – December 2003 (from implementation of the State marine reserve and marine conservation areas network to the end of 2003). Note that these are draft statistics and have not as yet been through quality assurance and quality control. Final results may vary slightly from those described here.

The total number of consumptive use6 vessels counted in the period was 439 vessels. The total number of survey flights was 15 (3 of which were surveys of Anacapa and Santa Barbara Islands only). As a comparison, the raw vessel counts for consumptive use vessels for the 9 month period prior to implementation of the State marine reserve and marine conservation areas network was 433 vessels counted in 16 survey flights. Though the raw numbers pre and post implementation are very close, it should be noted this may be coincidental. Further data accumulation is necessary to verify if the raw numbers can be comparatively repeated over other survey periods.

The charts and tables on the following pages show monthly statistical information for vessel time/space distributions over the post implementation period. The data are shown as both raw numbers and normalized numbers. Data were normalized by dividing raw monthly numbers by number of flights per month.

Figures E-1 & E-2 show distribution of consumptive use vessels over the 9 month post implementation period. NEPA reserve alternative 1 has been used as an example set to show consumptive use vessel proximity to existing State marine reserve and marine conservation areas and proposed MPAs. The percentage of consumptive use vessels recorded within the current State reserves was 0.025%. No vessels were recorded within the proposed offshore waters. Figure E-3 displays all pre-implementation (July 1997 – March 2003) consumptive use distributions surveyed via SAMSAP.

[6] Consumptive use vessels are: commercial fishing vessels (urchin, lobster, trawlers, etc.), recreational "head" or party boats, and private sportfishing boats.

Figure E-1: Raw Vessel Count

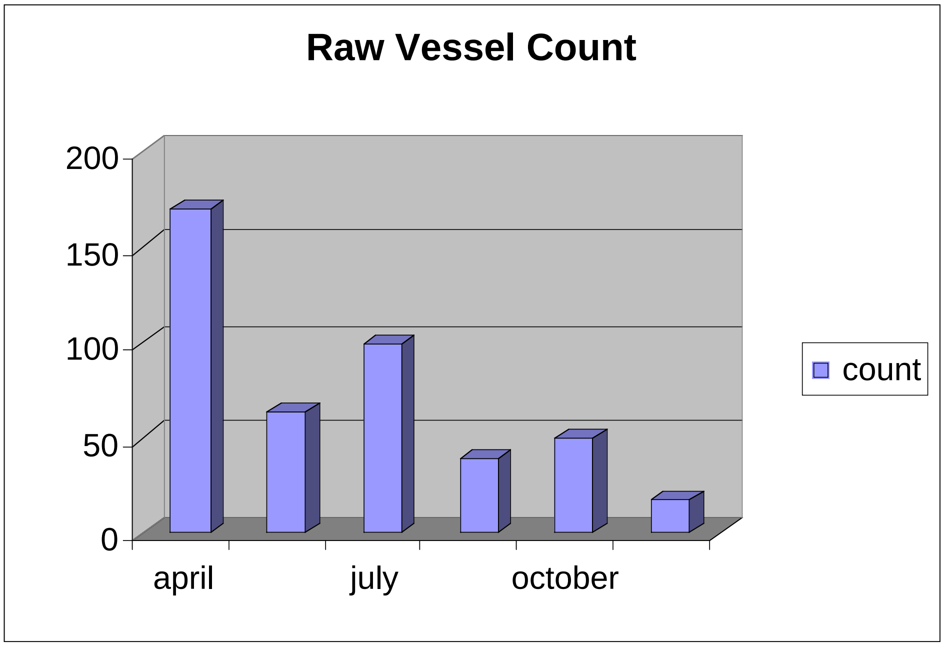


Figure E-2: Normalized Data

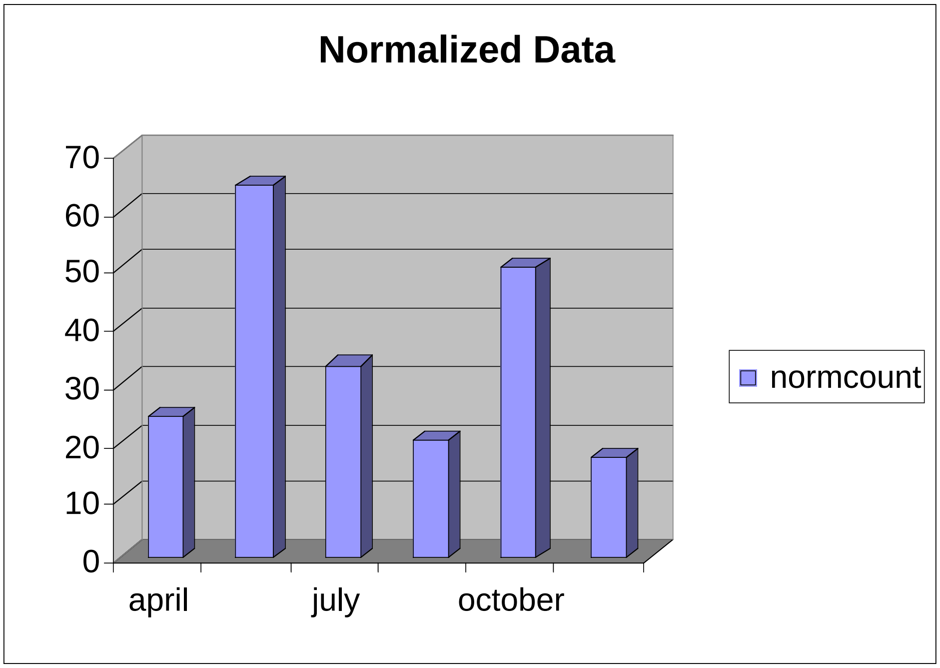


Figure E-3: Sanctuary Consumptive Vessel Use Pre Reserve Implementation

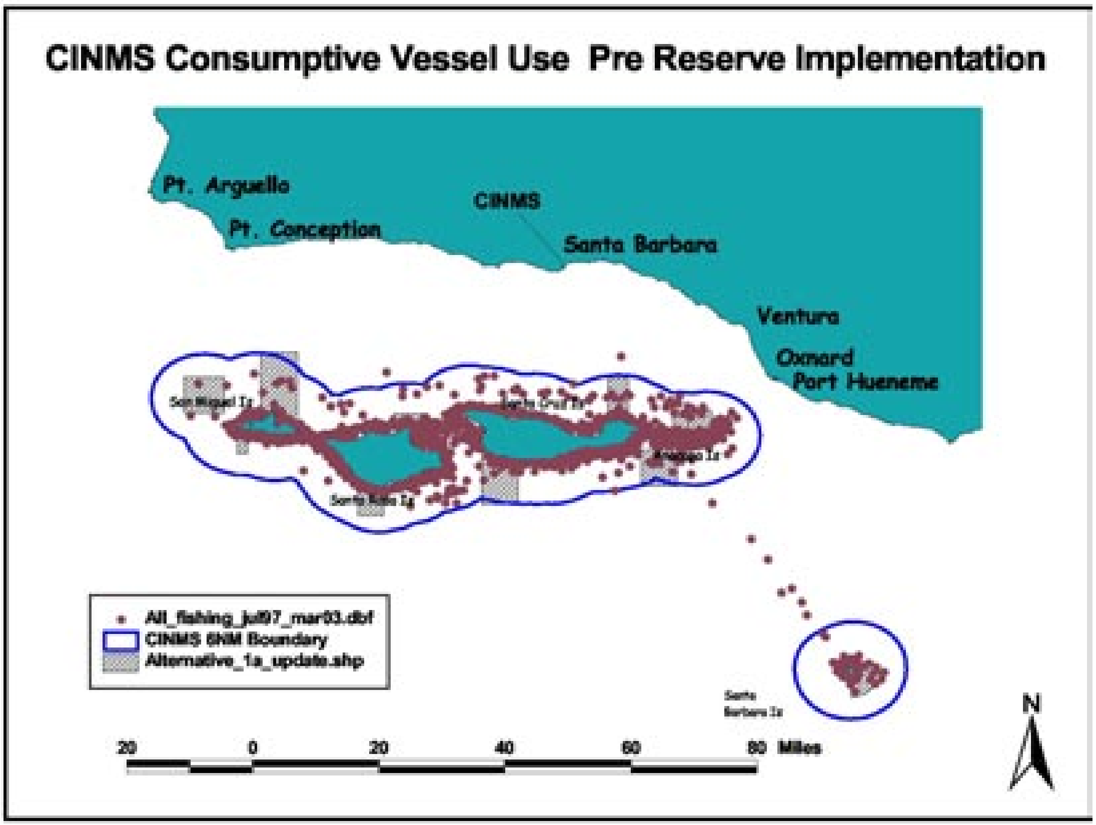


Figure E-4: Eastern Sanctuary Consumptive Vessel Use Post Reserve Implementation

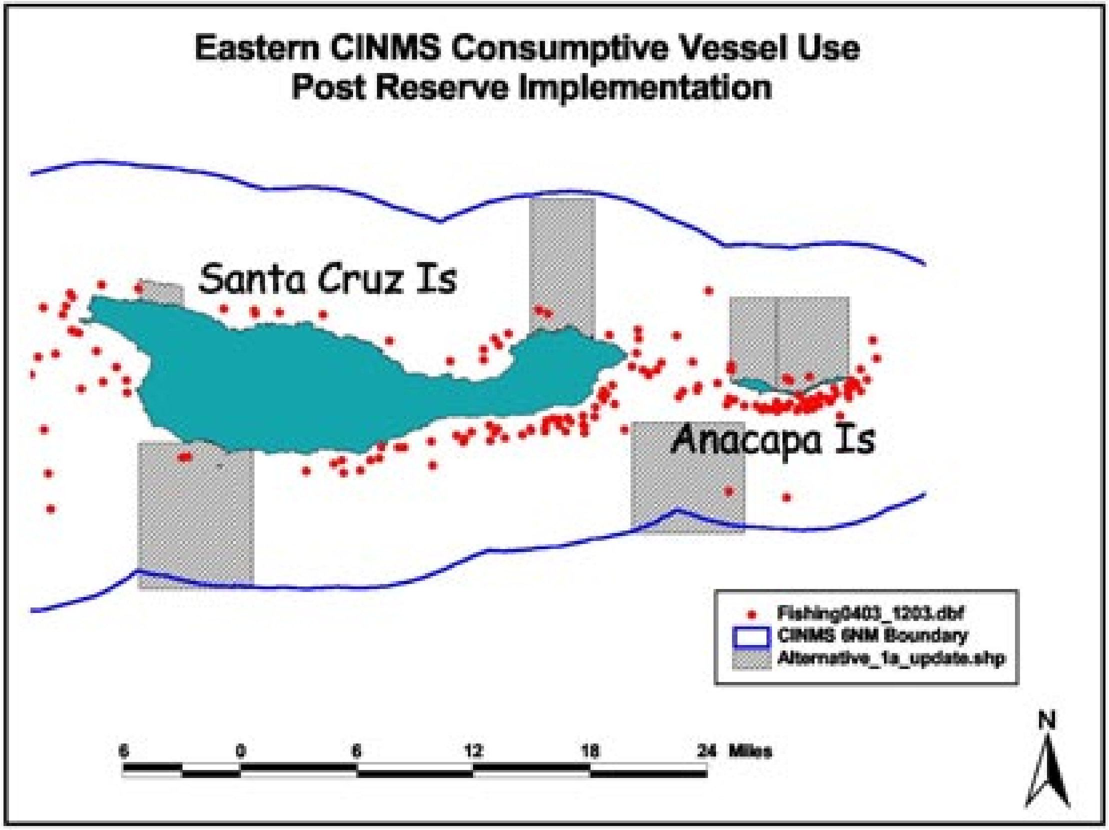
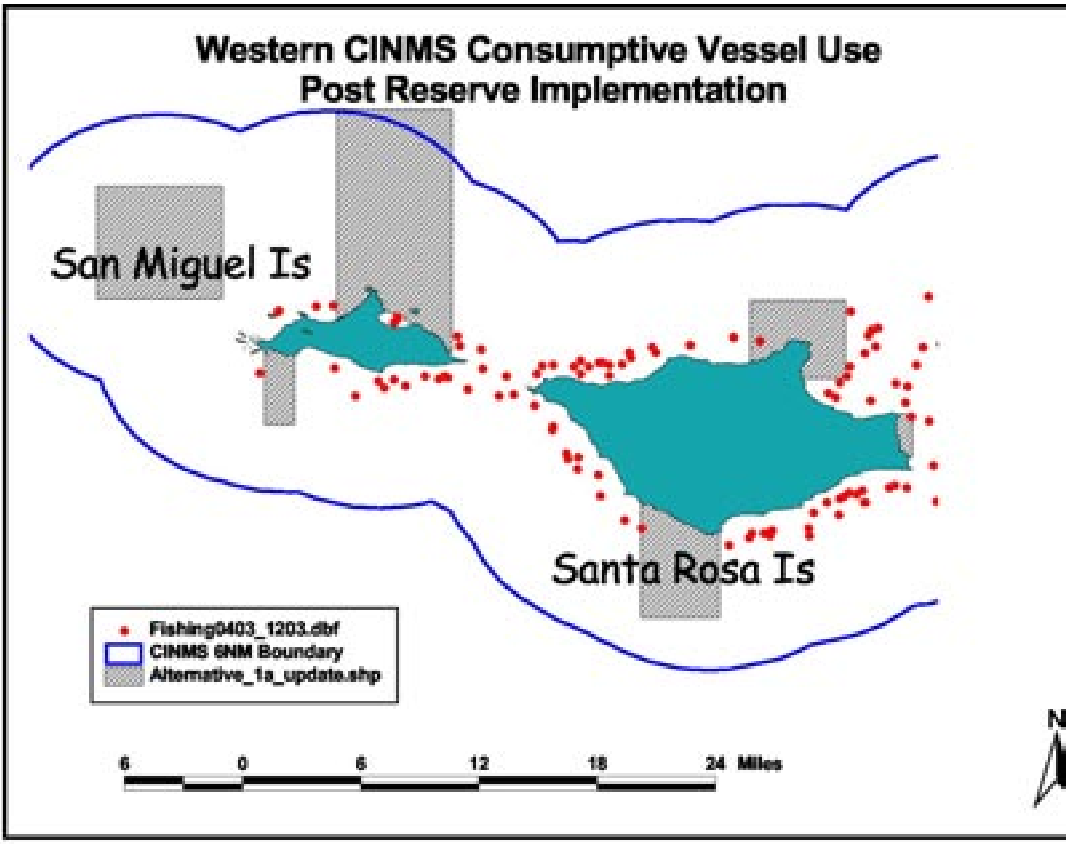


Figure E-5. Western Sanctuary Consumptive Vessel Use Post Reserve Implementation



10.3.9. Other Potential Benefits - Scientific Use and Education

Marine reserve and marine conservation areas can support scientific and educational activities. Educational activities may be directed at improving the general or technical understanding and appreciation of marine resources and habitats and scientific methodology, and to assist researchers in making observations and measurements. Educational activities contribute to the management and enhancement of marine species and would be compatible with the purposes of the proposed marine reserve and marine conservation areas.

For example, educational activities such as wildlife surveys would be allowed, as well as certain scientific projects to assess and study the marine environment. These activities would have to be carefully planned to avoid disruption to other research or critical habitats, and would have to contribute to the management and enhancement of marine resources.

Existing research activities include various monitoring programs that track natural trends. These programs would benefit from the establishment of marine reserves because such establishment would eliminate human consumptive uses within reserves, thereby removing this variable's influence on temporal changes.

Research activities also provide a needed baseline of information to gauge the function and effectiveness of the both the existing state network and the proposed federal network. In addition, one of the goals of the marine reserve and marine conservation areas is to promote scientific research that will enhance the knowledge and management of marine resources.

Although it may be difficult or impossible to quantify the economic value of marine reserve and marine conservation areas for education or science, measuring the number of educators and researchers using marine reserve and marine conservation areas may serve as indicators of the education and scientific values of marine reserve and marine conservation areas (CDFG 2002 and Leeworthy and Wiley 2003).

10.3.10. Non-Use or Passive Economic Use Values – Net Benefit Analysis

NOTE TO REVIEWER:
The NMSP is currently involved in a process to estimate the passive economic use value for no-take zones in both Hawaii's Main and Northwest Islands. Six focus groups have been conducted so far with about 50 people (two groups each in Hawaii, Madison, Wisconsin and San Diego, California). So far, results are revealing that our assumption on the percent of households willing to pay some amount for no-take zones is extremely conservative.

The net benefit assessment section will also address the issue of benefit-cost analysis versus economic impact assessment.

In Step 2 analysis, we will do a policy simulation that incorporates non-use or passive economic use values. Non-use or passive economic use values are people's willingness to pay to protect a resource in a given condition even though they never plan to visit and use the resources. Other terms to describe these values are based on underlying motives (e.g., bequeath value or the willingness to pay to ensure future generations have the opportunity to experience the resources in a given condition, or existence value or the willingness to pay just to know the resource will exist in a certain protected condition). Passive economic use value requires knowledge of what people are valuing. People receive information about what they are valuing through a variety of media (e.g., newspapers, books, magazines, radio, television, etc.).

To support a policy simulation we provide information to support a lower bound range of passive economic use values for marine reserve and marine conservation areas in the Sanctuary. There are no available studies on the passive economic use values for marine reserve and marine conservation areas in the Sanctuary or elsewhere in the world. Currently, we know of 19 studies on non-use or passive economic use values. In deriving the range of estimates of passive economic use values, we provide information about both the supply and demand for marine reserve and marine conservation areas . National and California State-wide public opinion surveys are summarized to show the extent of public support for marine reserve and marine conservation areas . On the supply side, we address the uniqueness of the Sanctuary and the marine reserve and marine conservation areas relative to Prince William Sound (site of the Exxon Valdez oil spill and one of the studies where passive economic use values have been measured). We use the combination of this information to establish a lower bound range of estimates on the percent of U.S. households that would be willing to pay some amount per year for the Sanctuary marine reserve and marine conservation areas.

The net benefit assessment compares the consumer's surpluses from all consumptive uses (maximum potential loss assumption) with the lower bound range of passive economic use values. Consumer's surplus and producer's surplus (economic rent) are both zero for the commercial fisheries. Economic rents are likely negative in the Sanctuary (fishermen earning below normal returns to investment, i.e., economic overfishing). Policy simulation shows net benefits to Sanctuary marine reserve and marine conservation areas (see Leeworthy and Wiley, 2003).

11. Appendix F: Fishermen's Proposals

NOTE TO READER
Local Santa Barbara and Ventura commercial fishermen submitted four alternatives proposals to the Sanctuary in late January 2004. Their proposals were to be included in this Appendix. The fishermen also presented these proposals to the Fish and Game Commission in February, 2004 and to the Pacific Fishery Management Council in September, 2003.

The Sanctuary, in concert with the National Marine Fisheries Service and State of California, needs to review these proposals further, prior to the release of a formal DEIS. CINMS does not consider these proposals to be feasible alternatives at this time. Based on an initial assessment, the Sanctuary believes that these proposals have the following problems in their current form:

- Each proposal calls for altering or eliminating existing State MPAs, which is beyond the jurisdiction of the Sanctuary.
- Each proposal suggests marine protected areas significantly outside the current Sanctuary boundary.
- Detailed ecological and economic data with spatial resolution comparable to available data within the current Sanctuary boundary is unavailable, which makes a quantitative comparative analysis more difficult.
- All proposals appear to focus on maximizing benefits to groundfish, rather than on meeting the Sanctuary's purposes and needs described in Chapter 1.

The Sanctuary has discussed these issues with these fishermen as well as other fishing interests in meetings of the Sanctuary Advisory Council's Recreational and Commercial Fishing Working Groups. These groups are now developing a new proposal for Sanctuary and PFMC consideration. It is our expectation that this proposal will be available for analysis shortly after release of this preliminary working draft document.

This January, 2004 proposal is available upon request to the Sanctuary. Information about ongoing efforts by the SAC Recreational Fishing Working Group and Commercial Fishing Working Group, including contact information, can be found on line at:
http://www.cinms.nos.noaa.gov/sac/sacwgsub.html

12. Appendix G: Biological and Socioeconomic Monitoring Plans

TO BE ADDED

13. Appendix H: References

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REVISED
Proposed Activities and Timeline - Channel Islands National Marine Sanctuary Environmental Review Process to Consider Marine Reserves

1999-2001	**Channel Islands Marine Reserves Community Based Process – Joint Partnership between the State of Calif. and NOAA to consider marine reserves in the sanctuary**
Aug. 2001 – Oct. 2002	**Fish and Game Commission and Department of Fish and Game State Environmental Review Process and Decision**
April 2003	**Channel Islands Marine Protected Areas implemented in state waters of the sanctuary**

March 2003

- Sanctuary prepares Notice of Intent to Prepare a Draft Environmental Impact Statement (DEIS). *(completed)*
- Brief Pacific Fishery Management Council (PFMC) on Sanctuary initiation of Environmental Review Process. *(completed)*
- Brief Sanctuary Advisory Council (SAC) on Sanctuary initiation of Environmental Review Process. *(completed)*

April 2003

- Sanctuary submits letter to PFMC describing Environmental Review Process for discussion at April PFMC meeting. *(completed)*

May/June 2003

- Sanctuary releases Notice of Intent to prepare DEIS in Federal Register. *(completed)*
- Sanctuary hosts scoping meetings in Ventura and Santa Barbara Counties. *(completed)*

November 2003

- Sanctuary briefs PFMC, State of CA, and Sanctuary Advisory Council on progress.
- Sanctuary begins drafting of Preliminary DEIS.

Early 2004

- Sanctuary sends consultation letters to PFMC, NOAA Fisheries, State of California and other entities regarding a potential change to the terms of designation of the Sanctuary (60 day response period).

Early 2004 (continued)

- Sanctuary notifies PFMC of opportunity to prepare draft National Marine Sanctuaries Act (NMSA) fishing regulations for the Exclusive Economic Zone portion of the Sanctuary (NMSA regulations allow for 120 days for PFMC response)

Spring/Summer 2004

- PFMC considers preparing draft NMSA fishing regulations and if it chooses prepares draft NMSA regulations (March/April 2004 PFMC meetings).
- Sanctuary, in cooperation with PFMC, State of Calif. and SAC, finalizes DEIS, appropriate proposed regulatory changes and related proposed change to the terms of designation.
- Sanctuary releases to the public and Congress the DEIS, proposed regulations and related proposed change to the terms of designation
- Conduct public review of the DEIS, and proposed regulations and related proposed changes to the terms of designation. This will include an opportunity for public comment of at least 45 days and must include at least one public hearing if the rulemaking necessitates a change in a term of designation

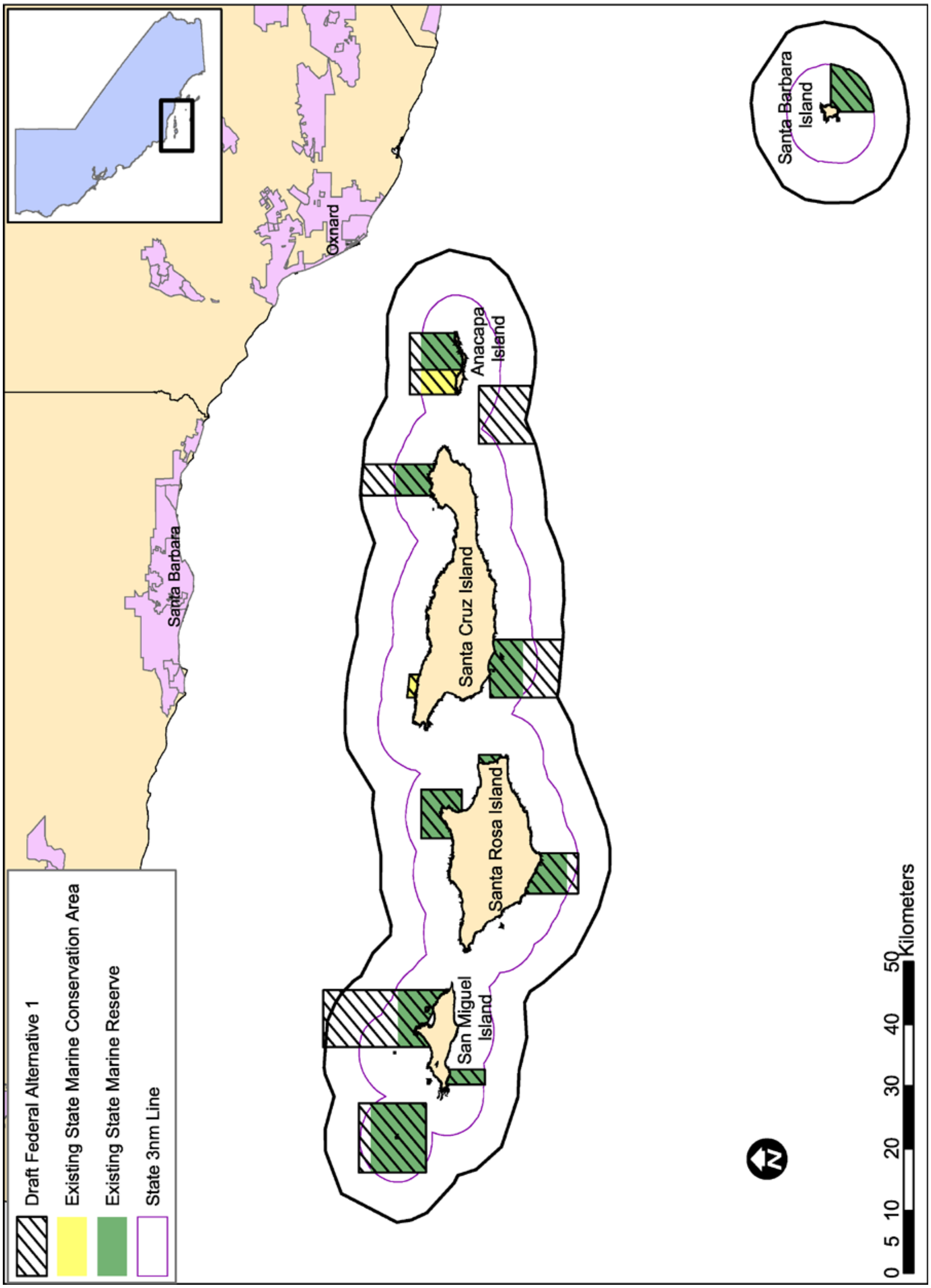
Fall 2004

- Sanctuary prepares responses to comments
- Sanctuary drafts Final EIS, and if necessary for chosen action, drafts final regulations and revises terms of designation

Winter 2004

- Sanctuary releases the Final EIS by publishing a notice of availability in the Federal Register and by providing copies to interested parties.

After a 30-day "cooling off" period, the final regulations appear in the Federal Register and the Sanctuary sends the final regulations and revised terms of designation to Congress and to the governor's office, if State waters are involved. The final regulations will take effect after the close of a review period of 45 days of continuous session of Congress. If State waters are involved, and the governor certifies that the change in terms of designation (and therefore the final regulations or portions thereof) is unacceptable, the affected final regulations will not take effect in State waters.


Oxnard
Santa Barbara
Anacapa Island
Santa Cruz Island
Santa Rosa Island
San Miguel Island
Santa Barbara Island
Draft Federal Alternative 1
Existing State Marine Conservation Area
Existing State Marine Reserve
State 3nm Line
0 5 10 20 30 40 50 Kilometers
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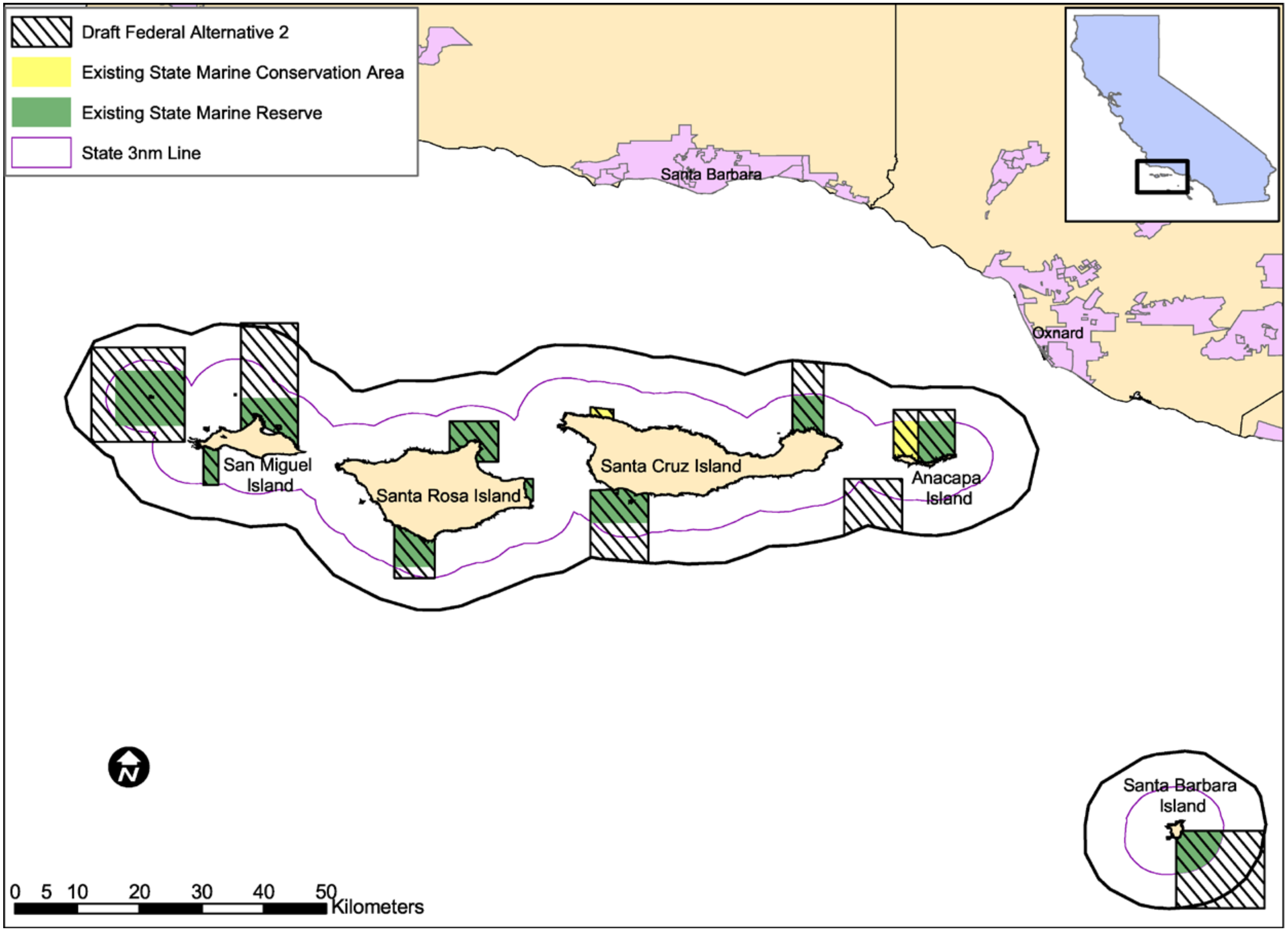
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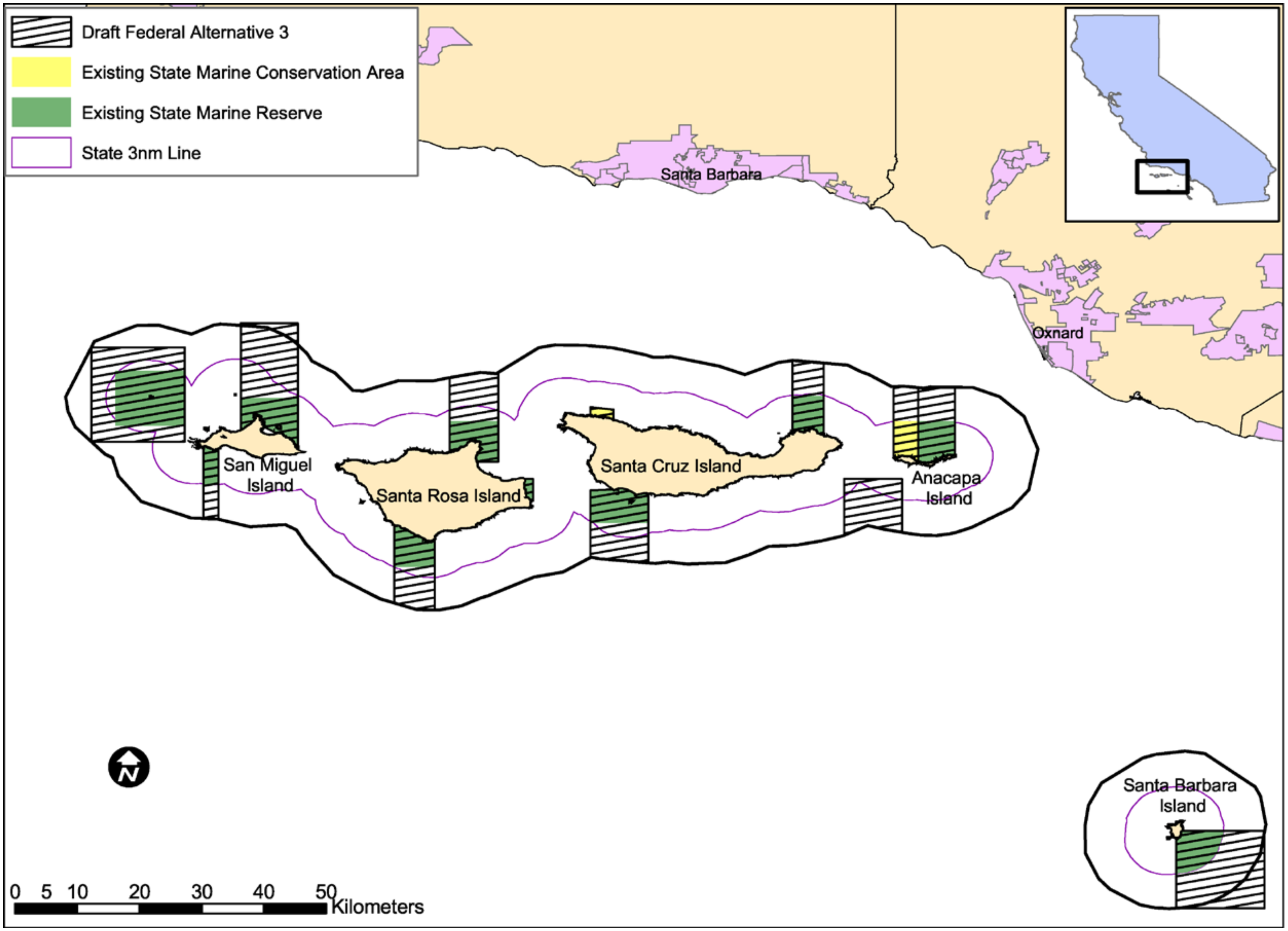
Existing State Marine Conservation Area
Existing State Marine Reserve
State 3nm Line
Santa Barbara
Oxnard
San Miguel
Island
Santa Rosa Island
Santa Cruz Island
Anacapa
Island
Santa Barbara
Island
N
0 5 10 20 30 40 50
Kilometers



Draft Federal Alternative 3
Existing State Marine Conservation Area
Existing State Marine Reserve
State 3nm Line
Santa Barbara
Oxnard
San Miguel Island
Santa Rosa Island
Santa Cruz Island
Anacapa Island
Santa Barbara Island
N
0 5 10 20 30 40 50 Kilometers

GROUNDFISH ADVISORY SUBPANEL STATEMENT ON FEDERAL WATERS PORTION OF THE CHANNEL ISLANDS NATIONAL MARINE SANCTUARY SCHEDULE UPDATE

The Groundfish Advisory Subpanel (GAP) received a presentation from the manager of the Channel Islands National Marine Sanctuary (CINMS) on Phase II of CINMS' proposals for creating marine protected areas (MPAs). Five years ago, a California State process began for closures around the Channel Islands in state waters. Phase II will increase these areas in and around CINMS itself.

While the Sanctuary Manager presented the GAP with three maps delineating proposed closures, maps showing the "no action" alternative and a Channel Islands fishermen's alternative were not provided. The GAP was asked to provide comments to the Council's Ad Hoc Channel Islands Marine Reserve Committee, which is scheduled to meet in August.

GAP members made clear that they cannot support MPAs that are not based on science. Members of the GAP reminded CINMS staff that CINMS' role is not fisheries management. It can bring recommendations to the Council where rigorous scientific scrutiny can be applied. The Council was established to manage fisheries and the recommendations of CINMS should be considered as those of any other interested group. We see no need for any MPAs or fishing regulations above what the Council decides is necessary for fisheries management. We cannot support another agency reducing harvest opportunity without going through the Council process.

The GAP recommends that existing closures, restrictive measures implemented though regulation affecting fishing areas, and de facto protected areas due to the inability to use gear in areas be quantified before new closed areas are established. Analysis should include the economic impact of MPA management on the fishery.

Finally, the GAP notes that the proposed MPAs are inside the Rockfish Conservation Area (RCA) and close to the Cowcod Conservation Area. Both of these areas qualify as MPAs and are de facto marine reserves. Is an additional marine reserve really needed? After all, the RCA stretches from the Canadian border to the Mexican border, which should be enough.

PFMC
06/16/04

HABITAT COMMITTEE COMMENTS ON FEDERAL WATERS PORTION OF THE CHANNEL ISLANDS NATIONAL MARINE SANCTUARY SCHEDULE UPDATE

Mr. Chris Mobley, superintendent of the Channel Islands National Marine Sanctuary (CINMS), spoke to the Habitat Committee (HC) about the schedule for developing the environmental document for creating marine reserves in the federal waters portion of CINMS. The HC recommends that the CINMS Marine Reserves Subcommittee convene to review this document prior to the September Council meeting. The HC will also discuss the document in more detail at the September meeting. If the Council chooses to convene the CINMS Marine Reserves Subcommittee, HC members will coordinate input with Dr. Robert Lea, the HC representative to the subcommittee, via email.

PFMC
06/14/04

SCIENTIFIC STATISTICAL COMMITTEE COMMENTS ON FEDERAL WATERS PORTION OF THE CHANNEL ISLANDS NATIONAL MARINE SANCTUARY

The Scientific Statistical Committee (SSC) received a report from Mr. Chris Mobley, Sanctuary Manager, on the status of the working document being developed as a draft Environmental Impact Statement (EIS) to implement a network of marine reserves and conservation areas within the federal waters portion of the Channel Islands National Marine Sanctuary (CINMS). Currently, the CINMS has a network of marine reserves inside California State waters (within 3 nm of the islands). This document addresses the sanctuary's proposal to extend the current reserve boundaries to federal waters and revise the schedule for submission of a draft EIS. To facilitate the ability of the Council's Ad Hoc Channel Islands Marine Reserve Committee to meet this schedule, the SSC Marine Reserves Subcommittee is prepared to schedule a meeting with CINMS and their analysts later this summer. The purpose of this meeting would be to provide a more thorough review of the working draft and supporting documents.

The SSC notes that the goals and purpose statement has been considerably revised from the goals used by the Marine Reserves Work Group (MRWG) to establish reserves in state waters at CINMS. In the current draft, the principal justification has been shifted away from a focus on ecosystem and fishery benefits to a more exclusive focus on protection of the ecological communities and processes, biodiversity, and physical and biogenic habitats within the sanctuary. This shift in emphasis is more aligned with the goals of the National Marine Sanctuaries Act.

The SSC recognizes that this is a working draft with a number of sections incomplete.

The SSC offers the following suggestions to strengthen the document:

1. The need and rationale for extending the state-approved marine reserves into federal waters should be highlighted and moved into the introduction, which is the purpose of the proposed action.
2. The development of the three alternatives and their rationales need to be better explained and justified. The differences among the alternatives appear to be largely a matter of spatial extent of closures, but the document offers little guidance on how to evaluate the alternatives in their ability to achieve the objectives.
3. A table that ranks the effectiveness of each alternative in achieving each of the goals bulleted in Section 1.3 (page 7) should be included.
4. The level of fishing activity within CINMS may have changed, since state reserves were established in 2003 depending on the extent to which displaced effort left CINMS waters. If information is available regarding the extent of such displacement, this information should be used to formulate a new socioeconomic baseline for the analysis of alternatives. At minimum, uncertainty regarding the baseline should at least be acknowledged.

PFMC
6/16/04

Exhibit G.1.d
Public Comment
June 2004

Glen Pittman

1301 Crossing Place # 121, Austin, Texas 78741

RECEI[illegible]

APR 14 2004

PFMC

April 09, 2004 10:22 PM

Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, OR 97220

Subject: Support for Preferred Alternative Marine Reserve Network at the Channel Islands

Dear Pacific Fishery Management Council:

I write to encourage your support for the establishment of a network of fully protected marine reserves within the federal waters of the Channel Islands National Marine Sanctuary. The preferred alternative is fully supported by the CEQA document and by the California Fish and Game Commission.

Fully protecting portions of the waters around the Channel Islands within a network of marine reserves is the only real way to help the once thriving marine life around the Islands rebound and thrive. The islands receive important protections as a National Marine Sanctuary, however new measures are needed to restore declining fisheries and preserve habitat.

There is now compelling scientific evidence that an appropriately designed system of marine reserves can help restore damaged rockfish and invertebrate populations. To ignore these problems at this time simply invites a more severe crisis in the future. Our Channel Islands support diverse marine habitats and a unique ocean ecosystem. I strongly urge that you support a configuration of fully protected marine reserves, which protects the Islands' many habitats, including rocky reefs, sandy seafloor, and subsea canyons. By leaving a portion of our coastal waters undisturbed, marine reserves can restore biological diversity and prevent the extinction of individual species. The resulting protected areas can also provide tangible, long-term benefits to commercial and recreational fishermen.

Please finish the marine reserve network recently approved by the California State Fish and Game Commission, by completing the federal portion of this carefully-negotiated, science-based protection for key ecosystems at the Channel Islands.

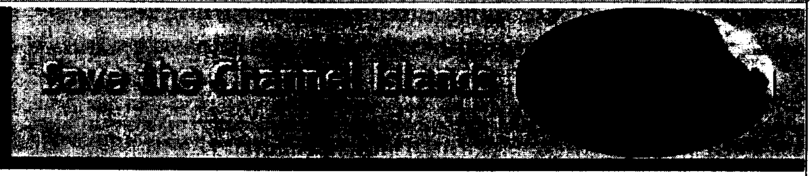
Thank you for your attention to this pressing matter.

Sincerely,

Glen Pittman

Text-only e-mail? Please open this page in your web browser:
http://www.bluevoice.org/jcemail/BVchannelislands.htm

e
ENVIRONMENTAL DEFENSE
finding the ways that work



Protect the Channel Islands - "The American Galapagos"

BlueVoice.org, on behalf of Environmental Defense, invites you to take action on this important issue.

The waters around the Channel Islands, off the coast of central California, support a lush diversity of marine life, including giant kelp forests, migrating blue and humpback whales, southern sea otters, Guadalupe fur seals, dolphins, sharks and more. California brown pelicans and the California least tern ply the skies, while once-abundant fish populations include giant sea bass, sheephead and rockfish. The islands of San Miguel, Santa Rosa, Santa Cruz, Anacapa and Santa Barbara rise majestically from the sea, enticing millions of visitors to nearby coastal communities each year.

TAKE ACTION TO PROTECT THE CHANNEL ISLANDS:
The State of California just recently decided to fully protect portions of the state's waters that surround the Channel Islands in a network of marine reserves. However, other portions of Channel Islands waters under federal control don't yet enjoy the same protections. Take action and send a message to the Pacific Fishery Management Council. Urge them to follow California's lead and fully protect portions of the federal waters that surround the Channel Islands. Timing is critical. Take action now!

Send a letter to the following decision maker(s): Pacific Fishery Management Council

Below is the sample letter:

Take Action!

Instructions:
Click here to take action on this issue.

What's At Stake:

CHANNEL ISLANDS AT RISK:
The diverse marine ecosystems around these islands are at risk. While Franklin D. Roosevelt recognized the Channel Islands as a national monument in 1938, and the area later achieved designation as the Channel Islands National Marine Sanctuary, in the decades since, legions of white abalone, Guadalupe fur seals, and a number of rockfish have been disappearing. We are now witnessing what could become a wave of extinction.

New measures are needed to preserve this unique ecosystem. Scientists agree that an appropriately designed network of fully protected marine reserves would help to restore marine life in the waters around the Channel Islands. Marine "no-take" reserves, special ocean areas losed to all extractive activities, including fishing, have

Subject: Support for Preferred Alternative Marine Reserve Network at the Channel Islands Dear [decision maker name automatically inserted here], I write to encourage your support for the establishment of a network of fully protected marine reserves within the federal waters of the Channel Islands National Marine Sanctuary. The preferred alternative is fully supported by the CEQA document and by the California Fish and Game Commission.

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Please finish the marine reserve network recently approved by the California State Fish and Game Commission, by completing the federal portion of this carefully-negotiated, science-based protection for key ecosystems at the Channel Islands.

Thank you for your attention to this pressing matter.

[redacted]

proven successful in other parts of the world at helping damaged ecosystems to recover. Other activities that are compatible with protecting habitat - like recreational diving, pleasure boating and cientific research - can continue. Currently, only 0.2% of California's coastal waters are withinfully protected marine ecological reserves. By leaving a portion of the ocean undisturbed, marine reserves can restore biological diversity and prevent the extinction of individual species within the ecosystem. These protected areas can also provide tangible, long-term benefits to commercial and recreational fishermen. Reserves that maintain intact habitat where fish can feed, grow and spawn effectively help to increase fish populations elsewhere. The larger, older fish, more typically found in marine reserves, produce more young and provide the best opportunity for achieving successful species recovery.

Visit Environmental Defense on the web for more information about efforts to strengthen protections for the Channel Islands National Marine Sanctuary.

Campaign Expiration Date:
February 28, 2003

To unsubscribe, please visit our home page at http://www.bluevoice.org, enter the e-mail address where you received this message in the text box, select the 'unsubscribe' radio button and click 'Join'.

Jennifer L. Ferrick
5011 Kinter Hill Road
Edinboro, PA 16412
October 31, 2003

Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, OR 97220

Dear Pacific Fishery Management Council:

I write to encourage your support for the establishment of a network of fully protected marine reserves within the federal waters of the Channel Islands National Marine Sanctuary. The preferred alternative is fully supported by the CEQA document and by the California Fish and Game Commission.

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Thank you for your attention to this pressing matter.

Sincerely,

Jennifer Ferrick

Subject: [Fwd: Commercial Fisheries Seat Update]
From: "Jennifer Gilden" <Jennifer.Gilden@noaa.gov>
Date: Tue, 01 Jun 2004 10:11:14 -0700
To: Daniel Waldeck <Daniel.Waldeck@noaa.gov>

Dan, this should have gone to you. I will email Chris and tell him you're the main contact in the future.

Jennifer

-------- Original Message --------
Subject: Commercial Fisheries Seat Update
Date: Fri, 28 May 2004 15:26:20 -0700
From: Chris Miller <chrisjmiller@earthlink.net>
Reply-To:<chrisjmiller@earthlink.net>
To:<Jennifer.gilden@noaa.gov>
CC:<don@danawharfsportfishing.com>, <joelg@rfasocal.org>, <swordstuna@aol.com>, <Mark.helvey@noaa.gov>, <Chris.Mobley@noaa.gov>, <Rhoeflinge@aol.com>, <oamoroso@aol.com>, <phalmay@earthlink.net>, <mike.murray@noaa.gov>, <john.devore@noaa.gov>, <greg.haas@mail.house.gov>, <rebecca.lent@noaa.gov>

Channel Islands Marine Reserve Update federal phase alternatives May 28,2004

Commercial Fishing Representatives and Sport Fishing Representatives met with NMFS Southwest Regional Director Rod Mcinnis and Sanctuary Manager Chris Mobely at NMFS headquarters in Long Beech.

Based on this meetings review of Commercial Fisheries Alternative designs presented the PFMC for NEPA process NOAA provided input.

1. **Develop Joint Recreational and Commercial Alternatives**
2. **Focus on Federal Waters**
3. **Eliminate design alternatives that reconfigure state phase at this time.**

Fisheries representatives develop forum for stakeholder involvement through Sanctuary Advisory Council process. Initiate Fisheries seat NEPA working group. Hold two joint recreational and commercial meetings.

Our fisheries seats and representatives jointly created a design Alternative for the NEPA range of alternatives for CINMS. To support goal of fishery supported design in the main NEPA document.

The design is justified by the need to include MPA options in the design. That also includes reconfiguration of proposed no-take reserves to add to the integrity of the

design with slope habitat to achieve full representation of habitat.

The objective of this design is to

1. Expand the parameters of analysis in the NEPA document to consider MPA's meeting the stated ecological goals.
2. Add ecological integrity with full representation of habitats
3. Provide broader cost benefits analysis as a basis for future reserve implementation protocols for fisheries impacts assessments.
4. Fully evaluate integrated management issues with baseline cumulative regulatory inventory.
5. Provide framework for comments on area based monitoring design

5. Develop context for crafting interagency memorandums of understanding and actions needed to measure objectives of MPA's and performance standards
6. Mitigate fisheries congestion and redirection of effort.

The general recommendation to the council at this time is that existing fisheries management provides a combination of species and gear regulatory authority that can effectively protect diversity of marine communities and maintain sustainability of harvested populations. That attaining full representation of habitats in MPA's requires considering habitats outside the Sanctuary Boundaries to achieve the objectives of the project. That no Sanctuaries engage in expanding their regulatory authority to include promulgating fisheries regulations under the guise of implementing MPA's or Marine Reserves.

The specific recommendations are for the analysis of all alternatives to receive analysis through the Sanctuary Advisory Council Process in conjunction with a similar opportunity through the Ad-Hoc Marine Sub-Committee on MPA's from the PFMC. With a joint meeting to develop the scope of analysis taking place in the CINMS region this summer.

We greatly appreciate Rod Mcinnis and Chris Mobley's investment in jointly assisting in developing stakeholder involvement and are very appreciative of the recreational fisheries leadership adding their support to developing the NEPA analysis.

Sincerely,

Chris Miller Commercial representative Santa Barbara Port
Chris Hoeflinger Commercial Representative Ventura Port

From: Dan Toomey [dan@anacapa.biz]
Sent: Wednesday, June 16, 2004 9:05 PM
To: Randy Fry
Subject: Talking point re CINMS for PFMC
Hey Randy,

If you get a chance to make a statement regards the CINMS at the PFMC meeting it would be great if you could raise the following points:

1) The recreational fishing community is firmly opposed to any change in the Sanctuary's designation that would allow them to engage fisheries management. The Sanctuary has neither the skills, resources nor the expertise to make proper determinations with respect to fisheries.

2) The recreational fishing community is firmly in favor of leaving the management of fisheries within the sanctuary to the PFMC and CA DFG.

3) The Sanctuary has stated that its current push for no-take reserves is based upon the work done by California in its MRWG process. This process was an utter failure and ultimately failed to reach a definitive conclusion. The Rec Fishing Community does not believe that the blanket no-take reserves called for in the State's Alternative should be treated as credible - the plan was developed through a deeply flawed process (for your reference I have attached NOAA's analysis of the State's process and its short comings authored by Professor Mark Helvey - "Seeking Consensus on Designing Marine Protected Areas: Keeping the Fishing Community Engaged").

The State's process was a case study in what shouldn't be done and it shouldn't be built upon. The simple fact is that the State failed to develop a sound scientific basis for its preferred alternative. This issue was addressed directly by the Pacific Fishery Management Council in its July 15, 2002 letter to Mr. Robert C. Hight, Director, California Department of Fish and Game. In this letter the PFMC makes the following comments with regard to the species that inhabit the proposed reserves:

> "The SSC notes, due to the relatively small scale of the CINMS relative to the full distribution of most of the fishery resources that inhabit the CINMS, substantial fisheries benefits on a stock-wide scale are unlikely to result under any of the MPA alternatives at CINMS. More specifically, the SSC notes the arguments for expected fisheries benefits (pp. 6-66, 6-67 and Figure 6-1) are technically weak and not compelling."

4) The recreational fishing community requests that the PFMC perform a thorough peer review of any analysis submitted by the CINMS Sanctuary Staff in its EIR

5) The CINMS Sanctuary Staff has not maintained a neutral position in facilitation of community involvement during their abridge process. The Staff asserted that the passing of the executive for MPA's by president Clinton in the Sanctuary made them stakeholders. They are pushing create no-take marine reserves and have biased all input processes towards this goal. This is readily apparent in the Recreational Fishing representatives to the Sanctuary Advisory Council. Both the current recreational fishing representative and have expressed grave reservations about their ability to adequately represent our community.
Both have stated that they are not comfortable advocating against no-take marine reserves and acknowledge that their views differ from those they supposedly represent.

6) The socio-economic data presented by the Sanctuary Staff to date is deeply flawed and severely understates the value of consumptive activities while overstating the value of non-consumptive activities in the Sanctuary. This short coming must be addressed before any decision can be made.

7) The Federal waters of the Sanctuary are among the most heavily regulated in the world. Currently, the PFMC and CA DFG have enacted closures affecting the entire reserve. The area is a Marine Managed Area already and there is no need for further protection.

I think that should be enough, please let me know how it goes!

GUIDELINES FOR REVIEW OF MARINE RESERVE ISSUES

Situation: The Scientific and Statistical Committee (SSC) Marine Reserves Subcommittee has developed a white paper to facilitate Pacific Fishery Management Council (Council) consideration of marine reserve initiatives in relation to West Coast fishery management. The paper, titled "*Marine Reserves: Objectives, Rationales, Management Implications and Regulatory Requirements*," evaluates the implications of marine reserves for contemporary fishery management on the West Coast, taking into consideration reserve objectives and uncertainties associated with both reserves and traditional fishery management. A draft of this report is included under Exhibit G.2 (see Exhibit G.2.b, Attachment 1). At this meeting, Ms. Cindy Thomson, marine reserves subcommittee chair, will summarize the contents of the report. The SSC will also provide their recommendations for finalizing the SSC white paper.

Council Action:

1. Consider Adopting Guideline Recommendations.

Reference Materials:

1. Exhibit G.2.b, Attachment 1: SSC white paper titled "*Marine Reserves: Objectives, Rationales, Management Implications and Regulatory Requirements*."
2. Exhibit G.2.d, Public Comment.

Agenda Order:

a. Agendum Overview	Dan Waldeck
b. SSC Report	Cindy Thomson
c. Reports and Comments of Advisory Bodies	
d. Public Comment	
e. **Council Action**: Consider Adopting Guideline Recommendations	

PFMC
05/27/04

Exhibit G.2.b
Attachment 1
June 2004

DRAFT WHITE PAPER

MARINE RESERVES: OBJECTIVES, RATIONALES, MANAGEMENT IMPLICATIONS AND REGULATORY REQUIREMENTS

June 2004

Marine Reserves Subcommittee
Scientific and Statistical Committee
Pacific Fishery Management Council

TABLE OF CONTENTS

ES. Executive Summary
ES.A. Introduction

The objective of this white paper is to facilitate Council deliberations on marine reserves by: (1) describing the rationale underlying a number of commonly cited reserve objectives and providing an SSC perspective regarding whether reserves can be reasonably expected to achieve each of these objectives; (2) discussing the implications of reserves for fishery management, taking into consideration the objective of the reserve; and (3) describing SSC expectations regarding the technical content of proposals initiated by the Council (or submitted for Council consideration by outside entities) that involve change in fishery regulations associated with establishment of marine reserves in Federal waters.

SSC recommendations are guided by the Council's mandate to rely on best available science and adhere to Federal regulatory requirements as specified in the National Environmental Policy Act, the Regulatory Flexibility Act, Executive Order 12866 and other applicable law. SSC interest in this topic is prompted by the limited extent to which reserves have been evaluated in the context of Federal regulatory requirements and the likelihood of the Council's continued engagement in this topic.

ES.B. Reserve Objectives and Rationales

Based on existing rationales and evidence regarding reserve effects, the SSC offers the following perspective regarding the extent to which available scientific evidence indicates that reserves can be reasonably expected to achieve the following reserve objectives:

- *Reserves as insurance policy* - Reserves are uniquely qualified to provide a complete age structure for target species and thereby enhance persistence, i.e., the ability of fish stocks to withstand adverse effects associated with management uncertainty and error. In this sense, reserves have significant potential as a tool for mitigating uncertainty in stock assessments and managing unassessed stocks.

- *Reserves as source of fishery benefits* - Theoretical models that are used to demonstrate increases in fishery yield outside the reserve are highly sensitive to underlying assumptions regarding the behavior of fish stocks, the extent of exploitation prior to the reserve and the extent of effort redistribution after the reserve is established. While such models provide insights into how particular circumstances and processes might affect yield, the practical question of how well model assumptions apply to particular fish stocks remains largely unanswered. For purposes of management, detailed life stage modeling is less relevant than whether an empirical relationship can be established between reserves and yield outside the reserve. Existing empirical studies focus largely on increases in fish abundance and size inside reserves; however, such effects do not necessarily imply increased recruitment to the fishery. The evidence for increased yield is not compelling - particularly in well-regulated fisheries. The SSC cautions against raising such expectations in Council-managed fisheries.

- *Reserves as source of ecosystem benefits* - In evaluating the ecosystem effects of reserves, it is important to consider effects both inside and outside the reserve as the ecosystem itself extends to both areas. Depending on the nature and extent of fishing prior to reserve establishment, cessation of fishing may yield significant ecosystem changes within the reserve area. Reserves are a potentially useful tool for providing ecosystem benefits, provided that notable effects of effort displacement on the ecosystem outside the reserve are also effectively managed.

- *Reserves as means of achieving social objectives* - Reserves may be used to achieve objectives such as reducing social conflict among user groups, accommodating values held by various segments of the public regarding resource use, discouraging or encouraging particular types of resource use, protecting areas that are deemed unique in terms of cultural or natural heritage. This objective differs fundamentally from the other reserve objectives in that the choice of criteria to evaluate achievement of this objective is a matter of policy rather than science. However science (most notably social science) can be useful for evaluating management alternatives relative to the policy criteria. Just as the Council has some discretion to address social issues such as allocation under the MSFCMA, reserve proposals may also employ social objectives to the extent that the objective is consistent with the specific legal mandates and constraints underlying the proposal.

- *Reserves as opportunities to advance scientific knowledge* - Proposals for research reserves should be evaluated on the same basis as other types of research proposals. Technical requirements for such proposals would include a well-defined hypothesis, a rationale for why the research is worth pursuing, a description of experimental design, and sampling and analytical methods.

ES.C. Analytical Framework for Marine Reserve Proposals

SSC recommendations regarding the analytical content of reserve proposals prepared by the Council (or submitted for Council consideration by outside entities) are as follows. These recommendations are intended to be consistent with what the SSC generally expects to see in regulatory analyses.

- The management objective addressed by the proposal should be described in specific terms and in the context of relevant mandates. The proposal should describe the problem to be addressed, why the problem is significant and why the *status quo* is inadequate to address the problem.

- The proposal should include a description of the *status quo*, i.e., current and future conditions that can reasonably be expected to prevail if the proposal is not implemented. The time frame used to define the *status quo* (as well as alternatives to the *status quo*) should reflect the time period over which effects of the proposed regulatory change are expected to be realized. This is particularly important if benefits and costs are expected to change over time or to be realized over different time frames. Current (baseline) conditions may be a useful proxy for the *status quo*, but only if current conditions are expected to continue into the future.

- The proposal should include a reasonable range of alternatives to the *status quo*. If the problem identified in the proposal can be addressed only by reserves, the alternatives should take the form of different reserve configurations. If the problem can also be addressed by non-reserve management measures or by combining reserves with other measures, the alternatives considered should reflect the broader range of feasible solutions. The proposal should include a description of the operational requirements (i.e., the specific combination of regulations) associated with each alternative, as these requirements are crucial for revealing the biological, social, economic, environmental and enforcement implications of each alternative.

- Alternatives should be compared in terms of how well they achieve the management objective. Biological, social, economic and ecosystem effects should be documented, as well as monitoring and enforcement requirements. To the extent possible, the analysis should be based on information specific to the fish stocks, ecosystems, fishery participants and fishing communities that will be affected by the proposal. All alternatives should be evaluated on a common spatial scale, in terms of effects inside and outside reserve areas. Regulatory analysis - whether it involves marine reserves or other types of management measures - is constrained by limited knowledge and data. It is important that reserve proposals be explicit about sources of risk and uncertainty in the analysis.

- Reserve proposals should include a description of the process by which the need for reserves was identified and management alternatives were developed and analyzed. The extent of public involvement in the process and the nature of public comment should be documented.

ES.D. Conclusions and Recommendations

In considering reserves as a management measure, it is important not to lose sight of the fact that the appropriate starting point for discussion is the management objective. Management effectiveness is not achieved by focusing *a priori* on any particular regulatory measure but by determining which measure (or combinations of measures) would be most effective in addressing the objective. To accomplish this, it is important that the range of feasible solutions not be unduly restricted from the outset.

The regulatory analysis plays a substantive role in the process by providing a meaningful synthesis of the information relevant to the issue at hand, conveying that information to the public and policy makers, and moving the process forward in a systematic and well-documented way. The public cannot be expected to provide constructive input and policy makers cannot be expected to make well-informed decisions unless they have access to an analysis that is technically sound, informative and balanced.

Regardless of the management objective, the choice of a preferred management alternative is ultimately a policy decision. While science (meaning both natural and social sciences) may inform some aspects of reserve design and facilitate systematic consideration of reserve effects, all relevant factors must ultimately be weighed in ways that are beyond the scope of science. In order to ensure that management is informed by the best available science, it is important to distinguish between issues that can be addressed by science and those that cannot. This distinction is important for ensuring that scientific issues receive the technical scrutiny they deserve and for clarifying the respective roles of scientists and policy makers in the management process.

The Council's 2003 groundfish management specifications included use of OYs, spatial closures, season closures, vessel landings limits and gear restrictions to protect overfished groundfish stocks. While this was an important objective for the Council, the types of management measures employed to achieve this objective also tend to reduce the operational flexibility of fishing operations and thus accentuate the incentive for vessels to seek additional avenues of investment to remain competitive in the race for the fish. The SSC takes note of this latter effect not to discourage use of such measures (which are integral to addressing many of the Council's needs) but to point out that there is no panacea for fishery management problems. Reserves - like other types of management measures - are well suited for some purposes but not others, and can aggravate as well as address problems. The SSC encourages caution in making broad generalizations about reserve effects.

The SSC requests that the Council consider developing procedures for dealing with reserve proposals submitted to the Council by outside entities and assuming a more proactive role in reserve discussions and plans that pertain to its area of jurisdiction, including working with other appropriate entities to develop a coordinated approach to marine reserves on the West coast. Such coordination would facilitate communication, avoid duplication of effort and increase the likelihood of a productive outcome for all parties. Proactive Council involvement in marine reserve planning processes would help ensure that such planning is grounded in the best available science and realistically reflects the complexities of management.

Given the Council's increasing reliance on area closures as a management tool and the interest in reserves being conveyed to the Council by other entities, the SSC sees a growing need for spatially explicit data and models. However data collection is costly and model development is not guaranteed to improve the science needed for management. Increased spatial resolution will require more complex models and thus estimation of more parameters. Model selection techniques will need to be applied to determine how differences in spatial resolution affect model performance and what approaches to data pooling might be appropriate.

A potentially important issue for the Council in evaluating reserve proposals is whether fishery-independent surveys would be allowed in reserve areas and (if allowed) whether any constraints would be imposed on the conduct of such surveys. To the extent that reserves significantly interfere with the customary spatial coverage of surveys, the Council may be faced with loss of age structure information that is critical to estimating year class strengths in stock assessment models. Increased dependence on alternative non-lethal data collection methods may need to be considered in reserve areas to address management needs. In addition to issues regarding loss of data important for stock assessment, the use of such methods also raises issues of cost and calibration. Consideration may also need to be given to whether possible changes in fish dynamics associated with reserve establishment may require changes in stock assessment models.

I. Background

The Pacific Fishery Management Council has a long history of using area closures as a management tool. For instance, the Northern Anchovy Fishery Management Plan (FMP), as implemented in 1978, prohibited reduction fishing in nearshore waters to protect pre-recruits and reduce the possibility of social conflict between the reduction fishery and the live bait and recreational fisheries. The Groundfish FMP, as implemented in 1982, included area closures for foreign and joint venture operations. The Salmon FMP, implemented in 1984, closed designated areas around river mouths to fishing, and also specified the use of flexible time/area closures as a tool for setting annual specifications for the fishery.

Since adoption of these FMPs, the Council has periodically used area closures to address new management needs. The most notable examples in recent years have occurred in the groundfish fishery. In 2001, the Council closed designated areas south of Point Conception to groundfish fishing to reduce bycatch of overfished cowcod. During September-December 2002, the Council implemented depth-based closures on the continental shelf to reduce bycatch of darkblotched rockfish, and subsequently expanded those closures in 2003 to protect overfished bocaccio and canary as well as darkblotched rockfish.

In response to a court order, the Council is in the process of preparing a Programmatic Environmental Impact Statement (PEIS) for the groundfish fishery to address essential fish habitat (EFH) requirements of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA, Section 303(a)(7)). The PEIS includes consideration of area closures as a management tool. Unlike the rationales previously used by the Council to justify such closures, the EFH mandate requires a more systematic consideration of habitat requirements than previously undertaken by the Council and a change in focus from protecting habitat to benefit fish stocks and fisheries to protecting habitat from potentially adverse effects of fishing operations.

In recent years there has been growing attention to the use of area closures as a means of protecting and managing not only target species but marine resources in general. While closures initiated by the Council have been intended to improve management of particular fisheries, proposals are being made to close areas of the ocean to most, if not all, fishing activity. While the time frame for closures customarily used by the Council ranges from short-term (e.g., salmon closures as part of annual specifications) to longer-term (e.g., groundfish closures to facilitate recovery of overfished stocks) to permanent (e.g., anchovy closures to protect pre-recruits and reduce social conflict), the new proposals focus more exclusively on permanent closures.

The SSC's intent in this document is to adhere to the Council's definition of a marine reserve as "an area where some or all fishing is prohibited for a lengthy period of time" (http://www.pcouncil.org/reserves/reservesback.html). This definition reflects the Council's area of regulatory authority (fishing) and encompasses but is not limited to permanent closures. Other definitions of marine reserves also exist which may differ from the Council's in terms of the nature of the activities restricted, the degree of allowable use and the duration of the closure.[1]

Expanding interest in marine reserves is evident at both Federal and State levels. For instance, Executive Order 13158 (Marine Protected Areas) mandates that, "To the extent permitted by law and subject to the availability of appropriations, the Department of Commerce and the Department of the Interior ... shall develop a national system of MPAs" (Presidential Documents 2000, pp. 34909-34910). The five National Marine Sanctuaries on the West coast (four in California, one in Washington) are in varying stages of revising their own management plans, with marine reserves being one area of consideration. One of these sanctuaries (Channel Islands) has already implemented reserves in the State portion of Sanctuary waters and is in the process of extending these reserves into the Federal portion. California's Marine Life Protection Act (MLPA) requires the California Department of Fish and Game to develop a Master Plan that includes "recommended alternative networks of MPAs" (California Fish and Game Code, Section 2856) in State waters.[2] Oregon's Ocean Policy Advisory Council has recommended that "Oregon test and evaluate the effectiveness of marine reserves in meeting marine resource conservation objectives through a system of marine reserves ..." (Oregon Ocean Policy Advisory Council 2002, p. 1).

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[1] For instance, the National Research Council describes a marine reserve as "a zone in which some or all of the biological resources are protected from removal or disturbance" (NRC 2001, p. 12). California's Marine Life Protection Act refers to a "marine life reserve" as "a marine protected area in which all extractive activities, including the taking of marine species and, at the discretion of the commission and within the authority of the commission, other activities that upset the natural ecological functions of the area, are prohibited" (California Fish and Game Code, Section 2852(d)). The Oregon Ocean Policy Advisory Council defines a reserve as "a highly regulated ocean or estuarine area designated to meet specific goals and to protect resources or uses from activities that may conflict with these goals" (OPAC 2002). A related but broader concept of area closures is a marine protected area (MPA). For instance, Executive Order 13158 defines an MPA as "any area of the marine environment that has been reserved by Federal, State, territorial, tribal or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (Presidential Documents 2000, p. 34909).

[2] Implementation of the MLPA has been indefinitely delayed due to State budget constraints.

II. Introduction

Marine reserves are advocated for a variety of reasons: (1) as an insurance policy against uncertainty and errors in fishery management, (2) as a source of fishery benefits, (3) as a source of ecosystem benefits, (4) as a means of addressing social issues, and (5) as an opportunity to advance scientific knowledge. The scientific literature pertaining to marine reserves has proliferated in recent years. Much of the discussion in the literature has focused on the development of theoretical models and guiding principles. In addition, some (albeit limited) empirical research has been conducted on the effects of West coast reserves (e.g., Martell *et al.* 2000, Paddack and Estes 2000, Palsson and Pacunski 1995, Schroeter *et al.* 2001, Tuya *et al.* 2000). The literature provides useful insights into conditions and processes that are conducive to achieving reserve benefits, as well as suggestions for how to improve existing research in this area. However, if reserves are to achieve their true potential, real world management implications must also play a pivotal role in these discussions. The Council, given its management responsibilities, does not have the luxury of ignoring such considerations.

Marine reserves are generally not discussed in the literature in a currency that is useful for management. This lack of a common currency is partially reflected in the different perspectives taken by fishery biologists (who focus on fish stocks at the population level), ecologists (whose interests are less species-specific and more focused on the relationship between organisms and their environment) and social scientists (who focus on human behavior within particular cultural, economic and institutional contexts). While much can be learned from each perspective, the differences among the disciplines make it difficult to integrate the knowledge that each provides. This difference is exacerbated by differences in perspective between the worlds of academia and policy making - the former focused on the use of specialized expertise to develop and explore innovative ideas, the latter focused on considering each management problem in its real world context and in all its dimensions. While good science is essential for good management, managers must be selective in focusing on scientific results that are not only technically sound but also applicable to the issue at hand. Management requires that concepts and objectives be translated into operational requirements. It is in the course of defining such requirements that the biological, socioeconomic, environmental and enforcement implications of an action become apparent.

The objective of this white paper is to facilitate Council deliberations on marine reserves by:

- describing the rationale underlying various marine reserve objectives and providing an SSC perspective on the scientific basis for the expectation that reserves can satisfy these objectives;

- discussing the implications of reserves for fishery management, taking into consideration the objective of the reserve; and

- documenting SSC expectations regarding the technical content of proposals initiated by the Council (or submitted for Council consideration by other entities) that involve changes in fishery regulations associated with establishment of marine reserves in Federal waters.[3]

Given the SSC's responsibility as a scientific advisory body, this paper distinguishes between reserve issues that are scientific in nature and therefore amenable to SSC input and review and policy issues that are outside the SSC's purview. Given the SSC's responsibility to review regulatory proposals considered by the Council, this paper includes SSC recommendations and expectations regarding the analytical content of such proposals as they relate to reserves. Given the SSC's responsibility to recommend processes that facilitate consideration of science in the management process, this paper provides suggestions regarding procedure and coordination that are intended to encourage systematic consideration of technical issues as they relate to reserves. SSC recommendations are guided by the Council's mandate to rely on best available science and adhere to Federal regulatory requirements as specified in the National Environmental Policy Act, the Regulatory Flexibility Act, Executive Order 12866 and other applicable law.

Section III elaborates on the five reserve objectives previously mentioned in this paper. Section IV provides guidance on the preparation of regulatory analyses of reserve alternatives as they relate to each objective. Section V summarizes SSC recommendations to the Council, and Section VI identifies research and data needs. Appendix A includes excerpts from the Environmental Impact Statement (EIS)[4] prepared by the Council for the 2003 groundfish specifications (PFMC 2003) that illustrate some of the points made in Section IV. Appendix B discusses implications for the Council if fishery-independent surveys are restricted inside reserves.

This white paper should be considered a living document which may be modified over time as additional issues become apparent to the SSC in the course of

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[3] Reserves in State waters are subject to different regulatory requirements that those indicated in this document. To the extent that the Council is involved in deliberations regarding reserves in State waters, the SSC will rely on the Council for specific guidance regarding its role (if any) in reviewing State proposals and the criteria to be used in such review.

[4] Throughout this document, the term "Environmental Impact Statement" is intended to refer to all of the analytical requirements (including Regulatory Impact Review and Regulatory Flexibility Analysis) for Federal regulations specified by law and executive order.

reviewing marine reserve proposals, or as significant new research becomes available on marine reserves. References to government documents and the marine reserve literature cited in this paper are intended to be illustrative rather than comprehensive.

III. Reserve Objectives and Rationales

The following five objectives are commonly included among the reasons to implement marine reserves: (1) to provide insurance against management uncertainty and error, (2) to provide fishery benefits, (3) to provide ecosystem benefits, (4) to address social issues, and (5) to provide opportunities to advance scientific knowledge. Each objective is discussed here in terms of its underlying rationale. Guidance is provided for reserve proposals in terms of the need for specificity in defining objectives, careful interpretation of the literature and conceptualization of reserve issues in a manner that is useful for management. The separate treatment given to each objective in this section is intended to facilitate discussion of issues specific to the objective and should not be interpreted as an effort to preclude or discourage reserve proposals that may have multiple objectives.

Evaluating the scientific basis of particular reserve rationales requires careful consideration of what the reserves literature does and does not demonstrate with regard to reserve effects. The SSC offers the following caveats in interpreting that literature:

- Existing reserves (at least in the U.S.) have not been sited on the basis of statistical design considerations (see Section III.E). As a result, empirical studies of the effects of such reserves have been conducted primarily and by necessity under less than ideal conditions - e.g., lack of replicate reserves, non-random placement of reserves, lack of baseline information prior to reserve establishment. Lack of replicates makes it difficult to isolate reserve effects from other influences. Non-random placement of reserves makes it difficult to extrapolate results to other settings and complicates the placement and interpretation of control areas. Lack of baseline information limits the empirical analysis to comparisons of reserve and control areas after reserve establishment. In many of these empirical studies, technical difficulties are carefully discussed and appropriate caveats are placed on study results. Reserve proposals that rely on results of empirical studies to justify claims of potential benefits must be similarly cognizant of the limitations as well as strengths of such studies and scale their claims accordingly.

- An issue that merits further discussion in the literature is the possibility that the reserve itself - due to the effects of effort displacement on fishery resources and habitat in the open area - contributes to the differences observed between reserve and open areas. In other words, the very establishment of the reserve modifies the context within which its effects are evaluated. While it is theoretically possible to control for this effect by including replicates that reflect varying degrees of effort displacement from the reserve, it is generally impractical to do this. Differences between reserve and open areas detected in empirical studies should not be interpreted as improvements that reserves would provide over the *status quo*. The open area does not represent the *status quo* but rather the *status quo* modified by effort displacement and other changes precipitated by the reserve. The effects of the reserve are more aptly reflected in what occurs both inside and outside the reserve after reserve establishment; the *status quo* is what would have occurred in the same two areas if no reserve had been established.

III.A. Reserves as "Insurance Policy"

Reserves are sometimes advocated as an "insurance policy", that is, as a means of protecting fish stocks against environmental variability and errors and uncertainty in management (e.g., Guenette *et al*. 1998, Lauck *et al*. 1998). Uncertainty in fishery management arises from two general sources: getting the science wrong and getting the management wrong. Potential sources of scientific error include (1) biological process error (variability in demographic parameters), (2) observation error (survey, laboratory and database error), (3) model choice error (e.g., Ricker versus Beverton-Holt), and (4) error structure error (e.g., gamma vs. lognormal). Potential sources of management error include (5) judgment error (e.g., not paying adequate attention to the science) and (6) implementation error (e.g., implementing regulations that result in catches over or under the intended target). This characterization of management uncertainty pertains to stocks which are assessed. Many stocks are not assessed. For unassessed stocks, uncertainty is more fundamental, since the uncertainty itself is unknown without an assessment.

Reserve proposals intended to achieve an insurance objective should be specific regarding what the insurance is intended to achieve. For instance:

- If the objective is to reduce the risk of overfishing, the concept of overfishing has a particular technical meaning in the context of Council-managed fisheries. Reserve proposals that are intended to "protect against overfishing" must similarly include a clear definition of what the proposal defines as overfishing and how reserves can protect against it. A certain amount of risk aversion is currently reflected in Council harvest policy and regulations.[5] It is important that reserve proposals explicitly contrast their suggestions with existing policy and regulations in terms of reducing overfishing risks.

- If the objective is to insure for persistence, reserves - because of their potential to change the age structure of target species in ways that cannot be accomplished with other fishery management tools - may be uniquely qualified to achieve this. Persistence implies that it is better to have a complete age structure in one area (i.e., the reserve) than an exploited age structure everywhere. With a full age structure, target species are more likely to weather environmental and human-induced adversity. In this sense, reserves may be suited as a tool for mitigating the uncertainty in stock assessments and managing unassessed stocks - irrespective of any judgment regarding whether they are over- or under-exploited but simply to ensure persistence.

The potential for reserves to serve as insurance for persistence varies among species. For sessile species with small dispersal distances (e.g., abalone), a network of reserves can be quite effective. For groundfishes, information regarding distribution and movement is limited, with available information indicating significant behavioral differences among species. Given these differences, it is unlikely that any single reserve can be tailored to achieve a complete age structure for more than a handful of groundfish species. It would be helpful if reserve proposals identified (to the extent possible) the species or species complexes likely to be affected by the reserve.

III.B. Reserves as Source of Fishery Benefits

The reserve literature includes a number of theoretical models that demonstrate benefits to fisheries associated with the export of adults and eggs/larvae from reserve areas (e.g., Rowley 1994, Russ 2002). Fishery benefits are typically defined in such models as an increase in yield. Underlying these models are critical assumptions regarding species mobility, the extent of density dependence at different life-history stages, the amount of exploitation prior to creation of the reserve, and the nature and extent of effort redistribution after the reserve is established.

The basic scenario is as follows: Fishery exploitation causes reductions in numbers, ages and sizes of target species. Conversely, increases in numbers, ages

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[5] Precautionary measures employed in the groundfish fishery include the 40-10 harvest rate policy for assessed stocks. For stocks for which data are not adequate to conduct assessments, the Council sets levels of allowable biological catch - i.e., 75% of average annual historical landings for rudimentarily assessed stocks and 50% for unassessed stocks - that are consistent with NMFS guidelines for data-poor situations (Restrepo *et al.* 1998).

and sizes can be expected to occur when target species are protected in reserves. These structural changes in fish populations within the reserve cause yield to increase outside the reserve, via several possible mechanisms.

Adult export hypothesis - According to this hypothesis, increases in the biomass/density of fish within the reserve result in net emigration of adult fish from the reserve to the open area. This adult "spillover" is precipitated by density-dependent processes, i.e., fish leave the reserve as density and thus competition for resources increases within the reserve (e.g., DeMartini 1993, Polacheck 1990).

The degree to which fish move has a significant bearing on the extent of adult spillover from the reserve. If mobility is low relative to reserve size, substantial biomass may accumulate in the reserve but export will be low because fish will not migrate to the open area in appreciable numbers. Conversely, if mobility is high relative to reserve size, fish will not remain in the reserve long enough to avoid the impact of fishing. Mobility must therefore be in an "intermediate" range in order to achieve both the accumulation of biomass within the reserve and the level of spillover that may lead to enhanced yields.

Egg/larval export hypothesis - The change in age structure that occurs in the absence of fishing causes total egg production per recruit to increase in the reserve; this increase is largely due to the higher fecundity of older females. Older females may also tend to produce eggs that experience higher survival rates. In addition, the total number of fish in the reserve can be expected to increase due to the removal of all sources of fishing mortality, irrespective of any changes that may occur in the age structure. In concert, these two effects act to boost total egg production within the reserve. Dispersal of larvae from the reserve to the open area may then increase yield to the fishery, particularly if it is presently overexploited (e.g., Holland and Brazee 1996, Sladek Nowlis and Roberts 1997).

Due to density dependent processes (e.g., competition for resources), the per capita surplus production of fish populations tends to increase as biomass/density decreases. Thus total surplus production (i.e., the product of per capita production and population size) tends to be highest at intermediate levels of biomass and/or density. Consequently, adverse effects from density dependent interactions are expected to occur at the reserve level as fishing mortality decreases. The manner in which density dependence manifests itself has a significant bearing on the egg/larval export argument for marine reserves. If density dependence occurs pre-dispersal, the per capita production of adult fishes in reserves will decrease as density increases, thus countering the potential increase in egg production per recruit associated with the presence of older females in the reserve. If density dependence occurs post-dispersal, the extent to which egg/larval production results in increased recruitment to the fishery will depend on factors such as dispersal distances, metapopulation structure and source-sink dynamics.

Conclusions drawn from theoretical models of adult or egg/larval export regarding the effect of reserves on fishery yield are highly sensitive to the assumptions underlying the model. The validity of model assumptions to particular fish stocks is generally known only in a qualitative sense. For purposes of management, detailed life stage modeling is less relevant than whether an empirical relationship can be established between reserves and yield outside the reserve. Moreover, the body of empirical studies on West coast reserves is limited and not definitive in terms of yield effects. Most empirical studies do not focus directly on fishery yield but rather on whether increases in fish abundance and size occur inside reserves. However, increases in yield cannot be inferred solely on the basis of such changes.

Advocacy of reserves as a means of increasing fishery yield is typically based on comparisons of reserves with a vaguely defined *status quo* - typically a general statement regarding the failure of management or disparate examples intended to illustrate such failure. The SSC notes that the *status quo* in reserve proposals must pertain to the specific fishery for which reserves are being considered, as the details of that fishery matter a great deal to the conclusions that can be drawn. For instance, if the *status quo* is an overexploited fishery, reserves may enhance fisheries yield. However, if the *status quo* is a fishery that is being managed for maximum sustainable yield (MSY), it is not clear that reserves can enhance yield, given existing theoretical studies that demonstrate a general equivalence between the yield obtained through area-based and quota-based management schemes (e.g., Hastings and Botsford 1999, Mangel 2000).

Fishery benefits are typically characterized in reserve models in terms of increased yield outside the reserve. Even in cases where potential yield increases outside the reserve, there is no guarantee that fishery benefits will increase. For fishery participants and fishing communities, economic and social effects (e.g., changes in producer and consumer surplus, income and employment impacts, community stability) often matter more than yield. Whether or not changes in yield imply such benefits depends on what happens outside the reserve with regard to displaced effort, harvesting costs, pressure on fishery resources, potential for social conflict and fishery regulation (e.g., Hannesson 1998, Smith and Wilen 2003). Factors such as these will need to be considered in assertions of fishery benefits.

III.C. Reserves as Source of Ecosystem Benefits

Ecosystems can be characterized in a variety of ways. Reserve proposals based on claims of ecosystem benefits must be clear in what is meant by this objective. It is important that the objective not be expressed as a vague claim (e.g., “the objective of the reserve is to provide a fully functioning ecosystem”). Rather the objective should be expressed in terms that make apparent the relationship between the objective and measurable criteria that convey progress toward meeting the objective.

The literature on ecosystem benefits of reserves provides a number of theories and guiding principles regarding what happens to ecosystems in the absence of fishing and differences in ecosystem effects associated with larger versus smaller reserves. A number of empirical studies have also been conducted (largely outside the U.S.) that evaluate the nature and extent of ecosystem effects associated with reserves (e.g., Shears and Babcock 2002). Depending on the study, the comparison is typically based on one or more indicators (e.g., density, numbers, biomass, size, diversity of organisms) classified in some particular way (e.g., trophic level, family, genus, species, rare or keystone species, target versus non-target species, all species); habitat characteristics are occasionally also included in the comparison.

A number of reviews and meta-analyses have been conducted of ecosystem reserve studies conducted around the world (e.g., Cote *et al.* 2001, Halpern 2003, Mosquiera *et al.* 2000). Given the many ways in which ecosystem changes can be characterized, meta-analysis is necessarily constrained by the limited number of studies which provide common indicators that can be used as a basis for comparison. Comparison is further hampered by lack of documentation in some studies of additional factors that may also account for some of the observed ecosystem changes (e.g., extent of exploitation and habitat condition prior to reserve establishment, effectiveness of enforcement of reserve boundaries). One consistent result noted in many studies is that overall abundance/density of organisms tends to increase inside reserves. When analyses focus on effects at the individual species level, results tend to be mixed - with a tendency for some species (e.g., larger fish, predators) to increase in abundance/size and for other species (e.g., smaller fish, prey) to do the opposite. Reserves that are intended to provide ecosystem benefits will not necessarily foster outcomes that are consistent with objectives of single species management. Trade-offs like this are inevitable, given the complexity of species interactions in the ecosystem. Similar trade-offs also occur at the single species level, e.g., when regulations that benefit one species adversely affect other species.

Ecosystem effects of reserves are typically characterized in the literature by contrasting what happens inside and outside the reserve area. Depending on the nature and extent of fishing prior to establishment of the reserve, cessation of fishing may bring about significant ecosystem changes within the reserve area. However, it is important to note that the ecosystem includes the area inside and outside the reserve; it does not end at the boundary of the reserve. Thus, reserve proposals intended to provide ecosystem benefits must focus not only on potential effects within the reserve but also potentially adverse effects of displaced effort on the ecosystem outside the reserve. Reserve size must be tempered by the trade-off between ecosystem effects inside and outside the reserve. Effort displacement - which is typically viewed as implying economic and social effects - also has direct implications for whether reserves can achieve ecosystem objectives; ecosystem effects cannot be determined independently of displacement effects.

III.D. Reserves as Means of Achieving Social Objectives

Reserves may be intended to achieve objectives such as reducing social conflict among user groups, acknowledging and accommodating values held by various segments of the public regarding resource use, discouraging or encouraging particular types of resource use, protecting areas deemed unique in terms of cultural or natural heritage (e.g., Bohnsack 1996). Clarifying the motivation is important, given its relevance to reserve design. For instance, if the intent is to reduce social conflict, then a design that focuses on achieving spatial segregation of conflicting uses may be appropriate. If accommodating different public values is the motivation, then a zoning approach that is tailored to finding a “balance” among various types of consumptive use, non-consumptive use and non-use areas may be appropriate. If the intent is to discourage (encourage) particular types of use, then strategies such as spatial restrictions on use (spatial set-asides for use) may be appropriate.

Generally speaking, regulatory analysis requires that a management objective be defined, that a problem be identified that impedes achievement of the objective, that criteria be identified that measure progress toward addressing the problem, that regulatory alternatives be evaluated in terms of the criteria, and that a determination be made regarding which alternative best achieves the objective. Defining the objective and selecting a preferred alternative are ultimately policy decisions that reflect consideration of factors such as legal mandates and constraints, scientific evidence, and the magnitude and distribution of benefits and costs. In cases where an objective is expressed in terms that are subject to scientific evaluation, science can play an invaluable role in terms of diagnosing the problem, identifying appropriate evaluative criteria and evaluating the relative merits of alternatives relative to the criteria. In cases where the objective pertains to social issues, the choice of criteria is a policy decision that is more appropriately based on notions such as equity, fairness and the public interest; the SSC’s role in evaluating the suitability of any such criteria would be limited, at best. However, a technical analysis of some type may still be needed to evaluate the alternatives relative to the criteria. For instance, if economic value is considered a relevant criterion, economic methods may be used to analyze relative gains or losses in value associated with different alternatives. If “fairness” is a criterion, then methods of analyzing distributional effects may be useful. In such cases, the SSC could be of assistance to the Council in reviewing such analysis.

Some of the same approaches to reserve design that can be used to meet social objectives (e.g., zoning for multiple use, protection of unique areas) can also be used to address other objectives (e.g., ecosystem benefits). However, different objectives will not necessarily yield similar reserve outcomes. For instance, the attributes of an area that make it unique in terms of its role in the natural ecosystem may differ from attributes that are deemed unique and valuable to the public. It is important that reserve proposals clearly relate each management objective to criteria that are relevant to that objective.

The criteria used to evaluate achievement of a social objective are often themselves topics of intense public interest and advocacy, as these criteria typically have direct and obvious allocative implications.[6] One criterion sometimes advocated in the context of marine reserves is "existence value". Existence value is the value that people attach to an amenity independent of whether they use, consume, observe or otherwise directly experience it.[7] Typically economists use "revealed preference" methods to infer the value of market goods. However, because existence value is not revealed or expressed in observable behavior, it must be measured by "stated preference" methods such as contingent valuation (CV).[8]

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[6] This situation is not unique to marine reserves. The Council has had similar experiences in its own deliberations on fishery allocation issues.

[7] Other concepts of value that are also disassociated from current use of an amenity include "quasi-option value" (the value of future information associated with retaining an option that would be otherwise be lost by irreversibly modifying an amenity) and "option value" (a risk premium that reflects the value of increasing the probability of future access to an amenity in the face of uncertainty in future supply or demand of the amenity).

[8] CV involves the use of survey methods to elicit the economic value attached by respondents to a particular good or service. CV surveys include a hypothetical scenario that is designed to be specific and plausible in terms of the nature of the amenity being valued, the context in which it is to be considered, and the payment vehicle. As a prelude to the valuation questions, respondents are reminded of their personal income constraint and the availability of substitutes for the amenity. The valuation questions are worded in terms of willingness to pay or willingness to accept compensation, depending on the assignment of property rights to the amenity (i.e., whether the respondent must pay in order to obtain access to the amenity or must be compensated for its loss). CV surveys typically include attitudinal and socioeconomic questions, as well as debriefing questions that facilitate determination of whether the valuations provided by respondents represent their "true" preferences. Strategies are

While broad consensus exists among economists regarding the legitimacy of the concept of existence value, disagreements exist regarding the reliability with which it can be estimated. In 1992, in the wake of controversy associated with the use of CV to estimate damages associated with the *Exxon Valdez* oil spill, the National Oceanic and Atmospheric Administration (NOAA) convened a panel of economic experts co-chaired by two Nobel laureates to evaluate the CV method. After hearing extensive testimony from CV proponents and opponents, the NOAA Panel concluded that "... CV studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values [existence values]". In elaborating on this conclusion, the Panel cautioned that "The phrase 'be the starting point' is meant to emphasize that the Panel does not suggest that CV estimates can be taken as automatically defining the range of compensable damages within narrow limits" (NOAA 1993, p. 4610). The Panel also provided guidelines for CV studies that NOAA subsequently adopted in developing standards for the use of CV in damage assessment.

While CV has been subject to extensive research and refinement since the NOAA Panel issued its findings, the methodology remains a topic of debate within the economics profession. While some argue that well-conducted CV surveys can reveal true economic preferences associated with the particular scenario depicted in the survey (e.g., Carson *et al.* 2001, Hanemann 1994), others argue that CV (at best) reveals only generalized attitudes regarding classes of amenities and (at worst) provides little meaningful information regarding public preferences (e.g., Diamond and Hausman 1994).

In addition to the issue of how well existence value can be estimated, its role in the policy arena is also subject to debate. Some of this debate reflects deeply held philosophical differences regarding the appropriateness of imputing a dollar value to environmental amenities.[9] Additionally, although the use of CV to estimate existence

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employed to ensure impartiality in the wording and administration of the survey and representativeness of the sample. Survey results are analyzed in ways to determine their plausibility and consistency with existing theories of consumer preference (e.g., Mitchell and Carson 1989). In addition to CV, stated preference methods that require respondents to rank alternative scenarios or identify a preferred scenario rather than attach a monetary value to particular scenarios may also be used to estimate existence value (e.g., Louviere *et al.* 2000).

[9] This debate is commonly framed in terms of anthropocentric versus biocentric views of the world. Utilitarianism - a particular form of anthropocentrism that attributes value to whatever brings satisfaction to human beings - is an underlying premise of cost-benefit analysis. As pointed out by Goulder and Kennedy, "...utilitarianism does not necessarily imply a ruthless exploitation of nature. On the contrary, it can be

value has occurred largely in the context of environmental damage assessment, existence value is a matter of public preferences and can conceivably exist for a broad range of goods and services. Just as gains in existence value may occur as a result of regulatory improvements, losses of existence value may occur as a result of regulatory costs.[10] Given the limited types of amenities to which CV has been applied, it is difficult to make generalizations regarding the relevance of existence value to the breadth of goods and services affected by regulation or to anticipate the particular circumstances in which a regulatory action is likely to trigger notable gains or losses in existence value.

All market and non-market values (including existence value) should rightfully be considered in cost-benefit analysis. Cost-benefit analysis, in turn, implies a decision criterion of economic efficiency (i.e., the desirability of allocating scarce resources to uses that yield highest economic value).[11] It is not clear to the SSC whether advocacy of existence value in the context of marine reserves is intended

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consistent with fervently protecting nonhuman things, both individually and as collectivities" (Goulder and Kennedy 1997, p. 24) - thus the relevance of existence value to cost-benefit analysis. A more biocentric view is expressed by Ehrenfeld: "Assigning value to that which we do not own and whose purpose we can not understand except in the most superficial way is the ultimate in presumptuous folly" (Ehrenfeld 1988, p. 216).

[10] "...in considering rules that limit economic activity to protect the environment, it is as appropriate to include a contingent valuation of existence value for destroyed jobs as the one for protection of the environment" (Diamond and Hausman 1994, p. 59).

[11] The role of economic efficiency in Federal fishery management policy is prescribed in National Standard 5 of the MSFCMA: "Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose" (NOAA 1998, p. 24234). Policy makers are often at least as concerned with distributional effects as with economic efficiency. In this regard, it is relevant to note that the market and non-market valuation methods used in cost-benefit analysis reflect the prevailing distribution of wealth, with wealthier individuals generally mattering more both in terms of market influence and expressions of existence value. Distributional considerations are implicitly reflected in cost-benefit analysis in terms of the weights attached to the various costs and benefits and the discount rate used to weight current relative to future effects. Explicit consideration of distributional effects can be achieved by disaggregating the individual costs and benefits that comprise the cost-benefit ratio. Methods other than cost-benefit analysis can also be used to evaluate distributional effects in units other than economic value.

solely to highlight its importance in the decision process or (more broadly) to signal support of economic efficiency as a decision criterion. In either case, the policy choice is not one of considering only quantified estimates of existence value or ignoring it altogether, as the public process allows for advocacy on behalf of all values - e.g., market values, non-market values attached to the existence of unfished areas and fishing fleets - whether they are quantified or not. The issue appears to be whether the public process yields a "better" policy outcome when values that are not normally quantified (e.g., existence value) are monetarily expressed. Generally speaking, data and analytical requirements make it difficult to estimate both market and non-market values of the type required for cost-benefit analysis. The Council typically relies on regulatory analysis using best available information (non-monetized and monetized) - as well as public input - in evaluating benefits and costs.

In cases where CV estimates of existence value are included in reserve proposals, documentation of survey design, implementation and analytical methods is important for determining whether the estimates meet standards for well-conducted CV surveys (e.g., Carson 2000, NOAA 1993). With regard to the CV requirement for a scenario that establishes context for the amenity being valued, completeness and accuracy of the scenario would be enhanced by a description of the trade-offs associated with provision of the amenity. Given existing uncertainty regarding the range of goods and services to which existence value can be reasonably attributed, a scenario that describes reserve benefits and associated short- and long-term gains and losses to the fishing industry would help ensure that whatever notions of existence value that respondents associate with both gain and loss aspects of the scenario can be reflected in their valuation responses. For proposals that include existence value estimates derived via benefit transfer methods (i.e., methods of transferring valuation estimates associated with a study site to a policy site), a rationale for why the study site results are relevant to the policy site is needed to determine whether the benefit transfer was conducted in a manner consistent with the literature (e.g., Kirchhoff *et al.* 1997, O'Doherty 1995, Smith *et al.* 2000). Finally, while CV can provide insights into public preferences, given the NOAA Panel's characterization of CV results as a useful "starting point" for discussion, it will also be important for proposals to avoid interpreting such results as highly precise estimates of such preferences.

III.E. Reserves as Opportunity to Advance Scientific Knowledge

Reserves are sometimes advocated as a way to advance scientific knowledge (e.g., Murray *et al.* 1999, Roberts 1997). Reserve proposals specifically intended to meet this objective will need to meet the standards of a scientific research proposal. The established scientific paradigm for experimental research involves hypothesis testing based on replicated treatments (Hurlbert 1984). Hurlbert (1984) identified control, replication, randomization, and interspersion as essential elements in the design of ecological studies. These elements are required if the study is to produce data suitable for comparative statistical analysis. Reserve studies of this type are rare and occur largely outside the U.S. (e.g., Mapstone *et al*. 1996, Punt *et al*. 2001).

Reserve proposals based on a replicated study design will need to include a well-defined hypothesis, a rationale for why the hypothesis is worth exploring and a statistically valid experimental design (including a power analysis). In cases where some flexibility exists regarding the number/size/location of reserves to be used in the experiment, it would be helpful if the proposal included a comparison of experimental design alternatives in terms of the nature and conclusiveness of results that can be expected from each alternative, as well as any other notable differences (e.g., budget) that may exist among alternatives.

A replicated study design, including hypothesis testing and statistical analysis, is probably best suited to systems of small nearshore reserves where replication and random or interspersed-random site selection is more likely to be feasible. However rigorous research of this type is often impractical or impossible, particularly with regard to offshore reserves. Access is limited, the physical and biological systems are dynamic, and reserves are open systems with import and export of water, nutrients, and organisms. Properly applying such an experimental design to marine reserves poses major challenges of cost, scale and logistics. In such cases, serious consideration should be given to alternative approaches, including before-after impact studies that can provide important scientific insights using primarily descriptive techniques.

An unreplicated treatment may provide useful information if a gross effect is expected or if the objective is to make only an approximate estimate of the effect. However, studies of this type require a different approach to data analysis. Hurlbert (1984) cautions strongly against applying standard statistical techniques such as t-tests, ANOVA and their non-parametric analogues to data from experiments that lack proper replication. For example, he points out the inappropriateness of applying inferential statistics to experiments involving a single treatment and control pair. One possible solution is to make graphs or tables showing mean values or trends, along with confidence intervals, allowing a reader to evaluate the likely importance of patterns. Effects on response variables can be related to treatments through measurements of factors related to known mechanisms of interaction. In this way a treatment effect can be convincingly described without the use of standard significance tests.

Successful unreplicated large-scale studies include artificial eutrophication of an experimental lake (Schindler *et al*. 1971) and clear cut logging and herbicide treatment in an experimental forest (Likens *et al*. 1970). These studies tracked or mapped variables of interest such as temperature, nutrient concentrations, primary production, and phytoplankton species composition and distribution over time. Measurements were taken at intervals before and after treatment. Both studies demonstrated the effects of experimental manipulations without replicate experimental units and provide insights into design and analysis that may also be useful in marine reserve research.

Reserve proposals based on a non-replicated design will need a clear description of the system proposed for study and how the treatment is expected to affect this system, along with a rationale for the importance of the research. Especially important for this kind of proposal is a sampling program expected to illustrate the treatment effect in a meaningful way. Non-replicated designs are vulnerable to temporal changes which may be due to to environmental and other influences being interpreted as treatment effects. Proposals should detail how they expect to be able to detect such confounding influences and distinguish them from treatment effects. Proposals should establish the current level of understanding of the system and describe the expected system response and mensuration techniques in sufficient detail to enable reviewers to evaluate the likelihood of success.

All scientific research proposals should include information on the time line for completion of the experiment, the methods of data collection and analysis that will be used, and the budget (including any assurances that can be provided regarding the adequacy of funding for the duration of the experiment). While pressures may arise to initiate experiments by taking immediate action to establish reserves, a well-designed experiment may require that sampling be conducted for a number of years prior to reserve establishment. Establishment of research reserves essentially require that exclusive use of an area be given to a particular user group (scientists). Thus in weighing research benefits against costs, it is important to consider not only research costs but also the costs associated with displacement of other user groups from the area. Proposals for research reserves should provide reasonable assurance that they will yield conclusive and policy-relevant results if policy makers are to be receptive to the establishment of reserves solely on the basis of research.

In the U.S., research on reserves is more likely to be conducted opportunistically than at reserves established primarily for that purpose. While opportunistic research is necessarily conducted under less than ideal statistical design conditions (see Section III), it may provide valuable information that could not otherwise be obtained. Even research that is only capable of providing site-specific rather than generalizable insights into reserve effects may be useful, particularly to those with management responsibility for that site. In situations where reserve proposals do not include research as an objective but there is some flexibility in reserve design over and above what might be required to meet the objective of the proposal, it may be desirable to consider whether such flexibility is conducive to accommodating research needs in some way. The point is not to discourage research but to encourage sound research methods and ensure that expectations and outcomes are conveyed to policy makers in ways that are commensurate with the technical merits and uncertainties associated with the particular research in question.

III.F. SSC Perspective on Scientific Basis for Achievement of Reserve Objectives

Reserves - like other types of management measures - must be considered in the context of the specific objective that they are intended to achieve. Based on existing rationales and evidence regarding reserve effects, the SSC offers the following perspective regarding the extent to which available scientific information indicates that reserves can be reasonably expected to achieve the objectives discussed in Sections III.A. to III.E. SSC comments should not be construed to imply any judgment about the relative merits of the objectives themselves, as the choice of objective is a policy decision. Nor are these comments intended to imply that an objective can be achieved by reserves alone (i.e., without other accompanying regulations) or that reserves are always essential to achieving the objective.

- *Reserves as insurance policy* - Reserves are uniquely qualified to provide a complete age structure for target species and thereby enhance persistence, i.e., the ability of fish stocks to withstand adverse effects associated with environmental variability and management uncertainty and error. In this sense, reserves have significant potential as a tool for mitigating uncertainty in stock assessments and managing unassessed stocks. Other reserve rationales also exist that pertain to reducing risk and uncertainty. For instance, the Council's biennial specifications for the groundfish fishery include long-term area closures as a way to reduce the risk of overfishing.

- *Reserves as source of fishery benefits* - The reserves literature typically characterizes fishery benefits in terms of increased yield outside the reserve. Theoretical models that are used to demonstrate increases in yield are highly sensitive to underlying assumptions regarding the behavior of fish stocks, the extent of exploitation prior to the reserve and the nature and extent of effort redistribution after the reserve is established. While such models provide insights into how particular circumstances and processes might affect yield, the practical question of how well model assumptions apply to particular fish stocks remains largely unanswered. For purposes of management, detailed life stage modeling is less relevant than whether an empirical relationship can be established between reserves and yield outside the reserve. Existing empirical studies focus largely on increases in fish abundance and size inside reserves; however, such effects do not necessarily imply increased recruitment to the fishery. The evidence for increased yield is not compelling - particularly in well-regulated fisheries. The SSC cautions against raising such expectations in Council-managed fisheries.

- *Reserves as source of ecosystem benefits* - In evaluating the ecosystem effects of reserves, it is important to consider effects both inside and outside the reserve as the ecosystem itself extends to both areas. Depending on the nature and extent of fishing prior to reserve establishment, cessation of fishing may yield significant ecosystem changes within the reserve area. Reserves are a potentially useful tool for providing ecosystem benefits, provided that notable effects of effort displacement on the ecosystem outside the reserve are also effectively managed.

- *Reserves as means of achieving social objectives* - This objective differs fundamentally from the other reserve objectives in that the choice of criteria to evaluate achievement of this objective is a matter of policy rather than science. However science (most notably social science) can be useful for evaluating management alternatives relative to the policy criteria. Just as the Council has some discretion to address social issues such as allocation under the MSFCMA, reserve proposals may also employ social objectives to the extent that the objective is consistent with the specific legal mandates and constraints underlying the proposal.

- *Reserves as opportunities to advance scientific knowledge* - Proposals for research reserves should be evaluated on the same basis as other types of research proposals. Technical requirements for such proposals would include a well-defined hypothesis, a rationale for why the research is worth pursuing, a description of experimental design, and sampling and analytical methods. Section III.E. provides guidance to facilitate preparation and evaluation of such proposals.

Marine reserves are one of many tools available to fishery managers. They are well suited to addressing objectives such as reducing management uncertainty and providing ecosystem benefits. The decision to implement reserves should be decided on a case-by-case basis - depending on the specific objective, the particular context in which reserves are being considered, and how management alternatives compare in terms of expected effects.

IV. Analytical Framework for Marine Reserve Proposals

As indicated in Section II, SSC expectations of all regulatory analyses are guided by the Council's mandate to rely on best available science and by Federal requirements as specified in the National Environmental Policy Act (NEPA), the Regulatory Flexibility Act (RFA), Executive Order (EO) 12866 and other applicable law. This paper is not intended to serve as comprehensive guidance to such regulatory requirements. Such guidance exists elsewhere (e.g., CEQ 1993, CEQ 1997, NMFS 2000, NMFS 1997, NOAA 1999, NOAA 1998, SBA 2003). Nor is the intent to provide a "cookbook" approach to evaluating reserve alternatives, as reserve proposals can vary widely in terms of their objectives and the particular context in which they are considered. The intent is rather to make recommendations regarding how to address technical issues and analytical requirements that are specific (though not necessarily unique) to marine reserves.

The guidance provided here pertains to topics that are customarily included in regulatory analysis: defining the objective, describing the management context and affected environment, identifying the problem that is impeding achievement of the objective, and devising and analyzing management alternatives intended to address the problem. In reviewing such regulatory analysis, the SSC considers a number of factors - e.g., the appropriateness of the data, the validity of data collection methods, the soundness of analytical methods, the manner in which the data and analysis are used to characterize the problem and evaluate potential solutions to the problem. For illustrative purposes, Appendix A includes examples of how each topic was addressed in the EIS prepared by the Council for the 2003 groundfish specifications (PFMC 2003). The reason for using this particular EIS as an illustration is that area closures were an integral component of the management alternatives considered in the EIS. Moreover, as a recently completed analysis, the EIS reflects current Federal regulatory requirements under the NEPA, the RFA and EO 12866.

The Council's 2003 EIS may also differ in significant respects from an EIS that might be prepared for future marine reserve proposals prepared by the Council (or submitted for Council consideration by outside entities):

- The management objective addressed in the Council's 2003 EIS is to reduce the risk of overfishing. As indicated in Section III, other types of objectives are also possible.

- The area closures considered in the EIS are unprecedented in the Council's experience in terms of their size and the range of affected fishing operations. Other reserve proposals will differ in scope and size.

- The Council's 2003 EIS pertains to setting annual specifications for the groundfish fishery. These specifications are subject to reconsideration according to the Council's biennial management cycle. Proposals involving reserves will require a much lengthier temporal analysis than the EIS.

- The management objective addressed in the EIS is to ensure that optimum yields (OYs) for individual species - expressed as specific numeric values - are not exceeded. Marine reserve proposals may not be based on such strictly quantitative criteria.

Thus, the Council's 2003 EIS should not be viewed as a strict template for marine reserve proposals but rather as suggestive of the types of issues that may arise in considering reserves and the types of data and analytical approaches that may be useful for considering the impacts of reserves. Each topic heading in this section includes in parentheses the section of Appendix A that describes how that particular topic was addressed in the EIS.

IV.A. Specifying the Management Objective (see Appendix A-1)

The management objective addressed by the proposal should be described in specific terms and in the context of the relevant mandates. Some of the mandates that the Council is responsible for addressing (e.g., MSFCMA) may differ from mandates for reserve proposals initiated by outside entities (e.g., National Marine Sanctuaries Act).

IV.B. Describing the Management Context and Affected Environment (see Appendix A-2)

Background information should be provided that enhances understanding of the problem that the proposal is intended to address. Relevant areas of discussion include (1) the current management situation, (2) events leading up to the current situation, (3) ongoing or anticipated management issues or measures that may not be directly related to the proposal but may have a bearing on the larger context within which the proposal is considered, and (4) the environment (e.g., ecosystem, fish stocks, fishery participants, fishing communities) expected to be affected by the proposal.

IV.C. Identifying the Problem and Role of Reserves in Addressing the Problem (see Appendix A-3)

The proposal should describe the problem to be addressed, why the problem is significant and why the *status quo* is inadequate to address the problem. If reserves are deemed a unique solution to the problem, the proposal should explain what makes reserves unique. As indicated in Section III, the role of reserves should be explained in specific terms. For instance, if reserves are intended to address an ecosystem objective, rather than stating that reserves will "provide a fully functioning ecosystem", the proposal should describe what aspects of ecosystem well-being are expected to be enhanced by reserves. If reserves are intended to reduce management uncertainty or provide fishery benefits, the proposal should specify the type of uncertainty that will be reduced or the type of benefits that will be provided.

IV.D. Defining the *Status Quo* (see Appendix A-4)

The proposal should include a description of the *status quo*, i.e., current and future conditions that can reasonably be expected to prevail if the proposal is not implemented. The time frame used to define the *status quo* (as well as alternatives to the *status quo*) should reflect the time period over which effects of the proposed regulatory change are expected to be realized. This is particularly important if benefits and costs are expected to change over time or to be realized over different time frames. Also, as discussed in Section III, all alternatives (including the *status quo*) should be evaluated on a common spatial scale, i.e., including areas both inside and outside the proposed reserve. Current (baseline) conditions may be a useful proxy for the *status quo*, but only if current conditions are expected to continue into the future.

IV.E. Defining Alternatives to the *Status Quo* (see Appendix A-5)

Reserve proposals should include a reasonable range of alternatives to the *status quo* and describe the rationale underlying them. If the problem identified in the proposal can be addressed only by reserves, the alternatives should take the form of different reserve configurations. The relevance of particular reserve features (e.g., location, size, configuration) should be discussed in relation to the management objective and other relevant considerations. Documentation of the data and assumptions underlying reserve design (e.g., habitat maps, species distributions, larval dispersal patterns, spatial distribution of fishing activity) should be provided, as well as any models or algorithms[12] that contributed to reserve design.

The marine reserves literature provides some insights into general principles for the design, size and location of reserves (e.g., larger reserves provide greater ecosystem benefits within their borders than smaller reserves; networks of reserves are needed to provide insurance against uncertainty). Specific recommendations in the literature regarding reserve size are based largely on theoretical models that focus on fishery benefits of reserves. As indicated in Section III.B., the results of such models are highly sensitive to underlying assumptions and have been subject to limited validation. Reserves are not "one size fits all". If reserve proposals intend to rely on size recommendations from the literature, it is important that such recommendations be consistent with model assumptions that are reasonably realistic in the context of the proposal.

The proposal should include a description of the operational requirements (i.e., the specific combination of regulations) associated with each alternative. If reserves are not a unique solution to the problem - that is, if the problem can also be addressed by non-reserve management measures or by combining reserves with other measures - the alternatives considered should reflect the broader range of feasible solutions. For instance, achieving an ecosystem objective may involve consideration of gear modifications or effort reduction - either separately or in conjunction with

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[12] If a reserve siting algorithm is used to evaluate impacts of alternative siting schemes, it is important that use of the algorithm not be limited to a single reserve size. The algorithm should be rerun over a range of sizes to gain a better understanding of how achievement of the objective specified in the algorithm is affected by alternative sizes. It is also important to recognize that such algorithms are analytical tools and that not all considerations relevant to selection of a preferred alternative can necessarily be quantified in a single algorithm.

reserves. Achieving an insurance objective may involve considering more precautionary adjustments to existing harvest rate policies - either as a separate alternative or in conjunction with reserves. In designing management alternatives, it is important to consider not only regulatory features that promote achievement of the management objective but also features that may be needed to address unintended consequences (e.g., adverse effects associated with effort displacement outside the reserve).

IV.F. Analyzing Management Alternatives (see Appendix A-6)

In addition to specifying an objective (Section IV.A.) and the specific problem impeding achievement of the objective (Section IV.C.), the proposal should provide measurable, verifiable indicators of progress toward achieving the objective and thresholds for determining when the objective has been achieved. Alternatives should be compared in terms of success in meeting the objective. Since the point of the analysis is to determine whether a change from the *status quo* is warranted, each alternative should be evaluated relative to the *status quo*.

Effects that may not be directly relevant to the objective should also be evaluated. For instance, if the objective of the reserve proposal is biological, management alternatives should also in terms of socioeconomic and ecosystem effects - both positive and negative. Documenting all consequences is important, as effects that may be unrelated to achievement of the objective may also have a bearing on the feasibility or desirability of an alternative.

One effect common to all reserve proposals is effort displacement. The SSC is aware of the limited information and high degree of uncertainty inherent in addressing the effects of displacement. However, given the need for managers to consider whether closer monitoring and/or additional regulation are needed to address such effects, this issue cannot be ignored. The size of the closures considered in the Council’s 2003 groundfish specifications warranted extensive consideration of this issue, including more restrictive regulation outside the closed area. Not all reserve proposals will necessarily warrant changes in monitoring or regulation outside the reserve; however, this cannot be determined without some demonstration of the extent of displacement.

Reserves involve trade-offs between benefits that may accrue to fish stocks and ecosystems inside the reserve and potentially adverse biological, socioeconomic and ecosystem effects associated with effort displacement. In considering the effects of displacement, it is important to distinguish between effort foregone (effort that disappears from the fishery altogether) and effort that shifts to the open area. From an economic perspective, effort foregone implies economic losses, while effort shifted to the open area provides at least some opportunity to mitigate the short-term economic losses associated with the reserve. Effort shift may have implications not only for displaced vessels but also for vessels with whom they interact outside the reserve in terms of increased competition, congestion, harvesting costs and social conflict.

Whereas effort shift implies some ability to mitigate the short term economic losses associated with the reserve, from a biological or environmental perspective, the less effort that moves to the open area the better. Determining the nature of such effects is not always straightforward. For instance, biological effects are not necessarily limited to stocks previously harvested in the reserve, as effort transferred to the open area may focus on different species than were targeted in the reserve. Bycatch patterns may also differ from what previously occurred in the reserve. Ecosystem effects may vary, depending on whether the transferred effort is associated with gear types or fishing strategies that are more or less likely to adversely affect habitat, and whether effort is transferred to habitats that are more or less vulnerable to gear effects.

To the extent possible, the analysis should be based on data and studies specific to the fish stocks, ecosystems, fishery participants and fishing communities that will be affected by the proposal. Assumptions underlying the analysis should be plausible in terms of reflecting the characteristics and behavior of the affected entities. To the extent that the analysis relies on data or results for other stocks, ecosystems, participants and communities, the appropriateness of relying on such outside information should be apparent in the analysis.

Regulatory analysis - whether it involves marine reserves or other types of management measures - is constrained by limited knowledge and data regarding the environment, fish stocks, and the social and economic behavior of fishery participants. A number of analytical approaches (e.g., risk assessment, sensitivity analysis) can be used to convey the extent of risk and uncertainty in an analysis. Careful interpretation and qualification of results are also useful for conveying the extent of uncertainty. In cases where effects cannot be quantified, a qualitative analysis may be useful for portraying the direction of change or relative differences among alternatives. A careful qualitative evaluation is preferable to a quantitative evaluation that conveys more certainty than is warranted. If an effect is unknown, it should be characterized as unknown.

IV.F.1. Biological (Species-Specific) Effects (see Appendix A-6a)

If the management objective pertains to protection or enhancement of particular species, analysis of biological benefits should focus on those species. Effects on species that are not directly relevant to the objective may also be of interest, particularly if such effects have implications for management of those species. While anticipating effects of reserves at the species level can be difficult, even information on the identity of affected species or species complexes and the direction of the effect may be helpful in identifying biological effects.

As discussed in Appendix B, the exclusion of fishery-independent surveys from reserve areas may complicate the Council's efforts to conduct the types of assessments needed to fulfill its management responsibilities. Reserve proposals should be clear regarding whether conventional research surveys, based for example on trawling, would be allowed in the reserve area and (if allowed) whether any constraints would be imposed on the conduct of such surveys.

IV.F.2. Social and Economic Effects (see Appendix A-6b)

Approaches for evaluating economic effects include economic impact analysis and cost-benefit analysis. Economic impact analysis focuses on income and employment impacts in local economies, while cost-benefit analysis focuses on societal-wide effects, as estimated using standard concepts of economic value (producer and consumer surplus, opportunity cost). Available data and models are rarely adequate for conducting a comprehensive cost-benefit analysis that addresses effects on all affected entities expressed in appropriate units of value (e.g., consumptive, non-consumptive, non-use values). A partial cost-benefit analysis (e.g., covering some affected entities) may be useful, although any such analysis should also be accompanied by appropriate caveats regarding the types of effects that could not be addressed.

In cases where limitations in existing information preclude estimation of economic impacts or economic value, it may be necessary to rely on other monetary or non-monetary indicators of economic and social well-being. For instance, effects on fishery participants may be evaluated in terms of numbers of affected entities (e.g., boats, processors, other businesses, fishermen); amount of commercial and recreational effort displaced; changes in landings, revenues, costs, profits; extent of prior dependence on fisheries within the reserve area; nature and extent of fishing opportunities outside the reserve.

Socioeconomic effects expressed in a common monetary unit can have different meanings. Monetary effects that have disparate meanings should not be directly compared or added. For instance, measures of economic impact and economic value are not comparable. Even in cases where the same monetary variable is used to characterize effects on different entities, its meaning may depend on the context in which it is used. For instance, the ex-vessel value of landings is a source of revenue when applied to fishing vessels but a cost when applied to processors. While this particular component of processor cost may be correlated with processor revenue or differ from revenues only by a markup factor, it nevertheless has a different meaning to vessels and processors.

Reserve proposals should also include a discussion of the allocational implications of each management alternative, i.e., who reaps the benefits and who bears the costs. For instance, effects may be categorized by fishery, gear type, geographic area (e.g., ports, counties, states, management areas), vessel size class.

The types of categorization relevant to evaluating distributional effects will depend on the specifics of individual reserve proposals.

IV.F.3. Ecosystem Effects (see Appendix A-6c)

As indicated in Section IV.F., reserve proposals should provide some measurable, verifiable indicator of progress toward achieving the objective. In cases where the objective is ecosystem-related, identifying such an indicator is complicated by the many ways in which ecosystem effects can be portrayed. Given the limited information regarding density/numbers/biomass/size/diversity of organisms, it may be more feasible to characterize alternatives in terms of the extent to which they protect relevant habitat types. Reserve size should be tempered by the trade-off between beneficial ecosystem effects inside the reserve and potentially adverse effects of effort shifted to the ecosystem outside the reserve. Given the difficulty of directly evaluating such adverse effects, it may be necessary to rely on indirect indicators - e.g., the amounts and types of effort shifted to the open area, the size of the fishing grounds over which this effort is likely to be dispersed, the habitat types like to be occupied by this effort.

IV.F.4. Monitoring and Enforcement (see Appendix A-6d)

Reserve proposals should include a description of monitoring plans. These plans should be relevant to the objective of the proposal and the criteria identified in the proposal that measure progress toward meeting the objective. For instance, if a proposal is intended to achieve objectives such as reducing management uncertainty or providing ecosystem or fishery benefits, monitoring would provide the feedback needed to evaluate the effectiveness of the action taken and make adjustments as necessary to that action. If the objective is to advance scientific knowledge, monitoring would need to be consistent with the requirements of the experiment. If the objective is to establish reserves solely as an expression of public preferences, monitoring may not be needed to measure progress toward meeting the objective, as the objective may be met simply by the act of reserve creation. Reserve proposals should include a description of the types of data that will be collected, the regularity with which they will be collected, data collection methods and costs, and whether there is any long-term commitment of resources for data collection.

The SSC appreciates the difficulties associated with designing and implementing monitoring programs. For instance, pilot studies may need to be conducted in order to address statistical design requirements of the program. Unanticipated issues may arise after the program is initiated that require reconsideration of data needs or sampling methods. It is important that data analysis and review of monitoring procedures be conducted periodically so that such issues can be revealed and resolved in a timely manner. If results of the monitoring program are intended to be relevant to future management decisions, it is important that the relevant data and analyses be available at appropriate points in the management cycle.

The proposal should indicate the extent to which existing data collection programs are expected to contribute to the monitoring effort. Monitoring costs (like other aspects of the management alternatives) should be evaluated relative to the *status quo*. If relevant monitoring efforts are already underway (and these efforts can be reasonably expected to continue into the future), then only the incremental cost over and above existing monitoring efforts should be considered in evaluating alternatives.

Reserve proposals should also specify enforcement requirements associated with each management alternative. Enforcement costs (like monitoring costs) should be evaluated relative to the *status quo*. If the management alternatives themselves include any features that are intended to facilitate monitoring or enforcement, these features should be identified.

IV.G. Documenting Public Process (see Appendix A-7)

Reserve proposals should include a description of the process by which the need for reserves was identified and management alternatives were developed and analyzed. The extent of public involvement in the process and the nature of public comment should be documented.

V. SSC Conclusions and Recommendations to the Council

V.A. Marine Reserves in the Larger Management Context

Marine reserves are advocated as a means of achieving management objectives such as reducing uncertainty in management and providing fishery and ecosystem benefits. In considering reserves as a management measure, it is important not to lose sight of the fact that the appropriate starting point for discussion is the management objective. Management effectiveness is not achieved by focusing *a priori* on any particular regulatory measure but by determining which measure (or combinations of measures) would be most effective in addressing the objective. To accomplish this, it is important that the range of feasible solutions not be unduly restricted from the outset. The Council's EIS on the 2003 groundfish management specifications provides a good illustration of this point. While area closures were integral to achieving the Council's objective, the objective could not have been achieved without combining those closures with other types of management measures.

The SSC is keenly aware of deficiencies and gaps in existing data and scientific knowledge and the high degree of uncertainty that this situation brings to the management process. Just as uncertainty is an important and explicit topic of discussion in assessment models and regulatory analyses produced by the Council, marine reserve proposals are also expected to convey the extent of uncertainty in data, methods and results. The SSC supports the Council's commitment to fostering a management process in which technical issues can be aired openly and frankly; such dialogue is essential for improving data, methods and the scientific basis of management decisions. Similar transparency is expected in discussions of marine reserve proposals.

An EIS is much more than a paperwork requirement. It plays a substantive management role in terms of providing a meaningful synthesis of the information relevant to the issue at hand, conveying that information to the public and policy makers, and moving the process forward in a systematic and well-documented way. To serve the public process, several iterations of an EIS may need to be drafted and made available for public comment to ensure that a reasonable range of alternatives is identified and adequately evaluated. The public cannot be expected to provide constructive input and policy makers cannot be expected to make well-informed decisions unless they have access to a technically sound, informative and balanced EIS. Any policy preferences expressed in an EIS should be based on a rationale that reflects a careful weighing of alternatives and a recognition of positive and negative effects as well as uncertainties associated with all alternatives (including the recommended one).

Regardless of the management objective, the choice of a preferred alternative is ultimately a policy decision. While science (meaning both natural and social sciences) may inform some aspects of reserve design and facilitate systematic consideration of reserve effects, all relevant factors must ultimately be weighed in ways that are beyond the scope of science. The uncertainty and imprecision that are inherent in fishery data and assessment methods are also inherent in existing knowledge of marine reserves. Policy makers must weigh the risks and uncertainties associated with reserve and non-reserve management outcomes. Potential beneficial effects within the reserve must be weighed against potentially adverse effects of effort displacement outside the reserve. Intertemporal effects must be weighed in terms of short- versus long-term effects. The distribution of costs and benefits among affected entities must be weighed in terms of defining an equitable outcome. Policy decisions are further complicated if the reserve is intended to achieve multiple objectives, as the same reserve outcome is not necessarily suited to all objectives and the importance of each objective will need to be weighed in making the decision. In order to ensure that management is informed by best available science, it is first important to distinguish between issues that can be addressed by science and those that cannot. This distinction is important for ensuring that scientific issues receive the technical scrutiny they deserve and for clarifying the respective roles of scientists and policy makers in the management process.

The EIS for the Council's 2003 groundfish management specifications highlighted the role of OYs, depth-based closures, season closures, vessel landings limits and gear restrictions in protecting overfished groundfish stocks. This was an important objective for the Council. However, by reducing the operational flexibility of fishing operations, such measures may also accentuate (however unintentionally) the incentive for vessel operators to seek additional avenues of investment that allow them to remain competitive in the race for the fish.[13] [14] The SSC takes note of this latter effect not to discourage use of such measures (which are integral to achieving many of the Council's objectives) but to point out that there is no panacea for fishery management problems. Reserves - like other types of management measures - are well suited for some purposes but not others. Reserves - like other measures - can aggravate as well as address problems, depending on the context in which they are applied and the manner in which they are used. The SSC encourages caution in making broad generalizations about reserve effects.

V.B. Process for Considering Marine Reserves

The Channel Islands National Marine Sanctuary has established reserves in State waters and intends to extend these reserves into Federal waters; similar additional proposals from other entities may be forthcoming. To the extent that the Council becomes involved in implementation of such proposals, the SSC requests that the Council consider developing procedures for dealing with them. Council guidance could extend to a number of areas - e.g., procedures for keeping the Council informed and getting on the Council agenda; time constraints and deadlines for participating in the Council process (e.g., Council meeting schedules, briefing book deadlines, meeting notice requirements); types of information regarding the proposal that are needed at various stages of the process (initial discussion, development of

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[13] The "race for the fish" - which is endemic in most West coast fisheries - creates an incentive for fishery participants to invest in boats and equipment in ways that increase their competitive advantage. Because all vessels share this incentive, the initial advantage gained from such investment eventually dissipates as more vessels engage in this strategy. The collective result is to encourage additional rounds of investment to stay competitive and more intensive fishing to pay off the debt burden associated with this wasteful type of investment. The economic pressures resulting from excess investment encourage the industry to take a short- rather than long-term view of resource stewardship, require increasingly restrictive measures that contribute to the continuing cycle of overinvestment, and place untenable demands on fishery managers. This is the fundamental problem of fisheries management.

[14] The Council's EIS made several allusions to this issue as follows: "Proposed gear restrictions [finfish excluders, small footrope requirements] are likely to reduce gear efficiency, increasing cost per unit of harvest" (PFMC 2003, p. 4-29). Also, "As fishery revenue declines, absent new innovations that increase efficiency, and given the tendency of regulators to impose inefficiency as a means of fishery management, it is likely the fishery's ability to service debt declines" (PFMC 2003, p. 4-29). In an effort to change the incentive to race for the fish, the Council and the industry are now considering the use of individual transferable quotas in the groundfish trawl fishery.

alternatives, regulatory analysis, Council deliberation); advisory committees that need to be consulted at each stage; relative responsibilities of the Council and the proposal sponsor in terms of developing management alternatives and preparing the regulatory analysis.

Proposal sponsors would logically have prime responsibility for justifying their own proposals and preparing the analyses needed to evaluate the effects of what is proposed. However, in cases where the objective of a reserve proposal could also be achieved by changes in existing fishery regulations (or by some combination of reserves and non-reserve management measures), the SSC expects the proposal to include alternatives that reflect such possibilities. Not all sponsors are likely to know enough about Council regulations to adequately address this expectation on their own, and may desire Council input in shaping or suggesting alternatives as they relate to fishery regulation. This may be desirable from the Council's perspective as well, to ensure that reserve proposals do not compromise the Council's ability to fulfill its own management responsibilities.

The SSC also requests that the Council consider assuming a more proactive role in reserve discussions and plans as they relate to the Council's area of jurisdiction by developing an explicit policy with regard to marine reserves and working with other appropriate entities to develop a coordinated approach to reserves on the West coast. Such coordination would facilitate communication, avoid duplication of effort and increase the likelihood of a productive outcome for all parties. Limited resources are clearly an issue. However, some commitment of resources will be required, regardless of whether the Council chooses to involve itself by reacting to individual reserve proposals on a case-by-case basis or by being more strategic in its involvement. The SSC is concerned that the currently fragmented focus on marine reserves as a management strategy may result in outcomes that unduly complicate the Council's ability to carry out its management responsibilities. Given the stock assessment and fisheries expertise available within the Council family and the Council's experience with regulatory process and requirements, Council involvement in marine reserve planning processes would help ensure that such planning is grounded in the best available science and realistically reflects the complexities of management.

VI. Research and Data Needs

The data and models currently used by the Council provide limited consideration of the spatial distribution of habitat, fish and fishing activities. Recent developments (e.g., groundfish closures, EFH considerations) indicate a growing need for spatially explicit data and models. Such needs are directly relevant to Council management concerns and are not unique to marine reserves. Because reserves can affect a broad range of fisheries (depending on the types of fishing activity eliminated from the reserve and the alternative fisheries pursued by displaced vessels in the open area), spatial data are needed for a broad range of fisheries in terms of the distribution of fishing effort and social and economic characteristics of fishing activity. More and better information is needed on habitat and fish distributions. Research is needed on stock assessment models that include a spatial as well as temporal dimension, models that predict spatial shifts in fishing effort, and models that integrate stock and fleet dynamics in a spatially explicit way. Development of appropriate constrained optimization models based on explicit management objectives would be helpful for designing spatial management alternatives and evaluating the degree to which they meet the stated objective.

While more attention to spatial data and models is needed, data collection is costly and model development is not guaranteed to improve the science needed for management. Increased spatial resolution will require more complex models and thus estimation of more parameters. Model selection techniques will need to be applied to determine how differences in spatial resolution affect model performance and what approaches to data pooling might be appropriate. To the extent that data pooling occurs in non-spatial dimensions, the possibility exists that models will become less informative with regard to non-spatial dimensions of fish and fishery behavior.

Spatial closures are one of several methods that can be used in fishery management to reduce bycatch. The Council's groundfish closures are an example of this, albeit an extraordinary one due to the size of the closures. The groundfish closures provide a unique opportunity to analyze the effects of effort displacement on fishery participants, fishing communities and fish stocks in the open area. An important aspect of such research will be to distinguish the effects of effort displacement from other factors that may be going on concurrently with the displacement (e.g., regulatory changes).

If fishery-independent surveys are prohibited in reserve areas, the possibility of alternative data collection methods in the reserve may need to be considered to ensure the continuity of time series data used in stock assessments. This will require evaluating alternative non-lethal sampling methods in terms of feasibility, cost and whether they would provide the types of data needed for stock assessment. If non-lethal methods are deemed suitable, sampling procedures for reserve areas will need to be developed, as well as methods of calibrating results of such surveys with those from more traditional survey techniques used in the past. Consideration will also need to be given to whether possible changes in fish dynamics associated with reserve establishment may require changes in stock assessment models.

VII. List of Acronyms

CEQ - Council on Environmental Quality
CPUE - catch per unit effort
EFH - Essential fish habitat
EIS - Environmental Impact Statement
EO - Executive Order
ESA - Endangered Species Act
fm - fathom
FMP - Fishery Management Plan
GMT - Groundfish Management Team
HG - harvest guideline
IPHC - International Pacific Halibut Commission
LE - limited entry
MPA - marine protected area
MSFCMA - Magnuson-Stevens Fishery Conservation and Management Act
mt - metric tons
NEPA - National Environmental Policy Act
NMFS - National Marine Fisheries Service
NOAA - National Oceanic and Atmospheric Administration
OA - open access
OY - optimum yield
PFMC - Pacific Fishery Management Council
RFA - Regulatory Flexibility Act
SBA - Small Business Administration
SSC - Scientific and Statistical Committee
VMS - vessel monitoring system

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Appendix A. Relevant Examples from Pacific Council EIS on 2003 Groundfish Management Specifications.

A-1. Specifying the Management Objective

The management objective addressed in the EIS was "to ensure that Pacific Coast groundfish subject to federal management are harvested at OY during 2003 and in a manner consistent with the ... Groundfish FMP and National Standards Guidelines [of the MSFCMA](50 CFR 600 Subpart D)" (PFMC 2003, p. 1-1).

A-2. Describing the Management Context and Affected Environment

The EIS placed the 2003 groundfish specifications in their historical context. Extensive information on the history and current status of groundfish stocks and management was provided. The EIS described the criteria used by the Council to determine whether assessed stocks are overfished, in precautionary status, or healthy (PFMC 2003, p. 3-6); current harvest rate policies (PFMC 2003, Figure 3.2-1 for assessed stocks and Section 3.5.1 for unassessed stocks); life history, status and management history of individual groundfish stocks (PFMC 2003, Section 3.2.1); and rebuilding parameters for currently overfished stocks (PFMC 2003, Tables 3.2-2 and 3.2-3).

The OYs for overfished stocks associated with each management alternative were based largely on results of rebuilding analyses conducted as part of the Council's stock assessment and review process. The EIS placed these rebuilding analyses in their broader temporal context: "The management framework and rebuilding analyses for overfished species are based on long-term stock rebuilding targets; current year OYs are based both on estimates of how past fishing mortality has affected the population and an assumption that the current harvest will be used over the course of the rebuilding period. In this sense a rebuilding analysis is a cumulative effects analysis of 'past, present, and reasonable foreseeable future actions'" (PFMC 2003, p. 4-14).

The EIS identified a number of pending Groundfish FMP amendments that were relevant to the setting of annual specifications. These included amendments related to establishment of a biennial management cycle (PFMC 2003, p. 4-61) and a vessel monitoring system (VMS) for the limited entry (LE) trawl and fixed gear fleets (PFMC 2003, pp. 3-62, 4-60 and 4-61).

Because the 2003 management specifications were expected to affect fisheries coastwide that target groundfish or harvest groundfish as bycatch, the affected environment described in the EIS broadly encompassed all such fisheries. Thus the EIS described historical trends in coastwide commercial and recreational fisheries (PFMC 2003, Tables 3.3-1a to 3.3-1d, Tables 3.3-2a to 3.3-4c, Tables 3.3-5a to 3.3-5b, Tables

3.3-6a to 3.3-6b, Table 3.3-20) and provided detailed baseline descriptions of commercial harvesting activity (PFMC 2003, Tables 3-3.23a to 3.3-25, Table 3.3-7), commercial processing activity (PFMC 2003, Tables 3.3-26 to 3.3-33), recreational fishing (PFMC 2003, Tables 3.3-34 to 3.3-38) and fishing communities (PFMC 2003, Tables 3.3-39 to 3.3-47, Tables 3.3-49 to 3.3-50). Given the emphasis of the 2003 specifications on protecting overfished species, the EIS described landings and discard of overfished species in the recreational fishery (PFMC 2003, Table 3.4-3) and landings of overfished species in the commercial fishery (PFMC 2003, Table 3.4-2), and provided detailed documentation (as available) of bycatch in selected sectors of the commercial fishery (PFMC 2003, Tables 3.3-8 to 3.3-15, Tables 3.4-4 to 3.4-9, Table 3.4-11, Tables 3.4-13 to 3.4-14).

A-3. Identifying the Problem and Role of Reserves in Addressing the Problem

The EIS characterized the management problem as follows: "... groundfish fisheries are now largely managed for certain key constraining overfished species. The harvest limits placed on these species prevents the fisheries from approaching OYs for other overfished and healthy stocks" (PFMC 2003, p. 4-14).

With regard to the role of area closures in reducing the risk of overfishing, the EIS stated: "The centerpiece of the Council-preferred Alternative and for all considered alternatives other than the No Action Alternative and Allocation Committee Alternative (without depth restrictions) is depth-based restrictions that seasonally move fisheries that catch overfished stocks out of the depth zones they inhabit. This management strategy was considered critical for managing fisheries to stay within the OYs of the most constraining overfished groundfish stocks given the current uncertainty in monitoring total catch for most fishery sectors. Depth-based fishery restriction zones are therefore prescribed to reduce the risk of overfishing these stocks" (PFMC 2003, p. 2-1).

With regard to the role of area closures in providing continued opportunities to fish healthy stocks, the EIS noted that "While bycatch reduction is the primary goal of depth-based management, it also provides some economic benefits for some sectors of the fishery, especially those sectors operating in areas deeper than the outer bounds of Conservation Areas. In those circumstances, there is an ability to allow larger trip and cumulative landings limits that are not constrained by the need to limit harvest of otherwise co-occurring overfished species" (PFMC 2003, p. 2-1).

According to the EIS, fishing activities that did not contribute to the problem would be allowed in the closed area: "... fisheries without a significant bycatch of overfished groundfish species or those with mitigative gear modifications may be allowed to occur" (PFMC 2003, p. 2-1). The particular fisheries and gears that would be prohibited in the reserve varied among management alternatives, depending on the OYs associated with the alternative, and also by area, depending on which overfished species were present in the area and how susceptible those species were to particular gear types. For instance:

- With regard to the Council Preferred Alternative, the EIS noted: "All gears with a demonstrated significant bycatch of bocaccio, cowcod, and other constraining overfished groundfish species are excluded from the 20-150 fm [fathom] depth zone south of Cape Mendocino, California where these species reside" (PFMC 2003, p. 2-1).

- For the Low OY Alternative, which prohibited all bocaccio harvest, "it was assumed that any nongroundfish fishery with reasonably measurable amounts of bocaccio would be closed in order to achieve the zero OY". To justify the choice of fishery closures, the EIS documented the extent of bocaccio bycatch in a number of fisheries - including pink shrimp, ridgeback prawn, salmon troll, sea cucumber and spot prawn (PFMC 2003, Table 3.4-5). For other non-groundfish fisheries for which bocaccio bycatch data were not available (e.g., Dungeness crab, gillnet complex, Pacific halibut, coastal pelagics, highly migratory species), the likelihood of bocaccio bycatch was surmised on the basis of groundfish bycatch and whether the fishery occurred in areas where bocaccio were likely to be encountered (PFMC 2003, pp. 3-56 to 3-57, pp. 3-58 to 3-59). "Based on discussions of the Ad Hoc Allocation Committee and Council" (PFMC 2003, p. 4-26), the EIS identified the non-groundfish fisheries that would be closed under the Low OY Alternative to include California halibut, gillnet complex, shrimp and prawn trawl and coastal pelagics.

A-3. Defining the *Status Quo*

Because the EIS pertained to setting management specifications for a single year (2003), the time frame for the analysis was also one year. It should be noted that this time frame is shorter than would be required for marine reserve proposals. The *status quo* (as well as alternatives to the *status quo*) was defined to include conditions both inside and outside the proposed reserve area.

For purposes of the EIS, the regulatory *status quo* consisted of the management measures implemented in 2002 (PFMC 2003, Table Tables 2.1-6 to 2.1-8). However, defining the fishery *status quo* was more complicated. Because Council deliberations on the 2003 management specifications began in 2002, the most recent year for which complete annual fishery information was available was 2001. The EIS, however, deemed November 2000-October 2001 to be a more plausible baseline period for the commercial fishery than calendar year 2001 on the basis that "in November and December of 2001 the fishery was under severe limits that are not typical of the usual fishing cycle" (PFMC 2003, pp. 4-23 to 4-24). A *status quo* estimate of the ex-vessel value of landings was then derived from the baseline by assuming (1) a 10% reduction in groundfish landings and revenues from the baseline, to account for more restrictive regulations in 2002, and (2) no change in non-groundfish landings and revenues relative to the baseline period (PFMC 2003, pp. 4-24 to 4-25). Thus the EIS provided an example of a situation in which adjustments to baseline had to be made to obtain a reasonable representation of the *status quo*.

A-5. Defining Alternatives to the *Status Quo*

The EIS included five alternatives to the *status quo* (PFMC 2003, pp. 4-14 - 4-15). A regulatory package was specified for each alternative that included OYs, depth-based closures, seasonal closures, cumulative landings limits, and gear restrictions for individual commercial fishery sectors (including LE groundfish, directed OA groundfish, tribal groundfish and non-groundfish sectors), and bag/size/gear/depth/season restrictions for the recreational fishery (PFMC 2003, Table 2.1-3).

The OYs specified under each alternative for key constraining overfished stocks (PFMC 2003, Table 4.2-1) reflected varying degrees of risk with regard to the probability of rebuilding these stocks to B_{MSY}. The EIS provided a rationale for the range of OYs as follows:

- The Low OY Alternative was consistent with bocaccio fishing mortality of 0 metric tons (mt) and rebuilding probabilities of 80%-100% for other overfished stocks. According to the EIS, this alternative "projects the lowest bycatch of all the overfished species and is the only alternative to meet the zero fishing mortality standard for bocaccio" (PFMC 2003, p. 4-41).

- The High OY Alternative was deemed "risk neutral" in the EIS in that it is "based on rebuilding trajectories with an estimated 50% probability of rebuilding by T_{MAX}. This is the longest rebuilding duration and the highest harvest allowed for overfished groundfish species under the National Standards Guidelines" (PFMC 2003, p. 2-3).

- With regard to the remaining three alternatives, the EIS noted that "The OYs represent a mix of the harvest levels and management measures within the range specified under the Low OY Alternative and the High OY Alternative" (PFMC 2003, p. 2-3). The two Allocation Committee Alternatives (one with, the other without reserves) were consistent with rebuilding probabilities of 60%-70%. The Council Preferred Alternative was more conservative than the Allocation Committee Alternatives in terms of depth and gear restrictions but less conservative than the High OY Alternative in terms of OY levels.

The EIS elaborated on each alternative by describing the role of each management measure - OYs, depth-based closures, season closures, trip/cumulative landings limits, gear restrictions - in ensuring precautionary management of overfished stocks while providing (to the extent possible) continued fishing opportunities. For instance:

- The EIS highlighted the role of area closures as a key feature of the alternatives: "The Council and its advisors recommend a depth-based management strategy that prohibits some fisheries and fishing gears in the depth zones these [overfished] species inhabit. This is considered a significant precautionary strategy and, in effect, establishes (if ultimately adopted) the largest marine reserve in U.S. territorial waters" (PFMC 2003, p. 4-39). The boundaries of the closure were based on the depth affinity of the harvestable component of key constraining overfished stocks - most notably bocaccio in areas south of 40°10' N. lat., and canary and yelloweye in areas north of 40°10' N. lat. To meet the needs of these species, reserve boundaries differed north and south of 40°10' N. lat., and also varied depending on the OYs and the other regulatory measures associated with each management alternative. Reserve boundaries specified in the EIS design were also influenced by enforcement considerations. "Upon the advice of the Council's Enforcement Consultants, these lines are specified to be as straight as possible for ease of enforcement" (PFMC 2003, p. 2-1).

- With regard to the effect of the OYs on the size of the spatial closures and duration of seasonal closures, the EIS noted: "The area and time fisheries are restricted varies among alternatives relative to the amount of harvest allowed under each alternative. More liberal harvest alternatives allow more fishing opportunities in those depth zones during a greater portion of the year in order to better access healthy co-occurring groundfish and non-groundfish stocks" (PFMC 2003, p. 2-1).

- The relationship of depth and time closures to landings limits was described as follows: "While bycatch reduction is the primary goal of depth-based management, it also provides some economic benefits for some sectors of the fishery, especially those sectors operating in areas deeper than the outer bounds of Conservation areas. In those circumstances, there is an ability to allow larger trip and cumulative landings limits that are not constrained by the need to limit harvest of otherwise co-occurring overfished species" (PFMC 2003, p. 2-1).

- Gear restrictions were also imposed that would provide continued fishing opportunities in the sanddab fishery by reducing the likelihood of groundfish bycatch in that fishery: "The Council OY exception of allowing commercial line gear with no more than five hooks (number 2 or smaller) and up to five lbs of eight if the gear is closely attended is designed to allow some risk-averse target opportunities to catch Pacific sanddabs. The smaller hooks and the horizontal groundlines used in the fishery significantly reduce bocaccio impacts" (PFMC 2003, p. 4–44).

In addition to protecting fish stocks within the closed area, the EIS also focused on the need to prevent bycatch of overfished species outside the closure from exceeding the OY levels specified in the management alternatives. Bycatch reduction regulations were customized to suit particular fisheries. For instance:

- "Yelloweye rockfish catch is a particular concern given their high market value, sedentary life style, and vulnerability to baited longlines. The GMT [Groundfish Management Team] recommended prohibiting retention of yelloweye rockfish in 2003 fixed gear fisheries and restricting most of these fisheries to outside the 100 fm management line....The recommendation to prohibit fixed gears in waters shallower than 100 fm...was based on the results of the IPHC [International Pacific Halibut Commission] Halibut longline survey where 99.1% of the yelloweye rockfish was caught inside 100 fm (Table 4.2-3)" (PFMC 2003, p. 4-43).

- With regard to the need to protect nearshore fish stocks from the effects of displaced effort, the EIS noted: "One of the consequences of limiting shelf fishing opportunities south of Cape Mendocino in 2003 is a significant commercial and recreational effort shift to nearshore areas. The southern nearshore fishery therefore needs to be restructured in 2003 in order to prevent over-harvesting of 14 nearshore rockfish species (including California scorpionfish) that are found primarily inside 20 fm" (PFMC 2003, p. 4-49).

  One method of restructuring nearshore fisheries involved strategic use of season closures that took into consideration the migratory patterns of key species. For instance, "...it was determined necessary to concentrate fishing opportunities during summer and autumn months, when the deeper nearshore stocks typically undergo an inshore migration....This approach matches fishing opportunities with the depth distribution of the resource, avoids over harvest of other deeper nearshore (i.e., non-permit) species that have a more shallow depth distribution (such as olive rockfish and treefish), and addresses concerns the proposed 20 fm restriction could increase the potential for localized depletion of those species with a preference for shallow habitat. These specifications form the basis for the Council-preferred Alternative harvest levels for the 2003 southern nearshore fishery" (PFMC 2003, p. 4-50).

- Gear restrictions were also used to reduce bycatch: "Gillnets were a gear with a demonstrated bycatch of groundfish. The gillnet complex fishery primarily occurs in waters off California where bocaccio bycatch is a major concern. One of the specifications of the Council-preferred Alternative was to prohibit set gill and trammel nets with mesh sizes less than six inches within the CRCA [California Rockfish Conservation Area]" (PFMC 2003, p. 4-40).

- The EIS utilized information on the participation of LE groundfish trawl, hook-and-line and pot vessels in non-groundfish fisheries during 1994-1998 (PFMC 2003, Figures 3.3-2a to 3.3-2c) to predict which non-groundfish fisheries would most likely be impacted by the transfer of groundfish effort from the reserve. The EIS noted that "It is clear...there is some degree of gear loyalty for groundfish vessels participating in groundfish fisheries. For example, a notable proportion of the nongroundfish fishery participation by groundfish trawl vessels occurs in the shrimp and prawn trawl fisheries" (PFMC 2003, p. 3–40). Based on this result, several State regulatory actions were included in the management alternatives (PFMC 2003, Table 2.1-5) to reduce the effect of displaced effort on groundfish bycatch in the shrimp and trawl fisheries. Specifically:

  (1) "Vessels targeting pink shrimp also land groundfish species.... Efforts are underway to reduce the incidence of groundfish bycatch, by requiring bycatch reduction devices (BRDs a.k.a. finfish excluders) and no-fishing buffer zones above the seafloor" (PFMC 2003, p. 3-56).

  (2) "Trap and trawl gears that target spot prawn exhibit differential bycatch rates; trawls are much more prone to catch overfished groundfish species (PFMC 2003, Table 3.4-9)....California revealed plans to either eliminate spot prawn trawls, convert the gear endorsements to trap only, or restrict spot prawn trawls to waters deeper than 150 fm. Despite the fact that spot prawn trawls are rare north of Cape Mendocino, Oregon plans to eliminate spot prawn trawls soon and Washington has already done so" (PFMC 2003, p. 4-46).

- Given the assumption that non-groundfish fisheries would absorb the extra costs associated with bycatch avoidance requirements and continue to operate unless otherwise constrained (PFMC 2003, p. 4-26), particularly severe action was expected to be required to implement the Low OY alternative. Specifically, "it was assumed that any nongroundfish fishery with reasonably measurable amounts of bocaccio would be closed in order to achieve the zero OY" (PFMC 2003, p. 4-26).

The EIS also documented features of the management alternatives that were intended to mitigate adverse ecosystem effects associated with effort shift to the open area. These included gear restrictions and closed area boundaries that encouraged movement of effort toward habitats where it would be less likely to have adverse effects on the ecosystem. Specifically:

- “Footrope restrictions, already implemented but extended to all areas shoreward of the closed areas under the Council-preferred Alternative, also reduce habitat impacts” (PFMC 2003, p. 4-3).

- The Council-preferred OY alternative specified an offshore closed area boundary of 250 fm (compared with the 150-250 fm boundary specified in the Allocation Committee alternative), while also allowing some trawling with small footropes in the nearshore CRCA. As noted in the EIS, “Assuming that trawl impacts in mud and sand areas are moderate, these exemptions may counterbalance the deeper outer boundary of the closed area, when comparing these two alternatives” (PFMC 2003, p. 4-4).

The alternatives were crafted in ways that highlighted the significance of particular management measures. For instance:

- Two versions of the Allocation Committee Alternative (with and without area closures) were devised to illustrate what would happen if the closures were not included in the regulatory package. Specifically, the EIS notes that “The Allocation Committee Alternative with no depth restrictions has lower trip limits and would result in the lowest projected catch of target species, although it would result in the highest bycatch of overfished species” (PFMC 2003, p. 4-4).

- Two versions of the Council-preferred alternative were evaluated to illustrate the importance of the nearshore caps. “For the nearshore fisheries it was assumed that effort and harvest would increase during open periods, and any nearshore caps established to control harvest would be fully harvested.... In order to better depict the economic effects of the cap, the recommended Council-preferred Alternative was modeled with and without the nearshore caps” (PFMC 2003, p. 4-25).

The EIS also documented alternatives that were considered and rejected. For instance, alternatives that would allow the bocaccio OY to exceed 20 mt were rejected on the basis that “More liberal bocaccio harvest level alternatives could risk stock extinction or an Endangered Species Act (ESA) listing” (PFMC 2003, p. 2-6). Complete year-round closure of the commercial fishery was rejected on the basis that it “would have significant socioeconomic consequences” (PFMC 2003, p. 2-7). Complete closure at certain times of the year was rejected on the basis that it “could force some segments of the fishery into times of the year when bycatch rates for a particular overfished species are highest....there is not one optimal time when all mixed stock fisheries could be closed and achieve the lowest bycatch rates” (PFMC 2003, p. 2-7). Documentation of this type is advisable in situations where management alternatives that may have been of particular interest to a stakeholder group did not make the “final cut” in the regulatory analysis.

A-6. Analyzing Management Alternatives

The analysis in the EIS relied on landings receipt, port sampling, logbook and survey data that were specific to the fisheries and species potentially affected by the management alternatives. The EIS also relied on relevant results from previous studies. For instance, descriptions of the distribution, life history and status of individual groundfish stocks contained in the EIS (PFMC 2003, pp. 3-6 to 3-24, Table 3.2-1) included numerous references to previous research specific to these particular stocks. The stock assessment and rebuilding analyses that served as the basis for the OYs specified in the management alternatives - as well as the development and analysis of alternatives - were based on information directly relevant to the species and fisheries under consideration.

All alternatives were evaluated on a comparable spatial scale, i.e., including areas both inside and outside proposed closed areas. Alternatives were evaluated on a common temporal basis, i.e., single year effects. Given that the EIS pertained to annual fishery regulations, this time frame was appropriate for this particular analysis.

Table 4.3-1 of the EIS compared the management alternatives relative to the *status quo*. However, in other tables (PFMC 2003, Tables 4.3-2a to 4.3-11), the comparison was made relative to the baseline rather the *status quo*. The reason for this inconsistency is not clear. However, it appeared to make little difference to the conclusions of the EIS, as the relative differences in ex-vessel revenue among alternatives tended to be similar, regardless of whether the basis for comparison was the baseline or the *status quo* (PFMC 2003, Table 4.3-1).

Sections A-6a to A-6c describe some of the approaches used in the EIS to analyze biological, social, economic and ecosystem effects. Section A-6d addresses monitoring and enforcement requirements.

A-6a. Biological (Species-Specific) Effects

The EIS provided a verifiable and measurable way to evaluate each alternative in terms of achieving the biological objective. Specifically, “The alternatives are compared in terms of their efficacy in constraining total fishing mortality on overfished stocks and the probability of rebuilding stocks” (PFMC 2003, p. 4-14). Alternatives were compared relative to the objective as follows: “Table 4.4-1 presents estimates of bycatch of overfished species across all fisheries....These values can be compared to the OYs in Table 2.1-1, which shows that the projected total mortality is at or below the OYs for all of these species, in some cases by a substantial amount (e.g., widow rockfish) due to the need to manage for constraining overfished species such as bocaccio, canary rockfish and darkblotched rockfish” (PFMC 2003, p. 4-15).

In evaluating the accuracy of the bycatch projections (Table 2.1-1), the EIS noted that harvests above OY "will have significant biological impacts," while harvests below OY will result in "socioeconomic impacts because of foregone income and fishing opportunities....Harvests above OY are unlikely because management measures can be changed throughout the year in order to slow harvest rates. However, harvests below OY for a given species have occurred in past years because of difficulty in managing multi-species fisheries" (PFMC 2003, p. 4-14).

As indicated in Section A-4, the OYs specified under each alternative for key constraining overfished stocks (PFMC 2003, Table 4.2-1) reflected varying degrees of risk with regard to the probability of rebuilding those stocks to B_{MSY}. These probabilities were based on the results of formal risk assessments. The EIS offered the following caveat regarding the uncertainty in the assessment results: "The accuracy and reliability of various data used in assessments - and the scientific assumptions on which they are based - need to be further evaluated to improve the quality of forecasts. Uncertainty associated with fishery logbook data, calibration of surveys, and accuracy of aging techniques also need more evaluation when considering survey reliability. Finally, a better understanding of ecosystem change and its influence on groundfish abundance will also improve stock assessments" (PFMC 2003, p. 3-60).

The bycatch estimates for overfished species provided in the EIS were based on an analysis of the separate effects of each management alternative on each key overfished species and each fishery sector. Some examples of the methods used in the EIS (and associated caveats regarding outcomes) are as follows:

- The EIS relied on a formal quantitative bycatch model developed by the GMT (PFMC 2003, pp. 4-40 to 4-43) to project harvest of key overfished species in the limited entry (LE) non-whiting trawl fishery under each management alternative. The model used PacFIN and trawl logbook data to estimate historical participation patterns specific to each vessel, target fishery, two-month cumulative landing period, area and depth. Using historical fishing patterns as a baseline, the model predicted the amount of effort displaced from the reserve under each alternative and the percentage of displaced effort expected to move to the open area. Observer data were used to estimate bycatch rates of individual overfished species in the various target fisheries (PFMC 2003, Tables 4.2-3a to 4.2-3b).

- The EIS offered the following caveats regarding bycatch estimates for non-trawl fisheries: "Without a comparably informative bycatch model for the fixed gear fisheries (including both the limited entry and open access sectors), there is much greater uncertainty estimating bycatch in these fisheries" (PFMC 2003, p. 4-43). Also, "The distribution of groundfish catch and bycatch in incidental open access fisheries is far less certain than in the other sectors (Table 3.4-5)" (PFMC 2003, p. 3-56).

- The EIS relied on behavioral inferences drawn from historical data and results of prior empirical studies to project the effect of the recreational fishery on key overfished groundfish stocks. Specifically, "The potential impact of nearshore fishing on these species [bocaccio, canary, yelloweye] may be estimated by (1) examining catch by depth from the recent recreational fishery, (2) estimating potential effort shift based on the recent performance of the recreational rockfish fishery during those periods when only 0 to 20 fm fishing was allowed; and (3) applying hooking mortality estimates to the bycatch of overfished species that will be inadvertently caught and released in the 0 to 20 fm fishery" (PFMC 2003, p. 4-51).

- Another example of an inference drawn from prior studies was use of a study by Lawson (1990) to predict the extent of groundfish bycatch in the salmon troll fishery: "With four spreads (the current configuration in Oregon south of Cape Falcon), catch rate reductions associated with alternatives that require a 4 fm distance between the cannonball and the lower most spread would be: 95% for canary rockfish, 0% for yelloweye rockfish (only two were caught), and 89% for lingcod (Figure 4.2-4)" (PFMC 2003, p. 4-45).

- To deal with uncertainties regarding how the Council might choose to allocate OYs of nearshore species between commercial and recreational fisheries and the effects of effort displacement in the recreational fishery on overfished stocks, the EIS described the implications of alternative feasible commercial/recreational allocations (PFMC 2003, Table 4.5-1) and also included a sensitivity analysis that explored the implications of different recreational effort shift and hooking mortality assumptions (PFMC 2003, Tables 4.5-2 and 4.5-4).

Given the importance of not underestimating bycatch of overfished species, the EIS preferred to err on the side of caution in making such estimates. For instance:

- "Since the [GMT bycatch] model did not incorporate more recent logbook data than 1999, the effect of the small foot rope restrictions on bottom trawling on the shelf are not represented. Use of the model in 2003 may tend to overestimate the bycatch of overfished shelf rockfish species and, in effect, provides a conservative buffer against overfishing" (PFMC 2003, p. 4-40).

- "For the nearshore fisheries, it was assumed that effort and harvest would increase during open periods, and any nearshore caps established to control catch would be fully harvested" (PFMC 2003, p. 4-25).

- "For the whiting and sablefish fisheries, it was assumed OYs would be fully harvested" (PFMC 2003, p. 4-26).

The EIS described various types of surveys (trawl, hook-and-line and SCUBA) that provide data in support of groundfish management. The EIS noted the usefulness of these surveys in providing "fishery-independent data which - because it is gathered in a uniform, consistent manner - provide 'benchmarks' used to track natural and anthropogenic changes in fish abundance" (PFMC 2003, p. 3-61). The management alternatives considered in the EIS allowed for continued collection of research survey data and an explicit accounting of mortality of overfished species in NMFS trawl and shelf surveys in the 2003 management specifications (PFMC 2003, Table 4.4-1).

A-6b. Social and Economic Effects

The EIS described the management alternatives in terms of how they would affect economic opportunities in specific fisheries. For instance:

- "The Low OY alternative would effectively end the recreational groundfish fishery in the south since the harvest rate on bocaccio would be set to zero. While other recreational fishing activities may be supportable in southern waters, these may be limited by the fact that bocaccio are not exclusively caught on the bottom or over hard substrate" (PFMC 2003, p. 4-46).

- "The High OY, Allocation Committee (with depth restrictions) and Council-preferred alternatives all specify no fixed gear opportunities in the 27-100 fm zone north of Cape Mendocino in California and Oregon and restricts the fishery to outside of 100 fm in waters off Washington to minimize canary rockfish and yelloweye rockfish bycatch....Without the depth restrictions, as modeled in the Allocation Committee Alternative, the fishery would be restricted to the nearshore 0 fm to 27 fm zone in northern California and Oregon. Fixed gear fisheries would be eliminated in Washington without depth restrictions since Washington does not allow commercial groundfish fisheries in their coastal marine waters" (PFMC 2003, p. 4-44).

The monetary and non-monetary indicators used in the EIS to describe socioeconomic effects were driven largely by data availability. In using available data, no attempt was made to "over-interpret" the data or construe the analysis as a cost-benefit analysis. Thus, for instance, because effects of the alternatives could not be measured in a consistent way among fishery sectors, comparison of alternatives was done on a sector-by-sector basis. The EIS also demonstrated a clear understanding of the distinction between economic impacts and economic value and took care to provide an accurate interpretation of income impacts: "These effects [income impacts] should be thought of as those 'associated with' the fishery rather than 'generated by' the fishery, because in the absence of the fishing opportunity some of the income would still be generated in the community or elsewhere in the economy" (PFMC 2003, p. 3-44).

Effects of the management alternatives on fishery participants and fishing communities were characterized in a variety of ways. For instance, fishery effects were expressed in terms of ex-vessel value for commercial harvesters (PFMC 2003, Tables 4.3-1 to 4.3-9, Table 4.3-13) and buyers/processors (PFMC 2003, Tables 4.3-10 to 4.3-11), and in terms of fishing effort and personal income impacts for the recreational fishery (PFMC 2003, Table 4.3-12).

In considering the distributional implications of each alternative, the EIS went to great lengths to compare effects not only among fishing communities and among commercial, recreational and tribal fisheries but also within fisheries. For instance, effects on the commercial fishery were evaluated separately for LE trawl, LE entry fixed gear, targeted open access (OA), incidental OA and non-groundfish vessels. Additional analysis was done to demonstrate how effects within each of these categories varied, depending on vessel dependence on groundfish (measured as percent of revenue attributable to groundfish), vessel involvement in fishing (measured by total fishing revenue) and vessel length (PFMC 2003, pp. 4-30 to 4-31, Tables 4.3-2a to 4.3-3b, Tables 4.3-5a to 4.3-6b). Effects on buyers/processors were evaluated in terms of their fishery participation (measured by the ex-vessel value of their landings receipts) (PFMC 2003, Table 4.3-10). Effects on the recreational fishery were evaluated by area and fishing mode (PFMC 2003, Table 4.3-12). Tribal effects were evaluated by gear type (PFMC 2003, Table 4.3-13). Community effects were evaluated by categorizing coastal ports into 17 fishing communities (PFMC 2003, Table 4.3-14), and expressing effects in each community in terms of the ex-vessel value of landings and income and employment impacts (PFMC 2003, Tables 4.3-14 to 4.3-18).

In addition to providing quantitative measures of socioeconomic effects, the EIS also provided qualitative insights into other socioeconomic implications of the alternatives. For instance:

- "To the degree that vessels might possibly target the species covered in the preceding list [species for which fishing would be potentially affected by depth restrictions south of Cape Mendocino] by moving their effort in areas that remain open, it is likely that costs would be higher and/or CPUEs lower than in normal fishing areas, raising cost per unit of catch" (PFMC 2003, p. 4-28).

- "Recreational charter vessels are probably more dependent on their home port than commercial vessels, though recreational charter vessels are known to exhibit some mobility between ports....Charter vessel operators and crew which do attempt to move operations to a port in an open area will face obstacles in recruiting clientele or developing new relationships with booking agents. The operator and crew may experience social effects associated with distance from family and social networks" (PFMC 2003, p. 4-32).

- "Those [recreational groundfish anglers] that live in an area may respond to a time/area closure by (1) not going groundfish fishing at all and spending their time and money in the same community on an alternative activity; (2) going groundfish fishing at a different, less optimal time; or (3) traveling to a different area to go fishing or take part in an alternative recreational activity. All cases reflect a loss of value to the individual associated with a shift to second choice activities" (PFMC 2003, p. 4-32).

- "Total value placed on offsite nonconsumptive use of the stock or component of the ecosystem set aside will depend on 1. the size of the human population, 2. the level of income, 3. education levels, 4. environmental perceptions and preferences. The above relationships imply that as human populations and the welfare of these populations increase and as the fish stocks and their ecosystem remaining in good condition declines, the nonconsumptive values associated with maintaining ocean resources is likely to increase. Also implied is that once the basic integrity of ecosystem processes and marine fisheries components are preserved, the likely additional benefit from incremental increases will decrease (PFMC 2003, pp. 3-37 to 3-38).

A-6c. Ecosystem Effects

While the Council's management objective was largely biological (to protect overfished stocks), the management action was of sufficient magnitude to warrant careful consideration of potential (albeit unintended) effects of displaced effort on the ecosystem outside the reserve.

Citing several west coast studies on the effects of trawl gear on habitat (Freese *et al.* 1999, Friedlander *et al.* 1999), the EIS concluded that "Bottom trawling is known to modify seafloor habitats by altering benthic habitat complexity and by removing or damaging infauna and sessile organisms" (PFMC 2003, p. 4-1). With regard to other gear types, the EIS noted that "Limited qualitative observations of fish traps, longlines, and gillnets dragged across the seafloor during set and retrieval showed results similar to mobile gear, such that some types of organisms living on the seabed were dislodged. Quantitative studies of acute and chronic effects of fixed gear on habitat have not been conducted" (pp. 4-1 to 4-2). Given the limitations in existing knowledge regarding gear effects, the EIS concluded that "... there is insufficient information to quantitatively predict the effects of the Pacific Coast groundfish fishery on ecosystems and habitats because indirect and cumulative effects are poorly understood" (PFMC 2003, p. 4-3). The evaluation of ecosystem effects provided in the EIS was thus largely qualitative.

The EIS noted the beneficial effect of area closures on the ecosystem inside the reserve: "Depth-based restrictions, if used, would eliminate bottom trawl impacts to habitat in large areas of the continental shelf (depending on the alternative)" (PFMC 2003, p. 4-3). In addition, the EIS evaluated potentially adverse effects on the ecosystem outside the closed area in terms of the specific regulatory measures associated with each alternative. For instance, the EIS noted that alternatives associated with smaller closures and/or lower OYs for overfished species would necessarily be accompanied by lower trip limits on target species to ensure that total bycatch of overfished species remained within the bounds set by the OYs; because lower trip limits would discourage targeting of healthy stocks, they would also imply lower levels of fishing effort and thus lesser effects on the ecosystem outside the closed area. The EIS described existing gear restrictions intended to protect habitat against adverse effects of fishing gear: "Bottom trawl footrope restrictions implemented by the Council make it difficult for fishers to access rock piles and other areas of complex topography (due to the risk of gear damage)" (PFMC 2003, p. 4-1). As indicated in Section IV.E., the EIS also discussed specific features of the management alternatives - i.e., spatial expansion of footrope restrictions, boundary features of the closed area that encouraged movement of effort toward habitats where such effort would be less likely to adversely effect the ecosystem - to mitigate the effects of displaced effort on the ecosystem outside the closed area.

The EIS utilized fishing effort as a surrogate for evaluating relative ecosystem effects among alternatives. Effort displacement, however, could only be modeled for the LE trawl fleet. As noted in the EIS, "...in the absence of a comprehensive assessment that will enhance the ability to quantify the effects of different types and amounts of fishing, the relative effects [derived from the trawl effort model] are presumed to correlate with total fishing effort and its distribution among the alternatives, which must also be evaluated qualitatively since currently we do not model fishing effort across all fisheries. This makes it difficult to meaningfully distinguish between the alternatives with respect to effects on the ecosystem because, although we know that the alternatives would have differential effects on ecosystem and habitat, we cannot specify the nature or magnitude of those effects with any precision" (PFMC 2003, p. 4-3).

The EIS described each management alternative in terms of closed area boundaries and trip limits (PFMC 2003, Tables 2.1-9 to 2.1-12). Footrope restrictions were described in Table 2.1-2 for the LE trawl fishery and in Table 2.1-5 for non-groundfish trawl fisheries (California halibut, sea cucumber, ridgeback prawn). By comparing the alternatives in terms of presence or absence of these ecosystem-relevant features, the EIS was able to provide some qualitative insights into the ecosystem effects of particular alternatives. For instance:

- "The Low OY Alternative will have the least impact on ecosystem and habitat because it has the lowest projected catch and most extensive closed areas" (PFMC 2003, p. 4-3).

- "Trip limits under the High OY Alternative are generally higher and depth-based restrictions are not as extensive as under the Low OY and Council-preferred alternatives. Thus this alternative is likely to have the greatest relative effect on ecosystem and habitat because it would allow the highest level of fishing effort. It would, however, implement depth-based restrictions but not the depth-based footrope requirement" (PFMC 2003, p. 4-4).

Conclusions in the EIS regarding ecosystem effects were tailored to what could be surmised from available information: "All of the action alternatives will result in reduced fishing effort in comparison to baseline conditions because of lower trip limits. Depth-based restrictions, if used, will eliminate bottom trawl impacts to habitat in large areas of the continental shelf (depending on the alternative). Footrope restrictions, already implemented but extended to all areas shoreward of the closed areas under the Council-preferred Alternative, also reduce habitat impacts. Thus, although the alternatives will have some effect on ecosystems and habitat (including EFH), these effects will be reduced from historical levels" (PFMC 2003, p. 4-3).

It is important to note that the management objective specified in the EIS was to protect overfished species, not provide ecosystem benefits. Thus for purposes of the EIS, it was deemed sufficient merely to demonstrate that management action would not make the ecosystem worse off relative to the *status quo*. Reserve proposals for which ecosystem benefits are the objective will require more concerted efforts to rank alternatives in terms of ecosystem effects than demonstrated in the EIS.

A-6d. Monitoring and Enforcement

The EIS described the *status quo* in terms of existing monitoring and enforcement activities. These included vessel reporting requirements (e.g., fish tickets, logbooks, declaration programs[15]), as well as agency activities such as dockside sampling and shoreside and at-sea surveillance (PFMC 2003, p. 3-62). Achieving the objective specified in the EIS (i.e., ensuring that harvests do not exceed OYs) has been a long-standing Council responsibility: "In accordance with the Groundfish FMP, since 1990 the Council has annually set Pacific Coast groundfish harvest specifications (acceptable and sustainable harvest amounts) and management

[15] According to the EIS, "Under declaration programs, legal incursions into closed areas must be reported to state enforcement authorities prior to fishing. This requirement is generally reserved for vessels that would otherwise appear to be fishing illegally when viewed from an at-sea patrol craft" (PFMC 2003, p. 3-62).

measures designed to achieve those harvest specifications" (PFMC 2003, p. 1-2). As indicated in the EIS, existing methods of harvest monitoring and making in-season regulatory adjustments would continue to be used. For instance, "The commercial fishery HGs [harvest guidelines] will be tracked inseason through the PacFIN 'Quota System Management' (QSM) system next season, and adjustments to the trip limits will be employed to align the cumulative landings with the available tonnage for the commercial sector" (PFMC 2003, p. 4-54).

The EIS described several ways in which monitoring and enforcement considerations shaped the management alternatives. For instance, with regard to alternatives that included area closures, the EIS noted that "Upon the advice of the Council's Enforcement Consultants, these lines [closed area boundaries] are specified to be as straight as possible for ease of enforcement" (PFMC 2003, p. 2-1). As another example, the EIS identified a provision of the High OY, Allocation Committee and Council-preferred alternatives that was intended to encourage full accounting of canary bycatch in the recreational fishery: "...a sublimit of one canary rockfish in the daily bag limit would be allowed in the north. This accommodates unavoidable bycatch and reduces the number of canary rockfish that are discarded dead. In the Council's judgment, this would not promote targeting of the species" (PFMC 2003, p. 4-47).

The EIS distinguished between management alternatives that included area closures and those that did not in terms of enforcement requirements: "Depth-based closed areas are proposed in four of the action alternatives as a way to reduce bycatch by keeping vessels out of areas where species of concern - overfished species - occur. However, this change in the management regime introduces a new set of enforcement issues because compliance must occur at sea, requiring different monitoring and enforcement requirements" (PFMC 2003, p. 4-48).

The EIS described the Council's plans to address enforcement requirements associated with the management action: "The existing methods of patrolling sea areas either by airplane or ship (carried out primarily by the Coast Guard, although state agencies have some capacity in this regard), and using fishery observers to monitor vessel position can be used to monitor and enforce closed areas. In fact, until VMS is implemented these will be the available methods. However, VMS is a superior enforcement technology because the position of vessels with transmitting units can be tracked at all times. Because violations can be relatively easily determined, VMS would also serve as an effective deterrent for participating vessels" (PFMC 2003, p. 4-49).

The EIS documented the cost of using VMS for enforcement: "The Council has recommended that VMS units be installed on the limited entry trawl and limited entry fixed gear fleets (over 400 vessels).... Currently, the estimated costs of a VMS transmitting unit ranges from $1,800 to $5,800 with transmission costs of $1.00 to

$5.00 per day. In the absence of federal funding the costs may be bourne entirely by the vessel owners" (PFMC 2003, pp. 3-62 to 3-63). The EIS also noted the potential for VMS to enhance enforcement capabilities: "As a new monitoring tool for West Coast groundfish fisheries, VMS will dramatically enhance rather than replace traditional techniques" (PFMC 2003, p. 3-62).

A-7. Documenting Public Process

The EIS included a description of the annual specifications process - including scoping and public review processes. It also includes comments by the Ad Hoc Allocation Committee and a summary of written, email and oral comments provided by the public at Council meetings, State-sponsored public hearings and other public fora (PFMC 2003, pp. 1-5 to 1-13, Tables 1.5-1 to 1.5-2).

Appendix B. Implications of Restricting Fishery-Independent Surveys Inside Reserves

An important issue to consider in evaluating reserve proposals is whether or not fishery-independent surveys currently used for stock assessment would be prohibited (along with other types of fishing activity) inside the reserve. To the extent that the size and location of reserves do not significantly interfere with the customary spatial coverage of fishery-independent surveys, this will not be a problem. However, to the extent that such interference does occur, alternative non-lethal data collection methods - e.g., remotely operated vehicles (ROVs), submersibles (subs) - may need to be considered in reserve areas.

Dead fish sampled in fishery-independent surveys provide valuable data on length, age, sex, stomach contents and stock structure, as well as an index of abundance. Non-lethal survey methods can provide data on observable characteristics of fish that are useful for stock assessment (length, index of abundance, also sex for species where this is visually obvious). In some cases, it may also be possible to collect genetic material without killing the animals. However, data on age and stomach contents cannot be obtained from non-lethal surveys (Table B-1). The loss of age structure information - which is critical to estimating year class strengths - is particularly significant in terms of limiting what can be done with stock assessment models.

In addition to issues regarding loss of data important for stock assessment, the use of non-lethal sampling methods also raises issues of cost and calibration. Non-lethal sampling is costly. Because sampling of this type provides an index of abundance for a limited time period, it must be repeated frequently to be useful for stock assessment. By contrast, a single trawl survey can provide a whole demographic sample from which inferences can be drawn regarding year class strengths.

This is not to say that trawl surveys are well suited for all purposes. For instance, trawls have limited access to rocky areas. Trawls are also incapable of providing observations of fish behavior (e.g., fish-habitat associations, fish-fish associations) in the context of the environment in which they occur. On the other hand, non-lethal methods also have their limitations. For instance, the ability of small ROVs to run transects in heavy currents is limited. Large ROVs and subs are costly to operate. Use of subs is limited by weather conditions. Video techniques used on ROVs and subs are not suitable for observing pelagic rockfish. No single data collection method is suitable for all ocean conditions or purposes.

Fishery-independent trawl survey data provide critical information for stock assessment. A lengthy time series has been constructed with such data. Combining trawl survey data collected outside the reserve with data from live sampling inside the reserve will require intercalibration of surveys. Achieving such calibration will likely require that both survey methods be used outside reserves for a number of years.

If at some point the Council is faced with the prospect of utilizing non-lethal survey methods in reserve areas for its own assessments, it will be important that the Council evaluate the desirability of relying on sponsors of reserve proposals to provide such data from their own monitoring programs. One issue that may arise is whether the proposal sponsor is willing to provide the Council not only with summaries of monitoring results but also the raw data collected in the monitoring program. This may be problematic, for instance, If the data are collected by individual researchers who may claim the data as intellectual property. Additional issues in this regard pertain to whether the Council can count on the data collection being sustained over the long term and whether the data will be made available to the Council in a sufficiently timely manner to allow the Council to meet its assessment schedules. Continuity and timeliness of data are issues that the Council already faces with the data that it routinely uses. These issues are potentially more difficult if the Council must rely on data being collected by entities who do not have an ongoing stake in Council decisions.

The development of alternative survey methods is an issue that the Council may need to address in the future, for reasons of its own. As indicated in the Council's Environmental Impact Statement on the 2003 groundfish management specifications, "For overfished stocks with low OY values, the research take can represent a significant proportion of the harvest specification. At the same time, the reduction in fishery catches means less data are available from this source, making it even more difficult to determine abundance, measure stock recovery, and estimate potential yields....Because catches of overfished species has become a critical concern, survey methods that do not involve capture need to be developed" (PFMC 2003, p. 3-61).

Table B-1. Types of biological data that can be obtained using non-lethal and lethal sampling methods.

Data Type	Non-Lethal Sampling Methods (e.g., subs, ROVs)	Lethal Sampling Methods (e.g., trawling)
Index of abundance	Yes	Yes
Length	Yes	Yes
Age	No	Yes
Sex	Maybe	Yes
Stomach contents	No	Yes
Genetics	Maybe	Yes
Fish-habitat association	Yes	No
Fish-fish association	Yes	No

GROUNDFISH ADVISORY SUBPANEL STATEMENT ON GUIDELINES FOR REVIEW OF MARINE RESERVES ISSUES

The Groundfish Advisory Subpanel (GAP) received a presentation from Ms. Cindy Thomson regarding the draft Scientific and Statistical Committee (SSC) paper containing objectives and guidelines for marine reserves. The GAP has commented favorably on previous drafts of this paper and continues to support the excellent work done by the SSC. The GAP strongly agrees with the paper's recommendations that marine reserves undergo rigorous scientific and economic scrutiny before establishment and that a clear set of objectives be developed and adhered to when marine reserves are contemplated for use as fishery management tools.

PFMC
06/17/04

MAKAH TRIBAL COUNCIL

P.O. BOX 115 • NEAH BAY, WA 98357 • 360-645-2201

IN REPLY REFER TO:

The Honorable Donald Evans
Secretary of Commerce

July 14, 2003

Dear Mr. Secretary:

Billy Frank Jr., recently presented to you the Northwest Indian Fisheries Commission's Tribal Policy Statement on Marine Protected Areas, Marine Reserves, Marine Sanctuaries, and Fishery Conservation Zones. As Mr. Frank noted in his transmittal letter, each tribal government is a sovereign entity, which may choose to develop its own statement regarding marine resource initiatives. Mr. Frank pointed out that the Commission's statement should be read as supporting these tribal specific statements, as it is appropriate that each tribe represent its unique geographic, social, economic, and legal interests.

The Makah Tribe has developed our own statement regarding Marine Protected Areas, which we enclose with this letter. The Reservation, located on the northwest corner of the Olympic Peninsula, borders both the Pacific Ocean and the Strait of Juan de Fuca in Washington State.

Because of our unique geographic location, and our reliance on marine resources harvested from the Pacific Ocean and the Strait of Juan de Fuca, our tribe has unique concerns regarding the possible establishment of Marine Protected Areas. We have attempted to articulate those concerns clearly and concisely in the enclosed statement. The Makah Tribe joins Mr. Frank in urging you to understand where we stand with this issue, and we share his belief that government-to-government dialog is essential to preserve marine resources while at the same time upholding Indian treaty rights and fulfilling the federal trust responsibility to Indian Tribes.

We would appreciate the opportunity to discuss our position with you and your agencies, and hope to hear from you about how to begin this effort.

Sincerely,

MAKAH TRIBAL COUNCIL

Nathan Tyler, Tribal Chairman

pmeaus

Cc: Washington State Congressional Delegation
Conrad C. Lautenbacher, Jr., NOAA
William Hogath, Ph. D., NOAAF
Richard W. Spinrad, Ph. D., NOS
Daniel Basta, Director, NMSP
Aureen Martin, AS-IA, DOI
Craig Manson, AS-FWP, DOI
Stan Speaks, BIA Regional Director
Bill Laitner, Superintendent Olympic National Park
Fran Mainella, Director, National Park Service
Carol Bernthal, Olympic Marine Sanctuary
Northwest Straits Commission
Governor Gary Locke
Puget Sound Action Team
Washington Department of Natural Resources
Washington Department of Ecology
Washington Department of Fish and Wildlife
Washington Fish and Wildlife Commission
Northwest Indian Fisheries Commission

STATEMENT OF THE MAKAH INDIAN TRIBE REGARDING MARINE PROTECTED AREAS

July 2003

In recent years, various individuals, organizations and government agencies have proposed the establishment of marine protected areas (MPAs). Already, MPAs have been established off the coasts of the United States and elsewhere. In 2000, President Clinton signed an Executive Order to "strengthen and expand the Nation's system of marine protected areas."

In his Executive Order, President Clinton defined an MPA as "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." The MPA Center in the Department of Commerce states on its website that there "are many different types of MPAs in the United States," including "national marine sanctuaries, fishery management zones, national seashores, national parks, national monuments, critical habitats, national wildlife refuges, national estuarine research reserves, state conservation areas, state reserves, and many others."

However, despite these definitions, MPAs are typically understood as areas in which harvests of marine resources are prohibited. Ostensibly designed to conserve and enhance over-fished marine resources, MPA proposals can often mask an extreme preservationist agenda, which seeks to prohibit harvests regardless of their sustainability, the actual condition of affected marine resources, or alternative means to conserve and enhance such resources. Moreover, proposals for MPA "no-take zones" often reflect a "one-size-fits-all" approach to marine management, which fails to consider the unique attributes of particular areas, resources and fishing communities.

The possible establishment of MPAs off the northwest coast of Washington is very threatening to the Makah Tribe. The Makah Tribe depends on treaty secured fishing rights in marine waters to sustain culture and economics. Because the Tribe's rights are geographically restricted to our usual and accustomed fishing grounds at treaty times, "no-take" MPAs could deprive the Tribe of the most important part of our livelihood and way of life.

Some MPA proponents suggest that harvest restrictions would not apply to Indian treaty harvests. However, the Makah Tribe's experience with the Olympic Coast National Marine Sanctuary is that exemptions for treaty or other harvests put harvesters in the untenable position of harvesting resources from a sanctuary. Despite continuing rights to engage in harvesting activities, the existence of the Sanctuary is used to attack and limit such rights. The Makah Tribe fears that the establishment of MPAs within our usual and accustomed fishing grounds would be used in the same manner.

For these reasons, the Makah Tribe generally opposes the establishment of MPAs. As President Clinton stated in his Executive Order, the pursuit of MPAs "does not diminish, affect, or abrogate Indian treaty rights or United States trust responsibilities to Indian tribes."

Before a "no-take" MPA is established in tribal usual and accustomed fishing grounds, there must be: (1) compelling scientific evidence that particular resources are in need of conservation and rebuilding; (2) scientific analyses of stock structure and distribution to support the location of the MPA; (3) a rigorous examination of alternative means to conserve and enhance such resources to rebuild marine stocks (including fisheries enhancement programs used successfully in Japan and elsewhere, more conventional fisheries management measures, and special management areas in which measures are tailored to the particular area, resources and communities affected); and (4) a clear demonstration that establishment of an MPA within tribal usual and accustomed grounds is a necessary last resort to conserve and enhance the resources.

Based on the information currently available to the Makah Tribe there is no basis for the establishment of "no-take" MPAs in the Makah Tribe's usual and accustomed fishing grounds. Rather, the development of enhancement programs and special management measures tailored to these areas can conserve and enhance marine resources while permitting sustainable harvests and the continued exercise of the Makah Tribe's treaty rights.

In all events, the Makah Tribe must be a full partner in the consideration and development of any measures, including any MPA proposals that might affect the resources or harvests in tribal usual and accustomed fishing grounds. Because of our treaty rights and the federal trust responsibility to Indian tribes, and as required by Executive Order 13175 on Consultation and Coordination with Indian Tribal Governments, the Makah Tribe must be consulted and invited to participate in scientific analysis and formulation and evaluation of alternatives throughout the development and consideration of such measures. In addition, funding sources must be identified for tribal scientific research and analysis, to enable the Makah Tribe to participate meaningfully in such processes.

MAKAH INDIAN TRIBE

Nathan Tyler, Tribal Chairman

Exhibit G.2.c
Supplemental SSC Report
June 2004

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON GUIDELINES FOR REVIEW OF MARINE RESERVES ISSUES

The Scientific and Statistical Committee (SSC) discussed the latest draft of its white paper (i.e., "Marine Reserves: Objectives, Rationales, Management Implications and Regulatory Requirements" [Exhibit G.2.b, Attachment 1, June 2004]). The latest draft includes a significant number of revisions that were made in response to comments received at the March Council meeting in Tacoma, Washington. Moreover, significant public comment on the white paper was also received for this meeting (Exhibit G.2.d, Public Comment, June 2004), and it is evident the document has generated considerable interest. The goals of the SSC's white paper,[1/] which pertains to marine reserve proposals that come before the Council, are to, (1) describe the rationale underlying a number of commonly cited objectives of marine reserves, (2) discuss the implications of marine reserves to fishery management, and (3) describe SSC expectations regarding the technical content of proposals considered by the Council, whether internally or externally generated.

It is important to note that much of the Public Comment (Exhibit G.2.d) was developed in response to the SSC's February draft white paper, and the current June 2004 version has addressed several of those concerns. Even so, in the time available the SSC was unable to provide a thorough evaluation of the complete record of Public Comment, some of which was technical in nature. Given the importance of the white paper to the Council and the public, and the desire of the SSC to carefully consider all points of view before finalizing the document, the SSC decided to undertake another revision to the document over the summer. To facilitate that revision, the SSC requests that all public comment on the June 2004 version of the white paper be submitted to the Council by June 30th. The next revision should be available in the briefing materials for the September meeting, at which time the SSC expects to forward the white paper to the Council for adoption.

PFMC
06/16/04

1/ To clarify the purpose and intent of the white paper, the SSC has decided to change the title to "Marine Reserves: Objective, Rationales, Fishery Management Implications, and Regulatory Requirements."

Exhibit G.2.d
Public Comment
June 2004

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT
Silver Spring, Maryland 20910

May 24, 2004

RECEIVED
MAY 25 2004
PFMC

Dr. Don McIsaac
Executive Director
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, Oregon
97220-1384

RE: National Marine Sanctuary Program Comments on the Marine Reserves White Paper

Dear Dr. McIsaac: Don

The National Marine Sanctuary Program (NMSP) appreciates the time and effort that the Pacific Fishery Management Council's (Council) Science and Statistical Committee (SSC) has put into the drafting of the marine reserves white paper. We hope that it will be used as a document that will provide useful guidance to both the Council and those proposing marine reserves to the Council in the future. Given that there are five west coast national marine sanctuaries with overlapping and complementary jurisdiction, we feel that it is important that we provide our perspective on both the substance of the draft and the process associated with the document's review.

Process for Adoption
The white paper may have been intended to provide scientific guidance to the Council and those who propose marine reserves for consideration under the Magnuson-Stevens Conservation and Management Act (Magnuson-Stevens Act). However, as currently drafted it appears to establish Council policy by requiring that these proposals, as well as consultations with the Council on marine reserve issues, demonstrate certain benefits and contain certain analyses. A document that has the potential to have such an impact on the review of future proposals and consultations and the standards to which they will be held, should be made available for review and comment by affected and interested parties. We encourage the SSC and the Council to allow for sufficient time for release and meaningful review of the revised draft before it is adopted by the Council. We recommend that at a minimum that Council vote be postponed until the September 2004 meeting, thus providing the review period that the document deserves.

Implementation of this document as a Council program or policy defining the Council's approach to future actions may also require the completion of a programmatic Environmental Impact Statement under the National Environmental Policy Act (NEPA).

Standards and Scope of Review
The NMSP, NOAA Fisheries and the Council have made significant progress in developing a constructive partnership that goes well beyond basic statutory requirements. From the NMSP perspective, addressing sanctuary protection and measures such as marine reserves, requires cooperation, flexibility and dialogue with other authorities, including the Council. However, it is important that the statutory foundation that establishes the framework of our relationship remains unaltered and clear. We recognize that the white paper was drafted to address various types of marine reserve proposals for the Council's consideration under the Magnuson-Stevens Act. However, the distinction between such proposals and consultations required by other authorities is significant, and can have considerable bearing on the appropriate breadth of Council evaluation. It is therefore important to include a discussion of the various statutory and regulatory contexts under which the Council may receive a proposal or consultation request in order to be clear about the corresponding scope of review.

Section 304(a)(5) of the National Marine Sanctuaries Act (NMSA) requires a sanctuary to provide the Council with the opportunity to prepare draft sanctuary fishing regulations necessary to implement a sanctuary's management strategies and goals. While, under 304(a)(5), the Council is to use the Magnuson-Stevens Act national standards as "guidelines", the Council is to provide the draft sanctuary fishing regulations to further the stated sanctuary goals for such regulations. Thus, the purposes and goals, and underlying mandate for marine reserves under the NMSA may differ from any reserve proposed to further Magnuson-Stevens Act purposes and goals. Further, a reserve under the NMSA is ultimately implemented by the NMSP as the decision-making and implementing body. Therefore, for proposed reserves under the NMSA, it is the NMSP that must establish the validity and acceptable range of goals. It is also the NMSP that is legally responsible for determining whether its analyses are in compliance with the requirements of NEPA, the Regulatory Flexibility Act, and the Administrative Procedure Act (APA). Further, under NEPA, an agency must consider the environmental impacts of identified alternatives. However, NEPA is not concerned with the substantive merits of a proposed course and does not dictate the course of agency action. As such, NEPA does not speak to what constitutes a valid use of a marine reserve, it only requires that the associated potential adverse environmental impacts and alternatives be identified and considered.

We are therefore concerned that the white paper will have the practical effect of confusing the appropriate scope of review of consultations under the NMSA. While a sanctuary's proposed action and its accompanying analyses may well resemble what the white paper has outlined, the white paper should clearly state that as it relates to sanctuaries, it is not intended to expand or constrain the Council or others regarding the requirements of the NMSA or NEPA.

Utility of Reserves
In regards to the substance of the document, we share the concern of several SSC members that the white paper creates an inconsistent standard for the use of marine reserves as a management option. While the document outlines some valid information needs associated with given marine reserve objectives, there is an emphasis on certain

facets such as redistribution of effort or the need to exhaust other fishery management based alternatives that, as applied, could create a uniquely high standard for marine reserve proposals. Such extensive analyses have not always been required to establish gear restrictions, limited entry programs, or seasonal closures. While closing areas to fishing must be done with serious deliberation, this inconsistency appears to create an institutional bias against what may be a valuable tool to various facets of marine conservation and protection, and management of ecosystems. In revising the document, we encourage the SSC to hold the use of marine reserves to the same standard as Magnuson Act management measures.

Thank you for your consideration of these concerns. The National Marine Sanctuary Program is committed to working cooperatively with the Council in ways that help achieve our respective mandates. We believe that frequent and meaningful dialogue is critical to moving forward in a way that meets both our concerns and is mindful of Council protocols and the pressing issues the Council addresses. If you have any questions regarding these comments please contact Bill Douros or Dr. Holly Price at 831-647-4201.

Sincerely,

Dan Basta
Director
National Marine Sanctuary Program

CC: Tom Jagielo, Chair Science and Statistical Committee
Don Hansen, Chairman, PFMC
Ryan Broddrick, Director CDFG
Rod McInnis, NMFS, Acting Regional Administrator

OREGON STATE
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7 May 2004

Dr. Donald McIsaac, Executive Director
Pacific Fisheries Management Council
7700 NE Ambassador Place, Suite 200
Portland, OR 97220-1384

re: Draft White Paper by the Marine Reserves Subcommittee of the SSC
(Exhibit H.1.a, Attachment 1, March 2004)

Dear Dr. McIsaac:

As the sole West Coast academic fish biologist serving on the Marine Protected Areas Federal Advisory Committee (http://mpa.gov/), I feel compelled to offer suggestions for revising the draft report entitled "Marine Reserves: Objectives, Rationales, Management Implications, and Regulatory Requirements."

The Council and the SSC have been inundated with much advocacy and hyperbole regarding marine reserves. In light of the unfortunate interactions between academic scientists and the SSC regarding the California Channel Islands marine reserve system, it is understandable that there is reaction to the controversy. My sense is that the draft report was written in the context of these unfortunate events, and I respectfully request that the SSC consider three major suggestions in revising the draft report. These suggestions focus on burden of proof, habitat protection, and literature review:

(1) **Burden of Proof**: From my perspective, the draft report places a heavy burden of proof on marine reserves compared to conventional management measures, so much so that there appears to be a double standard. I suggest that the revised report simply state that marine reserves should undergo the same review process as all other management tools implemented by the Council. During these difficult times, it appears that various management measures have been implemented on an ad hoc basis without nearly as rigorous a process as proposed for marine reserves. It seems that the Council has often believed that plausibility in itself is indeed sufficient reason to justify particular measures. I understand that the cowcod conservation area has been adopted by the Council as a marine reserve of indefinite duration. Perhaps the process by which this marine reserve was implemented can serve as a model. In general, I encourage the SSC to fully embrace the precautionary principle and adaptive management.

(2) **Habitat Protection**: I was surprised to see habitat mentioned only in passing under the discussion of the potential ecosystem benefits of marine reserves. In my mind, habitat protection from bottom gear impacts is *the* primary ecosystem benefit. Given the widespread focus on EFH and HAPCs, I suggest that the revised report more explicitly acknowledge that marine reserves are ipso facto a useful tool for protecting fish habitat.

(3) **Literature Review**: I found the literature cited by the draft report to be curiously incomplete. The findings of scientific studies of existing West Coast marine reserves, and especially, highly relevant recent data on the reproduction and population structure of rockfishes, are both absent. I encourage the SSC to review and incorporate these data in the revised report.

Regarding existing West Coast reserves, I attach a review I prepared in 2002 for the Oregon Ocean Policy Advisory Council and the California Fish and Game Commission, a report I also presented to the Council in Sacramento in 2003. Having considerable experience conducting undersea ecological research, I can say up front that current studies of existing West Coast reserves (which at that time were both tiny and strictly coastal) are far from perfect. At the same time, I do not believe that these studies should be summarily dismissed. The 9 studies of 13 reserves I reviewed (which excluded studies that were clearly not rigorous) focused on 17 fished species (red sea urchin, red and pink abalone, and 14 fishes, mostly rockfishes). Considering cases where statistical differences were detectable at the species level inside vs. outside reserves, animals were more abundant inside reserves in 15 of 17 comparisons (88%), animals were larger inside reserves in 12 of 15 comparisons (80%), and animals inside reserves were inferred to produce more eggs in 15 of 17 comparisons (88%). Although these data do not prove that larger reserves will necessarily benefit fisheries in our region, these general trends from our own species and habitats are certainly consistent with findings from many reserves worldwide, including those that have clearly benefited fisheries.

Regarding relevant recent data on the reproduction and population structure of rockfishes (references follow), new and forthcoming publications by Steven Berkeley and his students clearly demonstrate the recruitment value of big old fat female fish (BOFFFs) beyond the fact that they are highly fecund. BOFFFs of black rockfish (closely related to widow and yellowtail rockfish) not only have earlier and longer spawning seasons (Bobko and Berkeley 2004), but also produce larvae that grow faster and survive starvation better than smaller females (Berkeley et al. 2004). Most importantly, most of the surviving YOY are the offspring of BOFFFs (Bobko 2002) and the BOFFFs are disappearing (Berkeley et al. submitted). Given the well-documented age truncation that occurs with even moderately low levels of fishing mortality, and the fact that slot limits are difficult to implement with rockfishes, there is really only one realistic means of ensuring that a reasonable number of BOFFFs survive and old-growth age structure is preserved: marine reserves.

Additionally, recent genetic and otolith microchemical studies are demonstrating that West Coast rockfish populations are reproductively subdivided at smaller spatial scales than previously assumed (e.g., Withler et al. 2001 for Pacific ocean perch, Buonaccorsi et al. 2002 for copper rockfish, Miller and Shanks 2004 for black rockfish), indicating the value of systems of marine reserves to ensure the persistence of economically viable subpopulations.

Marine reserves are obviously not a panacea for fisheries management, and there has clearly been too much hype about them. However, the best available science has convinced me that marine reserves are a useful tool that can and should be integrated effectively with conventional ground-fisheries management. I am heartened by the upcoming working group being formed by NOAA to study the application of marine reserves in fisheries management. My hope is that the final SSC report on marine reserves will reflect this timely synthesis. Thank you for considering my suggestions.

Sincerely,

Mark A. Hixon
Professor

attachment

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MPA★news
Vol. 4, No. 3
September 2002
International News and Analysis on Marine Protected Areas

MPA Perspective: Existing Small Marine Reserves Can Indicate Whether a Larger Network Is Feasible: Case Study from the West Coast of the United States

By Mark A. Hixon

Two of the greatest concerns of the fishing community regarding fully protected marine reserves are, first, whether reserves will work in their particular part of the ocean, and second, whether a network of reserves would truly help to replenish and sustain fisheries. Such issues are critical in regions such as the US West Coast, where an ongoing fishery crisis has resulted in closure of a substantial portion of the continental shelf [*see page 4 in this issue — Editor*]. As in many regions worldwide, the difficulty of addressing fishermen's concerns is that existing reserves are much too small and too few to benefit fisheries in ways that are directly detectable statistically. Indeed, there are only about a half-dozen fully-protected reserves in Washington (all in Puget Sound, accounting for only about 0.003% of state waters), only 1 in Oregon (about 0.003% of state waters), and 11 scattered along the California coast (about 0.2% of state waters). Ultimately, the effectiveness of a network of reserves can be tested rigorously only after implementation. However, it is nonetheless possible to use existing reserves as indicators of whether a scaled-up network would provide fishery benefits.

The predicted fishery benefits of fully-protected reserves are twofold: (1) the "seeding effect," whereby reserves function as a source of eggs and larvae that replenish fish and shellfish populations outside reserves via dispersal in ocean currents, and (2) the "spillover effect," whereby reserves function as a source of juvenile and adult emigrants that literally swim or crawl out of reserves into adjacent fished areas. The seeding effect occurs only if the *number* and especially the *size* of organisms inside reserves is substantially greater than outside, so that abundant eggs and larvae produced inside reserves can effectively seed a large area outside. The spillover effect occurs if (a) the *number* of mobile animals inside reserves becomes great enough that crowding occurs and a substantial number of animals consequently emigrates to adjacent fished areas, or (b) the life history of mobile animals is such that they gradually move from habitat to habitat as they grow, so that the early stages of the life history can be protected within reserves, and older animals later move into fished areas. Thus, comparisons inside vs. outside reserves provide indicators of whether seeding and spillover effects are probable, and examination of *movement* patterns can further suggest whether spillover is likely.

There have been scientifically rigorous comparisons inside vs. outside about a dozen existing reserves in Washington, Oregon, and California that were studied at least 10 years after the reserves were established. In all studies — which span unpublished graduate theses and technical reports to articles in peer-reviewed journals — SCUBA divers compared areas inside and outside reserves in similar seafloor habitat by visually censusing plots or transects. Compared indicators included the number and size of fish and shellfish, and sometimes calculated egg production. Egg production is well-documented to increase dramatically with body size in these fish and invertebrates, so areas with high abundance and large sizes of animals clearly produce numerous eggs that may contribute to the seeding effect.

A total of 22 species-specific comparisons involving 17 fished species (red sea urchin, red and pink abalone, and 14 species of fish, mostly rockfishes) were conducted among 13 reserves. Considering cases where statistical differences were detectable, in 15 of 17 comparisons (88%), animals were more abundant inside reserves than outside. In 12 of 15 comparisons (80%), animals were larger inside reserves than outside. In 15 of 17 comparisons (88%), animals were inferred to produce more eggs inside reserves than outside. The exceptions may be cases of smaller species that are out-competed or eaten by more abundant or larger fish inside reserves, although there are presently no definitive data.

A variety of studies have also examined movement patterns of West Coast groundfishes using tag-and-recapture methods. A common life history of species such as lingcod, rockfishes, and some flatfishes is that juveniles live in shallow water, then slowly migrate to deeper water as they grow, eventually living within relatively limited home ranges as adults. Published movement distances suggest that these fishes could spillover from marine reserves of substantial size. Exceptions include exclusively shallow species that inhabit coastal rocky reefs for their entire juvenile and adult life.

Overall, for a broad variety of fished species along the U.S. West Coast, available data indicate that the existing few and small marine reserves are effective in supporting substantially more abundant, larger, and more fecund animals (i.e., more eggs) than comparable fished areas outside. Moreover, many groundfish move sufficiently during their lifetimes to allow for spillover to occur from reserves of substantial size. These results are consistent with the prediction that a scaled-up network of numerous larger reserves would produce detectable fishery benefits via both the spillover and seeding effects.

Editor's note:

Mark Hixon is a professor of marine ecology and conservation biology at Oregon State University (USA). Hixon excerpted this piece from a report he prepared for the Oregon Ocean Policy Advisory Council and the California Fish and Game Commission. His full report, entitled *Fishery Effects of Existing West Coast Marine Reserves: The Scientific Evidence*, can be obtained via e-mail directly from Dr. Hixon. The report contains full citations for studies mentioned in the adjoining piece.

For more information:

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[full report attached]

2002. Report submitted to the Oregon Ocean Policy Advisory Council and the California Fish and Game Commission.

FISHERY EFFECTS OF EXISTING WEST COAST MARINE RESERVES: THE SCIENTIFIC EVIDENCE

compiled by Dr. Mark Hixon, Department of Zoology, Oregon State University (541-737-5364, hixonm@science.oregonstate.edu)

Although fully-protected marine reserves are being touted as effective fishery management tools worldwide, it is important to consider in detail whether existing reserves along the West Coast of the United States provide fishery benefits, or more specifically, would provide benefits if scaled-up. It is clear from the outset that existing West Coast reserves are much too small and too few to benefit fisheries in ways that are directly detectable statistically. Indeed, there are only about 7 reserves in Washington (all in Puget Sound, accounting for only ca. 0.003% of state waters), only 1 in Oregon (Whale Cove, ca. 0.003% of state waters), and 11 scattered along the California coast (ca. 0.2% of state waters). Only half of these reserves are truly fully-protected. However, it is nonetheless possible to examine indicators of whether a scaled-up network of reserves would provide fishery benefits.

The predicted fishery benefits of fully-protected reserves are twofold: (1) the "**seeding effect**," whereby reserves function as a source of eggs and larvae that replenish fish and shellfish populations outside reserves via dispersal in ocean currents, and (2) the "**spillover effect**," whereby reserves function as a source of juvenile and adult emigrants that literally swim or crawl out of reserves into adjacent fished areas. The **seeding effect** occurs only if the *number* and especially the *size* of organisms inside reserves is substantially greater than outside, so that abundant eggs and larvae produced inside reserves can effectively seed a large area outside. The **spillover effect** occurs if (a) the *number* of mobile animals inside reserves becomes great enough that crowding occurs and a substantial number of animals consequently emigrates to adjacent fished areas or (b) the life history of mobile animals is such that they gradually move from habitat to habitat as they grow, so that the early stages of the life history can be protected within reserves, and the animals later move into fished areas. Thus, comparisons inside vs. outside reserves can provide an indication of whether seeding and spillover effects are probable, and examination of *movement* patterns can further suggest whether spillover is likely.

There have been scientifically rigorous comparisons inside vs. outside about a dozen existing reserves in Washington, Oregon, and California that were studied at least 10 years after the reserves were established (**Table 1**). Excluded from this compilation are analyses of (1) the Edmunds Marine Park in Washington, because seafloor habitats inside and outside the reserve are not strictly comparable, and (2) the Big Creek Reserve in California, because protected status was implemented only in 1994. In all studies, SCUBA divers compared areas inside and outside reserves by visually censusing plots or transects. Compared indicators included seafloor habitats, fish (mostly rockfish) and invertebrate (sea urchin and abalone) number and size, and sometimes calculated egg production. Egg production is well-documented in increase dramatically with body size in these fish and invertebrates, so areas with high abundance and large sizes of animals clearly produce numerous eggs that may contribute to the seeding effect.

Table 2 summarizes 9 independent scientific studies that compared unfished marine reserves with nearby fished areas of similar seafloor habitat. A total of 22 comparisons involving 17 fished species (1 species of sea urchin, 2 species of abalone, and 14 species of fish) were conducted among the 13 reserves listed in Table 1. Considering cases where statistical differences were detectable, in 15 of 17 comparisons (88%), animals were more abundant inside reserves than outside. In 12 of 15 comparisons (80%), animals were larger inside reserves than outside. In 15 of 17 comparisons (88%), animals were inferred to produce more eggs inside reserves than outside. The exceptions may be cases of smaller species that are out-competed or eaten by more abundant or larger fish inside reserves, although there are presently no definitive data.

Table 3 summarizes movement patterns of representative West Coast groundfish determined from tag-and-recapture studies. The general life history pattern is that lingcod and rockfishes, among other species, live in shallow water as young, then slowly migrate to deeper water as they grow, eventually living within relatively limited home ranges as adults. Movement distances suggest that these fish could spillover from marine reserves of substantial size. Exceptions include exclusively shallow species that inhabit coastal rocky reefs for their entire juvenile and adult life.

Overall, for a wide variety of fished species along the U.S. West Coast, available data indicate that the existing few and small marine reserves are effective in supporting substantially more abundant, larger, and more fecund animals (i.e., more eggs) than comparable fished areas outside. Moreover, many groundfish move sufficiently during their lifetimes to allow for spillover to occur from reserves of substantial size. These results are consistent with the prediction that a scaled-up network of numerous larger reserves would produce detectable fishery benefits via both the spillover and seeding effects.

TABLE 1. Existing U.S. West Coast marine reserves that have been the subject of inside vs. outside scientific comparisons. Comparisons made at two other reserves are not included: (1) Edmunds Marine Park in Washington (0.04 nmi^2, established in 1970) because seafloor inside and outside are not directly comparable; and (2) Big Creek in California (1.11 nmi^2, established in 1994) because protection is only recent.

Reserve	Area (nmi^2)	Year	Protection
WASHINGTON:			(reference 2)
Shady Cove	0.49	1990	herring and salmon fishing allowed
Shaw Island	0.37	1990	herring and salmon fishing allowed
Yellow Island	0.07	1990	herring and salmon fishing allowed
OREGON:			(reference 8)
Whale Cove	0.04	1967	seaweed collection allowed
NO. CALIFORNIA:			(reference 7)
Pt. Cabrillo/Caspar	0.13	1975/90	only sea urchins protected
Salt Point	1.60	1990	only sea urchins protected
Bodega Marine Lab	0.18	1965	only invertebrates protected
Hopkins Marine Lab	0.09	1984	fully protected
Pont Lobos	0.80	1973	fully protected
SO. CALIFORNIA:			(reference 7)
E. Anacapa Island	0.04	1978	fully protected
Laguna Beach	0.04	1973	fully protected
Catalina Marine Lab	0.05	1988	fully protected
La Jolla	0.54	1971	fully protected

TABLE 2. Comparisons of number, size, and calculated egg production of fished species inside vs. outside existing U.S. West Coast marine reserves listed in Table 1. "Yes" means that values were statistically greater inside, "No" means that values were statistically greater outside, "ns" means no statistically detectable difference, and "?" means not reported. ("Yes") and ("No") are conclusions regarding egg production based on relative number and size of fish (i.e., egg production not calculated directly, but if number and size of adult fish are greater inside the reserve, than egg production must be greater). "Ref" refers to the reference number(s) cited.

Species	Number	Size	Eggs	Comments	(Ref)
WASHINGTON:				[all WA data from 3 reserves]	
lingcod	ns	Yes	Yes		(2,10,11)
black rockfish	Yes	Yes	(Yes)	seen only in reserve	(2)
copper rockfish	Yes	Yes	Yes		(2,10,11)
quillback rockfish	No	No	(No)	competition or predation?	(2)
yellowtail rockfish	Yes	Yes	(Yes)	seen only in reserve	(2)
OREGON:					
red sea urchin	Yes	Yes	Yes		(8)
NO. CALIFORNIA:					
red sea urchin	Yes	?	?	Caspar, Salt Pt., Bodega	(13)
red abalone	Yes	?	?	Caspar, Salt Pt., Bodega	(13)
lingcod	ns	Yes	(Yes)	[fish data from Pt. Lobos]	(18)
cabezon	ns	No	(No)	competition or predation?	(18)
black rockfish	ns	Yes	(Yes)		(18)
black-&-yellow rockfish	No	No	?	conflicting egg data	(9,18)
copper rockfish	Yes	Yes	(Yes)	seen only in reserve	(18)
gopher rockfish	Yes	Yes	(Yes)		(18)
kelp rockfish	ns	Yes	Yes		(9,18)
olive rockfish	Yes	Yes	(Yes)		(18)
vermilion rockfish	Yes	Yes	(Yes)		(18)
SO. CALIFORNIA:					
red sea urchin	Yes	?	?	Anacapa	(1)
pink abalone	Yes	?	?	Anacapa	(1)
barred sand bass	Yes	?	Yes	Laguna (sand bottom)	(17)
kelp bass	Yes	?	Yes	pooled So. Cal. reserves	(17)
California sheephead	Yes	?	Yes	pooled So. Cal. reserves	(17)
Total Yes (greater inside):	15	12	15		
Total No (greater outside):	2	3	2		

TABLE 3. Movement patterns of commonly fished West Coast groundfish. The general pattern is that lingcod and rockfish, among other species, live in shallow water as young, then slowly migrate to deeper water as they grow, eventually living within relatively limited home ranges as adults. These data suggest that these fish move sufficiently for the spillover effect to occur from marine reserves of substantial size. Exceptions include exclusively shallow species (e.g., black-and-yellow and gopher rockfish) that inhabit coastal rocky reefs for their entire juvenile and adult life (reference 4). "Ref" refers to the reference number(s) cited.

Species	Location	Movement Distance	Ref
JUVENILE FISH:			
bocaccio rockfish	California	move up to 80 nmi over 2 yr	(3)
brown rockfish	California	move up to 27 nmi as they migrate from San Francisco Bay to the outer coast	(5)
yellowtail rockfish	Washington	move up to 195 nmi as they migrate from Puget Sound to the outer coast	(6)
ADULT FISH:			
lingcod	Alaska	mean movement of 7.2 nmi	(15)
lingcod	British Columbia	95% of males move up to 9 nmi/yr 95% of females move up to 18 nmi/yr	(14)
bocaccio rockfish	California	10 of 16 adults spent less than 10% of 4 mo within 3.5 nmi^2 area, one for 50% of the time, and 5 for the entire time	(16)
yellowtail rockfish	Oregon	adults move up to 0.7 nmi/mo	(12)

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Comments on the March 2004 SSC white paper on marine reserves
Kate Wing, NRDC
5/11/2004

To the members of the SSC:

I appreciate the hard work the SSC, particularly Cindy, has put into the draft white paper and I thank you for considering my comments during the discussions at the March Council meeting. I see many of the changes the group discussed are reflected in the March meeting minutes and I believe the document will be improved by them. I am submitting expanded comments in writing here, with the hope that they may help with the next draft. Please feel free to contact me with any questions you have about them.

Structure and organization

This first draft did not accurately reflect the SSC's intent—to provide guidelines for how marine reserve proposals will be evaluated and reviewed by the Council. Some language to this point currently appears in Section IV, but this should be expanded and moved to the beginning of the document. Both the Council and the SSC have certain expertise and regulatory constraints that play into how they will review proposals. These factors should be clarified as they define the overall framework within which evaluation of any proposal will proceed.

My impression of what the SSC wants in proposals is the following basic information:

- What do you want to do
- How will a reserve will help you accomplish that
- How will you measure your progress and determine if you're meeting your goals

I suggest the revised draft be pared down and streamlined so it is clear these are the questions being asked, and the guidelines are the way the answers will be evaluated. The information under each category of reserve objectives offers a kind of checklist for questions applicants should be prepared to answer, as well as helpful literature references, but in essence it all comes back to answering the three above questions. The introduction in Section III. should also mention that proposals may seek to achieve multiple objectives and these generalized categories are not meant to be exclusionary or preclude such proposals.

One specific point—the March minutes mention Section III.E will be expanded for "scientific research proposals". My recollection of the March discussion was that III.E already had an extensive discussion of what Andre called "scientific playground" or research only reserves; what was missing was a discussion of "reference reserves", or areas that might be set aside to evaluate the impacts of fishing activities or other management measures. This is an important possible use of reserves, and it should be described either in this section or possibly III.B or C.

Finally, I agree with those members of the SSC who commented that, as written, the white paper seems to create a double standard for marine reserve proposals, one higher than that set for other fishery management measures. The document's length and organization play a role in creating that perception. I agree with the suggestion from the March meeting that the 2003 groundfish specs EIS be placed in an appendix, which should help with this issue. There was also some discussion that the SSC prepare two versions of the document: one for the general public, and one for a scientific audience that might eventually be submitted to a journal. I recognize the importance to the SSC of many of the detailed, technical discussions in the current paper and if it appears keeping this level of detail will make the paper overly long, I would suggest revisiting this idea.

Definition of marine reserves

I understand the SSC's desire to use "marine reserve" to include all marine protected areas for the sake of consistency with previous Council decisions. However, because this definition differs from that in California law and in the MPA Executive Order I still feel this will cause significant confusion. If the SSC will continue this use of the term, I suggest a larger disclaimer about the definition be placed both at the beginning of the report and in the executive summary. The disclaimer, which could easily be an expanded version of current footnote (1), should describe not only what the Council's definition of "marine reserve" is, but also what it is not. Because this document will be circulated widely, it is critical that the paper be abundantly clear—perhaps more than even seems necessary—about exactly what kinds of areas it addresses.

Language and audience

The wide circulation of the document among both general public audiences and scientific audiences makes presentation and language all the more important. For example, the term "plausibility" has a specific meaning among scientists in relation to designing experiments, but it has different connotations in common use, where it can imply the inverse—that somehow reserves are an implausible tool with no justification. I recommend the SSC rephrase these sentences so they are more in line with the idea of answering the questions laid out in the SSC's guidelines.

Along these lines, the SSC takes care throughout to point out what it feels are "policy decisions" and thus outside the scope of what the SSC can evaluate. This is wholly appropriate for the SSC, which is constrained by its charter to provide scientific advice, but the language used in the paper (see bullet 4, Sec. E.S.B and Sec. III.F) should reflect this constraint and not appear to dismiss choices made for policy reasons alone. The SSC may not be able to evaluate such policy goals, but they may be valid societal justifications for a reserve.

Scope of Council authority and involvement

At the March meeting, SSC members indicated that they did not want to be evaluating any and all proposals for marine reserves along the west coast. It's also not clear that the Council has authority over state decisions in state waters over state-managed species (i.e. the reference area diving closures recommended in the California Abalone Management and Recovery Plan), which would include many small marine reserve proposals. Section V.B. asks the Council to develop a process for monitoring marine reserve activities and to take a "proactive" role. This appears to conflict with the SSC's desire for only selective involvement.

The white paper should suggest recommended thresholds for when the Council decides to review a marine reserve proposal. In some cases, that review may be required by law, such as the Sanctuary Act. NEPA would apply to such federal actions, where the SSC's groundfish EIS example is an appropriate guide. However, other proposals may not fall under NEPA and they may have questionable relevance to the Council's work. In deciding whether or not to submit these proposals to a full review, the Council may want to consider factors such as:

- does the proposal include federal waters?
- is the proposed area large enough that it would impact Council management?
- do the goals involve significant effects on Council-managed species?

Of course, the Council may choose to take up proposal for any number of reasons, and the SSC cannot anticipate all of those, but I believe the SSC's guidance would be very helpful to the Council in setting these thresholds. The review thresholds should not only help manage the Council's workload, but also improve the quality of proposals submitted. For non-federal proposals, drafters may need to amend whatever package they must prepare to satisfy state and local regulatory requirements. The easier it is to determine if they may be subject to Council review, and the subsequent application of the guidelines outlined in the white paper, the better prepared proposals will be.

Phase II of groundfish reserves

One project where it would be appropriate for the SSC to take a proactive role would be developing marine reserves as part of the Council's strategic plan. The Council is currently in a very reactive mode, implementing annual closures in response to declining stocks. Designing a reserve network for groundfish would offer the SSC an opportunity for a test drive of the white paper, and the right network could contribute to long-term stability in managing the fishery. Since the release of the 2000 technical analysis, Dr. Parrish has prepared an additional analysis to suggest where reserves could be sited. The Ecotrust port effort analysis and the latest GIS data for the EFH EIS also provide new information. I encourage the SSC to put your combined knowledge into a proposal, once the white paper has been revised.

Comments on the draft report "Marine reserves: objectives, rationales, management implications, and regulatory requirements" prepared by the Marine Reserves Subcommittee of the Scientific and Statistical Committee, Pacific Fishery Management Council (exhibit H.1.a, Attachment 1, March 2004).

By Robert R. Warner and Steven Gaines (University of California, Santa Barbara), Felicia Coleman (Florida State University), and Benjamin Halpern (University of California, Santa Cruz)

We appreciate the opportunity to comment on this draft document.

1. Overall context: While the SSC stresses that the material in the report should be interpreted as guidelines for future proposals, it is unclear (1) from whom proposals will be accepted or solicited, or by whom proposals will be funded; (2) what the role of the SSC and the PFMC is after the proposals are in hand, and (3) what are the consequences of adhering or not adhering to the guidelines. Does the SSC envision that all proposals for marine reserves (regardless of the objectives, regardless of location) would be required to be submitted to the SSC for approval, and that the PFMC is the entity that actually establishes the reserves? Alternatively, does the SSC anticipate being informed of reserve establishment processes, with the opportunity to comment on how such processes might affect Council-managed fisheries? The extensive criteria proposed in this document imply regulatory authority. We contend that the SSC's role is advisory and should be limited to a review of how proposals might affect Council-managed fisheries. In this more limited role, the extensive guidelines proposed here are inappropriate.

The length and detail of this 56-page document suggests that marine reserve proposals will be subject to greater scrutiny than proposals for other types of management action. Given the emphasis in this document on reserve proposals being considered as only one option in the suite of management options, it seems reasonable and necessary that all other management options receive similar scrutiny. A simpler (and far more concise) policy statement would be that "Marine reserves should meet the same regulatory guidelines as other management proposals". Moreover, if proposals including marine reserves must include analyses of all other potential regulatory actions both at present and in the future, it seems only reasonable that all other regulatory actions considered by the PFMC and SSC must also explicitly consider marine reserves as part of the regulatory toolbox that is analyzed.

To ensure that the SSC does not appear biased, it is essential that the guidelines for marine reserves be incorporated into the broader context of other regulatory options for the region. We strongly suggest that these guidelines be subjected to a formal and rigorous external peer review. Once the guidelines are approved and established, to maintain the SSC's objectivity, it is essential that any proposals for the use of marine reserves be subjected to formal and rigorous external peer review.

2. Specific sections of the executive summary:

Fishery benefits: While the SSC cites recent reviews of effects inside reserves, it does not cite recent reviews of effects on fisheries from reserves (e.g., Roberts et al. 2001; Gell and Roberts 2003a,b). It is simply stated (in the executive summary) that the evidence is not compelling, while the main text only reviews theoretical models. We suggest that the results from these other studies should be included in the Council's review.
In the Executive summary, the SSC states that increased yield may not be a result of reserve establishment in well-regulated fisheries (a conclusion that is at odds with emerging theoretical comparisons), and then in the next sentence implies that all Council-managed fisheries are in this category. However, the most recent report to Congress on the Status of Stocks lists 64 major stocks, 31 of which are thought to not be sustainably harvested. In particular, 6 are overfished, one is both overfished and experiencing overfishing, 13 have an unknown status, 3 do not have overfished definitions established, and 8 are salmon species that have been removed from the management plan, are often endangered, but not listed as overfished. A similar pattern is found among the minor stocks. Given the life history characteristics of some of the overfished stocks, they appear to be species that would actually benefit from some protection. Thus, rather than dismissing marine reserves, it would be more objective to identify those fisheries that would be good candidates for benefit from closure and those that likely would not.

Ecosystem benefits: The only effect of reserve establishment in areas outside of reserves that the SSC considers is effort displacement, so the effect is always characterized as "adverse". Given the potential export functions of reserves, it is at least possible that the effects of displacement could be mitigated through increased production. One way to look at this possibility is to review BACI-designed reserve studies, and ask whether reference areas (outside reserves) declined relative to their state before reserve establishment. Of the seven available studies, five showed increases in reference areas after reserve establishment, one showed no change, and one declined (Halpern et al., in press, attached). Given this information, the presumption that the negative effects of displaced effort dominate the ecosystem impact of reserves is at best premature.

Societal benefits: This section sets up a caricature of claims for ecosystem services and non-consumptive benefits derived from reserves, and then dismisses them, suggesting that non-consumptive benefits are not quantifiable. Non-consumptive socioeconomic benefits are often quantified, and there are qualified economists well versed in quantitative methodologies who can be asked to address these questions: societal benefits can be estimated, just as fishery benefits can. In fact, there is an entire academic discipline, ecological and environmental economics, which addresses exactly these issues. This disproportionate attention to rigor in evaluating the costs and benefits of reserves to fishery goals to the exclusion of rigor for evaluating the costs and benefits to other goals points out a fundamental conflict in the process being established by the SSC. The SSC clearly should seek outside expertise to judge a proposal on all levels (including the socio-economic components).

Opportunities to advance scientific knowledge: The SSC implies that there is only one way to extract information from the natural world: with a fully replicated BACI design.

While this is useful in some circumstances, many systems (such as fisheries) do not lend themselves to this sort of analysis. One might start with carefully designed observational studies, which are entirely valid. The existence of a reference site where exploitation is not occurring can also be invaluable. The insistence for true control sites is especially important here: because of displaced effort and the potential export function of reserves, where are the sites that are unaffected by reserve establishment? Surely other experimental designs, perhaps employing gradients in and away from reserve borders, would be more appropriate. Again, the detail demanded here only for reserves as a management tool suggests that reserves are being singled out for special scrutiny, or forced to comply with extraordinary requirements not expected of other management proposals.

Analytical framework: We question whether the requirements set forth in this section for marine reserves go beyond those usually required for a management proposal under existing Federal regulations. For example, are there similar requirements for setting bag limits, size limits, or quotas? Are other management proposals required to have alternatives that include marine reserves? Whether the SSC intended to or not, it appears that the bar has been set higher for reserve proposals. If these are standard requirements, then it seems unnecessary to detail them here, and, as suggested earlier in our comments, the more objective approach is to include these requirements for marine reserves in the context of the requirements for other management strategies.

Conclusions and recommendations: The overall tone of this white paper and, in particular, the cautionary paragraph on trusting scientific fact rather than scientific opinion, is adversarial and unprofessional. Rather than making such statements in a white paper, it is imperative that the SSC objectively receive and review proposals for marine reserves or any other type of management action ensuring that the high standard of supplying the best available scientific information available is maintained.

3. Main text:

Reserve objectives and rationales:

P 10. California's Marine Life Protection Action not only requires a network of MPAs, but it specifies that this network include fully protected marine reserves that are replicated within biogeographic regions.

P 10, footnote #1. It should be noted that the council's definition of marine reserves as areas with *some or all* fishing excluded is at odds with the present standard definition within the scientific literature, which more typically defines marine reserves as areas completely closed to all fishing. MPA is used in the broader context of areas with different levels of protection.

P 12. Given that one of the main objectives of reserves is protecting habitat (e.g., rocky reefs) or other special features (e.g., historical sites), it is surprising that this is never mentioned here. Identifying and protecting habitat is clearly part of the charge of the

Council. However, making decisions about protecting historical features is not. If the Council wishes to become the general clearing-house for marine reserve decisions, then every aspect of marine reserve objectives must be covered thoroughly.

P 13. It is well appreciated in the scientific literature and policy arena that reserves should affect areas outside reserve boundaries, through both the export of production and displacement of effort. This should not be reported as new insight. The striking thing about this section of the report is that it assumes that areas outside reserves will degrade, due to "effort displacement and other changes precipitated by the reserve". Given the evidence so far (that in general conditions improve outside reserves, despite displacement – see above), why is the argument cast this way?

IIIA. Reserves as insurance policy. This white paper associates all uncertainty with errors in measurement and application. While these sources of error are important, they pale in comparison to the inherent variability of natural systems, the source of the greatest uncertainty in management.

P 14. The assertion that only a handful of groundfish species could see beneficial effects on age structure within reserves misrepresents both the existing empirical and theoretical scientific literature. The effects of adult movement and larval dispersal play fundamentally different roles in this issue and need explicit consideration. Large distance movement by adults does limit the ability of reserves to reduce mortality rates unless reserve size scales with adult movement. The number of species that would benefit should monotonically increase with individual reserve size. As a result, statements such as "only a handful of species" would benefit must include an explicit reference to reserve size. Clearly, at very large closures nearly every species that is currently fished would benefit. The council recognizes this obvious fact by their use of large scale fishery closures. By contrast to adult movement, large distance larval dispersal should play a *beneficial* role in promoting persistence in reserve networks (see Botsford et al., 2001) even when individual reserves are small. The assertion on this page that a limited range of species would be affected is also at odds with results of meta-analyses of responses within reserves from around the world, including the west coast of the US. If only a small handful of species are benefiting, how could overall biomass and density within reserves increase many fold even when we combine fished and unfished species in the analysis? There is a wealth of information from existing reserves worldwide that could be used to estimate more effectively the scope of response to reserves by species with different life histories, and as noted above, these estimates must always be placed in the contexts of reserve size and network configuration.

The white paper ignores what may be one of the most important forms of insurance provided by marine reserves – insurance from management failures in mixed species fisheries. The rockfish closures along the west coast are primarily driven by dramatic declines in a few species that are part of a much larger multi-species fishery. Variability among species in life histories creates a daunting challenge in such multi-species fisheries when they are managed using single-species models. There are inevitably weak-link species that either force the fishery to be regulated by their life history features at substantial costs to yield or eventually can close the entire mixed-species fishery when only one or a few species are threatened. Reserves provide *a unique form of insurance* against such weak-link closures. If sufficient stock of these species were protected within reserves, their by-catch in the mixed species fishery would never close the entire fishery. If a sizeable fraction of the west coast shelf were included in marine reserves a decade ago, the current west coast closures driven by four species embedded in much larger fisheries would almost certainly not have occurred. The closure of the west coast groundfish fishery is arguably the poster child for this potential benefit of marine reserve insurance.

P 14-15. The discussion of the issue of whether biomass inside reserves should be taken off the table or included in stock assessments pigeonholes a spatially explicit management action (i.e., reserves) into a modeling and decision framework that is not spatially explicit. The answers to the questions in this section are much clearer if viewed from the perspective of spatially explicit population models that include fishing in some locations and not others. This framework is the basis for a number of published and emerging modeling efforts. For example, the assertion that the decision to include or exclude the biomass within reserves in calculation of OY is a "policy decision" only makes sense if we are forced to estimate OY based on the existing modeling framework. Spatially explicit models recognize that this question includes critical scientific issues as well, specifically the rate and extent of the export of production (either as adults or larvae) from protected areas into the reserve to fished areas outside. These issues have received considerable attention in the reserve scientific literature, and they identify many scientific issues that directly address how to consider the distribution of individuals in and out of reserves. Adding marine reserves into the management mix creates yet another reason to move the conceptual framework for fisheries management to a more spatially explicit approach.

IIIB. Reserves as a source of fishery benefits.

P 16. While theory of reserve function is characterized as speculative, theory from traditional fishery models is taken as fact. Traditional theory posits that per capita production at high density decreases relative to that seen at intermediate density - but this has not been demonstrated, nor is it required to be demonstrated for ongoing decisions based upon models that depend on its accuracy. Worse, the SSC assumes that a sizeable fraction of all populations are at optimum density (i.e., perfectly managed) when reserves are established. While this is laudable optimism, it simply is not true for many Council-managed species, including some in the Pacific FMC's jurisdiction. The extensive recent closures are an obvious case in point. Instead of characterizing the "adverse" effect of reserves relative to perfectly managed species, the correct comparison is with actual densities in overfished species. Here, production will increase with protection. It appears that the subcommittee is straining, beyond scientific reason, to defend their traditional management.

The SSC correctly notes that the form of density dependence plays an important role in the effectiveness of marine reserves for fisheries benefits. This summary, however, leaves the impression that we know little about this issue. In fact, there is an extensive scientific literature on density dependence for both fish and invertebrate species, particularly for nearshore species. Even a cursory summary of this literature shows that post-dispersal density dependent mortality is far more common than pre-dispersal density dependence in fecundity.

The reason that empirical studies of existing marine reserves have focused on changes within reserves rather than enhancements to fisheries outside is abundantly clear – existing reserves are too small individually or collectively to have expected benefits to large scale fisheries through export of larvae. Spillover of adults can be addressed in even minute reserves, but it is simple to show that even if marine reserves enhance larval production per unit area by 3 to 5 fold (a common observation), the percentage of a total population protected in reserves would need to be substantial to produce easily measurable impacts on fisheries yields (see Halpern et al., attached). Benefits to the fishery may be occurring at smaller set-asides, but they are spread over large spatial areas (coincident with the scale of larval dispersal). This is demonstrated consistently in the wide range of modeling studies of fisheries impacts of marine reserves. Requiring that proposals for small reserves that protect a miniscule fraction of a species' range must include plans to demonstrate benefits to fisheries yields is unreasonable. The recently approved plan to set aside a third of the entire Great Barrier Reef by the Australian government is the first proposal for marine reserves anywhere in the world that is of the appropriate scale to require a demonstration of fisheries benefits. The SSC should note in its recommendations that for reserve proposals that represent small fractions of species' ranges there should be no demand for demonstration of fisheries benefits through export of production. The requisite benefit to be demonstrated should indeed only be changes in biomass, density, and reproductive output within reserves, unless proposals represent large fractions (>20%) of a species range.

P 17. The SSC claims that if a fishery is being managed for MSY, reserves are unlikely to have any potential fisheries benefit based upon theoretical studies (Hastings and Botsford, 1999) showing equivalence of maximum yield from effort and location based management. This ignores critical demographic differences that result from protecting (or recovering) truncated age/size structure, protecting juvenile habitat or spawning aggregation sites, or long-term sustainable yield. This finding is also sensitive to model assumptions. Indeed, it is *only* true without age structure and without spatial structure in the population – two assumptions that are unlikely to ever be remotely correct. Subsequent modeling has now shown that with age structure, spatial dynamics and other features not included in Hastings and Botsford, yields with management including reserves can exceed, often greatly so, yields under MSY conditions from traditional fisheries models. Indeed, Neubert (2003) has shown that the general solution for optimal yields always includes some marine reserves for a broad range of conditions. Several models that are currently in press or in review show a broad range of situations where management including reserves can produce substantially higher yields than MSY. Although the SSC cannot be expected to know about findings that are as yet unpublished, the conclusions of this paragraph are an inaccurate representation of current scientific findings. If this white paper is considered a living document that evolves with new scientific findings, the conclusions of this paragraph will soon become even more misrepresentative of the latest science.

In addition, this section continues a theme found throughout this document: that reserves will be proposed to focus on single fisheries. This is unlikely. By eliminating all fisheries within their borders, reserves will have impacts on a wide range of fisheries in any location they are proposed. Therefore, they should not be evaluated solely from the perspective of any single fishery.

IIIC. Reserves as a source of ecosystem benefits. The SSC highlights the lack of detail in terms of just which organisms respond to reserve protection. We attach Micheli et al. (in press), which specifies the differential responses of species classified by trophic level and level of exploitation. As the SSC speculates, exploited species respond the most strongly, and lower trophic level species may decrease as a result of restored trophic complexity when top level predators recover. It should also be noted that the complexities of such species interactions also affect the outcome of single species management, even though a traditional approach assumes species can be managed as distinct, non-interacting units.

The concern that different metrics have been measured in different reserves is used to diminish the significance of meta-analyses of reserve effects. One key finding in these meta-analyses that does not garner attention by the SSC is the consistency of findings across studies. The fact that few studies have been done in the US and fewer still along the Pacific coast is less problematic in terms of anticipating reserve effects, because of the qualitative consistency of reserve effects in a wide range of settings. This key finding of the meta-analyses warrants discussion. Why would we expect idiosyncratic results along the Pacific coast?

The SSC's caution about the "potentially adverse effects of displaced effort" on areas outside reserves is well taken. The study of fisher behavior relative to the establishment of marine reserves is an important issue, as Wilen and others have demonstrated. However, the call for defining negative effects in this regard is not balanced by mentioning the potentially positive effects of export. We attach Halpern et al. (in press), where the two effects are contrasted. The data from BACI-designed studies indicate a generally positive effect of reserve establishment in areas outside reserve boundaries. We feel that this is an oversight on the SSC's part.

IIID. Reserves as source of societal benefits. This section lacks content. Surely there are reasons beyond fishery benefits for establishing reserves, and competent economists have been quantifying non-consumptive benefits and ecosystem services for many years. To label all non-fishery based objectives as brute force attempts to achieve closure for its own sake is misleading.

IIIE. Reserves as opportunity to advance scientific knowledge. The implication of this section is that all scientific research proposals must have a complete BACI design, including replication, randomization, and interspersion. Aside from the problem that areas outside reserves are not true controls but can serve only as reference sites (see above and Halpern et al., attached), there are many ways in which reserves could contribute to scientific knowledge without a strict adherence to Hurlbert (1984). While it is important to request assurance that the scientific information obtained from reserve establishment be reliable, the requirement that any mention of science must adhere to an (inherently flawed) experimental design format is uninformed. We know of no other management technique that is tested this rigorously. It would certainly help for the SSC to provide examples of the replication, randomization, and interspersion used in establishing size limits, quotas, and bag limits in fisheries.

It should also be noted that there are very few reserves worldwide that were primarily established as a scientific experiment. This potential benefit merely arises from information that can be gleaned from reserves proposed for numerous other reasons.

IIIF. Plausibility of Reserve Objectives. This section is nearly identical to the executive summary, reviewed above. The SSC states that the most critical data are those demonstrating an empirical relationship between reserves and yield outside the reserve. Recent reviews of the fishery effects of marine reserves are not cited, and the evidence (no reference) is dismissed. Moreover, the primary connection between reserve size and fishery benefits is again ignored, setting up unjustifiable demands for reserve performance. These are critical points and deserve better scientific treatment here.

IV. Analytical framework for Marine Reserve Proposals: It is not clear why this section is included. Clearly, proposals for marine reserves should be subject to the same regulatory guidelines as other management proposals. No justification is offered for requiring more analytical rigor for this management technique.

V. Conclusions and recommendations. The extensive comments and caveats in this section are difficult to interpret, given the undefined role of the SSC and the Council in reserve establishment. The advice on constructing a sound EIS is generic, and useful if authority for final approval and establishment of reserves rests with the SSC and the Council. Clearly, this will not be the case in circumstances outside of the fishery arena. Rather, the Council will be informed of proposed activities in the area of establishing marine reserves. The SSC might realistically be charged by the Council to prepare a full analysis of how proposed reserves might affect Council-managed fisheries. Surely, proposals could be cast in ways to make the job of the SSC easier, and to that end a condensed version of this white paper might be provided as a *guideline* to those agencies. An extensive set of *requirements*, as embodied in the present document, implies a regulatory authority that requires some justification. It certainly does not derive from current regulations.

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Running title:

Predicting and monitoring reserve export

Title:

Communication: Export of production and the displacement of effort from marine reserves: effects on fisheries and monitoring programs.

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Abstract

Marine reserves affect areas outside reserve boundaries via the displacement of fishing effort and the export of production. Here we focus on how these key factors interact to influence the results seen once reserves are created. For a settlement-limited fishery, export of increased production from within reserves can offset the effects of displaced fishing effort. Given documented average increases in biomass within reserves, simple models indicate that net fisheries benefits can accrue at closures up to and perhaps beyond 50% of total stock area through the export of production. However, reserve monitoring programs face problems identifying independent control sites because the spatial extent of export is unknown. Efforts to monitor reserve impacts on recruitment are further complicated by the fact that large reserve closures are likely necessary before significant changes in recruitment can be detected above normal interannual fluctuations. Resolving these limitations requires comprehensive monitoring data before reserves are implemented. Fortunately, studies of reserves that used BACI experimental designs show that control and reserve sites were equivalent prior to protection, and that control sites improved after reserves were in place. Consequently, any bias in our current perception of reserve impacts likely underestimates their effect.

Key words: marine reserves, marine protected areas, reserve monitoring, export, recruitment, fishing effort, reserve design

Introduction

A major challenge in efforts to evaluate the effect of marine reserves on non-reserve areas stems from the fact that reserves are expected to affect areas beyond their borders by displacing fishing effort and exporting production. These two expectations lead to contradictory outcomes for biomass of populations outside the reserves and the consequent fisheries yields obtained from that biomass. The net result of establishing reserves could be a decrease, no change, or an increase in fish biomass outside the reserve, depending on which factor turns out to be more important.

In fact, much of the controversy around the creation of marine reserves and reserve networks stems from uncertainties about how or if reserves can compensate fishers for areas made unavailable to them as a result of implementation. Although marine reserves need not, and perhaps should not, be designed with fisheries management as a primary goal, it is important to explore how reserves will affect fisheries so that stocks outside reserve boundaries can be most effectively managed. The conventional wisdom is that little evidence exists for the export of production from reserves, and so the same number of fishers fishing in less area will cause there to be fewer fish per fisher. This would be the case if marine reserves provided no benefit to populations of fish outside their boundaries.

However, a growing body of evidence suggests that reserves can affect areas outside their borders. Reserves can compensate for the loss in fishing area in two ways: through the spillover of adults across reserve boundaries and through the export of larvae from reserves to fished areas. Evidence shows that adult spillover can and does occur (e.g., Russ & Alcala 1996a, McClanahan & Mangi 2000, Roberts et al. 2001, Gell &

Roberts 2002), but determining how many larvae reserves supply to non-reserve areas is a difficult task that has thus far relied primarily on theory (Man et al. 1995, Nowlis & Roberts, 1999, Crowder et al. 2000, Lipcius et al. 2001, Botsford et al. 2001, Gaines *et al.* 2003) and a few correlative studies (Stoner & Ray 1996, Murawski et al. 2000, Valles et al. 2001). Estimates of average larval dispersal distances using a variety of indirect means (Shanks *et al.* 2003, Kinlan and Gaines 2003), however, suggest that the larvae of nearly all fish and most invertebrate species disperse much further than the typical sizes of marine reserves (Halpern 2003).

From a fisheries management perspective, the important questions are less about how many larvae are exported and more about the ability of this exported production to supply and sustain fisheries at current or higher levels. What will be the stronger force structuring fish populations outside reserves – the displacement of fishing effort or the export of production? Put another way, how much export of production is necessary to offset the increase in fishing pressure from displaced fishers? One of the main goals of this paper is to evaluate and suggest answers to these questions.

Determination of the actual effects of reserves requires careful monitoring. However, a major challenge arises from difficulties in interpreting results from monitoring efforts. For example, a study may find that the biomass of fish inside a reserve is significantly higher than a comparable fished area nearby. Five possible scenarios exist to explain these results. After reserves were put into place, values could decrease in the reserve and decrease even more in the fished site, remain unchanged in the reserve and decrease in the fished site, or increase in the reserve while values in the fished site decreased, showed no change, or increased. These different responses clearly have different implications for how we interpret the impact of reserves, yet they all generate the same pattern – more biomass per unit area inside reserves than out. Well-designed Before-After-Control-Impact (BACI) studies can resolve these possibilities, and we review the evidence from several such studies. As we discuss below, interpretation of results from monitoring programs of networks of multiple reserves is even more challenging than for single reserves.

One of the main goals for future monitoring programs of marine reserve effects will be to determine the degree to which reserves supply larvae to areas outside reserve boundaries. A fair assessment of this potential impact requires that we have appropriate expectations. To help clarify and guide our expectations for the effects of reserves on areas outside their boundaries, we discuss three factors that should be kept in mind when designing reserves, developing monitoring programs, and interpreting results gained from such programs. First, we address the increase in fishing effort per unit area that would occur outside reserve boundaries if fleet capacity and regulations were not changed. Second, for a settlement-limited fishery, we ask how much additional production reserves must export to compensate for the increases in fishing pressure due to this displaced fishing effort. Finally, we discuss how these two factors interact to affect the choice of appropriate and informative control sites for monitoring reserve performance. Previous models evaluating the effects of reserves on areas outside reserve boundaries (e.g., Attwood & Bennett 1995, Hastings & Botsford 1999, Sladik-Nowlis & Roberts 1999, Jennings 2001, Botsford et al. 2001, Gaines et al. 2003) have not explicitly evaluated how displaced fishing effort may affect non-reserve fish populations, nor have they addressed whether increases in production from reserve populations can compensate for the change in fishing intensity outside reserve boundaries.

The Squeeze Factor

Quantifying the effect of squeezing the same number of fishers into a smaller area is relatively straightforward. Consider the most conservative case with no response by fishers or management agencies, i.e., total fishing effort remains the same, albeit forced into a smaller area, and no new regulatory changes are imposed, such as stricter catch limits or fleet buy-back programs. If the fraction of total habitat area set aside in reserves is R, then the previous fishing effort is now concentrated in an area that is only (1-R) as large. As a result, the proportionate increase in fishing effort per unit area outside the reserves will be 1/(1-R). For example, a 20% reserve closure (R = 0.2) would lead to a 25% increase in fishing pressure (1/[1-R]= 1.25) to areas outside the reserve. The fishing pressure on populations outside the reserve accelerates as the fraction of area in reserves increases (see Table 1). At R = 0.5, fishing effort outside the reserves doubles. From the perspective of fish that are the targets of fishing, these increases in effort should translate into a comparable increase in risk of mortality in the short term.

These calculations assume that displaced fishing effort is distributed equally to areas outside the reserve boundaries. In more realistic scenarios, displaced fishers may relocate only a short distance, causing fishing intensity to remain relatively unchanged at locations far from the reserve but be greater than 1/(1-R) at locations nearby the reserve. However, the potential for limited larval dispersal from within the reserve (Swearer et al. 1999, 2002) and the likelihood of at least some adult spillover (Attwood & Bennett 1994, McClanahan & Mangi 2000, Roberts et al. 2001) suggest that the benefits gained by fishers from reserves may parallel the spatial patterns of likely changes in fishing intensity. We deal with the possibility of reserves being able to compensate for changes in fishing intensity explicitly in the next section, but maintain the assumption of uniform redistribution of displaced fishing effort here for the sake of simplicity.

The Compensation Factor

The estimates above assume no response by people to compensate for the displacement of fishing effort (i.e., total fishing effort remains constant). The estimates also assume that any responses by the animal and plant populations that receive protection from the reserve have no impact on populations outside the reserve. However, if protection within reserves leads to enhanced production of young or adults, and part of this production then spills over into areas beyond reserve boundaries, some of the increases in mortality outside the reserve due to the concentration of fishing effort could be offset by the export of biological benefits produced from the populations protected within reserves. How much additional production from the reserves would be needed to offset the added losses beyond reserve borders? Spillover of adults from the reserve to unprotected areas will contribute to this compensation (e.g., Roberts et al. 2001, McClanahan & Mangi 2000), but export of adults will likely be limited in spatial extent relative to the entire management area. The export of larvae, on the other hand, has the potential to service much larger regions and perhaps entire populations.

The potential for larval export from reserves to compensate for displaced fishing effort is conceptually easiest to address when fisheries are recruitment-limited, such that future catch is determined primarily by the rate of successful settlement of larvae. For the rest of this paper we define recruitment as the settlement of larvae to the benthic phase of their life-cycle, and focus our attention on how recruitment changes in fished areas, acknowledging that populations within reserves may not be settlement-limited as they grow larger. Most if not all over-fished populations are recruitment-limited, and many other species, regardless of fishing intensity, have been shown to be recruitment-limited (reviewed in Doherty 2002). Consequently, the models we develop below should be broadly applicable.

To begin with, assume that 1) all larvae are released into a general larval pool and then settle equally to all areas, fished or not fished, 2) larval mortality is density-independent, such that increases in production lead to equivalent increases in recruitment, and 3) adult fish are evenly distributed throughout their range, such that the amount of adult biomass initially protected by a reserve is proportional to the reserve size. Suppose the ~~current (pre-reserve)~~ settlement rate of larvae per unit area of habitat $= L$. ~~To compensate for the enhanced concentration of fishing outside the reserve, the settlement rate of young~~For reserves to have no impact on fishing outside the reserve, this rate must remain the same in the face of increased fishing pressure. ~~increase in proportion to the increase in mortality risk, i.e., to~~ ~~$L \bullet \frac{1}{1-R}$.~~ Since reserves are unlikely to have any direct effect on larval mortality, ~~this increase in~~ settlement rates in fished areas must ~~come~~ be maintained from ~~a corresponding~~an increase in production of larvae by adults in the reserve. If reserves enhance the production of settlers per unit area to L_{res}, then the average settlement rate due to combined production from reserves and unprotected areas, given that total fishable stock is assumed to remain the same (i.e., L is the same before and after reserve creation), will therefore be:

$$L \bullet (1-R) + L_{res} \bullet R$$

To offset the added losses outside the reserve, this settlement rate must equal or exceed $L \bullet \frac{1}{1-R}$, so:

$$L \bullet (1-R) + L_{res} \bullet R = L \bullet \frac{1}{1-R}$$

Next solve for how large L_{res} must be to meet this criterion:

$$L_{res} = \frac{1}{R} L \left[\frac{1}{1-R} - (1-R) \right]$$

$$L_{res} = L \left[\frac{(2-R)}{1-R} \right]$$

Expressing this production rate in reserves relative to the production rate prior to reserve establishment, one obtains the critical compensation factor (CF) needed to offset the concentration of fishing effort:

$$CF = {}^{L_{res}}\!/\!_{L} = \frac{2-R}{1-R}$$

Table 1 shows values of this compensation factor for a variety of reserve sizes and resulting squeeze factors, given our assumptions about displaced effort. Regardless of the size of a reserve, and no matter how few fishers are displaced by the reserve, production of future settlers needs to at least double inside the reserve to compensate for displaced fishing effort. However, production need only triple inside reserves to compensate for the displacement resulting from a 50% closure.

It is clear that determining the effects of reserves on areas outside reserve boundaries depends critically on estimates of reserve production. Although the change in production within reserves has not been directly measured, many studies have examined changes in adult size. If gamete production increases linearly with biomass, a conservative assumption for most species (Wootton 1990), one can use existing empirical studies of changes in biomass to estimate CF. Halpern's (2003) synthesis of studies of more than 80 reserves worldwide provides a broad, general picture of how reserves can affect biomass. On average, biomass increased within reserves three-fold. This suggests that the expected increase in production within reserves could compensate on average for the displacement of fishing effort up to a 50% closure, if the fishery is settlement-limited. If the fishery is not settlement-limited, then increased production within a reserve will have smaller effects on yield in areas outside the reserve, although reserves could still have an effect via the spillover of adults to non-reserve areas. Given that no existing reserves or reserve networks enclose anything remotely close to 50% of the range of any marine species, these simple calculations predict that the impact of existing reserves on areas beyond their boundaries should commonly be beneficial despite the concentration of fishing effort.

One critical assumption in the above estimates is that larvae produced within the reserve disperse, on average, well beyond the boundaries of the reserve. For most species of fish and invertebrates this may be a reasonable starting assumption (e.g., see Shanks *et al.* 2003, Kinlan and Gaines 2003) given the size distribution of existing marine reserves (Halpern 2003). With this dispersal scenario, the fraction of larvae that ultimately settle back into a reserve is R. For some species, however, dispersal of young is much more limited. In addition, even with the potential for long distance dispersal, realized larval dispersal may be much more limited in some oceanographic settings (e.g., Swearer et al. 1999, Jones et al. 1999). If larvae have restricted larval dispersal, can reserves still compensate for the displacement of fishers? Clearly, if larvae do not disperse at all, none of the higher production generated within the reserve benefits the fishery, because it is not exported to fished areas. There will be no compensation for the "squeeze" in fishing intensity.

To explore the case of limited dispersal, we focus on individual reserves rather than the overall fraction of habitat protected. Imagine a coastline with reserves of width w separated from each other by a distance, s (Box 1) Suppose that larvae are dispersed away from their parents with a mean dispersal distance, d, a maximum dispersal distance, m, and probability distribution of dispersal distances, f(x). Consider a conservative case of restricted dispersal where the reserve size is large relative to the maximum dispersal distance. In this situation, the offspring of a female fish who spawns at the center of the reserve will all be retained within the reserve. A female spawning at the edge of a reserve, however, will export half of her offspring to the adjacent fished area. As spawning sites move from the edge of a reserve toward the center, the fraction of larvae exported declines. For any given location that is a distance b from the edge ($b \leq m$), the fraction of larvae exported is 1/2 (because only larvae dispersing in one direction are exported) times the probability that larvae disperse a distance greater than b, i.e., the area of the tail of the dispersal probability distribution, f(x), that lies beyond b:

$$Fraction\ Exported = \frac{1}{2}\left(\int_b^m f(x)\partial x \right) .$$

To estimate the total reserve contribution to the fished area, integrate over the contributions from all locations within a distance m of the edge of individual reserves. For any dispersal probability distribution, $f(x)$, this total contribution is

$$\frac{1}{2}\int_0^m xf(x)\partial x = \frac{1}{2}d$$

which is 1/2 of the average larval dispersal distance, d (see Box 1 for details). An equivalent contribution to each fished area comes from neighboring reserves on the right of the fished areas through export of larvae dispersed to the left from the reserves. Similarly, the fished area contributes an equivalent cumulative fraction of larvae to each of its neighboring reserves.

To estimate the critical compensation for the squeezed fishery, we focus on a single fished area between two reserves. Prior to the establishment of the reserve, the region s generated $L \bullet s$ settlers. Without reserves, contributions to and from adjacent fished areas through larval dispersal would be equivalent. Thus, the pattern of dispersal can be ignored. With reserves, the smaller fished area only generates $L \bullet (s-w)$ recruits. Some of these larvae are exported to the adjacent two reserves ($L \cdot 2 \cdot [\frac{1}{2}d]$). In addition, some recruits arrive from the adjacent reserves ($L_{res} \cdot 2 \cdot [\frac{1}{2}d]$). Therefore, to compensate for the enhanced fishing pressure, this total production to the fished area must equal $L \bullet s$.

$$L \cdot s = L \cdot (s - w - d) + L_{res} \cdot d$$

The resulting CF is

$$CF = \frac{L_{res}}{L} = \frac{w + d}{d}$$

If we express average dispersal distance in terms of reserve size, w, and a nominal scaling parameter, k, e.g., if $d = w/k$, then CF equals $k+1$ (Fig. 1). As with dispersal into a common larval pool, the *CF* converges to a minimum value of 2 as d approaches w. Shorter dispersal distances require a higher *CF* to offset the effects of displaced fishing. Therefore, fished species may respond differently to the same reserves. Using the biomass estimates of Halpern (2003) to project an average *CF* of 3, species with average dispersal distances greater than half the width of the reserve should ultimately compensate for the displacement of fishers. On the other hand, species with shorter average dispersal distances would receive insufficient export of production from the reserves to compensate for the squeezed fishery. Although estimates of dispersal distances are only available for a tiny fraction of marine species, it is likely that the great majority of fished species disperse farther than the average reserve size, given the distribution of existing reserve sizes (Halpern 2003). Some harvested species, however, such as abalone (McShane et al. 1988) or kelp (Reed et al. 1992), may rarely satisfy these compensation criteria, since their average dispersal distance can be quite limited. In addition, since the total fraction of habitat protected by a network of reserves can be increased both by increasing reserve size and by decreasing reserve spacing, scaling individual reserve size to the average dispersal distance of key fished species provides a simple mechanism for compensating for displaced fishing even for networks covering large cumulative areas.

Another implicit assumption in our calculations is that species are relatively sedentary and site-attached. Because they have limited ranges of movement, these species can benefit from reserve protection and grow to produce a greater number of offspring. Generally, these species comprise a majority of a community. The conclusions from our work likely do not apply to more highly mobile species. However, because of their mobility, these species are both unlikely to benefit from reserve protection nor be harmed by displaced fishing effort. They will simply be caught in different locations. In short, reserves provide little benefit but create little cost for highly mobile species, and would therefore have little effect on fishers who target these species, aside from constraints imposed by being forced to fish in different locations (e.g., with different travel costs).

Even sedentary species can make directed movements that may alter the way in which production is exported from reserves. In particular, many species are known to migrate to spawning aggregation sites. If these aggregation sites fall within reserve boundaries, then their effect on larval production depends on how much the reserves reduce mortality on the spawning females. If fishing mortality largely occurs prior to aggregation, then reserves that protect aggregation sites may have little impact on production. If substantial fishing mortality would otherwise occur when fish are aggregated to spawn (e.g., because they are much easier to catch while aggregated), then reserves should enhance larval production directly in proportion to the reduction in mortality they provide. For example, if two thirds of spawning females were, on average, caught prior to spawning while at the aggregation site, then a reserve protecting the spawning site would effectively triple larval production. This would be equivalent to the value of 3R assumed above. If aggregation sites fall outside reserve boundaries and are targeted by fisheries, then some of the benefits of the accumulated adult biomass within reserves would be lost when females migrate to spawn. In these circumstances, the simple model above would overestimate the benefits of reserves to the fishery.

Even though biological compensation appears to be large enough to offset fisher displacement from large reserves, this biological compensation does not occur immediately. Fishers can move in a day, changing the intensity of fishing effort outside reserves literally overnight. The accumulation of biomass within reserves (the source of compensatory production) will certainly take longer. Evidence suggests that community-wide average biomass responds rapidly to reserve protection, within 1-3 yrs after reserve creation (Halpern & Warner 2002), although there is also evidence that many species, particularly those with slow growth rates or late ages at maturation, will build up biomass within reserves much more slowly (e.g., Gell & Roberts 2002, Russ 2002). The spillover of adults from reserves should happen more quickly and therefore help offset some of the losses to fishers from fishing grounds becoming protected by reserves, but the interim years between reserve creation and the realization of production compensation will likely require alternate policy measures for fisheries on slowly growing species. However, our analyses suggest that fishers will often benefit in the long run with reserves in place.

Monitoring Reserve Impacts

To be politically feasible, reserves must achieve the goals established for them. However, accurately assessing reserve performance will be difficult for several reasons.

Lack of independent controls

Most notably, it is nearly impossible to identify a truly independent control site for monitoring the effects of reserve networks (systems of reserves that collectively span a wide area). Supposedly, reserves affect nearby areas both negatively, via displaced fishing effort, and positively, via export of production. In fact, one of the criteria used to design reserve networks is that individual reserves within a network are connected to each other, usually through larval dispersal. This implies that all areas between the reserves will also likely receive export. Thus areas both inside and outside of reserves should be subject to reserve effects, and contemporary sites used to take measurements inside (reserve effect) and outside (control) a reserve network cannot be truly independent. Consequently, monitoring programs may need to sample at many sites across a gradient of distances from the reserve boundary, both outside and within the reserve, to characterize the effects of reserves and the spatial extent of those effects. No particular area outside a reserve can be reliably identified as a control until we have a much better perspective on the dispersal distances of pelagic larvae.

Intrinsic variation in recruitment

Increases in the production of larvae within reserves may not result in detectable increases in recruitment outside the reserve unless substantial portions of the sea are set aside. Assuming that larval production triples within reserves (Halpern 2003) and that this production is dispersed equally across all areas (an assumption that approximates reality if the average dispersal distance of target species is much larger than the size of individual reserves, which is likely the case for most existing reserves since the reserves are relatively small), then the total productivity is the production contributed from the reserves (3•R) plus the production from non-reserve areas (1-R), adjusted by the change in survival outside the reserve due to the displacement of fishing effort (1/[1/(1-R)], or simply 1-R). So overall larval production is:

$$3R + [(1-R)\bullet(1-R)] = 1 + R + R^2$$

and the fraction of this total production that recruits back into reserves is equal to the fraction of the total area devoted to reserves (R). If increases in production of larvae are directly related to overall increases in subsequent recruitment, then closing 10% of waters would lead to an 11% overall increase in recruitment, a 30% closure to a 39% increase, and a 60% closure to a doubling of recruitment.

The calculation described above assumes that larvae disperse quite broadly. If dispersal distances are much shorter (on the order of the size of individual reserves), some of the increase in production within reserves will be retained inside the reserve, causing settlement rates to vary spatially as a function of distance from the reserve boundary. Far from the reserve, settlement rates should be unaffected by contributions from the reserve. If dispersal distances are smaller than the reserve size, settlement increases should match the increases in production in the center of the reserve, while at the reserve boundary settlement rates should be at the midpoint between these two extremes. Again, using the biomass patterns in Halpern (2003) to forecast a tripling of larval production within the reserve, settlement rates near the reserve boundary should be twice as high as average rates far from the reserve. The rate of average settlement should decline as a function of distance from the reserve boundary, with the rate of decline set by the shape of the probability distribution of dispersal distances.

These two scenarios present the two possible extremes for larval dispersal: larvae disperse a great distance relative to reserve size or they disperse a distance shorter than the width of the reserves. In either case changes in recruitment in fished areas after reserves are put in place will not be large (>30%) unless total reserve size is relatively large (wide dispersal) or one is measuring recruitment immediately next to the reserve boundary (limited dispersal). In a perfect world with adequate sample size, even a 10% increase in recruitment might be detectable. However, given the inherent variability in annual recruitment for most species (e.g., Caffey 1985, Roughgarden et al. 1988, Siegel et al. 2003), the effects of reserve networks on population-wide recruitment may not be detectable unless sizable areas are set aside or many years of data from monitoring programs are available. This is essentially a signal-to-noise problem. A synthesis of the recruitment dynamics of 82 invertebrate species of all life-history types (Eckert 2003) can give a sense of how much noise, i.e., normal variation, there is in recruitment. Short dispersers (species with planktonic, nonfeeding development) had an average CV value of about 155, i.e., average SD was half-again as large as the mean, while long dispersers (species with planktonic, feeding development) had an average CV value of 145 (Eckert 2003).

To overcome this formidable amount of natural variation, either recruitment must increase many-fold or it must be monitored for many years (larger N) after reserve creation. Consequently, increases in recruitment from networks of small reserves or small single reserves are unlikely to be detectable across the range of a species, especially for species with broad dispersal distances. Production is being increased, but its signal will likely be diluted broadly and masked by large temporal variation. Even large reserves will need to be monitored for many years after reserve creation before an effect on recruitment may be detectable statistically. Species with limited dispersal distances relative to reserve size should provide the most statistically powerful tests of reserve effects on recruitment, because they should show larger effect sizes near the reserve boundary. Since nearly all existing protected areas can be classified as small reserves or small networks, it will be very difficult to determine the extent to which these reserves are affecting recruitment given current set-asides. Even though reserves are enhancing production on average three-fold within their boundaries, the cumulative export benefits may be difficult to detect against a background of fluctuating recruitment.

Evidence from BACI studies

The need for designing reserve monitoring programs with adequate and appropriate controls has been discussed before (Guidetti 2002, Hilborn 2002, Russ 2002). One message from this work is that monitoring programs need to take measurements both before and after reserve creation at sites inside and outside the reserve, and we have discussed how control sites at varying distances from reserve boundaries may be necessary to determine the extent to which reserves affect areas beyond their borders. Few studies of individual reserve effects have had such sampling programs. Without measurements made before reserve creation, it is difficult to assign causes to any differences seen between reserve and fished locations. In fact, it has been suggested (Hilborn 2002) that a bias may exist in the perceived effect of reserve protection because 1) reserves were likely placed in inherently more productive locations and 2) displaced fishing effort when reserves are created should lower values in the control site outside the reserve due to the higher fishing pressure.

Although the need for a proper sampling design has been identified, it remains unknown how a lack of such a design may have influenced the results of previous reserve monitoring programs. Analyses of reserve studies that used a before-after-control-impact

(BACI) experimental design can be used to evaluate if the potential biases outlined by Hilborn (2002) exist. If reserves were placed in more productive locations, then measurements comparing reserve and fished locations from before reserve creation should indicate higher values of density, biomass, etc. at the reserve location. Furthermore, if displaced fishing effort as a result of reserve protection subsequently lowered values of density, etc. outside the reserve, then control sites should show a decrease in density, etc. after reserves were established.

Syntheses of results from the few reserve studies that used a BACI design (Castilla & Duran 1985, Castilla & Bustamante 1989, McClanahan & Kaunda-Arara 1996, Russ & Alcala 1996b, Edgar & Barrett 1999, Roberts et al. 2001, Tawake et al. 2001) suggest that such potential biases do not exist. There is no significant difference between pre-reserve fished and reserve values, nor do values change significantly in fished areas after reserve creation (Table 2). If anything, changes in fished areas tended to be positive despite displaced fishing effort, suggesting a service function for marine reserves that would create a bias against seeing a reserve effect. This is exactly the challenge we describe above for finding a true control site; reserves appear to be affecting areas outside reserve boundaries, and so a single "control" site will be insufficient to determine the extent of this reserve effect.

Combining all the results from these limited analyses suggests that "control" sites tend to improve after reserve protection in most situations (Table 2), although the small sample size of these analyses require that caution be used when generalizing the results. This service function of reserves to fished areas occurred despite the increased fishing intensity that most of these "control" sites likely incurred as fishers displaced by the reserve moved to these nearby locations. Although we have focused on the potential for reserves to export larval production to fished areas in our analyses above, the service function provided by the reserves in these studies is probably due to the spillover of adult fish, as suggested by the authors of the studies used in these analyses. Regardless of the source of this service function, these results demonstrate that changes in fishing pressure outside reserves that may have occurred from displaced fishing effort did not negatively affect fish populations outside reserves, and highlight the challenges inherent in efforts to evaluate the actual effect of reserves on marine populations.

Conclusions

The appropriate design and monitoring of marine reserves requires accurate expectations for the impacts of within-reserve changes on populations of fish outside reserves. To date most expectations have been based on only one of the two factors we discuss here: either reserves will increase reproductive output and therefore benefit fisheries catch, or displaced fishing effort will decrease catch. Here we combine these factors to develop simple expectations for how reserves affect areas outside reserve boundaries and highlight key issues that must be considered when developing and evaluating marine reserves and reserve networks. For settlement-limited fisheries, the increase of production within reserves (on average, a tripling) may compensate for greater fishing pressure outside the reserve, up to at least a 50% closure. However, if total reserve area is too small, then such compensation from reserves due to increases in overall recruitment may be difficult to detect within the normal fluctuations in recruitment, even when the increases are real.

Because reserves are expected to affect areas outside the reserve, it will be difficult to have independent control sites for monitoring reserve networks. Most studies to date that evaluated reserve effects probably did not have truly independent control sites, simply because export from reserves can affect areas outside the closure. Limited evidence suggests that biases for detecting a positive reserve effect are unlikely, however, in that reserves do not appear to have been placed in disproportionately productive areas, nor do areas outside of reserves decline in biological value after reserve establishment. In fact, a slight bias may exist against seeing a reserve effect, because areas outside the reserve actually tend to improve. This is encouraging evidence for the export function of reserves. These studies highlight the need for monitoring programs to include data from before reserve implementation if reserve effects are to be assessed accurately.

Attention to these issues does not ensure any particular result. Instead, it helps to set appropriate goals and expectations for the development and monitoring of marine reserves and reserve networks. Once developed, these goals and expectations can then allow for the proper design, and when necessary the redesign, of reserves and reserve networks.

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Table 1. Sample values of the compensation factor.

% of total area inside reserve	Increase in fishing effort outside reserve	Compensation factor
1%	1.01 x	2.01
5%	1.05 x	2.05
10%	1.11 x	2.11
20%	1.25 x	2.25
30%	1.43 x	2.43
50%	2.00 x	3.00

Note: Values are given for the times increase in fishing pressure [1/(1-R)] and the compensation factor [(2-R)/(1-R)] for a few sample reserve sizes. See text for the derivation and explanation of these values.

Table 2. Data for changes in 4 biological measures from studies that made measurements before and after in control (fished) and impact (reserve) sites (BACI design).

		Inside-before vs. Outside-before						Outside-after vs. Outside-before					
		Trends			Actual Values			Trends			Actual Values		
	N	**# better**	**# ND**	**# worse**	**mean log ratio**	**t**	**p-value**	**# better**	**# ND**	**# worse**	**mean log ratio**	**t**	**p-value**
density	9	3	1	5	0.12 ± 0.47	0.75	0.47	7	1	1	0.25 ± 0.50	1.52	0.17
biomass	3	1	1	1	0.08 ± 0.20	0.7	0.56	3	0	0	0.40 ± 0.41	1.71	0.23
size	2	2	0	0	0.02 ± 0.007			1	0	1			
diversity	3	2	0	1	0.05 ± 0.07	1.21	0.35	1	0	2	-0.05 ± 0.08	-1.2	0.37
combined	17	8	2	7				12	1	4			

Note: From the studies of marine reserves that were reviewed by Halpern (2003) and Gell & Roberts (2002), a total of 9 reserves from 7 different studies were evaluated using a BACI design. Data are presented for comparisons of reserve and non-reserve sites before reserve creation and of non-reserve sites before and after reserve creation. First, comparisons were classified as better, worse, or not different (ND) according to the value of the first comparator (inside-before or outside-after) relative to the second (outside-before in both cases) regardless of significance (no difference indicates that values were identical); in most cases of difference, values differed by over 100%. Second, the actual values for each reserve were expressed as a ratio, and then log-transformed for statistical purposes. Log ratio values are presented as mean ± SD. A two-tailed, one-sample t-test was performed to compare the log-transformed ratio of the indicated comparisons to the null hypothesis of no difference (i.e., log ratio = 0). The t-test was not performed for "size" because sample size (N=2) was too small for statistical comparison.

Figure Legends

Figure 1. The compensation factor (CF) value given varying average dispersal distances as a function of the width of individual reserves. If reserve size is less than or equal to the mean dispersal distance, CF=2 (i.e., larval production within reserves must be twice as high as in fished areas). Assuming that biomass triples within reserves (Halpern 2003), then species with average dispersal distances greater than half the width of the reserve should ultimately compensate for the displacement of fishers.

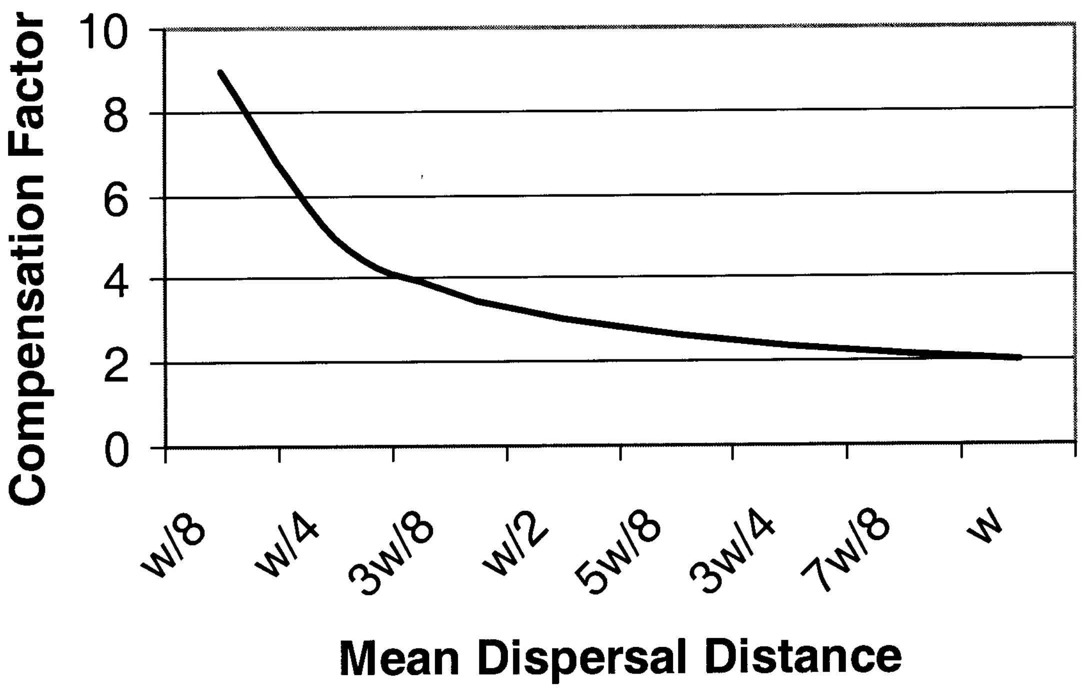
Compensation Factor
10
8
6
4
2
0
w/8
w/4
3w/8
w/2
5w/8
3w/4
7w/8
w
Mean Dispersal Distance

Figure 1

RUNNING HEAD: COMMUNITY CHANGES IN MARINE RESERVES

Trajectories and correlates of community change in no-take marine reserves

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ABSTRACT

Marine reserves are a spatial approach to marine management and conservation aimed at protecting and restoring multi-species assemblages and the structure and function of marine ecosystems. We used meta-analyses of published data to address the questions of how and over what time frames marine assemblages change within no-take marine reserves as they recover from fishing and other human uses. We used 20 studies of coastal fish assemblages from 31 temperate and tropical locations, reporting abundances, and in some cases biomass, of 10-134 species from reserve and reference conditions (i.e., conditions in nearby fished sites or before reserve establishment) spanning 1-25 years of protection. Synthesis of data from these diverse set of assemblages showed that: (1) a species' level of exploitation, trophic level, and the duration of protection through the no-take reserve explain small but significant amounts of variation in individual species responses to protection, with only species that are targeted by fishing or by aquarium trade showing overall enhanced abundances in protected areas, and increasing positive effects of protection on abundances at top trophic levels through time; (2) up to a third of species in different studies (19% on average) appeared to be negatively affected by protection, indicating that indirect effects of protection through competitive or predatory interactions may be common; and (3) variation and lags in species responses to protection resulted in protected assemblages diverging from reference conditions, with greater proportions of total fish biomass at top trophic levels in protected compared to fished assemblages. These results support previous conclusions that marine reserves are effective in enhancing local abundances of exploited species and restoring the structure of whole communities, but that these effects will likely occur through a series of transient states and, for some communities, over long time frames. Long-term

monitoring of community trajectories in MPAs and modeling studies scaling up local effects to relevant spatial and temporal scales are needed to increase our ability to protect and restore whole marine systems, and to set realistic targets for the conservation and restoration of specific assemblages.

Keywords: marine protected areas, marine reserves, community change, indirect effects, trophic cascades, community structure, human impacts, fishing impacts, recovery, temporal trajectories, meta-analysis, coastal fish assemblages.

INTRODUCTION

Marine reserves, portions of the coastline or ocean set aside and protected from fishing and other extractive uses, have recently received great attention as a means of conserving marine biodiversity and restoring depleted fish stocks (Allison et al. 1998, NRC 2001, Palumbi 2001, 2002). In addition to protecting the populations directly targeted by fishing, reserves are established with the goals of protecting and restoring habitat, whole assemblages, and ecological interactions among their components, and to replenish depleted populations in adjacent areas through export of larvae, juveniles and adults (NRC 2001, Palumbi 2002).

In recent years, a large number of studies have evaluated the performance of reserves with respect to these objectives. Increased abundances, biomass, organism sizes, and diversity have been documented for a variety of marine species and assemblages from many different locations (Boersma and Parrish 1999, Palumbi 2001, 2002, Halpern 2003). Changes in community composition have also been highlighted in a number of cases, and have been attributed to both differential responses to species with different life histories and dispersal abilities to fishing or to protection (e.g., Jennings et al. 1999, Jennings 2001, Fisher and Frank 2002), and to indirect effects of protection through trophic interactions (reviewed by Pinnegar et al. 2000). For example, recovery of predatory fishes and lobsters within a marine reserve was associated with subsequent lower abundances of sea urchins and recovery of algal beds in New Zealand, the Medes Islands (Spain), the Channel Islands (California), and in Kenya (Sala and Zabala, 1996; MacClanahan et al. 1996, 1999, Sala et al. 1998, Steneck 1998, Babcock et al. 1999, Lafferty and Kushner 2000, Shears and Babcock 2002). In addition to local responses within reserves, spillover into adjacent areas and increased CPUE following reserve establishment have also been documented (Yamasaki and Kuwahara 1990, Russ and Alcala 1996, Roberts et al. 2001, McClanahan and Mangi 2000, Gell and Roberts 2003).

Key questions that have just begun to be addressed concern the temporal trajectories and the between-species variability of population and community responses to protection. How rapid are biological responses within and around MPAs? How persistent through time? How do responses vary depending on the species or assemblages considered? What are the characteristics of species exhibiting differential responses to protection? How common are indirect effects of protection, where some species decline because of increased predation or competition within the protected areas? Answers to these questions are critical for predicting time frames of recovery of depleted populations and communities, and for implementing management and monitoring of MPAs. A better understanding of the patterns and correlates of the variation in efficacy of protection and in the temporal trajectories of recovery in MPAs is needed. This understanding will help predict what species and community attributes are more likely to benefit from protection within no-take reserves. Second, it will help select focal species, species groups, and biological variables for monitoring reserve effectiveness (Goñi et al. 2000, Fraschetti et al. 2002). Finally, it will contribute to establishing realistic targets for reserve evaluation (e.g., a 5 year timeframe was proposed to determine the efficacy of reserves in the Channel Islands Marine Sanctuary, California, USA; Gerber et al. 2003).

Empirical observations to date have indicated that some variables change relatively soon after the implementation of a reserve, and remain near the new level. A recent synthesis of empirical data showed that density, biomass, average organisms size, and diversity in reserves relative to controls reach mean levels within a typically short time (1-3 years) and subsequently remain consistent across reserves up to 40 years of age (Halpern and Warner 2002). Moreover, responses in these biological variables were independent of reserve size, indicating that even small reserves can enhance population and assemblages (Halpern 2003).

In contrast with persistent effects of total abundances, biomass and numbers of species, long-term studies of MPAs indicate that continuous change in community composition and transient states in community structure can occur over decades following MPA establishment (e.g., McClanahan 2000, Shears and Babcock 2002). Thus the distribution of the enhanced abundances and biomass among different components of the community may vary over long time frames. In the Leigh marine reserve, New Zealand, increased abundances of lobsters (*Jasus edwardsii*) and snappers (*Pagrus auratus*) were documented within 5-7 years from the reserve establishment in 1978. Decline of sea urchins, on which these species feed, and replacement of urchin barrens with macroalgal beds occurred with a ten-year time lag, and have continued for over 20 years (Babcock et al. 1999, Shears and Babcock 2002). Between 1999 and 2001, localized die-offs of sea urchins, possibly associated with disease, led to algal recovery at some of the control sites where urchin barrens had persisted for 25 years (Shears and Babcock 2002). Establishment of the Mombasa Marine National Park in Kenya was also followed by increases in a sea-urchin predator, the wrasse *Chelinus trilobatus* during the first 3 years (McClanahan 2000). However, sea urchin declines and recovery of benthic corals occurred after more than 10 years, and coincided with later recovery of the fish *Balistapus undulatus*, also a predator of sea urchins. Data from 5 fully protected Kenyan MPAs indicate that populations of the triggerfish *B. undulatus* showed positive trends in their abundances after over 30 years of protection (McClanahan 2000).

Species may respond differently to protection depending on the intensity of exploitation they are subject to outside the reserve and prior to its establishment, their life-history characteristics, and their larval, juvenile and adult dispersal ability. In a meta-analysis of studies of fish assemblages from marine reserves, Mosquera et al. (1999) found that differential responses of fish families to marine reserve establishment correlated with their level of exploitation and body size, with stronger positive responses for the taxa characterized by larger body sizes. Because maximum body size is usually correlated with life history parameters such as age at maturity, growth, and reproductive output, this variable may be a useful surrogate for predicting recovery rates from low population sizes (Jennings et al. 1999, Jennings 2001). Fisher and Frank (2002) analyzed 31-year time series of abundances of over 70 fish species within a fishery closure and an adjacent reference area on the Scotian Shelf, Canada. Fish community composition was significantly different after the implementation of the fishing closure relative to before closure, and several species contributed to these differences. A preliminary review of life history attributes for 16 species in this dataset indicated that different trajectories may be related to dispersal ability of the species. In contrast to the results reported above (Mosquera et al. 1999, Jennings et al. 1999, Jennings 2001), species with benthic eggs, ovoviviparity, and small body size (i.e., species likely to have limited dispersal in the larval, juvenile or adult stages), tended to benefit from the fishery closure more than those with pelagic eggs or larger body sizes, (i.e. potentially greater dispersal abilities and home ranges; Fisher and Frank, 2002).

The limited availability of long-term data series from MPAs prevents generalizations about the temporal trajectories in community structure and dominance by different species and trophic groups that may be expected following the establishment of MPAs. To examine variation in community structure as a function of duration of protection and of the ecological characteristics of the species in the community, we synthesized published data of fish assemblages from reserves ranging 1-25 years in age. We used this dataset to address the following questions: (1) How do responses to protection vary among species and/or species groups? (2) What are the correlates of the different responses of species to protection? (3) Over what time frames (e.g., few years to decades) do communities respond to protection? Answers to these questions are critically important to predicting recovery following fishing disturbance, and to the management and evaluation of reserves.

METHODS

The dataset

We searched the literature for field studies that examined responses of multi-species assemblages to protection within no-take marine reserves. Because our goal was to examine change in community structure associated with reserve establishment, we included studies where abundances or biomass within no-take reserves had been compared to reference conditions, determined from spatial reference sites or measurements before the reserve establishment (Appendix 1). Studies that focused on a few focal species (less than 10 species, as an arbitrary threshold) or that reported only total abundances or biomass instead of data for individual species were not included in the analyses. Because most studies meeting these requirements focused primarily on fish assemblages, we did not include the few studies that reported data on benthic algal and invertebrate assemblages (e.g., McClanahan 1997, Lasiak 1998, Edgar and Barrett 1999) and limited our analysis to examining variation in fish assemblages.

All studies had been conducted using visual census techniques (belt transects or point counts) with only one exception. Johnson et al. (1999) compared fish abundances between unfished and fished sites within the Merritt Island National Wildlife Refuge, Florida, using trammel-net samples. CPUE data were used for this study. Ultimately data from 20 studies, conducted at 31 different locations were included in these analyses (Appendix 1). Only 3 studies compared fish assemblages before and after reserve establishment. In a majority of studies, fish assemblages within no-take reserves were compared to assemblages at fished reference sites. Between 10-134 fish species were censused in each study (Appendix 1). The final dataset comprised a total of 376 species, belonging to 62 families. Because only 5 studies reported biomass data (Appendix 1), most analyses were conducted only on density or abundance data. From each study we noted the following variables describing the characteristics of protection and of the sampling intensity: (1) the duration of protection (ranging 1-25 years); (2) the reserve size (i.e., its surface area, ranging 11-32,388 hectares); (3) the type(s) of habitat sampled (e.g., coral reef, temperate rocky reef, seagrass beds, or estuary); (4) the number of species censused (ranging 10-134 species); (5) and the number of replicate belt transects or point counts conducted in the censuses (ranging 5-130; Appendix 1).

One of our goals was to establish how patterns of change in community composition varied depending on the level of resolution used to describe community composition. Weak responses of multiple species to protection may sum and result in overall greater effect sizes when species are pooled into broader groups (e.g., broader taxonomic or functional groups). Conversely, strong individual responses may be obscured when species are grouped into broader categories. We chose trophic groups as the functional categories within which species were pooled because fishing typically disproportionately targets species at high trophic levels and this can influence the overall trophic structure of marine communities (e.g., Pauly et al. 1998); thus, we expected recovery from fishing to include increased abundances or biomass of top predators and shifts in trophic structure. Halpern's (2003) analysis of published data indicated that different trophic groups show similar responses to protection. However, in that analysis species were assigned to trophic groups based on their family. Because there is considerable variation in species diets within each family (e.g., Froese and Pauly 2003), lumping of species into family-level trophic groups might have obscured differential responses of trophic groups.

Each species was assigned to one of six trophic groups using the diet information reported in the database "FishBase" (*www.fishbase.org*; Froese and Pauly 2003): herbivores, detritivores, omnivores, invertebrate-feeders, planktivores and piscivores. Piscivores included both species that tend to feed exclusively on other fishes and species feeding on both fishes and benthic or pelagic invertebrates (i.e., at trophic level ≥ 3.5). We extracted additional information about potentially important correlates of the responses of individual species to protection and criteria for grouping species from FishBase. These variables included: (1) exploitation level (i.e., whether the species is a major fishing target, a minor target, is targeted by aquarium trade, or is not targeted by any fishery); (2) trophic level (ranging 2.0-4.5 for the species in this dataset); (3) maximum body size (i.e., maximum length reported, ranging 5.5-300 cm for the species in this dataset); and (4) adult mobility (sedentary or territorial, mobile, and highly mobile or migratory). Information about larval dispersal, another species-specific trait that is likely to influence responses to protection (i.e., Palumbi 2001), was available for only a small subset of species, and was not included in these analyses.

Variation and correlates of species responses to protection

We quantified the effects of protection in no-take reserves on fish species as the natural log of the ratios between abundance within reserves and in reference conditions (response ratios, *lnR*; Osenberg et al. 1997, Gurevitch and Hedges 1999, Hedges et al. 1999). Positive response ratios indicate that the species has greater abundance within reserves than in reference conditions, whereas negative values are indicative of greater abundances in reference conditions compared to reserves. In some cases, separate comparisons had been conducted within different habitat types and depth strata within each study. Comparisons between reserves and reference conditions conducted in different habitat types or depth strata were kept separate in this meta-analysis because sampling had targeted different assemblages. Thus, separate response ratios (and similarity values, see *Community responses to protection*) were calculated for each comparison.

To assess the potential correlates of responses of species to protection, we conducted multiple regression analyses examining the relationship between the magnitudes of individual species responses (i.e., response ratios, *lnR*) with the species' exploitation level, trophic level, body sizes and adult mobility. In addition, duration of protection and reserve size were included in these models as potentially important variables influencing responses of species with varying life histories and mobility. We hypothesized that species characterized by large body size and/or large home ranges may exhibit strong positive responses to protection in relation to reserve size, whereas reserve size should not influence responses for smaller, sedentary species. Response ratios for each species in the dataset were the dependent variables in these analyses, and the duration of protection, reserve size, the species trophic level, maximum body size, exploitation level, and adult mobility were the independent variables. Backward elimination of terms was used to retain in the model only the variables that explained significant amounts of the variation in the dependent variable. Data on abundances in reserves and reference conditions were available for a total of 376 species. Multiple observations were available for several species, yielding a total of 920 observations.

To determine whether increasing numbers of species responded to protection through time, we examined the relationship between the proportion of species showing strongly positive responses to protection (i.e., $lnR \geq 0.69$; see below) with duration of protection. We subdivided response ratios into strongly positive (i.e., abundances in reserves are double than in reference conditions, resulting in $lnR \geq 0.69$), strongly negative (i.e., abundances in reference conditions are double that in reserves, resulting in $lnR \leq -0.69$), and intermediate ($-0.69 < lnR < 0.69$). These thresholds were chosen because previous meta-analyses of studies of marine reserves found that, on average, protection in no-take reserves results in abundances double those in reference conditions (Halpern 2003). The proportion of species falling in each of these categories was calculated for each study in the dataset. To examine whether greater proportions of species showed positive responses to protection with increasing duration of protection, we used multiple regression analyses with the proportions of species showing strong positive ($lnR \geq 0.69$) or negative ($lnR \leq -0.69$) responses as the dependent variable, and duration of protection and reserve size as the independent variables. Finally, to examine which characteristics of species correlated with their increased or decreased abundances within marine reserves, we calculated the proportion of species showing positive ($lnR \geq 0.69$), negative ($lnR \leq -0.69$) and intermediate responses ($-0.69 < lnR < 0.69$; see above) by trophic group, and by exploitation and mobility categories.

Responses of species groups to protection

We determined how species groups responded to protection by examining the average magnitudes and the temporal trends of their response ratios (*lnR*). Species were grouped in different categories based on their trophic level, exploitation status, or mobility. Response ratios were combined by calculating weighted averages within each category (Hedges and Olkin 1985, Gurevitch and Hedges 1999). Weights were defined as the inverse of the sampling variance for each study. Sampling variances were approximated, following Hedges and Olkin (1985), as:

$$v_i=[(N_i^R+N_i^C)/(N_i^R N_i^C)]+[(lnR_i)^2/2(N_i^R+N_i^C)]$$

Where N_i^R and N_i^C are the sample sizes for the ith study for the reserve and reference conditions, respectively, and lnR_i is the response ratio for the study. Weighted averages of response ratios were calculated as:

$$LnR+=\square(w_i lnR_i)/\square(w_i), \text{ where } w_i=1/v_i$$

Averages of the mean response ratio for each category (i.e., trophic groups, exploitation levels, and mobility categories, see *Results*) weighted by the sampling variance (Hedges and Olkin 1985, Gurevitch and Hedges 1999), were considered significantly different from 0 (i.e., there is a significant effect of protection on that particular group) when the 95% confidence limits around the mean did not overlap 0.

Temporal trends in the response ratios of different trophic, exploitation, and mobility groups were examined using multiple regression analysis as described above. Response ratios for each category were the dependent variable and duration or protection, reserve size, and the numbers of species in each group were the independent variables. Species richness within each group was included because groups composed of large numbers of species may exhibit stronger positive responses due to the higher probability of including species that benefit from protection. Because multiple analyses were conducted on the same dataset, the significance level for tests conducted on each group was adjusted using the Dunn-Sidék correction, as $\alpha'=1-(1-\alpha)^{1/k}$, with $\alpha=0.05$ and k the number of separate comparisons (e.g., k=6 separate comparisons for each of the six trophic groups, yielding an adjusted significance level of 0.009) (Sokal and Rholf 1995).

Community responses to protection

We quantified changes in community structure in terms of species and trophic groups using the Bray-Curtis similarity index (Bray and Curtis 1957). Bray-Curtis percent similarity expresses the distance between pairs of samples on a scale between 0 and 100, with 0 indicating that the two samples do not share any of the species, and 100 signifying that the samples have identical species composition, and species have identical abundances. Intermediate values can result from samples containing the same species in different relative abundances or varying to different degrees in their species composition. The pair of samples used in each similarity calculation was the reserve and the reference from each study. Abundances of individual species and trophic groups were square-root transformed before calculating Bray-Curtis similarity to decrease the influence of the most abundant species (Clarke and Warwick 1994).

Temporal trends in community and trophic similarity were examined using multiple regression models. Full models included the percent similarity between reserves and reference conditions as the dependent variable, and the duration of protection, reserve size, and number of species surveyed in each study (for species similarity) or the number of species within each trophic group (for trophic similarity) as the independent variables. In addition to the duration of protection, reserve size and species richness were included as variables that may influence responses of fish assemblages to protection.

We compared trophic structure between reserves and reference conditions by calculating the proportions of the total fish abundance or biomass in different trophic groups for each study. Average proportions, weighted by the sampling variance, were calculated separately for reserves and reference conditions. Because only 5 studies reported biomass data, temporal trajectories of trophic and community similarity could not be examined in terms of biomass, and biomass data were used only to calculate average proportional contributions of different trophic groups to total biomass. Analyses were conducted using the statistical package SAS v. 6.12 (SAS institute Inc., Cary, NC, USA).

RESULTS

Variation and correlates of species responses to protection

Duration of protection, trophic level, and exploitation level explained a significant but extremely small (only 3 %) amount of the variation in the magnitudes of individual species responses to protection, expressed as response ratios (Table 1). In contrast, reserve size, maximum length of species, and adult mobility exhibited no significant relationship with response ratios of individual species (Table 1). The magnitudes of individual species responses to protection showed a weak but significant positive relationship with duration of protection (Fig 1a). More interestingly, response ratios of individual species to protection exhibited broad variation, ranging from strongly negative to strongly positive in all studies (Fig. 1a,b). Some fraction of species in all communities showed decreased abundances (i.e., abundances within reserves half or less than abundances in fished, reference conditions) within reserves regardless of duration of protection. Between 5-91% (average 35.8%, SD=18.2) of species, in separate studies, showed strong increases in abundance (*lnR*≥0.69) within reserves compared to reference conditions (Fig. 1b), while a substantial proportion of species, between 0-36% (average 19.2%, SD=10.5), showed strong decreases in abundance (*lnR*≤-0.69) in reserves (Fig. 1b).

The proportions of species showing positive (i.e., *lnR*≥0.69; see *Methods*) responses to protection did not increase significantly with increasing duration of protection (Table 2 and Fig. 1b). Similarly, species exhibiting negative (i.e., *lnR*≤-0.69) responses to protection showed no temporal trend associated with increasing duration of protection (Table 2 and Fig. 1b). This result, combined with the positive temporal trend in the magnitudes of individual species responses, suggests that communities within no-take reserves and in reference conditions diverge through time (see *Community Responses*) because some species exhibit stronger responses to protection through time rather than because of increasing numbers of species responding through time.

No trends were apparent in the representation of different trophic groups among species exhibiting negative, positive or intermediate responses to protection (Fig. 2a). In contrast, a greater proportion of species showing negative responses to protection (i.e., *lnR*≤-0.69, see above) were not targeted by fishing or aquarium trade compared to species showing positive or intermediate responses (Fig. 2b). In addition, species showing negative responses comprised a greater proportion of species characterized by low mobility compared to species showing positive or intermediate responses (Fig. 2c).

Responses of species groups to protection

Meta-analysis of response ratios for different trophic groups indicated that protection in reserves is associated with significantly greater abundances, relative to reference conditions, for all trophic groups except the omnivores (Fig. 3a). Because of a significant temporal trend of response ratios for piscivorous fishes (see below, Fig. 4f and Table 3), we re-calculated average response ratios separately for reserves protected for different amounts of time. For piscivorous fishes, overall response was significantly greater than 0 only in assemblages protected for at least 10 years (average response ratio lnR=0.92, 95% confidence limits 0.81 and 1.04), but not in assemblages protected for less than 10 years (average lnR=0.09, 95% confidence limits -0.05 and 0.24). However, when the two extreme negative values were deleted (Fig. 4f), overall response was also significantly greater than 0 for assemblages protected for less than 10 years (average lnR=0.22, 95% confidence limits 0.07 and 0.37). Meta-analyses of response ratios by exploitation categories indicated that non-target species show no overall response to protection, whereas species targeted by fishing or aquarium trade show positive overall responses to protection (Fig. 3b). All three mobility categories exhibited significant increased abundances within reserves (low mobility: average lnR=0.08, 95% confidence limits 0.04 and 0.11; intermediate mobility: average lnR=0.27, 95% confidence limits 0.25 and 0.29; high mobility: average lnR=0.52, 95% confidence limits 0.48 and 0.55).

To determine whether different trophic groups varied in their response to protection through time, we examined temporal trends in the response ratios for each trophic group. Only piscivorous fish exhibited significant temporal trends in their response to protection in no-take reserves (Table 3 and Fig. 4). To examine whether these results were driven by the two extreme negative values of response ratios (Fig. 4f), we repeated the analysis after eliminating these values. After the two lowest values were deleted, backward elimination of non significant terms left the duration of protection as the only independent variable in a model explaining 17% of variation, although the p value for duration of protection (P=0.01) was only marginally significant at the adjusted significance level of 0.009 (see *Methods*). For all other trophic groups, relationships between the magnitude of the response, measured as the log ratio of abundances within reserves over reference conditions, and the duration of protection were non significant (Table 3 and Fig. 4a-e). The size of reserves and the number of species composing the trophic group did not explain a significant amount of variation in response ratios for any of the trophic groups (Table 3). None of the exploitation (P=0.40-0.97) or mobility (P=0.14-0.82) species groups exhibited significant relationships with duration of protection.

Community responses to protection

Similarity in species composition between fish assemblages within no-take reserves and reference conditions decreased with increasing duration of protection, indicating that assemblages tended to diverge in their species composition through time (Fig. 5a). However, this trend was not statistically significant (P=0.07; Table 4) when the whole dataset was included in the analysis. In separate analyses conducted on temperate (i.e., rocky reefs, estuaries, and seagrass beds) and tropical (coral reefs) fish assemblages, the negative relationship between species similarity and duration of protection was significant for tropical but not for temperate systems (Table 4). In addition to duration of protection, the number of species in each study explained a significant amount of variation in similarity (Table 4), with species-rich assemblages showing lower similarity than those containing fewer species. No significant relation between similarity and reserve size was found (Table 4).

Similarity between the trophic structure of fish assemblages within reserves and in reference conditions showed a weak and non-significant (Table 4) negative trend with increasing duration of protection (Fig. 5b). There was no significant relationship between trophic similarity and reserve size or number of species within trophic groups (Table 4).

The proportions of total fish abundance in different trophic groups were similar between reserves and reference conditions (Fig. 6a). However, when similar calculations were repeated using the biomass data reported in 5 studies (Appendix 1), there were clear differences between reserves and reference conditions (Fig. 6b). The proportion of the total fish biomass that was piscivorous fishes was greater in reserves (24.5%) than in reference conditions (15.5%), whereas the opposite was true for herbivorous fishes (45 vs 56%). Because only 5 studies reported biomass data, it was not possible to examine the temporal trajectories in the community trophic structure in terms of biomass.

DISCUSSION

Meta-analyses of studies of the effects of no-take marine reserves on fish communities yielded three key results. First, species in all assemblages showed wide variation in their responses to protection. In particular, up to a third of species in different assemblages (19% on average) appeared to be negatively affected by protection and had abundances within reserves that were half or less those documented in reference, fished conditions. Second, protection influences the trophic structure of fish assemblages, with abundances of top predators increasing gradually through time, and top predators accounting for greater proportions of the total biomass in the protected assemblages. These results indicate that no-take marine reserves are an effective tool for rebuilding top trophic levels, typically depleted through fishing (e.g., Pauly et al. 1998, Jackson et al. 2001), although recovery of long-lived top predators will likely require long time frames (e.g., Jennings 2001, Russ 2002). Third, the structure of fish assemblages protected in no-take reserves diverges through time from reference, fished conditions. Thus, in addition to general responses of aggregate variables (e.g., abundance or biomass of families, or all whole assemblages; e.g., Mosquera et al. 1999, Halpern 2003) to protection, synthesis of results from multiple studies shows that the distribution of abundances or biomass among different species is affected by protection, and that effects on resulting community structure vary depending on the duration of protection.

Variation in species responses to protection was significantly correlated to the degree to which species were exploited outside the no-take reserves, in addition to the duration of protection and trophic level, as discussed above. Species targeted by fishing or by aquarium trade showed overall significant increases in abundance within protected areas (Fig. 3). A large proportion of species negatively affected by protection are not targeted by fishing or aquarium trade (Fig. 2), resulting in an overall lack of response to protection for non-target species (Fig. 3). The nearly ubiquitous occurrence of strong negative effects of protection on some species in the assemblages (Fig. 1), most often non-target species characterized by low mobility (Fig. 2), is evidence of indirect effects of protection. That is, some species may decline because of the enhanced abundances of their predators or competitors that commonly occur within MPAs. Indirect effects of protection have been difficult to demonstrate and most case studies involve relatively sedentary herbivorous invertebrates, primarily sea urchins and limpets (Pinnegar et al. 2000). In contrast, our analyses suggest that indirect effects are common, but easily missed because they typically do not occurr over whole trophic levels, but rather in individual species belonging to different trophic levels (e.g., Polis 1999).

The magnitude of individual species responses to protection showed a weak but significant increase through time (Fig. 1a). In contrast, the proportions of species showing positive (i.e., $lnR \geq 0.69$; see *Methods*) or negative (i.e., $lnR \leq -0.69$) responses to protection did not increase significantly with increasing duration of protection (Fig. 1b). Thus, temporal trends of community similarity (Fig. 5a) are likely due to some species showing stronger responses to protection through time rather than to increasing numbers of species responding through time, and species' long-term responses to protection may be determined (and therefore predictable) by their response in the first few years after protection. This result has important implications for monitoring of reserve effectiveness.

The size of reserves and the mobility of species did not have significant effects on species and community responses to protection. Differential species responses associated with adult mobility and reserve size may be expected because high mobility or small reserve size may lead to high probabilities that individuals cross the reserve boundaries and are caught. Halpern's (2003) analyses also showed that reserve size did not explain significant amounts of variation in the responses of total abundance and biomass to protection, suggesting that regardless of mobility, all species are able to benefit from reserve protection. The lack of an effect of species mobility on their responses to protection may be explained by the strong positive correlation between mobility and exploitation level among the species in this dataset (r=0.38, P=0.0001, N=920). Thus, mobile species tend to be subject to intense fishing pressure and benefits from protection within reserves may outweigh losses through the reserve boundaries.

Similarity in species composition and relative abundances between protected and reference assemblages decreases with increasing duration of protection, indicating that protected assemblages become increasingly different from conditions prior to the reserve establishment, or at sites that are not protected from fishing and other extractive human activities (Fig. 5a). Moreover, changes in community structure associated with protection exhibited a linear trend with duration of protection (Fig. 5a), with no indication of reaching a plateau within the 25-year time frame considered in this study. These results suggest that continuous change in the relative dominance of different species reported for a few case studies (e.g., Babcock et al. 1999, McClanahan 2000, Shears and Babcock 2002) may be a general response of marine assemblages to protection.

Trophic composition does not show a significant temporal trend (Fig. 5b), and effects of protection on the trophic structure of fish assemblages are evident only when trophic structure is examined in terms of biomass, not abundance (Fig. 6). Assemblages protected from fishing for 3-13 years tended to have greater relative proportions of predatory biomass, whereas fished assemblages had relatively larger proportions of herbivore biomass, even though biomass for each trophic group increased within the reserves. These relative differences in trophic group biomass indicate a shift in the trophic structure of fish assemblages protected from fishing. When assemblage composition is quantified in terms of abundance, species-level changes in abundance in no-take reserves and the slight increase in the abundances of top predators through time do not result in observable changes in relative abundances of whole trophic groups. Effects of protection on the distribution of fish biomass among different trophic groups may occur because species in top trophic levels are typically characterized by large sizes, and protection from fishing allows them to attain larger sizes (e.g., Halpern 2003). A combination of increased abundances and increased individual sizes of piscivorous fishes likely explains their greater proportional contribution to fish biomass in no-take reserves compared to reference conditions.

In contrast to the rapid responses of other biological variables to protection, changes in species composition and relative dominance and in trophic structure seem to occur over relatively long time frames. Halpern and Warner (2002) showed that significant increases in total abundances and biomass in marine reserves typically occurred within a few years (1-3 years) after the reserve establishment. In contrast, our analyses of trophic group responses suggest that recovery of trophic structure may require decades. This conclusion is supported by the following observations. First, temporal trends in the magnitude of piscivorous fish responses were weakly positive, with no indication of having reached a plateau in reserves protected for more than a decade (Fig. 4). Second, average responses for this trophic group were statistically significant only for assemblages protected for at least 10 years when all data were included in the meta-analysis, and had greater magnitude in assemblages protected for over 10 years compared to assemblages with shorter protection when two extreme negative results were not included in the analyses (see *Results*). Third, even for the older reserves (protected for at least 10 years), increased piscivorous abundance did not result in overall changes in their relative contribution to total abundances (Fig. 6a). However, greater average proportions of piscivores were observed in terms of biomass, probably through the combined effects of protection on size structure in addition to abundance. Thus, exploited communities respond quickly to protection, but subsequent temporal trends in responses vary depending on the specific community attribute considered (e.g., total community abundance or biomass vs. community species composition and relative abundances, or trophic structure) The different temporal trajectories of responses of aggregate community descriptors and community structure to protection have important implications for evaluation of MPAs because these variables are linked to different ecological functions of communities (e.g., productivity vs. maintainenace of diversity and resilience in the face of natural disturbances) and their variation is likely underlain by different processes (e.g., Micheli et al. 1999).

Significant but slow changes in the community and trophic structure of fish assemblages within no-take marine reserves have important implications for the management and monitoring of reserves. In particular, while temporary closures may be effective for rebuilding populations and increasing yields of short-lived, fast growing species (e.g., scallops in Georges Banks;

Murawski et al. 2000), recovery of trophic structure and of ecological interactions structuring marine assemblages may require decades and may entail a series of sequential transient states. This consideration supports the notion that reserves aimed at conserving and restoring whole assemblages and ecological processes should be established as permanent no-take zones. Even though practical reasons (i.e., limited time and resources) have often constrained the evaluation of reserves efficacy to snapshot comparisons of some biological variable before and some time after the reserve establishment, or between reserves and some reference, unprotected sites (e.g., Palumbi 2001, 2002, Halpern 2003), evaluation of the effectiveness of reserves in allowing for the recovery of whole assemblages from human impacts should focus on long-term temporal trajectories of change. Long-term monitoring would explicitly account for the dynamic nature of marine assemblages, for the likely occurrence of unanticipated changes and lags in responses from indirect effects, and for the fact that the time scales over which ecological systems are influenced by natural and human disturbances are largely unknown, but likely longer than most ecological studies (e.g., Magnuson 1990).

A crucial question is how these observed changes in the abundances of top trophic levels and in their proportional contribution to total biomass compare to what might be observed in truly pristine ecosystems. The long history of human exploitation of all of the sites in this dataset, lack of information about actual enforcement and compliance to fishing restrictions within the reserves, and the general lack of baseline data for the sites, make it impossible to address this question. Data from the North Western Hawaiian islands, one of the marine ecosystems that has been indicated as possibly the closest to 'pristine' (Jackson et al. 2001), indicate that approximately 50% of fish biomass is accounted for by top predators, specifically large piscivorous snappers, groupers, carangids, and sharks (Friedlander and DeMartini 2002). A direct comparison of this estimate to those from the studies synthesized here is not possible because of system-specific characteristics that are likely to influence the carrying capacities of the sites, and because of the broad variability in the sampling methods and community components targeted. However, the Hawaiian value suggests that the average proportional biomass of piscivores observed in the reserves reviewed here may be well below what the system could potentially support. Widespread historical overfishing of virtually all marine ecosystems has dramatically altered the baselines that can be used to set desired targets (Pauly 1995, Dayton et al. 2000, Jackson et al. 2001). In the absence of meaningful baselines, modeling provides tools for making inferences about the pre-exploitaton trophic structure of different marine ecosystems (e.g., Christensen 2002).

The snapshot comparisons among reserves protected for different amounts of time are clearly not a replacement for actual time series data (e.g., Jennings 2001, Russ 2002). Thus, a limitation of this study is that temporal trajectories in community change in MPAs are inferred from a time sequence populated by different systems. Another significant limitation of the dataset is that in many cases the reference sites may not be true controls. This is because of two other possible effects of reserves, not discussed here: export of organisms to areas outside of reserve boundaries, and fishing effort displaced to other areas. Both of these factors could affect community structure in reference areas, producing misleading response ratios. Halpern et al. (*in review*) investigated this possibility in the small subset of marine reserve studies that have full before-after-control-impact designs. They found that in most cases, biological variables in control areas increased over time, but at a slower rate than areas under protection. This suggests that the divergence of similarity of protected areas relative to reference sites over time as shown in this paper may actually be an underestimate of the reserve effect.

Despite these limitations, studies of community changes from multiple protected systems provide an invaluable opportunity to examine the generality of species and community responses to protection, identify the most important correlates of responses, and generate hypotheses about patterns and trends of recovery from overexploitation. Synthesis of data from these multiple human-exclusion "experiments" indicate that the level of exploitation, trophic level, and the duration of protection explain small but significant amounts of variation in individual species responses to protection, with species targeted by fishing showing overall enhanced abundances in protected areas, and top trophic levels showing weak positive temporal trends in their response to protection. Second, up to a third of species in different studies appeared to be negatively affected by protection, indicating that indirect effects of protection through competitive or predatory interactions may be common. Species showing negative responses to protection tended to be most commonly species not targeted by fishing. Finally, variation and lags in species responses to protection resulted in protected assemblages to diverge from reference, fished conditions, and in greater proportions of total fish biomass at top trophic levels in protected compared to fish assemblages.

Evaluation and management of MPAs should acknowledge that while rapid responses of heavily-fished, fast-growing species may commonly occur soon after reserves establishment, recovery of whole assemblages and ecosystem function (e.g., the top-down effects of predatory fishes) will likely require longer time frames. Realistic expectations concerning the conservation and fishery benefits of MPAs should be based on the observation that transient states in community structure, indirect effects of protection, and lags in responses are common. Scaling up these results to more meaningful spatial and temporal scales will require long-term monitoring of networks of reserves, combined with modeling and historical reconstruction of ecosystem changes (e.g., Jackson et al. 2001, Christensen 2002, Botsford et al. 2003).

ACKNOWLEDGMENTS

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Table 1. Multiple regression analysis of response ratios for each species in the dataset. The independent variables in the full model were duration of protection (in years), size of reserves (in hectares), trophic level, exploitation level, maximum length, and adult mobility (from *FishBase*, see *Methods*).

Model	overall	variables	slope	*P*
Only significant	r^2=0.03	intercept	1.26	0.01
variables	$F_{3,916}$=8.2	duration of protection	0.04	0.002
	P=0.0001	trophic level	-0.46	0.002
		exploitation level	0.26	0.009

Table 2. Multiple regression analysis of percent of species showing positive (i.e., twice as abundant within no-take reserves than in reference conditions) and negative (i.e., twice as abundant in reference conditions than within no-take reserves) responses to protection. The independent variables in the full model were duration of protection (in years), and size of reserves (in hectares).

Y	overall	variables	slope	*P*
% positive	r^2=0.07	intercept	0.33	0.0001
	$F_{2,23}$=0.8	duration of protection	0.01	0.34
	P =0.44	reserve size	-0.00	0.33
% negative	r^2=0.02	intercept	0.20	0.0001
	$F_{2,23}$=0.3	duration of protection	-0.002	0.53
	P =0.76	reserve size	0.00	0.63

Table 3. Multiple regression analysis of response ratios for each trophic group (herbivores, detritivores, omnivores, planktivores, invertebrate-feeders, and piscivores). The dependent variables in the full model were duration of protection (in years), size of reserves (in hectares), and total number of species within each trophic group.

Trophic group	overall	variables	slope	*P*
Herbivores	r^2=0.05	intercept	-0.52	0.27
	$F_{3,32}$=0.5	duration of protection	0.04	0.37
	P=0.67	reserve size	0.00	0.95
		No. of species	0.02	0.38
Detritivores	r^2=0.03	intercept	0.07	0.95
	$F_{3,23}$=0.2	duration of protection	-0.04	0.66
	P=0.90	reserve size	-0.01	0.94
		No. of species	0.35	0.48
Omnivores	r^2=0.31	intercept	0.77	0.22
	$F_{3,19}$=2.8	duration of protection	-0.01	0.64
	P =0.07	reserve size	0.00	0.08
		No. of species	-0.14	0.16

Planktivores	r^2=0.28	intercept	-0.81	0.25
	$F_{3,22}$=2.8	duration of protection	0.06	0.16
	P =0.06	reserve size	-0.01	0.06
		No. of species	0.07	0.35
Invertebrate feeders	r^2=0.04	intercept	0.23	0.29
	$F_{3,35}$=0.5	duration of protection	0.01	0.83
	P =0.67	reserve size	-0.00	0.24
		No. of species	-0.01	0.58
Piscivores	r^2=0.31	intercept	-0.78	0.04
	$F_{3,34}$=5.2	duration of protection	0.07	0.01
	P =0.005	reserve size	-0.00	0.11
		No. of species	0.04	0.31

Table 4. Multiple regression analysis of Bray-Curtis percent similarity in species (a) and trophic (b) structure for: all studies in the dataset ; temperate systems; and coral reefs. The dependent variables in the full model were duration of protection (in years), size of reserves (in hectares), and total number of species (a) or total number of species within each trophic group (b), i.e., herbivores, detritivores, omnivores, planktivores, invertebrate-feeders, and piscivores.

a. Species similarity

Model	overall	variables	slope	*P*
All studies	r^2=0.31	intercept	85.36	0.0001
	$F_{3,36}$=5.3	duration of protection	-0.40	0.07
	P =0.004	reserve size	-0.00003	0.84
		No. of species	-0.17	0.001
Temperate systems	r^2=0.01	intercept	78.66	0.0001
	$F_{3,18}$=0.06	duration of protection	-0.06	0.87
	P =0.98	reserve size	-0.001	0.86
		No. of species	-0.03	0.78
Coral reefs	r^2=0.59	intercept	87.30	0.0001
	$F_{3,14}$=6.6	duration of protection	-0.66	0.04

	P =0.005	reserve size	0.0001	0.97
		No. of species	-0.19	0.003

b. Trophic similarity

Model	overall	variables	slope	P
All studies	r^2=0.04	intercept	85.8	0.0001
	$F_{3,35}$=0.5	duration of protection	-0.20	0.41
	P =0.66	reserve size	0.0002	0.34
		No. of species	0.02	0.73
Temperate systems	r^2=0.02	intercept	80.58	0.0001
	$F_{3,17}$=0.08	duration of protection	0.10	0.84
	P =0.97	reserve size	0.0004	0.91
		No. of species	0.06	0.70
Coral reefs	r^2=0.16	intercept	89.84	0.0001
	$F_{3,14}$=0.9	duration of protection	-0.44	0.15
	P=0.47	reserve size	0.0001	0.50
		No. of species	0.005	0.92

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HABITAT COMMITTEE COMMENTS ON GUIDELINES FOR REVIEW OF MARINE RESERVES ISSUES

The Habitat Committee (HC) heard a presentation by Ms. Cindy Thomson, who reviewed changes to the draft Scientific and Statistical Committee (SSC) white paper on marine reserves. The HC asks that additional time be given for review of the updated draft and the public comments received to date before Council action is taken. The HC also recommends proposals include information on habitat types to be protected and the associated utilization of habitat by Council-managed species.

PFMC
06/15/04

Exhibit G.2.d
Supplemental Public Comment 2
June 2004

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June 6, 2004

RE: Comments on the Draft Report "Marine Reserves: Objectives, Rationales, Management Implications, and Regulatory Requirements" prepared by the Marine Reserves Subcommittee of the Scientific and Statistical Committee, Pacific Fishery Management Council, Draft Dated June 2004

Dear Ms. Thompson:

The Ocean Conservancy thanks the SSC for the opportunity to comment on this Draft Report. We recognize the potential benefits of a report that includes criteria and management considerations to guide the assessment of marine reserve proposals, and we support the goal of the integration of reserves into the traditional fisheries management process. We also welcome the contribution of the SSC's experience and expertise to advance this objective. We also appreciate the revisions to this Draft that have improved the paper in several respects from the version dated February 2004. However, the June 2004 Draft Report still falls short of its potential, and, in its present form, does not provide a complete or comprehensive response to the issues and opportunities presented by marine reserves. We recognize in particular the revisions that have improved the Draft in the area of “tone”, the additions recognizing the distinctions between scientific and policy considerations and their applicability to marine reserve management – and non-management – objectives, and the improved language regarding the use of reserves to achieve social objectives (one type of non-management objective). The Draft Report, however, still suffers from problems in the areas of scientific thoroughness and utility to its users, and from a bias towards traditional stock management perspectives that is unlikely to advance the Council’s goal of meeting its management responsibilities in the context of emerging resource management initiatives. We recommend revisions to the scope and approach of the Council’s consideration of marine reserve proposal criteria to better suit the achievement of this central goal.

In pursuing the goal of assessing the potential effects of marine reserve establishment on waters under Council fishery jurisdiction, the Council should clearly identify its roles and responsibilities in marine reserve establishment for the entire scope of potential reserve proponents and objectives, and ensure that the scope of the Draft Report clearly matches those responsibilities. Doing so will bring clarity and utility to both the Council family and users of the document that is presently absent.

The Draft Report Proposes Criteria for Reserves that are not Applied to Other Management Measures:

As indicated above, The Ocean Conservancy welcomes the establishment of well-defined, objective and science-based criteria for the evaluation of the full range of protection and management measures, but believes they must be applied uniformly and fairly. The Draft Report proposes a suite of criteria that would be used to evaluate marine reserve proposals that are not applied to other proposals for the protection, recovery or management of marine environments and resources, thus creating a special, more stringent standard for reserve proposals, and a double-standard when compared to other proposals. Although revisions to the February 2004 draft has improved the document in this regard, there are still examples of the special, double standard throughout the Draft Report:

a. The Draft Report states that reserve models are "highly sensitive to underlying assumptions…", implying that such models are therefore unreliable. Fisheries management relies heavily on the use of stock-assessment models, which are not generally free from sensitivity to underlying assumptions, for example assumptions about the existence of a unit stock, the size of the virgin biomass, or the value of the natural mortality rate. And yet, the parameter and model uncertainty associated with stock-assessment model does not preclude their use by fisheries scientist and managers. Thus, to imply that the same problems with reserve models makes them unreliable is to apply a double standard.

b. The Draft Report states at III.B. "Detailed life-stage modeling is less relevant than whether an empirical relationship can be established between reserves and yield". Why is the same not true for other fishery management measures, such as size limits, seasonal closures or net restrictions? Fisheries managers routinely use such measures without knowing or requiring knowledge of the empirical relationship between the measure and yield. No justification is provided for this statement or why it would only be true of reserves, thus creating another double standard. Finally, as the SSC must be aware, the purpose of some reserves will be entirely unrelated to yield. In these cases, the relationship between reserves and yield would be irrelevant.

c. In section IV.F, the Draft Report directs reserve proposals to provide "measurable, verifiable indicators of progress…" While this may be a component of effective management, to our knowledge, an action-specific demonstration of success is not typically required by the PFMC for other types of management measures. Thus, this requirement sets a substantially higher standard for marine reserves.

<u>The Draft Report is Suffers from an Incomplete Treatment of the Scientific Literature on Marine Reserves:</u>

The Draft Report presents an incomplete and selective assessment of the body of research on marine reserves and their potential contributions to fishery management. Large volumes of marine reserve benefits with empirical, modeling and/or theoretical support are ignored or dismissed without sufficient comment or justification, while unsubstantiated theoretical costs (e.g. effort displacement effects) are uncritically accepted. Indeed, the Draft Report is potentially implicated in its own admonishment against scientific advocacy.

Below is a partial list of mis- or unrepresented issues in Section III.

a. III.F: The Draft Report raises the issue of uncertainty in scientific models. This discussion is selective and lacks context. The sensitivity of models to assumptions and data quality is not unique to marine reserves.
b. b. At III.B: The analysis of increased yield from reserves is inadequate and fails to recognize that the "reserve effect" has a strong theoretical foundation, is well-documented in existing reserves, and has a major role as a pre-cursor to yield enhancement. Fisheries benefits are dismissed without supporting evidence, and with insufficient reference to the substantial number of studies (15-20) now available that have found direct or indirect evidence of increased yield around marine reserves. The discussion recognizes the potential for reserves to mitigate "uncertainty in stock assessments" and to "ensure persistence", but again stops well short of a thorough treatment of the issue. The SSC misses two large issues. First, they almost completely neglect the influence of environmental uncertainty (e.g. unpredictable climate shifts, severe storms, other human influences, etc.), and the role that reserves might play in ameliorating the effects of that uncertainty on yield.. And, second, they make little mention of the potential for positive economic benefits, namely reduced variance in yield, a lowered probability of population collapses, and the damping of the boom-and-bust cycle common to so many ineffectively managed fisheries. In contrast, equally theoretical negative impacts such as effort displacement are directly connected to economic

impacts throughout the paper without documentation or substantiation, thus again giving the impression of an uneven and unfair treatment of the potential of marine reserve to benefit fisheries.

c. III.B.: The discussion regarding species' mobility and marine reserves repeats a common misrepresentation of the results of a large number of modeling studies. The Draft Report claims that high mobility (vagility) species will not experience accumulation within reserves ('reserve effect') and low mobility (vagility) will not produce 'spillover'. The models in fact indicate that accumulation and spillover, which will, respectively, be inversely and directly proportional to vagility, will occur across a wide range of vagilities, not only at the extremes of the continuum.

d. Also in this section, the paper suggests no yield benefits from reserves if "the status quo is a fishery managed for maximum sustainable yield." This is misleading and lacks context. First, yield increases are seldom predicted or claimed by reserve models for fisheries managed *at* MSY. Second, the reality is that many stocks are below MSY whether they are managed *for* MSY or not, and they remain below MSY for long periods of time despite the best efforts to manage them properly using traditional measures. Therefore, the theoretical, best, equilibrial performance of marine reserves relative to other measures should not be the only criterion against which they are judged, because they have enormous potential to increase the yield of depleted stocks, while providing the benefits that no other measures can as effectively, namely the 'insurance effect', protection of habitats, and other benefits to society.

<u>The Revisions to the February Draft Do Not Remove Instances of Unproductive Tone</u>

At several places in the revised Draft Report 'effort displacement', a potentially negative side-effect of a reserve, is taken as a given (almost a fact), despite the fact that there is virtually no data to support such a view. In contrast, the 'reserve effect', a positive outcome of a reserve for which there is a large volume of supporting research, is negatively contrasted with “real world” data. This leads to an inappropriate “caution” against predicting fishery benefits for Council-managed species.

The paper also betrays an inflexible focus on fisheries management at a time when resource managers are exploring and finding benefits in multi-disciplinary perspectives and the notion of ecosystem management. A fair reading of the literature and relevant agency initiatives would suggest this inflexibility will be unproductive and that scope of this paper may be larger than the ad-hoc SSC should attempt to address.

Conclusions

The characteristics of the Draft Report discussed above including tone, bias, inflexibility and inadequate analysis, when considered as a whole, would have the affect of creating a significant and unfair barrier to the acceptance of reserve proposals by the Council. One can expect that if the Pacific Fishery Management Council endorses this paper, or a version of it not dramatically revised from the June, 2004 draft, the positions outlined in the paper will become enshrined in Council policy, making these barriers permanent.

The Draft Report suggests a resistance to the use of reserves that cannot be supported by the science and would impose a limited understanding of what theory, modeling and empirical studies have to say about the potential benefits of marine reserves. The Draft Report seeks creation of a set of special standards for marine reserves, creating a significant and inequitable barrier for reserve proposals.

In sum, the Draft Report suffers from flaws that result in a product that meets neither the intent of the Council in authorizing it nor the needs of agencies, organizations and interests that are its apparent intended audience. The document substitutes conclusory remarks for a clear set of guidelines and criteria for evaluating reserve proposals. The review of scientific literature is incomplete and must at a minimum receive a formal peer review by scientists and researchers familiar with the extremely broad range of disciplines addressed in the document. The document in its current form would represent a setback to the goal of assessing the integration of marine reserves into traditional fishery management. The document suffers from what appears to be a highly insulated approach to a policy and management area that by its nature requires a broad and multi-disciplinary approach.

Sincerely,

Gregory Helms
Program Manager
The Ocean Conservancy

Cc: Pacific Fishery Management Council Members

Halpern, B. 2003. The impact of marine reserves: do reserves work and does reserve size matter? Ecological Applications 13(1): S117-137.

Palumbi, S.R. 2002. Marine Reserves. A Tool for Ecosystem Management and Conservation. Pew Oceans Commission. Arlington, VA. (http://pewoceans.org/reports/pew_marine_reserves.pdf)

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Ward, T.J., D. Heinemann and N. Evans. 2001. The Role of Marine Reserves as Fisheries Management Tools. A Review of Concepts, Evidence and International Experience. Bureau of Rural Sciences, Canberra, Australia. (http://www.affa.gov.au/corporate_docs/publications/pdf/rural_science/fisheries/brs_marine_report.pdf)

Willis, T.J., R.B. Millar, R.C. Babcock and N. Tolimieri. 2003. Burdens of evidence and benefits of marine reserves: putting Descartes before des horse? Environmental Conservation 30(2): 97-103.

UPDATE ON MISCELLANEOUS MARINE PROTECTED AREA ACTIVITIES

Situation: This update on ongoing marine protected area (MPA) activities includes information about:

1. Gulf of the Farallones and Cordell Bank National Marine Sanctuaries (NMS) Joint Management Plan Review.
2. NOAA MPA Science Institute – Integrating MPAs and Fishery Management Science Working Group.
3. National Fisheries Conservation Center (NFCC) Marine Reserves Science Conference.
4. Olympic Coast National Marine Sanctuary.

Gulf of the Farallones and Cordell Bank NMS

Since 2001, the NMS Program has been conducting a joint review of the management plans of Cordell Bank, Gulf of the Farallones, and Monterey Bay NMS. These sanctuaries are located adjacent to one another, managed by the same program, and share many of the same resources and issues. In addition, all three sites share overlapping interest and user groups. During the review, sanctuaries evaluated management and operational strategies, regulations, and boundaries. The review process also provides an opportunity to better coordinate programs between the three sanctuaries.

At the June 2004 Council meeting, Sanctuary staff representing Gulf of the Farallones and Cordell Bank NMS will provide an overview of joint management plan review activities and several issues related to fishing within the Sanctuaries (Exhibit G.3.b). At this time, the Sanctuaries are not seeking Council action. Rather the information is provided to keep the Council abreast of current activities and future actions that may require coordination with the Council. Council staff is working with these central California coast Sanctuaries.

NOAA MPA Science Institute – Integrating MPAs and Fishery Management Science Working Group

As reported previously to the Council, the National Oceanic and Atomospheric Administration (NOAA), through the MPA Science Institute, is coordinating a working group to synthesize a rational and comprehensive approach for integration of MPAs with traditional fishery management through review of important concepts within marine population dynamics and management and the development of novel approaches to predicting and evaluating performance in MPAs. The products of the NOAA-led effort will include a workshop proceedings to serve as a blueprint for integrating MPAs with existing fishery science and ecosystem management programs, and a series of published papers on specific technical topics addressed by the working group.

A suite of prioritized topics for the working group has been identified. This information will be presented to the Council at the June 2004 meeting (Exhibit G.3.c). The Council could be requested to provide input to tailor the issues such that information produced by the working group would be useful to the Council. For example, the SSC could be tasked with reviewing and commenting on the topic areas.

NFCC Marine Reserves Consensus Conference

This conference was held June 7-9, 2004 in Long Beach, California. Conference goals included:

- Identifying and prioritizing key marine reserve scientific issues.
- Determining the present degree of uncertainty and related constraints on decision making.
- Reaching agreement on the scientific studies needed to resolve these uncertainties.

Conference organizers intend to produce a set of carefully crafted answers to specific questions that were developed prior to the conference by a broadly representative planning committee. As more information becomes available it will be provided to the Council.

Olympic Coast National Marine Sanctuary (OCNMS)

Recently the Sanctuary Advisory Council (SAC) of the OCNMS has discussed the issue of marine reserves with the boundaries of OCNMS. There is a letter from the Northwest Indian Fisheries Commission in the briefing book (Exhibit G.3.e, Public Comment). Council staff participated in a OCNMS SAC meeting in Olympia, Washington on May 28, 2004, and will continue to track OCNMS activities as they pertain to marine reserves.

Council Task:

1. Council Discussion.

Reference Materials:

1. Exhibit G.3.b, Gulf of the Farallones and Cordell Bank National Marine Sanctuary Report.
2. Exhibit G.3.c, MPA Science Institute Report.
3. Exhibit G.3.e, Public Comment.

Agenda Order:

a.	Agendum Overview	Dan Waldeck
b.	Gulf of Farallones and Cordell Bank National Marine Sanctuaries Staff Reports	Sanctuary Staff
c.	Marine Protected Areas Science Institute Update	Lisa Wooninck
d.	Reports and Comments of Advisory Bodies	
e.	Public Comment	
f.	Council Discussion	

PFMC
05/28/04

CORDELL BANK AND GULF OF THE FARALLONES NATIONAL MARINE SANCTUARIES SITE-SPECIFIC PROPOSED REGULATORY ACTIONS

MEMRANDUM FOR: Pacific Fisheries Management Council

FROM: Dan Howard, Manager
Cordell Bank National Marine Sanctuary
Maria Brown, Manager
Gulf of the Farallones National Marine Sanctuary

SUBJECT: Joint Management Plan Review,
Draft Proposed Regulatory Actions

BACKGROUND

The 1992 Congressional legislation that reauthorized the National Marine Sanctuaries Act requires that each of the thirteen National Marine Sanctuaries engage in a management plan review process every five years to reevaluate specific goals and objectives, management techniques and strategies.

In 2001, the National Marine Sanctuary Program (NMSP) began a joint review of the management plans of Cordell Bank, Gulf of the Farallones and Monterey Bay National Marine Sanctuaries. These sanctuaries are located adjacent to one another, managed by the same program, and share many of the same resources and issues. In addition, all three sites share overlapping interest and user groups. During the review, sanctuaries evaluated management and operational strategies, regulations and boundaries. The review process also provides an opportunity to better coordinate programs between the three sanctuaries.

OVERVIEW OF THE JOINT MANAGEMENT PLAN REVIEW PROCESS

The Joint Management Plan Review Process (JMPR) began in Fall 2001 with a two-month public scoping period to identify specific management priority issues for the next 5 to 10 years. As a part of the Joint Management Plan Review (JMPR), the NMSP held 20 public scoping meetings in communities throughout the north-central California coast, Sacramento, and Washington, D.C. Approximately 1,000 people participated in these forums and submitted approximately 4,000 comments.

In addition to public scoping meetings, the NMSP accepted written comments. Comments were sent to the NMSP in the form of emails, letters, faxes, and petitions. The program received approximately 8,500 written comments from the public.

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

ISSUE-BASED WORKING GROUPS

Cordell Bank and Gulf of the Farallones staff convened issue-based working groups to recommend specific actions for the sanctuary to undertake to address these priority issues identified during the public scoping and prioritization phases. Both Cordell Bank and Gulf of the Farallones assembled fishing working groups to address: *Ecosystem Protection: Impacts From Fishing Activities.* The working groups met an average of eight times over a seven month period from December 2002 to June 2003. Members of the groups included Sanctuary Advisory Council representatives, nominated experts from the community, stakeholders, and sanctuary staff. The groups heard from technical advisors, reviewed published documentation, and used this information to recommend specific management actions for the sanctuary to use in developing the revised management plan.

The recommendations from the issue-based working groups underwent several rounds of review in preparation for creating the Draft Management Plan. The recommendations were first sent to the Sanctuary Advisory Council members, who reviewed the document as a whole and forwarded it with their comments and priorities to the sanctuary manager. The sanctuary staff then reviewed the recommendations with the same considerations and criterion as the Sanctuary Advisory Council. The sanctuary managers are considering both the staff and advisory council comments in making the final decision regarding what actions to be included in the Draft Management Plan. Currently, they are considering the changes discussed below.

RECOMMENDATIONS ON PROPOSED REGULATORY ACTIONS THAT MAY IMPACT FISHING ACTIVITIES

Cordell Bank National Marine Sanctuary

1. REMOVING, TAKING OR INJURING BENTHIC INVERTEBRATES OR ALGAE ON THE BANK

Current exception to this prohibition is for accidental take during “normal fishing operations”. Propose to change exception to “vertical hook and line fishing”.

Justification

As established during the sanctuary designation process, the core area that warrants additional protection afforded by sanctuary designation is within the 50 fathom isobath surrounding the Bank. The Bank is characterized by a combination of oceanic conditions and undersea topography that provides for a highly productive environment in a discreet, well-defined area, leading to a unique association of subtidal and oceanic species. The proposed regulatory change in the exception to the existing regulation provides for further clarification to ensure that those fishing activities (normally associated with gear type), that may have significant and cumulative impacts on the benthic organisms on the Bank are prohibited, while allowing for those activities with insignificant impacts to occur.

Impacts on Fishing Activities

Since 2001, the Sanctuary, the National Marine Fisheries Service and the California Department of Fish and Game have conducted submersible transects on and around Cordell Bank. The Bank consists of a series of steep-sided ridges, large boulder fields and narrow pinnacles rising from the edge of the continental shelf. This high relief and the swift, unpredictable currents over the Bank tend to entangle gear that would have negative effects on the benthic community. In the course of conducting submersible operations, snagged and abandoned gear, particularly long lines and relic gillnets, were regularly observed. The relief of the Bank makes trawling impractical. In recent times, the primary gear type used on the Bank has been vertical hook and line, thus this proposed regulatory action imposes minimal impact on the fishing community.

2. DISTURBING THE SUBMERGED LANDS

No exceptions within the 50 fathom isobath surrounding the Bank.
Exceptions for anchoring and lawful fishing activity for the remainder of the Sanctuary.

Justification

It was previously established during the sanctuary designation process that the core area that warrants additional protection afforded by sanctuary designation is within the 50 fathom isobath surrounding the Bank. The proposed new regulation provides greater protection for this core area from disturbance, while allowing for exceptions for anchoring or fishing activities that may disturb the submerged lands in the balance of the Sanctuary. In regards to prohibiting anchoring within the 50 fathom isobath of the Bank, the1989 Scope of Regulations (Designation Document) provides Cordell Bank National Marine Sanctuary with the authority to prohibit "Anchoring on the Bank or within the 50 fathom contour surrounding the Bank".

Impacts on Fishing Activities

Impacts on fishing activity are considered to be negligible since the high relief and the swift, unpredictable currents over the Bank tend to entangle gear that would have negative impacts on the submerged lands. In the course of conducting submersible operations, CBNMS has regularly observed snagged and abandoned gear, particularly long lines and relic gillnets. The relief of the Bank makes trawling impractical. In recent times, the primary gear type used on the Bank has been vertical hook and line, thus this proposed regulatory action imposes minimal impact on the fishing community.

3. KRILL HARVESTING IN THE EEZ

Cordell Bank, Gulf of the Farallones and Monterey Bay National Marine Sanctuaries are proposing one action to the Pacific Fisheries Management Council requesting a complete ban on harvesting of krill in the West Coast EEZ, under the Magnuson Act. A default minimum request of the Council would be to ban krill harvesting within the boundaries of the three National Marine Sanctuaries, under the Magnuson Act.

Impacts on Fishing Activities

This activity does not currently occur within the West Coast EEZ (Washington, Oregon, California).

RECOMMENDATIONS ON PROPOSED REGULATORY ACTIONS THAT MAY IMPACT FISHING ACTIVITIES

Gulf of the Farallones National Marine Sanctuary

1. DISTURBING THE SUBMERGED LANDS

Current exception to this prohibition for mariculture in Tomales Bay.
Propose to change exception to bi-valve mariculture within pre-existing lease tracks in Tomales Bay.

Of Special Note

As Tomales Bay is completely in state waters, Sanctuary staff has been coordinating with California Department of Fish and Game in coming up with a mutually beneficial solution for addressing new forms of mariculture being introduced into Tomales Bay. The net outcome may be that Gulf of the Farallones Sanctuary does not propose to take any new regulatory action, but rather enters into a formal agreement with Fish and Game to implement the needed change.

Justification

Tomales Bay represents one of the significant nearshore habitats within the Sanctuary. The shallow expanse of this narrow and deep estuary is susceptible to both land-based and nonpoint source impacts and point source impacts affecting water quality and the health of the Bay. In February 2004, the State Water Quality Resources Control Board released a list of impaired waters as determined under Section 303(d) of the Clean Water Act. Tomales Bay was listed as impaired due to pathogens, nutrients, mercury and sediment. The concern about unleased mariculture tracts in Tomales Bay, as well as renewed leases, is that they may lead to new forms and methods of mariculture, other than bivalve, potentially contributing to poor water quality conditions, and/or introducing exotic species into the system.

Impacts on Fishing Activities

The impacts on existing mariculture leases, based on current agreements, will be negligible. Renewed leases, or new leases for activities other than bi-valve mariculture may require review and approval, with conditions, by the Sanctuary manager.

2. IMPACTS ON SEABIRDS FROM VESSEL LIGHTS

The Gulf of the Farallones National Marine Sanctuary is participating in a working group with squid fisherman, Fish and Wildlife Service, Fish and Game, The Ocean Conservancy and NRDC. One of the issues the working group is seeking a consensus recommendation on is addressing impacts on nesting seabirds from vessel lights, both along the mainland and the Farallon Islands. The working group is looking to the Sanctuary to take action. The final recommendation has not been formulated. The Gulf of the Farallones Sanctuary will consult with PFMC once the working group has agreed upon a recommendation.

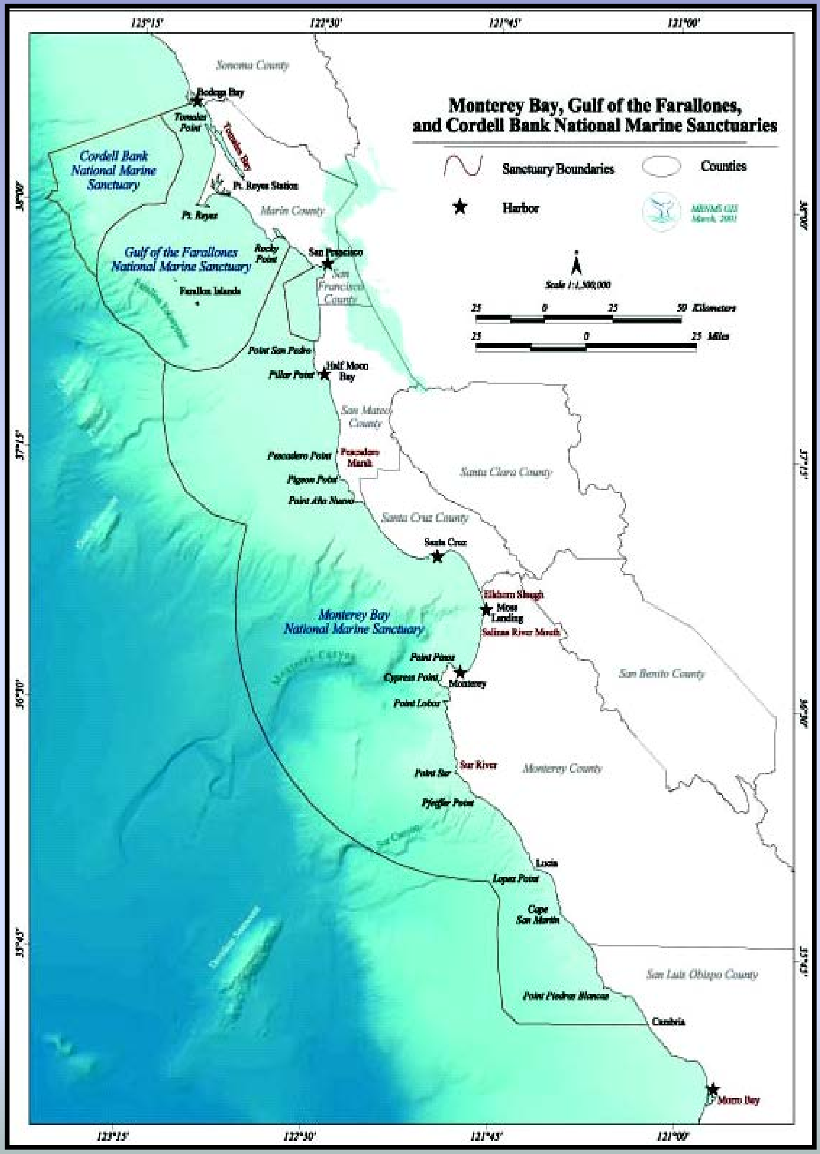
3. KRILL HARVESTING IN THE EEZ

Cordell Bank, Gulf of the Farallones and Monterey Bay National Marine Sanctuaries are proposing one action to the Pacific Fisheries Management Council requesting a complete ban on harvesting of krill in the West Coast EEZ, under the Magnuson Act. A default minimum request of the Council would be to ban krill harvesting within the boundaries of the three National Marine Sanctuaries, under the Magnuson Act.

Impacts on Fishing Activities

This activity does not currently occur within the West Coast EEZ (Washington, Oregon, California).

Joint Management Plan Review



- ❖Cordell Bank NMS
- ❖Gulf of the Farallones NMS
- ❖Monterey Bay NMS

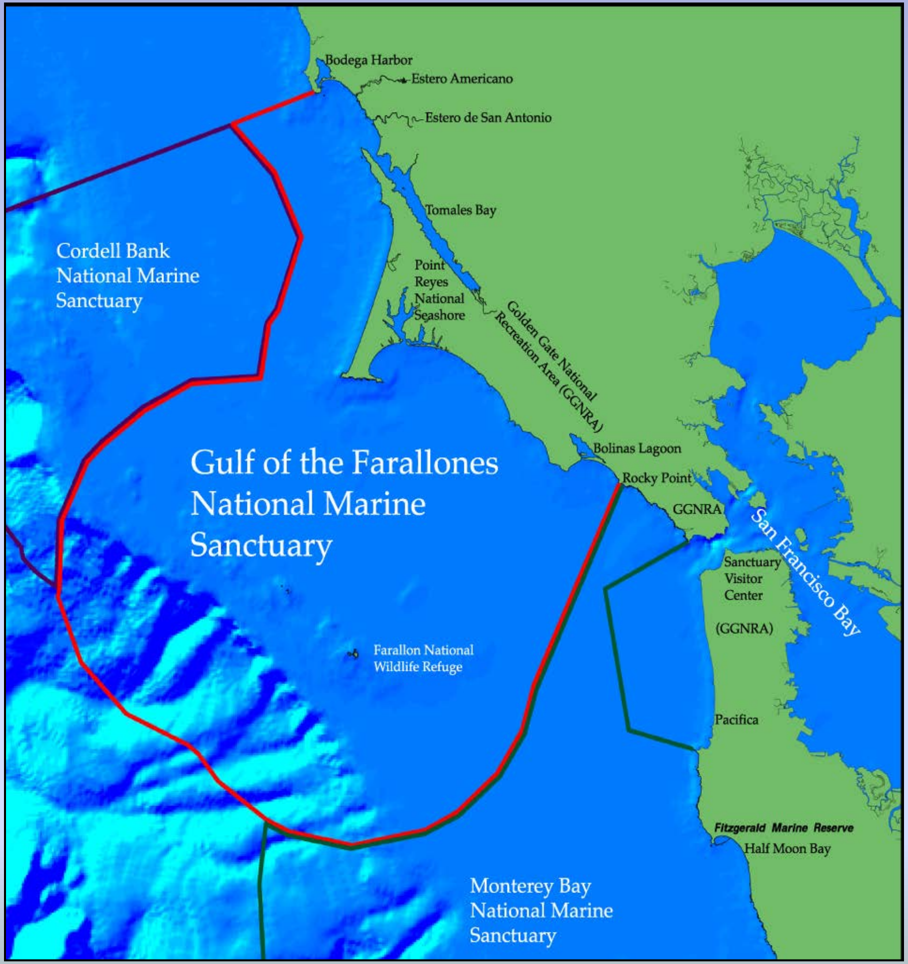
Key Steps

- Internal Review
- Release State of the Sanctuary report
- Public Scoping Meetings
- Narrow/Prioritize Issues
- Working Groups to Develop Action Plans
- Release Draft Management Plan
- Public Comment meetings on Draft Plan
- Release Final Management Plan
- Total Time: Approx. 3-4 years

JMPR:
A Community Based Process

- **ESTABLISHED SANCTUARY ADVISORY COUNCILS: 24 meetings, 2 workshops, 2 retreats**
- **20 PUBLIC SCOPING MEETINGS: 1,000 participants, over 12,500 comments**
- **16 WORKING GROUPS AND INTERNAL TEAMS: 118 participants, 4,094 volunteer hours**
- **PUBLIC HEARINGS IN 2005**

Gulf of the Farallones National Marine Sanctuary



- Designated: **1981**
- Area: **1,255 square miles**
- Shoreline to 35 miles offshore; shares boundary w/2 national parks
- Includes:
  - **Bodega Bay**
  - **Bolinas Lagoon**
  - **Drakes Bay**
  - **Estero de San Antonio**
  - **Estero Americano**
  - **Tomales Bay**

Gulf of the Farallones National Marine Sanctuary

DESIGNATION

The purpose of designating the Sanctuary is to protect and preserve the extraordinary ecosystem, including marine birds, mammals and other natural resources of the waters surrounding the Farallon Islands and Point Reyes.

GFNMS Priority Resource Management Issues

- Ecosystem Protection: Impacts From Fishing Activities
- Exotic Species (WG)
- Vessel Traffic (WG)
- Water Quality (WG)
- Wildlife Disturbance (WG)
- Education (WG)
- Administration (IT)
- Boundary Modifications (IT)
- New and Emerging Issues (IT)

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are needed to see this picture.

GFNMS
Proposed Regulatory Action 1

DISTURBING THE SUBMERGED LANDS

Current exception to this prohibition for mariculture in Tomales Bay.

Propose to change exception to bi-valve mariculture within pre-existing lease tracks in Tomales Bay.

GFNMS
Proposed Regulatory Action 1

TOMALES BAY MARICULTURE LEASES

- 12 active leases
- 7 abandoned leases (would require CEQA to reactivate)
- 3 new leases
- 513 acres total
- Escrow account for clean-up

GFNMS
Proposed Regulatory Action 1

CONCERN

- Tomales Bay represents one of the significant nearshore habitats within the Sanctuary. The shallow expanse of this narrow and deep estuary is susceptible to both land-based and nonpoint source impacts and point source impacts affecting water quality and the health of the Bay.

- Introduction of invasive/exotic species.

GFNMS
Proposed Regulatory Action 1

OPTIONS

- **Propose regulatory action with possible permit**
- **Consultation with Fish and Game on new leases**
- **Include Sanctuary requirements in lease agreement**

GFNMS
Proposed Regulatory Action 1

IMPACTS TO USER GROUPS

- **The impacts on existing mariculture leases, based on current agreements, will be negligible.**
- **Renewed leases, or new leases for activities other than bi-valve mariculture may require review and approval, with conditions, by the Sanctuary manager.**

GFNMS
Proposed Regulatory Action 2

IMPACTS ON SEABIRDS FROM VESSEL LIGHTS

GFNMS
Proposed Regulatory Action 2

CONCERNS

- The Farallon Islands support the largest concentrations of breeding seabirds in the Contiguous U.S.
- 11 of 16 species of seabirds known to breed along Pacific Coast breed on the Farallon Islands.
- Impacts on foraging, mating and nesting patterns of seabirds.
- Nesting seabirds become vulnerable to predation.
- Seabirds attracted to lights, becoming disoriented.

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QuickDraw decompressor
are needed to see this picture.

GFNMS
Proposed Regulatory Action 2

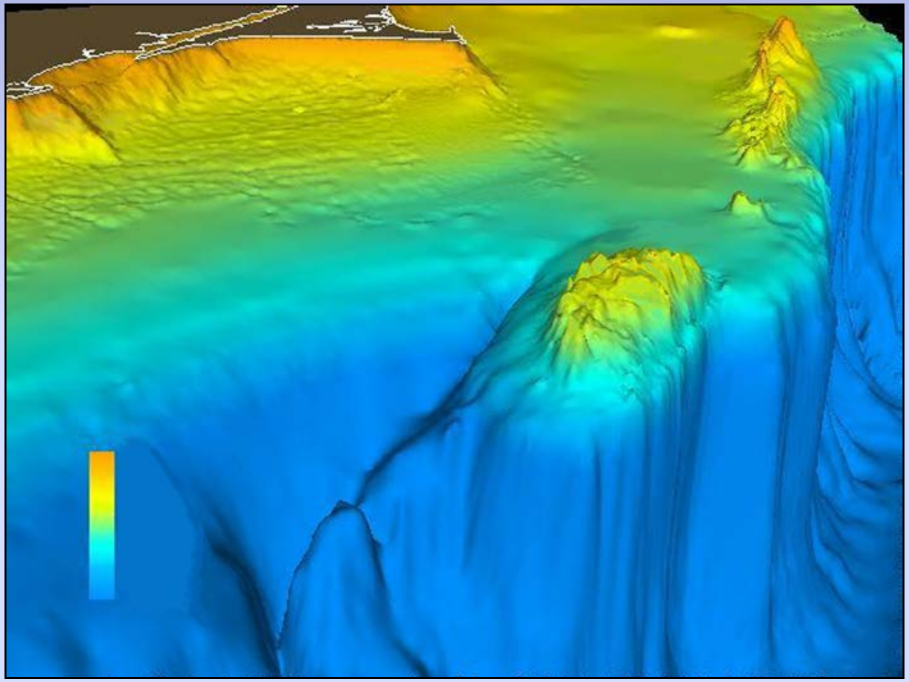
IMPACTS ON SEABIRDS FROM VESSEL LIGHTS

- Originally addressed by GFNMS Fishing Working Group.
- Stakeholder-based working group assembled to address issue.
- Package options to include:
  1. Education/outreach
  2. Monitoring
  3. Modification to lights on squid boats

GFNMS
Proposed Regulatory Action 3

KRILL HARVESTING IN THE SANCTUARY

Cordell Bank
National Marine Sanctuary



- Designated: **May 17, 1989**
- Area: **526 square miles**
- Offshore Site: 6 miles west of Point Reyes; to 1,000 fathoms
- Cordell Bank: 4.5 by 9.5 miles, top of Bank is 120 feet below the sea surface

Cordell Bank
National Marine Sanctuary

DESIGNATION

“The Bank is characterized by a combination of oceanic conditions and undersea topography that provides for a highly productive environment in a discreet, well-defined area, leading to a unique association of subtidal and oceanic species.”

CBNMS Priority
Resource Management Issues

- Ecosystem Protection: Impacts From Fishing Activities (WG)
- Education (WG)
- Partnerships with Community Groups (WG)
- Research (WG)
- Administration (IT)
- Boundary Modifications (IT)

QuickTime™ and a
Photo CD decompressor
are needed to see this picture.

CBNMS
Proposed Regulatory Action 1

REMOVING, TAKING OR INJURING BENTHIC INVERTEBRATES OR ALGAE ON THE BANK

Current exception to this prohibition is for accidental take during "normal fishing operations". Propose to change exception to accidental take during "vertical hook and line fishing".

CBNMS
Proposed Regulatory Action 1

CONCERNS

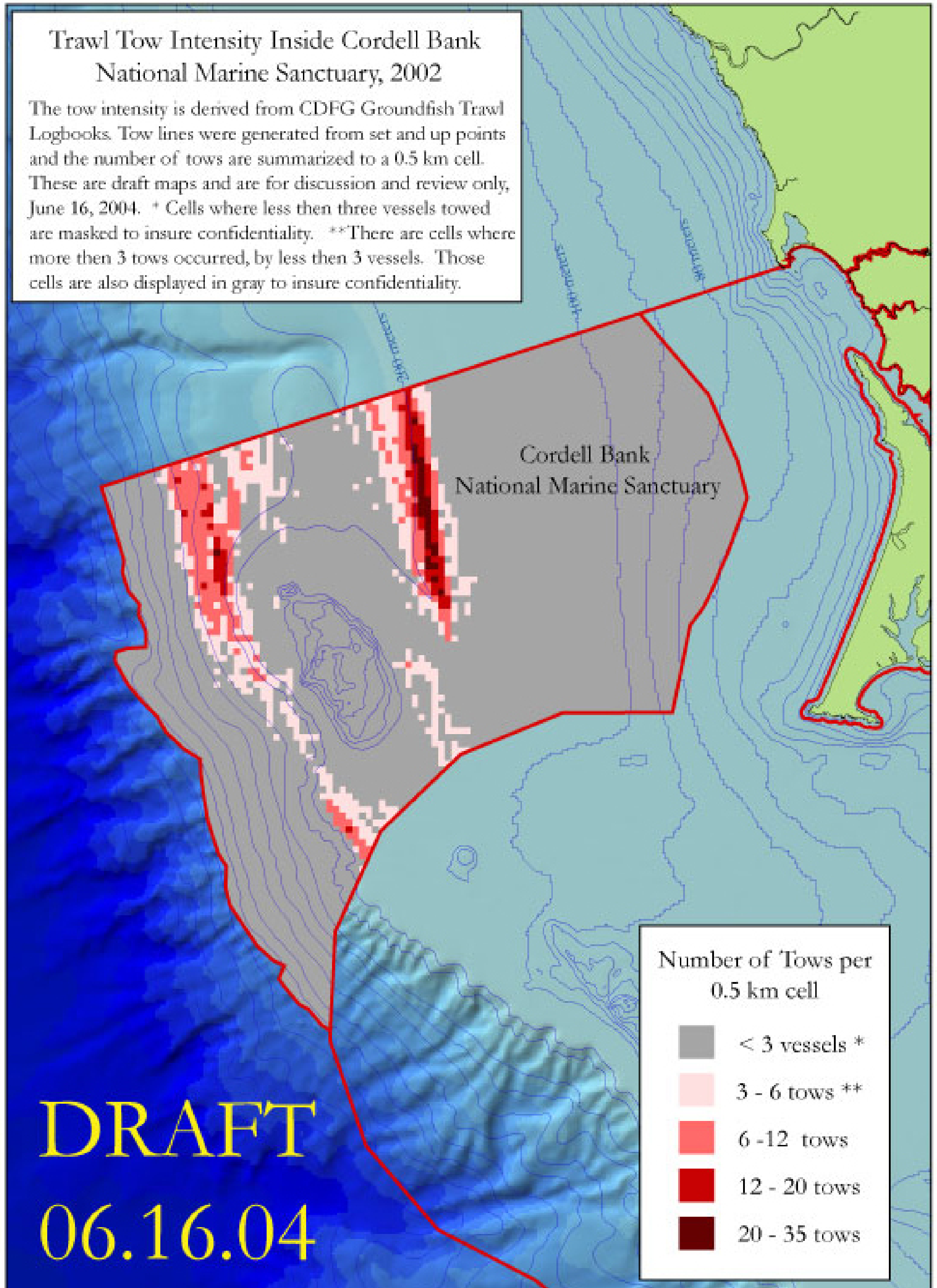
- As established during the sanctuary designation process, the core area that warrants additional protection afforded by sanctuary designation is within the 50 fathom isobath surrounding the Bank.

- Provides for further clarification to ensure that those fishing activities (normally associated with gear type), that may have significant and cumulative impacts on the benthic organisms on the Bank are allowed but may not result in the taking of benthic organisms.

CBNMS
Proposed Regulatory Action 1

IMPACTS TO USER GROUPS

- The high relief and the swift, unpredictable currents over the Bank tend to entangle gear.
- In recent years, the primary gear type used on the Bank is vertical hook and line, thus this proposed regulatory action imposes minimal impact on the fishing community.
- CDFG trawl log books for the groundfish fleet in sample year (2000) indicates negligible impacts to trawlers as this activity rarely occurs within the 50 fathom isobath around the Bank.


Trawl Tow Intensity Inside Cordell Bank National Marine Sanctuary, 2002
The tow intensity is derived from CDFG Groundfish Trawl Logbooks. Tow lines were generated from set and up points and the number of tows are summarized to a 0.5 km cell. These are draft maps and are for discussion and review only, June 16, 2004. * Cells where less then three vessels towed are masked to insure confidentiality. **There are cells where more then 3 tows occurred, by less then 3 vessels. Those cells are also displayed in gray to insure confidentiality.
Cordell Bank
National Marine Sanctuary
Number of Tows per 0.5 km cell
< 3 vessels *
3 - 6 tows **
6 -12 tows
12 - 20 tows
20 - 35 tows
DRAFT
06.16.04

CBNMS
Proposed Regulatory Action 2

DISTURBING THE SUBMERGED LANDS

No exceptions within the 50 fathom isobath surrounding the Bank.

Exceptions for anchoring and lawful fishing activity for the remainder of the Sanctuary.

CBNMS
Proposed Regulatory Action 2

CONCERNS

- As established during the sanctuary designation process, the core area that warrants additional protection afforded by sanctuary designation is within the 50 fathom isobath surrounding the Bank.

- The proposed new regulation provides greater protection for this core area from disturbance, while allowing for exceptions for anchoring or fishing activities that may disturb the submerged lands in the balance of the Sanctuary.

CBNMS
Proposed Regulatory Action 2

IMPACTS TO USER GROUPS

- In recent years, the primary gear type used on the Bank is vertical hook and line, which would not disturb the submerged lands. All other fishing activities are allowed within the 50 fathom isobath surrounding the Bank, but may not disturb submerged lands as a result of that activity.
- For the balance of the Sanctuary, all fishing activities are provided an exception for disturbiing the submerged lands.
- CDFG trawl log books for the groundfish fleet in sample year (2000) indicates negligible impacts to trawlers as this activity rarely occurs within the 50 fathom isobath around the Bank.

CBNMS
Proposed Regulatory Action 3

KRILL HARVESTING IN THE SANCTUARY

Where Are We Today?

Preparing Draft Management Plans

To reach this stage:

- Incorporated working groups' recommendations
- Drafts reviewed by Sanctuary Advisory Council and Staff

Management Plans include:

- Proposed Regulations
- Action Plans
- Timeline
- Budget
- Performance Measures

PROJECT TITLE:
Integration of Marine Protected Areas and Fishery Science and Management

PROJECT LEADERS:
National Marine Fisheries Service, Santa Cruz Laboratory and the National Marine Protected Areas, Science Institute

PROJECT DESCRIPTION
Differing scientific views and interpretations have tended to create confusion and concerns over the role of marine protected areas (MPAs) in the management of the nation's fisheries and the conservation of its marine biodiversity. To address this problem, the NOAA Fisheries Santa Cruz Lab (SCL) and NOAA's National Marine Protected Areas Center-Science Institute (NMPAC-SI) are convening a technical working group to develop the scientific information necessary to integrate MPAs with the broader context of fisheries. The working group will participate in a series of focused workshops over a span of two years to discuss and define the critical concepts and issues and using in-depth analysis and synthesis develop a rational approach for integration of MPAs and traditional fishery science and management. The working group will be composed of scientists, fishery managers and representatives from the fishing industry and conservation community with appropriate expertise in marine ecology, and fishery science and management.

STATUS REPORT
Prior to convening the working group, we organized a NOAA planning effort in February 2004 to assist us with developing the terms of reference for the working group. The NOAA planning committee consisted of members representing the various line offices within NOAA, the Pacific Fishery Management Council (PFMC), and the MPA Federal Advisory Committee. The planning committee produced and prioritized a list of main topics for the working group (see attachment A), and identified prospective members of the working group. The first working group meeting is scheduled for September 2004.

Additionally, our efforts to improve the scientific knowledge of the function and impact of MPAs and fisheries have been coordinated with a similar and ongoing effort by the National Fisheries Conservation Center (NFCC) and the PFMC's Science and Statistical Committee (SSC) marine reserve subcommittee. In fact, products of their efforts served as a starting point at the NOAA planning meeting to develop our working group's terms of reference. Furthermore we continue to work closely with PFMC staff to ensure that the information generated by the working group has effective and timely applications for PFMC's management schedule.

PROJECT DELIVERABLES
- Peer reviewed papers and reports
- Novel analytical approaches and scientific models for integrating fisheries and MPAs
- A conceptual framework to improve the integrative management of fisheries and MPAs

Attachment A

List of MPA topics for working group consideration

A) MPAs and management of natural resources (fisheries and natural heritage)

1) Develop common currencies for evaluating the biological and socio-economic impacts resulting from implementation of MPAs and other management tools.
Examples of currencies:

- Spawning biomass protection
- Fishing mortality rate control
- Gear impacts on non-target species (e.g., by-catch) and benthic forage base
- Gear impacts on physical and biogenic habitat.
- Indicators of ecosystem function and relative status relevant to MPAs.

2) Compare the demographic implications of MPAs (e.g., maternal effects and size-age composition) with those resulting from implementing more conventional measures.

3) What are the costs/benefits and trade-offs for fisheries and ecosystems of fully versus partially protected MPAs (e.g., areas closed to bottom fishing yet open to pelagic fishing)?

4) How are benthic and pelagic communities coupled?

5) Evaluate fisheries and ecosystem consequences (e.g., benefits and costs) of various types of restrictions within an MPA.

B) MPAs and conventional fishery management

1) Identify strengths/weaknesses and trade-offs of different fishery management measures – MPAs being one of them - in terms of common currencies.

2) How can the use of MPAs benefit traditional fishery management objectives in ways that conventional management tools cannot?

3) Evaluate the potential for fishery induced change in heritable versus phenotypic characteristics of populations, influenced by or resulting from MPA use versus traditional measures (e.g., selection for slow growth and early maturation by fishing, or selection for sedentary individuals by MPAs).

C) MPAs and natural heritage management

1) What is the maximum amount of fishing effort that still allows one to reach the goals of an MPA implemented to protect and conserve natural heritage?

D) MPAs as insurance in the face of uncertainty

1) Determine if the establishment of MPAs can provide an insurance effect for marine fisheries, considering the following:

- Uncertainty in implementation (e.g., statistical estimation, enforcement, and compliance)
- Protection of non-target species in multi-species systems
- Protection of population structure (genetic and maternal effects)
- Maintenance of population and community resilience against catastrophe

2) Juxtapose the use of MPAs as a precautionary adjustment versus other alternatives and compare targets and expectations.

3) Evaluate MPAs as a last resort measure when quantitative fishery management cannot be applied.

E) MPA design and evaluation

1) Evaluate the state of the art and promising developments in spatially explicit modeling of marine populations and fisheries, and prioritize data and modeling requirements to support analyses of individual MPAs and networks (i.e., effects outside MPAs).

2) Propose statistically based monitoring designs (e.g., BACI) for evaluating the effects of an MPA, include evaluation of impacts inside MPAs.

3) Survey, and where appropriate, develop more sophisticated empirical and theoretical tools to evaluate spillover and seeding effects (e.g., integrate oceanographic models, genetic and microchemical tools, and fishery dependent and independent population models).

4) Survey current socio-economic data and tools and where appropriate develop more sophisticated socio-economic tools to determine MPA effects (e.g., changes in use patterns, and effects of effort displacement on fishing industry, fish stocks, and ecosystem function).

5) What are reasonable benchmarks/targets and time lines for various MPA goals (e.g., forecast modeling)?

6) Evaluate benthic and pelagic coupling in design considerations.

7) How do activities outside MPAs hinder the achievement of MPA goals (e.g., what are the effects on MPAs of fishing outside MPAs, and what are the effects of fishing inside an MPA on the goals of the MPA)?

8) How does the implementation of an MPA affect harvest policies for populations of target species (e.g., are fish in the MPA included in the harvest quota)?

9) How do we monitor and assess populations and communities in MPAs without adversely affecting MPA goals (e.g., by extractive sampling)?

10) Evaluate the design of MPAs or network of MPAs to achieve multiple objectives (e.g., maximize gain from a minimum number of MPAs).

11) Evaluate alternative adaptive management scenarios (e.g., testing a sequential series of hypotheses).

Overview

NOAA Science Integration Project

- **Impetus** - Scientific uncertainty on role of MPAs in fishery mgmt.
- **Goal** - Develop synthesis approach for MPA science integration.
- **Principals** - NMFS-Santa Cruz Lab (SCL)

  NOAA MPA Center-Science Institute (NMPAC-SI)
- **Timeline** -

Proposal funded	**June 2003**
NOAA Organizing Committee	**Feb 2004**
Working group meetings	**Fall 2004 - Summer 2006**
1st working group meeting	**Sept 2004**

MPA Demonstration Project

1) **NOAA Science integration**
2) Policy integration
3) MPA implementation phase

- Goal - Science integration goal expanded to include policy and implementation phases
- Principals - NMFS-SCL, NMPA-SI and PFMC
- Timeline – Initial development - **Summer 2003**

  Science integration - **2003 – 2006**

  Policy integration and MPA implementation phases to follow science integration

NFCC Science Consensus Conference

National Fisheries Conservation Center

- Goal – Develop a consensus statement on the state of the science of marine reserves for fishery management.
- Principals - NFCC
- Timeline - project development — **summer 2003**

  Organizing committee — **Nov 2003**

  Consensus Conference — **June 7 – 9, 2004**
- Outcome – final document at www.nfcc-fisheries.org

PFMC - SSC Marine Reserves Subcommittee

- Goal – Develop a white paper to evaluate implications of marine reserves for fishery management and define SSC expectations of marine reserve proposals submitted to PFMC.
- Principals – PFMC - SSC
- Timeline - subcommittee formation **2001**
  white paper **June 2004**

Concepts from the draft white paper have been used to inform the NOAA science integration process

NOAA Science Integration Project

- Goal - Develop the scientific information necessary to integrate MPAs within the broader context of fishery science and management
- Objectives-

1. Convene a NOAA-wide planning group to determine the scope and main questions (attachment A) and goals of investigation.
2. Assemble a working group with appropriate expertise to discuss the issues, conduct meta analyses and synthesize an approach for integration of MPAs with conventional fishery science and management.
3. Produce a proceedings, peer reviewed papers, 'a blueprint' for integration of MPAs with conventional fishery science and management.
4. Establish a postdoctoral appointment and graduate fellowship.

Goals for This Presentation

1. Provide an update to the PFMC (its advisory panels, SSC) on our project.
2. Present the list of topics/questions developed by the NOAA planning team.
3. Request comments from the PFMC on ways to improve/refine topics to address critical science gaps the PFMC has.

List of MPA Topics for Working Group Consideration

A) MPAs and management of natural resources (fisheries and natural heritage)

B) MPAs and conventional fishery management

C) MPAs and natural heritage management

D) MPAs as insurance in the face of uncertainty

E) MPA design and evaluation

Overview

NOAA Science Integration Project

- Impetus - Scientific uncertainty on role of MPAs in fishery mgmt.
- Goal - Develop synthesis approach for MPA science integration.
- Principals - NMFS-Santa Cruz Lab (SCL)

  NOAA MPA Center-Science Institute (NMPAC-SI)
- Timeline -

Proposal funded	**June 2003**
NOAA Organizing Committee	**Feb 2004**
Working group meetings	**Fall 2004 – Summer 2006**
1st working group meeting	**Sept 2004**

MPA Demonstration Project

1) NOAA Science integration
2) Policy integration
3) MPA implementation phase

- Goal - Science integration goal expanded to include policy and implementation phases
- Principals - NMFS-SCL, NMPA-SI and PFMC
- Timeline – Initial development Summer 2003

  Science integration 2003 – 2006

  Policy integration and MPA implementation phases to follow science integration

NFCC Science Consensus Conference

National Fisheries Conservation Center

- Goal - NIH process with blue ribbon panel and expert presenters to reach agreement on key scientific issues with respect to MPAs and fishery management. Similar goals as the NOAA process and outcome will inform NOAA process
- Principals - NFCC, COMPASS, and PISCO
- Timeline - project development **summer 2003**

  Organizing committee (Grimes, Fogarty and Methot) **Nov 2003**

  Consensus Conference **June 7 – 9, 2004**
- Outcome – add this from Kate Wing

PFMC - SSC Marine Reserves Subcommittee

- Goal – Develop a white paper to evaluate implications of marine reserves for fishery management and define SSC expectations of marine reserve proposals submitted to PFMC.
- Principals - PFMC SSC
- Timeline - subcommittee formation 2001

  white paper June 2004

Draft white paper concepts have been used to inform the NOAA science integration process

NOAA Science Integration Process

- Goal - Develop the scientific information necessary to integrate MPAs within the broader context of fishery science and management
- Objectives-

1. Convene a NOAA-wide planning group to determine the scope and main questions (attachment A) and goals of investigation.
2. Assemble a working group with appropriate expertise in fishery and ecosystem science and management to participate in a series of meetings to discuss the issues, conduct meta analyses and synthesize an approach for integration of MPAs with conventional fishery science and management.
3. Produce a proceedings of the working group and peer reviewed papers that will serve as a blueprint for integration of MPAs with conventional fishery science and management
4. Establish a postdoctoral appointment and graduate fellowship to conduct research relevant to understanding the role MPAs play within fishery science and management and support the working group

Goals for This Presentation

1. Provide comment to the PFMC on the list of topics/questions developed by the NOAA planning team.
2. Provide us with comments on ways to improve/refine topics to address critical science gaps the PFMC needs.

List of MPA Topics for Working Group Consideration

- A) MPAs and management of natural resources (fisheries and natural heritage)
- B) MPAs and conventional fishery management
- C) MPAs and natural heritage management
- D) MPAs as insurance in the face of uncertainty
- E) MPA design and evaluation

SCIENTIFIC AND STATISTICAL COMMITTEE STATEMENT ON UPDATE ON MISCELLANEOUS MARINE PROTECTED AREAS ACTIVITIES

Dr. Churchill Grimes briefed the Scientific and Statistical Committee (SSC) on efforts to integrate marine protected area (MPA) concepts with those of fisheries science and fisheries management. In particular, the National Marine Fisheries Service (NMFS) Santa Cruz Lab and the NOAA National Marine Protected Areas Center – Science Institute (NMPAC-SI) are convening a technical working group to develop the scientific information necessary to integrate MPAs within the broader context of fisheries. Expertise within this working group will be broadly based. Members will include ecologists, stock assessment scientists, economists, and policy experts. Working group projects will be multidisciplinary from inception rather than the more traditional approach of carrying out research along disciplinary lines and attempting to integrate findings only after the fact. Previous SSC statements and the SSC's "white paper" on marine reserves have advocated such an approach. The SSC supports the formation of the NMPAC-SI working group and suggests that, if invited, members of the SSC's Marine Reserves Subcommittee should be encouraged to participate fully in the working group.

Dr. Grimes also presented a comprehensive list of MPA topics for possible consideration by the working group. Nearly all of these topics are important and it may be difficult to prioritize the list. From the SSC's perspective, it may be less important to struggle with priorities than to ensure that whatever projects are first pursued, they be approached in an integrated fashion, cutting across the appropriate disciplines. A project that may be of particular interest to the Council is the development of a flexible stock assessment model that explicitly allows MPAs to be used as one of several tools available in its forward projection module. Such a model would allow the Council to examine the effect of MPA-based management in conjunction with more traditional management measures.

The SSC recognizes the NMPAC-SI is a national program and as such, will be dealing with many diverse issues from across the nation. It will be important to maintain the "West Coast" perspective in this process. Case studies focusing on the Channel Islands, for example, may be ideally suited to keep West Coast specific issues at the forefront.

Finally, the SSC encourages Dr. Grimes or other NMPAC-SI steering committee members to periodically update the SSC on the working group progress and related issues.

PFMC
06/16/04

Exhibit G.3.e
Public Comment
June 2004

Northwest Indian Fisheries Commission

6730 Martin Way E., Olympia, Washington 98516-5540
Phone (360) 438-1180 www.nwifc.org FAX # 753-8659

May 3, 2004

RECEIVED
MAY - 6 2004
PFMC

Carol Bernthal, Sanctuary Superintendent
Olympic Coast National Marine Sanctuary
138 West First Street
Port Angeles, WA 98362

RE: Request for fishery management background and role of Sanctuary

Dear Ms. Bernthal:

We appreciate your interest in gaining a better understanding on how the ocean fisheries within the Sanctuary waters are regulated by the Secretary of Commerce. The Pacific Fishery Management Council is the regional fishery council that has provided and will continue to provide the Secretary with advice and recommendations for the ocean fisheries off the coast of Washington State. Under the Magnuson Fishery Conservation and Management Act of 1976, the Pacific Council is one of eight fishery management councils established to manage fisheries offshore of the United States of America coastline.

The Pacific Council provides the necessary public forum for dealing with ocean fishery management and essential fish habitat issues. Through the Pacific Council, detailed fishery management plans have been developed for salmon, groundfish, coastal pelagic species, and highly migratory species. These plans outline the conservation objectives, habitat and production information, overall fishery objectives, and management measures employed. Each of these fishery management plans has undergone environmental review in accordance with the National Environmental Policy Act (NEPA) and the Council on Environmental Quality regulations that implemented NEPA.

Either a two or three meeting cycle is employed to develop the annual fishery regulatory package for a given species. Generally, this consists of determination of harvest guidelines or quotas based upon stock status and a corresponding range of possible fishery management options pursuant to the stipulations of the fishery management plan. This package is released for public review and comment prior to final action by the Pacific Council. The annual fishery regulation package adopted by the Council is then submitted to the Secretary of Commerce for review and final approval.

While there may be value in the Sanctuary Advisory Council and the sanctuary staff securing a better understanding of fishery management, this activity falls outside the scope of regulations for the Olympic Coast National Marine Sanctuary. At its time of designation, the Marine Sanctuary Program reviewed the various fisheries and fishing practices employed off the coast. The Assistant Administrator for Ocean Services and Coastal Zone Management acknowledged the on-going fisheries and that a comprehensive and coordinated management process already existed for the fishery resources in the proposed sanctuary site. Consequently, no fishery management regulations or authority were placed within the designation document for the sanctuary.

The coastal tribes, then and now, feel strongly that fishery regulation should be retained within existing management processes and not duplicated (with far less resources and historical expertise) within the regulatory scope of the Olympic Coast National Marine Sanctuary. This position was discussed with both the Secretary of Commerce and the Assistant Administrator for Ocean Services and Coastal Zone Management during the development of the sanctuary's management plan. These discussions resulted in the National Oceanic Atmospheric Administration (NOAA) formally promising that the sanctuary would not regulate fishing. This commitment by NOAA and the Secretary of Commerce was paramount to the tribes not formally objecting to the designation of the Olympic Coast National Marine Sanctuary.

The coastal tribes are adamant that the commitment not to regulate fishing continue to be honored by the Olympic Coast National Marine Sanctuary. Furthermore, we propose that the management strategies contained within the management plan for the sanctuary be modified at the next regular interval to clearly articulate this commitment.

Sincerely,

Billy Frank Jr.

Billy Frank, Jr.
Chairman

cc: Vice Admiral Conrad C. Lautenbacher, Jr., Ass't Secretary, Department of Commerce
Dan Basta, Director, National Marine Sanctuary Program
Bob Lohn, Regional Director, NOAA Fisheries
Jeff Koenings, Director, Washington Department of Fish & Wildlife
Donald K. Hansen, Chairman, Pacific Fisheries Management Council

Alliance of Communities for Sustainable Fisheries
P O Box 1309, Carmel Valley, CA 93924 (831) 659-2838

December 1, 2003

Stephanie Harlan, Chair, Sanctuary Advisory Council
Bill Douros, Superintendent
Monterey Bay National Marine Sanctuary Advisory Council
299 Foam Street
Monterey, CA 93940

RECEIVED
DEC 5 2003
PFMC

Dear Chair Harlan and Superintendent Douros,

We are writing to express our qualified support for the Special MPA workplan that will be considered by the Sanctuary Advisory Council on December 5, 2003. We also want to provide some background information which we greatly hope the members of the Sanctuary Advisory Council will read thoroughly.

A total of seven Alliance members participated in the SMPA workgroup to develop this draft plan. The workgroup effort began with what appeared to be an assumption that there would be additional MPAs supported by and placed within the Sanctuary, and the workgroup process is one in which the location and size would be identified. Through a large effort by all involved, the workgroup effort shifted to address a concern that it be more of a fair scientific inquiry as to the need, if any, for additional MPAs within the Sanctuary, and fairly evaluate both potential benefits and potential harms that might occur from these MPAs. You should be aware that there are still elements of the plan which make us nervous, such as the goal statement which seems overly broad, and the lack of identification of the role and authority of the Sanctuary Program. However, it was in the desire to constructively move forward that the Alliance members voiced their consensus, but importantly, at the lowest level of comfort for the final workgroup plan.

In addition to the contribution of individual Alliance members, the Alliance does formally also give its guarded endorsement for this workplan. We request that our level of endorsement be passed on at every stage of decision-making as this draft plan moves through the Sanctuary Program and NOAA towards adoption. We do not want to have our consensus statement characterized as fishermen being "wildly supportive" of MPAs or this process.

You should also be aware that the fundamental basis for our support of this plan is to provide the Sanctuary Program a sound method of commenting to the appropriate state and federal agencies on the MPA issue. Any comments would, of course, come from the perspective of the goals of the Sanctuary Program, and after consulting with our industry, but they would be just that – comments. It has never been intended by the Alliance or its members that the Sanctuary Program take a leadership role in the MPA question. Further, in the scenario that the Sanctuary would ever want to use its own authority to create a fishing regulation, then a change in the Designation Document of the Sanctuary would be required. For fishermen to support such a change in the Designation Document, there would need to be ample evidence that the change would be good for them, and that the change would not lead to unintended consequences. Short of that, the fishing community is likely to actively resist any effort to change the Designation Document, as we believe it contains the inherent promise made to us that the Sanctuary would not regulate fishing or be in fishery management.

It was understood from the beginning of the SMPA workgroup process that the effort would be focused mostly on establishing MPAs for conservation, biodiversity, and science study goals. However, a point that was raised numerous times was that even if established for such goals, MPAs will have inherent and significant fishery management implications. In fact, the most current science available now shows what fishermen have intuited for awhile, that because MPAs essentially just shift fishing effort from one area to another, overfishing the outside areas, which includes damage to spawning and recruitment cycles, is a distinct possibility. The irony of this is huge, as it could be that permanent MPAs, unless carefully sized and placed, could actually have a net overall negative consequence on the environment. More critical thinking within the science community needs to occur before the MPA experiment is conducted to any great degree. We predict that there will continue to be a place for MPAs in the toolbags of both the fishery manager and the conservationist. However, the actual application of this tool will be very specific and limited if it is to stay in the positive environmental realm.

As background to these concerns, and for the SAC's knowledge of current MPA thinking, we have attached three short articles that recently appeared in the publication of the Ecological Society of America. These articles generally address the question "Marine Reserves: the best option for our oceans?" Also attached is a letter dated March 8, 2002, responding to a number of Alliance members participation in a forum on MPAs held in Portland, Oregon. This letter still serves as a good summary of fishermen's questions and concerns about the use of MPAs from a biological, social, economic, and even ethical perspective. We hope that SAC members will give all of these attached documents a careful review.

Sincerely,

Mike Ricketts
Co-Chair, ACSF

Kathy Fosmark
Co-Chair, ACSF

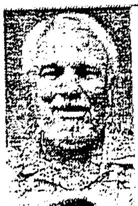
Supporting Associations & Organizations

- Pacific Coast Federation of Fishermen's Association
- Port San Luis Commercial Fishermen's Association
- Morro Bay Commercial Fishermen's Association
- Monterey Commercial Fishermen's Association
- Fishermen's Association of Moss Landing
- Santa Cruz Commercial Fishermen's Marketing Association
- Half Moon Bay Fishermen's Marketing Association
- Fishermen's Alliance
- Western Fishboat Owners Association
- Ventura County Commercial Fishermen's Association
- Federation of Independent Seafood Harvesters
- Golden Gate Fishermen's Association

Port San Luis Harbor District
City of Morro Bay Harbor
City of Monterey Harbor
Moss Landing Harbor District
Santa Cruz Port District
Pillar Pt. Harbor, San Mateo County Harbor District

C: The Honorable Sam Farr
The Honorable Anna Eshoo
The Honorable Lois Capps
Admiral Conrad Lautenbacher, USN (ret.)
Dr. William Hogarth, National Marine Fisheries Service
Don Hanson, Chair, PFMC

Enclosures




Churchill B Grimes and
Stephen Ralston
National Marine Fisheries Service, Santa Cruz, CA, USA

In his opening statement Norse writes, "Ideas and epidemics have intriguing similarities." So too, we believe, do epidemics and the sudden advocacy of (MPAs) as a panacea for the ocean's ills. Epidemic is exactly how we would describe the onslaught of information supporting the use of MPAs to save the imperiled seas from, among other things, the adverse effects of fishing (NRC 2001; Lubchenco *et al.* 2003). While we don't quibble with the assertion that, globally, the oceans are in dire need of increased protection, we would argue that some of the touted benefits of MPAs are controversial and have not been conclusively demonstrated.

Unfortunately, the debate concerning the use of MPAs to achieve sustainable fisheries has become polarized, and is rife with scientific advocacy and oversimplification (Lubchenco *et al.* 2003; Shipp 2003). Most egregious to us is the naiveté of some people regarding the accomplishments of fishery science. For example, Norse states that prior to 1997, "fisheries biology…had generally treated the sea as being uniform". Such a statement, at best, ignores the rich and long-standing contributions of fisheries science to our understanding of ocean ecosystems (Hjort, Cushing, Harden-Jones, and Sinclair) and, at worst, subliminally casts blame on fisheries science for bringing us to our current state of affairs. In fact, 50 years ago two pre-eminent fisheries biologists, Ray Beverton and Sidney Holt, modeled the impact of spatial closures on fishery yields (Guénette *et al.* 1998). As to the quality of government fishery science, several National Research Council studies (eg NRC 2002) concluded that US National Marine Fisheries Service (NMFS) stock assessment techniques are second to none among government fishery management agencies worldwide.

The justification that is most often cited for establishing domestic MPAs is that traditional fisheries management in the US is a failure. However, this is ill-informed. The present low levels of many fish stocks reflect poor management decisions made many years ago. A closer look at current exploitation rates reveals that current management is doing far better. Although many fisheries (eg cod in the northwest Atlantic and certain rockfish stocks along the west coast of the US) are in severe decline, many others, such as king mackerel in the Gulf of Mexico, summer and yellowtail flounder, Atlantic mackerel, and sea scallop along the US Atlantic coast, are at sustainable levels. In fact, of the 283 (25%) of 905 fish stocks managed by NMFS for which the status is known, only 15% are overfished and 39% are fished at or near their long-term potential yield (NRC 2002). Moreover, many US fisheries are already managed under severe spatial management regimes; for example, virtually the entire continental shelf of the west coast is presently closed to groundfishing.

While we are aware of evidence of the conservation benefits of biodiversity enhancement, population growth, attenuated size/age composition, and habitat recovery inside reserve boundaries, as well as adult spillover outside reserve boundaries, there are other critical scientific issues that are poorly understood. One simplistic generalization being touted by MPA advocates is that, at a minimum, 20% of a species' habitat needs to be protected to realize the benefits of an MPA (Agardy 2003). This figure is apparently based upon theoretical results showing that when fishing mortality is excessive, overall fishery yields could be enhanced by substantial area closures. However, many studies also show that traditional fishery management controls on fishing effort correspond directly to area controls, and that it is possible to manage fisheries optimally just using effort controls (Mangel 1998; Hastings and Botsford 1999), which has been the general paradigm practiced within the US. Moreover, the claim has been frequently made that MPAs will promote sustainable fisheries and enhance fishery yields (Nowlis and Roberts 1998), but density-dependent theory tells us that per-capita production is lowest at carrying capacity (ie in the absence of fishing), and that compensation at lower population levels produces a surplus that can be sustainably harvested. How will overall stock dynamics (eg potential yield, spawning stock-recruitment relations, spawning biomass targets and rebuilding trajectories) be affected by declining compensation within reserve boundaries, and how will the time-delayed impact of MPAs affect ecological and stock dynamics both inside and outside the reserve? Equally important, how will fishing effort displaced by MPAs affect catch rates, yields, and habitats outside reserve boundaries?

We are certainly not opposed to the use of MPAs to attain the conservation benefits pointed out above to provide insurance against errors in traditional fishery management, and as natural research and reference areas. However, we believe there are important unresolved issues that need to be answered before claims that MPAs will improve fishery management can be fully accepted. In addition, managing fisheries with MPAs needs to be placed in the context of existing management controls, which requires a case-by-case consideration of all available options.

References

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Ray Hilborn
School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, USA

Amidst the concerted rush of ecologists to push for the establishment of networks of MPAs, we need to brush off a little old-fashioned scientific skepticism and look carefully at the potential benefits and costs of MPA networks. As a conservation tool, MPAs move fishing effort out of some areas and shift it to others. It is not too surprising that abundance increases where fewer fish are removed, but the displaced fishing effort goes elsewhere. We need to ask whether the biodiversity benefits inside the protected area are more valuable than the biodiversity costs of additional fishing pressure outside. Once we realize that MPAs are effort-shifting programs, we recognize that the comparison of abundance inside and outside protected areas is flawed; the benefits estimated by comparing abundance inside and outside reserves, or before and after reserves are established (Halpern and Warner 2002) will be exaggerated.

Most MPA literature begins with a litany of the failures of fisheries management and MPA advocates have often used the fisheries management benefits of MPAs as a major selling point. MPAs can only benefit the yield of managed species if the species is overfished and if the movement rate of the spawning population is low enough relative to the size of the MPAs that spawning populations can build up inside them. Shipp (2002) points out that these two circumstances are rather unusual. Only 30% of the major fisheries in the US are classified as overfished, and for most of those species the movement of adults is great enough that only large MPAs would have much effect. Since current yield of US fisheries is over 80% of its potential yield (Hilborn *et al.* in press), there is little room for MPAs to increase fish yields.

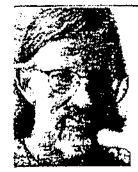
For MPAs to be effective in increasing sustainable yield for a species, the sizes of the protected areas must be carefully matched to the movement of that species. If the MPAs are very large relative to movement, then yield is reduced because the fish are locked up. If the MPAs are too small, then there is insignificant buildup inside the reserves. No pattern of MPAs will be optimal, or even suitable, for all species; having different areas closed for different species would provide better yield and conservation benefits than blanket MPAs. Such areas are steps forward in the management of fisheries because they recognize the need for spatial management, but they are very blunt tools and we can do much better than one-size-fits-all networks if our objective is to maximize sustainable yield. Rather than broadly improving fisheries yields, a network of MPAs might improve yield in a few instances.

MPAs must be integrated into the fisheries management system. It is easily demonstrated that adding an MPA to a fishery regulated by catch quotas will generally require that the quota be reduced. While advocates argue that MPAs will increase fish yields (PISCO 2002), they rarely, if ever, do the quantitative work necessary to determine how regulations will need to change when an MPA is put in place.

Despite my skepticism, I believe that the establishment of MPAs is indeed a good idea, and when done with very specific objectives can benefit specific fisheries. I have no doubt that the abundance of many species will be higher in protected areas, and would like to see more marine areas protected in the same way that I wish more of the

terrestrial habitat had been protected in parks.

I do see MPAs having an important role in fisheries management. First, in some places it may be possible to enforce protected areas where other forms of fisheries regulation are not practical. Second, in the US and other intensively managed countries, the vast majority of species are not regulated. Several hundred species are caught in the west coast trawl fishery, yet fewer than 20 are assessed (Hilborn *et al.* in press.). The vast majority of species are generally not of major commercial interest, but conservation concern for all species is currently driving management regulations; the west coast fishery is largely closed at present to protect several species classified as overfished. I see that MPA networks can be established to protect the biodiversity of marine communities, so that exploitation of the commercially important and healthy species can take place outside reserves. Essentially, the reserves would guarantee the protection of overfished or unassessed species. This will probably mean less (not more) yield of the healthy species compared to their potential yield, but it would allow commercial exploitation to continue in some places while providing for protection of a broad range of species.



Dave Fraser
Captain, FV Muir Milach
Adak, *AK*, *USA*

Elliot Norse would have managers unleash a virtual epidemic of MPAs, but not just any strain. His prescription calls for a particularly virulent genus: "marine reserves", also known as "no take zones" (NTZs). As Tundi Agardy (2003) wrote, "The enthusiastic prescription of simplistic solutions to marine conservation problems risks polarization of interests and ultimately threatens bona fide progress in marine conservation. The blanket assignment and advocacy of empirically unsubstantiated rules of thumb in marine protection creates potentially dangerous targets for conservation science."

No one benefits from sound fisheries management more than those dependent upon commercial, subsistence, and sport fishing. Good management requires finding the right tool for the job. What is missing from the current MPA/NTZ campaign is the critical need to carefully define the problem before reaching for a tool.

If overfishing is the problem, then as Andrew Rosenberg (2003) said in this journal, "The only way to end overfishing is to fish less." In Alaska, as the Chairman of the Pew Commission acknowledged, we've seen the wisdom in that all along (Panetta 2002), which is perhaps why we have no overfished groundfish stocks.

Time and gear closures of huge tracts of ocean have long been facts of life in the North Pacific. In the Bering Sea, year-round bottom trawl closures encompass about 30 000 square nautical miles, an area larger than Indiana. Trawl closures in the Gulf of Alaska encompass 60 000 square nautical miles. Large expanses of the North Pacific are closed seasonally for bycatch reduction or to protect marine mammal habitat and feeding areas. Together, these closures comprise some 25% of the continental shelf. More importantly, catch and bycatch are limited and closely monitored through an observer program – without a network of permanent NTZs. In Alaska, in short, fisheries management already proceeds from the assumption that the entire ocean should be a marine protected area.

Despite our experience in Alaska, Norse concludes, "the case for reserves is so strong that it seems imprudent to wait until implacable opponents of marine conservation are convinced by the evidence". As an implacable supporter of marine conservation – though a skeptic on the value of NTZs as tools for fisheries management – I prefer policy based on evidence.

So what is the evidence? Norse dismisses a study by Shipp (2002) because it was funded by sport fishers. If funding is an appropriate criterion for assessing validity of scientific research, Norse's conclusions as a Pew-funded author, citing a Pew commission report that cites Pew-funded scholars, including himself, are also suspect. In any case, let's review their evidence. The Pew Commission's report on marine reserves (Palumbi 2003) cites a variety of studies indicating that:

- proof of augmented reproductive capacity via larval transport is rare, except with extremely over-exploited species
- there are few US studies of NTZs (except for "boutique-size" closures)
- most studies are mathematical models
- effort control can achieve the same purposes
- reserve networks are poorly studied
- studies of reserves show beneficial results in specific circumstances, where there are heavily exploited species, that the benefits are stronger within reserve borders, and that the effect is clearer for sedentary species.

The evidence that NTZs offer substantial incremental benefit to well-managed fisheries outside the NTZ is less than compelling. In advocating NTZs, supporters should clearly differentiate between NTZs as a fisheries management tool and NTZs as parks. Where NTZs can be demonstrated to increase yields at a lower cost to fishers than other management tools, fishers will accept the price of lost fishing grounds. However, were the public to decide that it wanted to create a new national park in the grasslands of Iowa, we wouldn't simply evict the farmers. Society as a whole would shoulder the cost.

Scientifically-based closures, carefully designed to accomplish specific goals, are part of a broader set of management tools that together provide sustainable fish populations and sustainable fisheries with the economically important jobs they provide. But habitat protection measures are not simple; there are endless gradations between totally open and completely closed. From the perspective of the fishing community, any measure should meet four critical tests. MPAs must be scientifically justified, have clearly articulated goals, incorporate provisions for continued monitoring to ensure that those goals are being achieved, and their creation must take into account existing closures.

The Northwest Indian Fisheries Commission (Franks 2003) and Pacific Coast Federation of Fishermen's Associations (PCFFA 2002) have thoughtful online policy statements on MPAs, NTZs, and sustainable fisheries, which articulate the concerns of the broader fishing community. Due to space restrictions, I have posted links to their sites and further discussion of the fishing community's perspective on MPAs and NTZs at www.olympus.net/personal/dfraser/mpalinks.htm.

"For every complex problem", wrote HL Mencken, "there is an answer that is clear, simple, and wrong". Properly considered, researched, and implemented, various types of MPAs adapted to specific circumstances may prove useful. Applied broadly without meaningful participation by stakeholders in the fishing community and other interest groups, they will engender conflict and resistance. Let's get it right before we unleash an epidemic of NTZs.

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Alliance of Communities for Sustainable Fisheries
P O Box 1309, Carmel Valley, CA 93924 (831) 659-2838

March 8, 2002

Bob Eaton, Executive Director
Pacific Marine Conservation Council
P O Box 59
Astoria, OR 97103

Subject: Open Letter to MPA Forum Attendees

Dear Bob:

On behalf of the Alliance of Communities for Sustainable Fisheries, thank you to you, your staff and the Pacific Marine Conservation Council for hosting the Fishermen's Forum on MPAs. We feel that it is timely to focus on improved communication between all parties and exchange information.

In the spirit of furthering communication on the important topic of MPAs, we would like to share some observations, conclusions, and questions, resulting from our participation in the Forum. The points made in this letter express a wide variety of direct experiences from many people who fish from Santa Barbara to San Francisco. The points raised in this letter reflect our assessments thus far, but we stress that we are in a dynamic process, and the points are areas of concern that require further study. Hopefully this letter will be used as an "open letter" to attendees and other interested NGOs and agencies, and be distributed accordingly.

1. We understand and appreciate that many citizens have a real concern about the condition of the ocean, and we applaud that concern. However, we do have a concern that the marine reserve movement is missing the mark. Many fishermen see marine reserves as an extreme measure that overreacts, to their detriment, rather like trying to keep a child safe by never letting him/her out to play. To some degree the push for marine reserves represents the acceptance of failure - the failure to do the real work of the science of fishery management. To fishermen, marine reserves also represent a desire for the easy solution that is sometimes seen in our society: we want our wars to be quick and painless, our hamburgers fast and cheap, and we tend to love the quick fix. If there are needs in fishery management, marine reserves do not necessarily address the real issues, but may be a band-aid, placed on the wrong wound. We have heard marine reserves referred to as "an insurance policy against our ignorance". Why institutionalize ignorance? Why not provide the resources to understand and properly manage ALL of our ocean areas and resources? The wound that needs treatment is the lack of funding support for the science of fishery management! This is not the scientist's fault. As a specific recommendation, we suggest a new commitment, through all means possible, to obtain this better science and to make sure responsible agencies use it. Had this been the topic at our Fishermen's Forum, there would have been little dissension and great enthusiasm across the board.

2. There is a tendency to portray the entire ocean as in absolute crisis, and fishermen as the cause and as villains. This occurs in the media and we hear it directly from some environmental groups. Each one of these portrayals is a stand-alone premise in the marine reserve movement, and they create their own inner logic. If West Coast fisheries are not in crisis, then why do we need marine reserves - so the assertion of crisis is required. If fishermen are not villains, but low stocks are due to other factors (regime shifts, pollution, predation...), then why do we need marine reserves? Hence "over fishing" as the cause must be asserted to get marine reserves. If a traditional management measure is put in place and is working, that can't be acknowledged because it would cause the need for marine reserves to be questioned. If a particular stock shows low numbers, that is all you ever hear about. If fisherman question the crisis premise, well, they're the villains, aren't they? So we can't believe them! Marine reserves have become their own end game.

   The great majority of fishers are in fact, absolutely committed to fisheries managed in a way that can be sustained for generations to come. We are more a part of the solution than the problem. We would greatly value the cessation of this rhetoric, and are very willing to work cooperatively with the conservation community on real issues. This is what the Alliance is attempting to do by working with the Monterey Bay National Marine Sanctuary, and the local conservation and science communities, to formally look at marine reserves. When we are done with that (if ever!), we want to work cooperatively on other issues, such as by-catch, gear modifications, and regulatory reform.

   We want to be treated with respect for the knowledge we possess and for our commitment to properly managed fisheries.

3. We think that the best arguments FOR marine reserves lie in the scientific value of creating baseline data, and we acknowledge that a section of society sees intrinsic value (biodiversity) in having some wild areas set aside, just to know that they are there. However, the value of marine reserves becomes muddy when used as a fishery management tool, and not just any tool, but one proposed to dominate the toolbag. It is even less clear when the marine reserve is proposed to stop fishing for pelagic fish. Scientific study has shown that the benefits of marine reserves decrease in ratio to the degree to which external areas are regulated - and in fact marine reserves can have a negative environmental effect if 100% of the fishing effort is displaced to neighboring areas. There are enough tried and true, flexible, traditional fishery management tools in the toolbag, tools that can have the benefit of increased science, as described above. We respectfully suggest that the conservation community, who represent concerns for bio-diversity, intrinsic value, and for the benefits of creating a scientific baseline, should stay with those principles, and not try to sell marine reserves as a fishery management tool, at least on the West Coast. We feel strongly that the conservation community would benefit from this tactic and have an easier time convincing both fishermen and the general public of the value of their mission. If this would occur, one of the primary roles of the fishing community would be to help place the reserves so that they can meet science and conservation goals, but not harm our fisheries.

4. Fishers are more than dubious about the use of marine reserves as a fishery management tool on the West Coast, because our fisheries are already aggressively managed. Although we had no opportunity to hear from them at the Forum, an increasing number of respected fishery biologists are poking holes in the premises and conclusions drawn by other scientists who support marine reserves. We would have liked to hear from them at the Forum, perhaps as a debate between "pro and con". There has generally been a lack of critical thinking and studies regarding what role a marine reserve might play in an already highly regulated fishery and/or for pelagic fishes. The success of marine reserves in third world nations where there are no other management tools

does not relate to our situation. Nor does the theory hold true that you will only have large, fecund fish if you have marine reserves.

Why is there a lack of critical thinking regarding marine reserves as a fishery management tool? We think it's mostly about money! We observe that some fishermen feel that very large foundations are pushing an agenda that says: you will "save" the ocean if you institute severe limits on how humans can use it. We don't know if this is true or not, but we do ask: What would happen if, during the next year, $10 million dollars or so was made available to marine fisheries research institutions to explore critical questions, such as: Are marine reserves needed to assure sustainable fisheries? If not a single new marine reserve is placed off the West Coast, what is the probability of continuing to have sustainable fisheries? Are there gear and or regulatory modifications that are needed to assure that a population of large, fecund groundfish continues to survive? Can the placement of marine reserves within the context of a highly regulated fishery actually be counter-productive? How can the knowledge that experienced fishermen have be used to improve scientific collection and the evaluation of fishery data? What are the implications for fishery managers when natural regime shifts occur, changing the resident fish populations? How will natural predation affect marine reserves? What can our existing marine reserves tell us - and why haven't they been more thoroughly studied? What kinds of regulatory reform and/or gear modifications can be made to reduce by-catch? Why is it that so many marine reserves, even in tropical climates, are failing to meet their stated objectives?

5. We think both the science and conservation communities have lessons to learn about the social implications of the marine reserve movement. "Social" meaning in part, human relationships. As a social implication, there is a very basic point that the fishing community would like to make to the science community. In all the touting of the benefits of marine reserves, nowhere is it mentioned that there is and will be a powerful, influential benefit directly to the science community in the form of increased funding for research projects specific to marine reserves. Because of the private foundations described earlier, marine reserves offer a funding opportunity for the science community that is not necessarily related to developing broad knowledge about sustainable fisheries. In this regard they may actually divert funding the real work of fishery science that needs to be done. We would like to see funding stay focused on real fishery management issues, of which marine reserves play only a part. As fishermen's concerns are often dismissed as stemming only from concerns for financial loss, we suggest that many scientists be more forthright in stating their economic interest. You should be aware that some fishermen believe that the push for marine reserves is really about taking a public resource away from one set of users and instead turning it over to another set (scientists), as their near-exclusive laboratory. We suggest that the science community be more forthcoming with the fact that they have economic gain at stake, just like us.

   We believe that the conservation community also needs to be more forthright in dealing with the social and economic implications of marine reserves. The fact that large scale marine reserves will put a lot of Americans out of business and will change forever the culture of many communities, needs to be addressed head-on by the conservation community. If the conservation community doesn't understand or believe that fact, then the need for formal social and economic science is underscored. As a related point, please remember that according to the Federal Economic Development Administration, every one-dollar of fish value brought across the docks generates nine more dollars as it moves through our economy. The conservation community needs to fully address this. The loss of American jobs and the likelihood of increased reliance on foreign fish imports are real. And please--we hope that no one thinks that a few extra "eco-tourism" jobs that may come from marine reserves will make up for this, but if it is the goal to replace our work with eco-tourism, we'd like to hear that straight-up. If it is the intention of at least some conservation organizations to reduce fishing capacity (i.e., take people off the water), we suggest that those organizations take the straight path to this goal and fund-raise to buy boats and permits. Will the conservation community support adequate compensation for the loss of jobs and income that result from any large-scale implementation of marine reserves?

The conservation community also needs to address the social and environmental implications of displaced fishing effort. This occurs as a negative impact in the likelihood of over-fishing the areas outside the reserves (if the marine reserves take the most productive fishing grounds as has been proposed.) It also occurs on an international basis, as marine reserves decrease local fish production and the demand for fish expresses itself by an increased import market. Herein is the irony which the conservation community must face up to: marine reserves in U.S. waters are very likely to contribute to the over-fishing of the waters of developing nations, where far less (if any) fishery management occurs. It seems to set the stage for a dynamic for which our nation receives frequent criticism: we rip-off the resources of developing nations for our own benefit.

We also point out the ominous parallel with the demise of the small family farm, as fishermen are most fundamentally food producers. Fishing could end up being only corporate fishing by a few outfits with a few large vessels, supplemented by lots of foreign imports and farmfish. Real environmental protection and resource management has historically been done more effectively by small economic units who have immediate stakes in the outcomes. The work of Wendell Berry, who writes so eloquently about the role of the small family farm in America's local culture and economy, offers insight into the dilemma of fishing communities as well. We should not forget a basic law of socio-economics: The true wealth of a nation is created and sustained when its labor utilizes its own natural resources, turning those resources into finished products, for use and consumption by its own people, and for export.

That last social issue that we want to address relates to the legal basis for removing large areas from general usage and limiting public access. There are landside precedents for this, such as land-use/zoning laws, but there are coastal/ocean laws that seem contrary to that. In California the Coastal Act gives deference to the needs of the fishing community. The Doctrine of the Public Trust for State (California) Tidelands guarantees that tidelands will be used for "Commerce, Navigation, and Fisheries." In California, marine reserve status can also mean that all human uses may be excluded, including vessel anchoring, surfing, and non-extractive diving. Most people don't know this and we think that these points and their implications have not been adequately debated.

6. While we continue to have many questions about marine reserves as a primary tool in the fishery management toolbox, there may be specific areas of fishery management where they are useful. An example of some work that has begun on this question is the paper written by Parrish, Segar and Yoklvich titled Phase I Technical Analysis for Marine Reserves to Supplement Management of West Coast Groundfish Resources. This paper details a process of analysis, species by species, of the appropriateness of a marine reserve as a management tool, and alternatives. This is an attempt at the process of science, not political science, and it shows that there is no "one size fits all" marine reserve.

   It takes a very special fish life history for marine reserves to be an effective management tool, meaning a reasonably sedentary adult life history but highly dispersive larval stages - so marine reserves can't be an effective tool for most West Coast commercial fishes because they move too much. MPA's are one form of spatial management that would be really useful for some invertebrates, but the spatial scale that is appropriate for one species won't necessarily be appropriate for another. We need to move to spatial management, but MPA's are too blunt an instrument. We also need more basic information about which species really benefit from marine reserves - and which would not.

A main concern among fishermen is that marine reserves may only create management redundancies. In fact we wonder if marine reserves offer anything that conventional management can't accomplish with more flexibility and adaptability. This is one of our central questions. The focus of marine reserves is on human extraction being the main cause of stock depression, while mortality from non-point sources (sound testing, ultra-violet, pollution, etc) and predation, are not addressed. An advantage of an annual management process is that it allows for new information to be incorporated and adjustments made - adaptive management. Generally our thoughts right now are that marine reserves should be utilized as a management tool only if the desired goal cannot be achieved through gear modifications and/or conventional management measures.

7. We heard loud and clear that social science and economic science need to be done concurrently with biological science when considering marine reserves. Additionally, they should be given equal weight. Without this, who will value the culture and heritage of our fishing communities? Fishermen are far more at risk of being lost to our communities than there is danger of any West Coast fish becoming extinct.

8. Leadership in the consideration of marine reserves should be undertaken by the NMFS/PFMC and by State Fish and Game Agencies - and not by the National Marine Sanctuary Program. The Channel Island marine reserve process was, and is, a mess, and we need to learn from that experience. The PFMC's Science committee's peer review of the CINMS-MRWG Science panel's percentage conclusion (30-50% reserves) indicated that it was more policy than science. This is one example among many as to why this process was such a poor example of public decision making. As one participant pointed out at the Forum, the Sanctuary Program does not have the scientific expertise, nor the unbiased public decision making process, to be in a leadership role. The Sanctuary Program is not a neutral facilitator, but rather a stakeholder, just like us; therefore, the Program should not be put in charge of the decision-making process. As a related point, we certainly do not want States or the PFMC to abdicate their responsibilities and let the Sanctuary Program establish policy for marine reserves. The use of the Sanctuaries Act zoning authority would skip important evaluations required in the Magnuson-Stevens Act.

9. What our Alliance has attempted to do in setting up our own Marine Reserves Study Group, then inviting representatives from the Sanctuary Program and the Science and Conservation communities to work with US, is to provide leadership to this problem. This is not a game or a trick on our part. After watching the outcomes of other processes, we believe that you have to lead or be trampled. You will have to offer constructive suggestions and engage in discussion, appreciate other points of view, and work towards a common good. To avoid the "confuse, divide, wear-out, and get conquered" syndrome we must be organized, inclusive, and stay constructively focused on the issue. "Inclusive" means all gear types, recreational fishermen, divers, etc. Remember Ben Franklin's quote in 1776: "If we don't hang together, we will hang separately".

10. One point, which was developed during one of the Forum's breakout groups, contained the realization that the fishers and conservationists don't talk enough to each other. This is true, but odd, in as much as most fishermen consider themselves to be conservationists, and most conservationists we know love to eat fresh fish. To try to improve this situation, the Alliance of Communities for Sustainable Fisheries will make the offer to the conservation community, (and

agency people, and the science community), to come down to our harbors, go on our boats, and get to know us. Anyone who wants to do this through the Alliance can contact us at the Alliance main phone number and we can arrange a visit. We also hope that other fishermen and fishermen's groups will extend similar offers up and down the coast. We know this letter contains some blunt opinions, but we want everyone to know that the street runs both ways... we are listening as well.

Most policy statements regarding the addition of marine reserves in coastal waters (including the "Scientific Consensus Statement on Marine Reserves and MPA's", signed by 161 scientists), include the following: For marine reserves to work, whether it be for intrinsic value or as a fishery management tool, they must have the support and acceptance of the fishing community, both sport and commercial. To gain that support, the ideas and questions we have posed must be addressed.

"*Marine reserves are a solution looking for a problem*"
Anonymous California Fisheries Scientist

"*You've got to be careful if you don't know where you are going, because you might not get there.*"
Yogi Berra

Sincerely,

Kathy Fosmark
Co-Chair, ACSF
Moss Landing

Steve Scheiblauer
Board Member, ACSF
Monterey Harbormaster

Roxanne Jordan
Board Member, ACSF
Moss Landing

Duncan MacLean
Board Member, ACSF
Half Moon Bay

Tom Canale
Board Member, ACSF
Santa Cruz

Chris Miller
Member, ACSF
Santa Barbara

Craig Barbre
Member, ACSF
Morro Bay

Steve Fosmark
Member, ACSF
Moss Landing

Peter Halmay
Member, ACSF
Santa Barbara

Wayne Moody
Member, ACSF
Morro Bay

Steve Reebuck
Member, ACSF
Morro Bay

Donna Solomon
Member, ACSF
Moss Landing

Kurt Solomon
Member, ACSF
Moss Landing

Bill James
Member, ACSF
Port San Luis

Supporting Associations & Organizations

- Pacific Coast Federation of Fishermen's Associations
- Port San Luis Commercial Fishermen's Association
- Morro Bay Commercial Fishermen's Association
- Monterey Commercial Fishermen's Association
- Fishermen's Association of Moss Landing
- Santa Cruz Commercial Fishermen's Association
- Half Moon Bay Fishermen's Marketing Association
- Fishermen's Alliance
- Western Fish Boat Owners Association
- Ventura County Commercial Fishermen's Association
- Federation of Independent Seafood Harvesters
- Golden Gate Fishermen's Association
- Port San Luis Harbor District
- City of Morro Bay Harbor
- City of Monterey Harbor
- Moss Landing Harbor District
- Santa Cruz Port District
- Pillar Pt. Harbor, San Mateo County Harbor District

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Monterey Bay National Marine Sanctuary
299 Foam Street
Monterey, California 93940

November 19, 2003

Mr. Mike Ricketts, Co-Chair
and Ms. Kathy Fosmark, Co-Chair
Alliance of Communities for Sustainable Fisheries
P.O. Box 1309
Carmel Valley, CA 93924

RECEIVED
DEC 5 2003
PFMC

Dear Co-Chairs Ricketts and Fosmark:

I appreciate your letter to me and Dan Basta, dated October 13, 2003, expressing your concerns related to the potential inclusion of the Davidson Seamount into the Monterey Bay National Marine Sanctuary (MBNMS).

As you know, since April 2001, the National Marine Sanctuary Program (NMSP) has been engaged in a Joint Management Plan Review process that generated a number of ideas from the public about improving protection of the marine ecosystem off central California. One such idea was inclusion of the Davidson Seamount into the MBNMS. After careful review by the NMSP and the MBNMS Advisory Council, this proposal appears to have merit for due consideration in the management plan review process.

On August 1, 2003, the Sanctuary Advisory Council unanimously recommended that including the Davidson Seamount into the MBNMS be advanced to the next phase of the management plan review process. They agreed with the Davidson Seamount working group that agencies such as the Pacific Fishery Management Council could not address all forms of extraction (such as oil and gas), educational needs related to seamounts, or enhanced understanding through research and monitoring, and thus sanctuary designation was the best approach to pursue. The fishing and harbor representatives joined conservation, research, business, tourism and all the other seats on the Advisory Council to ask that the NMSP view this as an opportunity to work collaboratively with fishermen on an issue important to all parties. I am eager to work with the Alliance of Communities for Sustainable Fisheries and other interested fishermen to craft management strategies that will show how sanctuary resource protection of the Davidson Seamount and fishing on the ocean's surface can both be achieved.

I appreciate statements by Alliance members and other fishermen acknowledging the significance, uniqueness and importance of the benthic environment on the Davidson Seamount. Fishing does not occur on the top of the seamount nor is it likely to develop, given the scarcity of fish populations on or immediately adjacent to the seamount. Rather, we acknowledge and appreciate the importance of several fisheries for albacore and swordfish that occur near the ocean's surface, 3,500 ft. above the seamount. We fully recognize your concern that providing Sanctuary protection to the Davidson Seamount may one day lead to limitations on the surface fisheries. The management plan review process allows for fishermen such as yourselves to help the MBNMS craft management strategies for the Davidson Seamount that clearly identify and explain the protection goals for inclusion into the MBNMS. The ambiguities that you believe exist in the current management plan can be addressed for the entire Sanctuary as well as for any proposal to include the Davidson Seamount. By working cooperatively on the possible inclusion of the Davidson Seamount, the Alliance and the MBNMS could establish the next phase of our partnership, one where we build the trust and collaboration that we both have sought and worked hard to create over the past few years.

Other proposals from the public have prompted the MBNMS to develop specific action plans, such as the idea the Alliance suggested – an action plan focusing on involving and incorporating fishermen into the Sanctuary's research and education activities. We have also invested extensive staff time in working collaboratively with the Alliance and its members on many issues that affect fishing, such as marine protected areas. Many programs with an indirect benefit to fishing, such as protecting the region's water quality and preventing habitat damage from road repair, have been and continue to be significant priorities for the MBNMS.

There are other initiatives between the MBNMS and fishermen that have progressed our partnerships. Sanctuary staff have been working jointly with Alliance members to hold an educational open house for the public to benefit commercial fishing, tentatively scheduled for June 5, 2004. We were also pleased to be able to have Mike participate in our September research cruise to assess benthic invertebrates and fish assemblages using the *Delta* submersible. Our staff is already gaining insight on Sanctuary resources through this collaboration, and we look forward to building on the trust that is developing through these many interactions.

Since announcing its existence two and a half years ago to help the MBNMS establish and maintain a dialogue with fishermen, the Alliance has helped create a partnership where none had existed previously. I, and everyone at the Sanctuary, appreciate the opportunity you have created. With this partnership both the Sanctuary staff and the Alliance members have learned to listen and work together towards common goals. I have believed and continue to view the Davidson Seamount proposal as an example of another opportunity for partnership. Much like the action plan on fishing-related research and education, the Davidson Seamount proposal offers us the chance to work on a project that requires a level of trust between the Sanctuary and the Alliance.

In conclusion, we are responding to a broad audience in considering the Davidson Seamount issue and recognize your current opposition to its inclusion in the boundary. However, we look forward to working with the Alliance to resolve your specific concerns on this and many other issues in the future.

Sincerely,

William J. Douros
Superintendent

cc: Hon. Sam Farr
Hon. Anna Eshoo

Hon. Lois Capps
Hon. Elton Gallegly
Hon. Richard Pombo
Hon. Bruce McPherson
Admiral Conrad Lautenbacher, USN (ret.),
Dr. William Hogarth, National Marine Fisheries Service
Don Hanson, Chair, Pacific Fisheries Management Council
Sanctuary Advisory Council for Monterey Bay National Marine Sanctuary
Sanctuary Advisory Council for Gulf of the Farallones National Marine Sanctuary
Sanctuary Advisory Council for Channel Islands National Marine Sanctuary
Dan Basta, Director, National Marine Sanctuary Program

Bernard Bjork
Pres., Darb Fishing, Inc.
36293 Bartoldus Loop
Astoria, OR 97103

3-23-2004

Pacific Fishery Management Council
Attn: Chairman Donald Hansen
7700 NE Ambassador Place, Suite 200
Portland, OR 97220-1384

Dear Chairman Hansen;

I represent a grassroots organization calling ourselves the Lower Columbia Alliance for Sustainable Fisheries. Our membership consists of approximately 50 commercial fishing vessels and local businesses that are concerned about or totally against any new Marine Reserves, Sanctuaries, No Take Zones, being formed on the North Oregon and Southern Washington coasts. I recently sent this information to Mr Frank Warrens. He recommended that I send it along to you.

Thank you for your time in this very important matter.

Sincerely;

Bernard Bjork
F/V New Dawn

Darb Fishing, Inc.
F/V New Dawn
36293 Bartoldus Lp.
Astoria, OR 97103
Oct. 28, 2003

To Whom It May Concern;

This is to notify you that there is a grass roots coalition forming in opposition to the formation of any type of Marine Reserves on the North Oregon coast. Since the inception of Federally Mandated No Trawling and No Longlining Zones commercial fishermen have come to loathe the idea of any more unnecesary restrictions on their businesses.These proposed Marine Reserves are just such unnecesary restrictions. As you can see from the enclosed list, businesses are becoming aware of what these reserves may do to there bottom line. This list is being added to daily.
If you have any questions about this information, please do not hesitate to call me at 503-325-3900.

Sincerely;

Bernard Bjork

cc. Sen. Joan Dukes
S-318 State Capital
Salem, OR 97301

Rep. Betsy Johnson
P.O. Box R
Scappose, OR 97056

Port of Astoria Commission
Attn: Mr. Jim Bergeron
#1 Portway
Astoria, OR 97103

Ginny Goblirsch
Newport Fishermans Wives
P.O. Box 9
Otter Rock, OR 97369

Western Fishboat Owners Association
Wayne Heikkila Director
P.O. Box 138
Eureka, CA 95502

Fishing Vessel Owners Association
Bob Alverson Director
Rm. 232, West Wall Building,
Fishermans Terminal
Seattle, WA 98199

Alliance of Communities for
Sustainable Fisheries
P.O. Box 1309
Carmel Valley, CA 93924

Mr. Vincent Cook
Makah Tribe

The columbia Press
P.O. Box 130
Warrenton, OR 97146

Mr. Tom Freel
KAST Radio Station
1006 W. Marine Dr.
Astoria, OR 97103

Manson Construction
Attn; Pat McGarry
P.O. Box 20467
Seattle, WA 98124

Port of Chinook
Attn. Commissioner Dan Todd
P.O. Box 185
Chinook, WA 98614

Port of Ilwaco
Attn: Commissioner Mack Funk
P.O. Box 307
Ilwaco, WA 98624

Mr. Jim Brown
Governor's Assistant For Natural Resources
900 Court St., N.E.
Salem, OR 97103-4047

Oct. 21, '03

To Whom It May Concern;

The following individuals, businesses, sport, and commercial fishermen are concerned about, or completely against the formation of Marine Reserves, Marine Sanctuaries, No Take Zones, etc. on the coast of Oregon.

Afew of the reasons, but not all of the reasons for concern, are listed below;

I) Safety. Commercial and sport fishermen will be forced to go further away from home port and long established fishing areas in the pursuit of a living, or recreation.

II) Where is the need? The Federal Government recently closed vast areas off the coasts of Washington, Oregon, and California. Trawling has been closed between 50 and 200 fathoms. Longlining has been closed out to 100 fathoms (that is over 30 miles off shore in some places off the Oregon coast).

III) Governments should not put off limits vast areas of the coastal waters due to unnecessary, light, and transient causes.

<u>Concerned</u>

Jensen Communications, Inc
155 SE 1st St.
Warrenton, Or 97146

Scott McMullen
Individual
790 Harrison Ave.
Astoria, OR 97103

Roger Thompson
1191 Marine Drive
Astoria, OR 97103

Mike Strom
221 12th St.
Astoria, OR. 97103

<u>Totally Against</u>

Bernard Bjork
Commercial Fisherman F/V New Dawn
36293 Bartoldus Lp
Astoria, OR 97103

Blair Miner
F/V Columbian Star
Warrenton, OR

Gary Sjolstrom
F/V Home Brew
Warrenton, OR

Astoria Marine Construction Co.
92134 Front St.
Astoria, Or 97103
Don and Helen Fastabend

Tommy Morrison
F/V Pacific Queen
Warrenton, OR

Dave Johnson
Astoria Automotive
2275 Commercial
Astoria, OR 97103

Grover Utzinger
Utzinger's True Value
35408 Highway 105
Astoria, OR 97103

David Cordiner
Sport and Commercial Fisherman
3359 Irving Ave.
Astoria, OR 97103

Springer's Garage
Tom Tetlow, Owner
507 Old Highway 101
Astoria, Oregon 97103

The following are against the formation of Marine reserves.

Del's OK Tire Factory
Klyde Thompson, Owner
35359 Business 101
Astoria, OR 97103

Brim's Farm &Garden
Mike&Linda Brim, Owners
34963 Hwy. 101 Bus.
Astoria, OR 97103

Kenneth Hein
948 NE 175th
Portland, OR 97230
Ex-Commercial Fisherman
And Avid Sport Fisherman

Gary Marincovich
F/V Patriot; Crab, Sport
Charter, Tuna and Sal. Troller
198 Lexington Ave.
Astoria, OR 97103

Warren L. Junes LTD
Hydraulic And Machine Works
34700 Business 101
Astoria, OR 97103

Skipanon Marine & R.V. Supply Co.
Dick & Jan Kelly Owners
69 N.E. Heron St.
Warrenton, OR 97146

West Coast Propellor Service
John R. Kalander Owner
827 N.E. Harbor
Warrenton, OR 97146

Link's Outdoor
Sporting Goods Store
Kyle Johnson, Owner
1254 Commercial
Astoria, OR 97103

Englund Marine Supply
Suppliers of Sport and Commercial
Fishing Equipment
101 15th St.
Astoria, Or 97103

David Stevenson
F/V Sonja
37117 Towhee Dr.
Astoria, OR 97103
Sal. & Tuna Troller

Sky's Gunsmithing
1254 Commercial St.
Astoria, OR 97103

Tony Bates
F/V Elsie
811 10th Ave.
Seaside, OR 97138
Sal. & Tuna Troll

Craig Larsen
F/V Dustin Sea
560 7th Ave.
Hammond, OR 97121

Loop-Jacobsen, Inc.
Frank Van Winkle, Owner
1360 Commercial St.
Astoria, OR 97103

Mike Banks
Bank's Cedar Products
90557 Hwy. 202
Astoria, OR 97103

Keith Borders
Borders Farm, Logging,
and Trucking
79448 HWY 202
Seaside, OR 97138

City Lumber Company
Gregory Newenhof, Pres.
2142 Commercial St.
Astoria, OR 97103

Hauer"s Cyclery & Locksmith
Stan Hauer, CPL
1606 Marine DR.
Astoria, OR 97103

Keith Seal
Commercial Fisherman
711 Florence Ave.
Astoria, OR 97103

Fred Fisher
F/V Zebra
Coos Bay, OR

Mr. & Mrs. John Svensson
F/V Lively Jane
1635 Whispering Pines Dr.
Seaside, OR 97138

The following are against the formation of Marine Reserves.

Bergerson Construction
Dennis Bjork, Owner
55 Portway St.
'storia, OR 97103

Tom Potter
'rchitect
40141 'ngberg Lane
storia, OR 97103

Pacific Coast Insulation
Len Frketich, Owner & Port
Commisioner For Chinook
P.O. Box 208
Chinook, W' 98614

John Hankins
F/V Courageous
P.O. Box 1043
Warrenton, OR 97146

Port of Chinook
743 Water St.
P.O. Box 185
Chinook, W' 98614
Daniel Todd, Manager
Commissioner Ken Greenfield
Commissioner Len Frketich
Commissioner Les Clark

Dale Hughes
Chinook Marine Repair
Chinook, W' 98614
P.O. Box 61

Rex Simantel
F/V Star King
809 Florence
'storia, OR 97103

Oregon Ocean Seafoods
Norman&Judy Kujala Owners
225 SE Galena 've.
Warrenton, OR 97146

Dave Hubbard
Commercial Salmon Gillnet,
Crab, and Tuna Fisherman
'storia, OR

Pacific Machine Shop
Mervyn Helmerson-Owner
1381 Se 2nd
Warrenton, OR 97146

Paul Kujala-Skipper
F/V Cygnet II
Warrenton, OR

Fishhawk Fisheries
Steve Fick, Owner
100 4th Street
'storia, OR 97103

F/V Steve C
F/V 'shlyne
Dennis Rankin, 'gent
42684 Hillcr st Lp.
'storia, OR 97103

F/V Ila
Salmon Troller
Terry Hadley, Owner
42471 Tweedle Rd.
Seaside, OR 97138

F/V Piky & Crew
Bob Williams, Owner
4410 Leif Ericson Dr.
'storia, OR 97103
Longliner & Tuna Troller

F/V 'rrow
David Kelly, Owner
Warrenton, OR
Longliner

F/V Quest
David James Fastabend, Owner
Salmon & 'lbacore Troller
96278 Bartoldus Lp
'storia, OR 97103

F/v Maija Lisa
Tim Fastabend, Owner
Salmon Seiner
91922 HWY 202
'storia, OR 97103

F/V Endeavor
F/V Patience
Tim James, Owner
Shrimpers & Draggers
3335 Childs Rd.
Lake Oswego, OR 97034

Lower Columbia Alliance For Sustainable Fisheries
P.O. Box 1204
Astoria, OR 97103
Dec. 04, 2003

I am writing on behalf of a grass roots coalition of commercial fishermen, small businesses, sports fishermen, and individuals concerned about, or completely against, the formation of any more Marine Reserves, Sanctuaries, No Take Zones etc., on the Northwest coast. We declare are support for management programs that promote;;

I). Fish stock conservation.
II).Small community based independent fishermen and small businesses.
III).Sustain and create economic opportunity for future generations.

Instead of vast area closures we would promote gear restrictions, number of days at sea restrictions, and allowing new net and gear designs. Smaller area closures depending on the time of year to protect spawning grounds and depleted rock-fish species. Possibly, the formation of a scientific based management organization like the International Pacific Halibut Commission, that can work as an arbitrator between the interested parties.

Fishermen are not entirely to blame for these depleted species. Ocean conditions and government must also take their share of the blame. Please allow fishermen to be a part of the solution that brings back these depleted species.

Sincerely;

Bernard Bjork
Pres., Darb Fishing, Inc.
F/V New Dawn

PORT OF CHINOOK

P. O. Box 185
Chinook, WA 98614
Phone (360) 777-8797
Fax (360) 777-8415
pchinook@willapabay.org

Ken Greenfield, Port Commission Chairman
Les Clark, Commissioner
Leonard Frketich, Commissioner

Dan Todd, Port Manager

November 13, 2003

Mr. Bernie Bjork
36293 Bartoldus Lp.
Astoria, Or 97103

Dear Mr. Bjork,

As per our conversation on the 10th of November, it was voted unanimously by the Port of Chinook Commissioner's to sign and support the grass roots coalition that was formed in opposition to expanding the coastal marine reserves on the north Oregon and south Washington coast. You may add the Port of Chinook's name to the list of concerned citizens and business that will be affected by unnecessary restrictions. Dale Hughes at Chinook Marine Repair asked that his business be put on your list as he is against more restrictions. If you need any more information please call or e-mail.

Sincerely

Daniel Todd

Daniel Todd
Manager, Port of Chinook

Port of Chinook
P.O. Box 185
Chinook, WA 98614
Tele. (360) 777-8797
Fax. (360) 777-8415
E-Mail pchinook@willapabay.org

Chinook Marine Repair
P.O. Box 61
Chinook, WA 98614
Dale Hughes-Owner
Tele. (360) 777-8361

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

MAY 24 [illegible]

RECEIVED
JU
PFMC

Mr. Donald K. Hansen
Chair
Pacific Regional Fishery Management Council
Dana Wharf Sportfishing
34675 Golden Lantern
Dana Point, California 92629

Dear Mr. Hansen:

I want to thank you once again for having me at the Fishery Management Council Chairs and Executive Directors meeting. It was a privilege to be there with you. I found this not only productive but educational as well. Most important to me was being able to network with Council members and staffs, and continue to share the National Marine Sanctuary Program (NMSP) story.

There were three items that stood out from a number of our excellent discussions to which I wanted to respond. The first was a discussion of the 120-day period (as specified by NMSP regulations at CFR §922.22) during which Fishery Management Councils (FMCs) must respond (if they choose to respond) during a formal coordination process as specified by Section 304(a)(5) of the National Marine Sanctuaries Act (NMSA). Under this section, FMCs are provided the opportunity to draft fishing regulations for a sanctuary. As I understand it, the concern is that the 120-day period is an inadequate amount of time to undertake such a task.

In past practice, we have found that the 120-day limit is sometimes exceeded, in situations where the NMSP and the specific FMC were actively cooperating on preparing draft regulations. We are currently investigating this limitation as part of a general review of program regulations that we have recently initiated; however, we believe that some reasonable time limit is necessary to define language contained in Section 304(a)(5) directing the draft regulations should be prepared in a "timely manner." The current time limit ensures that the process keeps moving along, while allowing a reasonable time for the 304(a)(5) process to be completed.

The second item was a discussion of the role of FMCs on Sanctuary Advisory Councils as either voting or non-voting members. It is the general policy of the NMSP to provide extensive latitude to Sanctuary Managers in determining the composition of their Advisory Councils, including whether or not certain seats should be included and whether those government or FMC seats are either voting or non-voting. Several of the older Advisory Councils (including that for the Hawaiian Islands Humpback Whale National Marine Sanctuary) have government and FMC seats as voting members; most of the newer Advisory Councils (including the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve) also include government seats, but normally as non-voting members. This pattern has arisen for the following reasons: (1) numerous government agencies are normally represented by someone who is not in a position to vote and prefer to do agency-to-agency business through more traditional government channels; and (2) since newer Advisory Councils are subject to a fifteen-member limit (by the NMSA), which we have interpreted to be fifteen voting seats, having governmental seats as non-voting allows the sanctuary to maximize the number of non-governmental seats while still having the agency partners at the table. Since the older Advisory Councils are accustomed to operating in a certain fashion and since we continue to provide much discretion to each Sanctuary Manager, there has not been an across the board effort (either on the part of the individual sanctuaries or the NMSP as a whole) into turn their voting government seats to nonvoting seats. However, as we prepare for the reauthorization of the NMSA, we are considering various options that may address the fifteen-member limit while still allowing us to keep the Advisory Councils to a reasonable size.

The third item is coordination between the FMCs and the NMSP. As I indicated at the meeting, I believe that the most effective way for the FMCs and the NMSP to integrate their goals and purposes is with early and frequent coordination between our staffs. It is important that the NMSP begins to work with the FMCs early, often, and continuously in the development of Fishery Management Plans that may impact important sanctuary resources so that NMSP concerns can be integrated into the Fishery Management Plans. Likewise, the FMCs need to be involved early in the management plan review process so that their views can be considered as management approaches and regulations are developed by the NMSP.

In closing, let me repeat what I said at the meeting in Hawaii: I am firmly committed to improving our working relationship with NOAA Fisheries and with the FMCs. Such an effort will continue to take time and have its ups and downs, but if we can persevere, we will find a common ground. I look forward to continuing that effort.

Sincerely,

Daniel J. Basta
Director
National Marine Sanctuary Program

cc: Donald McIsaac, Pacific FMC Executive Director
Rod McInnis, Acting SE Regional Administrator, NMFS
Rebecca Lent, Deputy Assistant Administrator, NMFS

MONTEREY BAY NATIONAL MARINE SANCTUARY
KRILL HARVEST BAN PROPOSAL

Situation: Monterey Bay, Gulf of the Farallones, and Cordell Bank National Marine Sanctuaries (NMS) have jointly requested the Pacific Fishery Management Council (Council) prohibit the harvesting of krill in all of the West Coast exclusive economic zone (EEZ) or, at a minimum, within the boundaries of these three Sanctuaries (Exhibit G.4.b, MBNMS Letter). Initially, the Sanctuaries are requesting the Council consider prohibiting the harvesting of krill under the authority of the Magnuson-Stevens Fishery Conservation and Management Act. Alternatively, regulations prohibiting krill harvest within the three Sanctuaries could be promulgated under authority of the National Marine Sanctuaries Act.

At the June meeting, Dr. Holly Price, Monterey Bay NMS, will brief the Council on the joint sanctuary proposal. The Groundfish Advisory Subpanel and Habitat Committee are also scheduled to review the information provided by the three Sanctuaries. It is anticipated these advisory committees will report their findings and recommendations to the Council.

Based on the information provided by Dr. Price, the advisory committees, and the public, the Council should consider how to respond to the joint sanctuary request.

Information from the North Pacific Fishery Management Council's Bering Sea and Aleutian Islands Groundfish Fishery Management Plan is also provided for the Council. Exhibit G.4.a, Attachment 1 describes forage fish protective measures. These regulations prohibit development of directed fisheries for forage fish, krill is included in the list of species defined as forage fish.

Council Task:

1. Council Discussion and Guidance.

Reference Materials:

1. Exhibit G.4.a, Attachment 1.
2. Exhibit G.4.b, Monterey Bay National Marine Sanctuary (MBNMS) May 19, 2004 letter.

Agenda Order:

a. Agendum Overview — Dan Waldeck
b. MBNMS Staff Report — Sanctuary Staff
c. Reports and Comments of Advisory Bodies
d. Public Comment
e. Council Discussion and Guidance

PFMC
06/01/04

BSAI Amendment 36 Forage Fish Protection

Dates: BSAI Amendment 36 (GOA Amendment 39) was adopted by the Council in April 1997. NMFS published the proposed rule on December 12, 1997 (62 FR 65402) and the final rule on March 17, 1998 (63 FR 13009). Effective date of implementation was April 16, 1998.

Purpose and Need: Forage fish are generally small, abundant fishes that are preyed upon by marine mammals, seabirds and commercially important groundfish species. Forage fish perform a critical role in the complex ecosystem functions of the BSAI and the GOA by providing the transfer of energy from the primary or secondary producers to higher trophic levels. Significant declines in marine mammals and seabirds in the BSAI and GOA have raised concerns that decreases in the forage fish biomass may contribute to the further decline of marine mammal, seabird and commercially important fish populations. Forage fish are the principal diet of more than two thirds of Alaskan seabirds. In addition, many seabirds can subsist on a variety of invertebrates and fish during nonbreeding months but can only raise their nestlings on forage fish. Small forage fish such as capelin, herring, sandlance and eulachon also have been recognized as important prey items for a variety of marine mammal species including: Northern fur seal, Steller sea lion, harbor seal, spotted seal, bearded seal, humpback whale and fin whale.

Regulation Summary: Amendment 36 defined a forage fish species category and authorized that the management of this species category be specified in regulations in a manner that prevents the development of a commercial directed fishery for forage fish which are a critical food source for many marine mammal, seabird and fish species. Forage fish species are not included in a target species category. Management measures for the forage fish category will be specified in regulations and may include prohibitions on directed fishing, limitations on allowable bycatch retention amounts, or limitations on the sale, barter, trade or any other commercial exchange, as well as the processing of forage fish in a commercial processing facility.

The forage fish species category would include all species of the following families:

Osmeridae (eulachon, capelin and other smelts),
Myctophidae (lanternfishes),
Bathylagidae (deep-sea smelts),
Ammodytidae (Pacific sand lance),
Trichodontidae (Pacific sand fish),
Pholidae (gunnels),
Stichaeidae (pricklebacks, warbonnets, eelblennys, cockscombs and shannys),
Gonostomatidae (bristlemouths, lightfishes, and anglemouths),
and the Order Euphausiacea (krill).

Analysis: A 59-page EA/RIR (final draft dated January 1998) was prepared for this amendment. Two alternatives including the status quo were considered, along with four options for the non-status quo alternative. The options not chosen would have put forage fish in the other species category or the prohibited species category. The alternative chosen would protect forage fish by prohibiting a directed fishery and the sale and barter of forage fish. The preferred alternative would also reduce waste by allowing retention (up to a maximum retainable bycatch amount as set in regulations) and processing (into fishmeal) those forage fish caught incidentally in groundfish fisheries.

Results: No commercial fishery has been allowed to develop on forage fish in the Exclusive Economic Zone off Alaska.

BSAI Amendment 36 Forage Fish Protection

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Ammodytidae (Pacific sand lance),
Trichodontidae (Pacific sand fish),
Pholidae (gunnels),
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Results: No commercial fishery has been allowed to develop on forage fish in the Exclusive Economic Zone off Alaska.

Exhibit G.4.b
MBNMS letter
June 2004

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Monterey Bay National Marine Sanctuary
299 Foam Street
Monterey, California 93940

May 19, 2004

Mr. Donald K. Hansen
Chairman
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, Oregon 97220

Dear Mr. Hansen:

We would like to thank you and the staff of the Pacific Fishery Management Council (Council) for continuing to provide constructive input to the National Marine Sanctuary Program during the Joint Management Plan Review of Monterey Bay, Cordell Bank, and Gulf of the Farallones National Marine Sanctuaries (Sanctuaries). The perspective of fisheries managers has been invaluable in the creation of several key action plans that will help guide these Sanctuaries for years to come. Particularly, we appreciate the time and effort that the Council and its staff have allocated to helping us determine the appropriate means for pursuing a krill harvest prohibition within these Sanctuaries.

For the reasons that are more fully described below, by this letter we are requesting the Council prohibit the harvesting of krill in all of the west coast EEZ or, at a minimum, within the boundaries of these marine sanctuaries.

Importance of Krill to the Pacific Coast Marine Ecosystem

As I am sure you are aware, krill are fundamental to the trophic structure of the marine life all along the Pacific coast. They are preyed upon by almost all commercially and recreationally important species within these Sanctuaries including, salmon, rockfish, squid, sardine, mackerel and flatfish. In fact, krill is the primary prey of 7 of the 10 most important nearshore commercial fishes on the central California coast.[1] These seven species represented approximately 75% by weight of commercial landings at the central California harbors between 1981 and 2000.[2] These Sanctuaries contain several productive upwelling centers that generate high levels of primary production contributing to dense aggregations of krill.[3] The oceanographic and bathymetric features of the central coast provide physical habitats that further contribute to krill abundance and degree of aggregation.[4] This makes the waters within these Sanctuaries a critical feeding ground for countless forms of wildlife besides commercially harvested fish, such as blue whales, other cetaceans, and seabirds. Whale watching is also a large and growing use in all three Sanctuaries. In short, krill is one of the cornerstones of the entire marine ecosystem. Yet, these characteristics of dense available aggregations of krill also make the Sanctuaries likely targets for the potential of an emerging krill fishery and particularly susceptible to potential adverse effects from such a fishery.

Concerns Regarding Potential Krill Fishery

The National Marine Sanctuary Program is mandated to approach resource protection from a broad, ecosystem-based perspective while considering compatible multiple uses of the Sanctuaries. While presently there is no fishery for krill in the region, a fishery targeting this key link in the food chain could have significant adverse effects on the region's fisheries and overall ecological integrity. We believe the potential exists for a krill fishery to develop in the future due to an increasing need[1] for aquaculture feed or as a reduction fishery to produce fertilizers or related products.

An economically viable krill fishery requires areas with adequate levels of krill abundance and aggregation. During our Joint Management Plan Review, the attached document entitled "The Ecological and Economic Basis for Pursuing a Krill Harvesting Ban in the Marine Sanctuaries of Central California" which lays out in detail our reasons for seeking a prohibition on the harvesting of krill was produced. It describes the characteristics of the region that make it a potential viable target for a krill fishery, impacts from krill fisheries in other areas, and the importance of krill to numerous species offshore central and northern California. Information in this document was provided in large part by public working group members, including local researchers from UC Santa Cruz and Steve Ralston from the NOAA Fisheries Science Center in Santa Cruz. The Sanctuary Advisory Councils for all three central California Sanctuaries, after much consideration and public discussion, recommended that a ban on krill harvesting be implemented.

The Sanctuaries' primary concerns can be summarized as follow:

- A krill fishery could adversely impact commercial and recreational fisheries of all kinds as all target species are directly or indirectly dependent on the resource. Seven out of ten of the most commercially significant stocks in the region are dependent on krill as forage. (Market squid diet composition consists of almost 97% krill[5] and Pacific Hake 98% krill[6])
- Many recovering groundfish stocks rely on krill. (Bocaccio diet composition consists of 21-50% krill[7], widow rockfish 21-50%[8], and yellowtail rockfish over 50%[9])
- Wildlife viewing in general and whale watching in particular are critical components of the local tourism industry. A krill fishery could coincide with the times of peak whale abundance, competing with the whales for forage and with species of seabird that are seasonally reliant on the resource.

[1] Nicol, S.; Endo, Y. Krill fisheries of the world. FAO Fisheries Technical Paper. No. 367. Rome, FAO. 1997. 100p.

- Bycatch is also a concern in that even though krill swarms are densely aggregated, a fine mesh net is used which could indiscriminately catch larger predators.

No Krill Fishery in State Waters

The Pacific Coast Federation of Fishermen's Associations (PCFFA) and the state of California have recognized the threat that a krill fishery poses to the health of the marine ecosystem. In 2000, California became the first state to ban fishing for krill in state waters. The bill was aimed at protecting the marine food web by stopping any krill fishery before it could be started in the state. The bill was supported by PCFFA and conservation groups after a krill fishery was established off British Columbia and was implicated in the poor recovery of cod in the region. The law prohibits the taking of krill for commercial purposes from state waters or the landing of krill at any state port. The prohibition was expanded in 2003 and now prevents the harvesting of krill out to 200 miles in the absence of federal regulation. However, this law does not prevent vessels registered outside of California from harvesting krill outside of state waters and landing the krill outside of California. Consequently, any potential krill fishery in federal waters on the California coast would most likely consist of large out of state factory-style trawlers. In the Southern Pacific Ocean, similar vessels have harvested krill at a rate as high as thirty-five tons in eight minutes.

Request to the Pacific Fishery Management Council

We recognize that the Council deals with a broad array of pressing issues and we appreciate that the resources of the Council and the time available to take on additional issues are limited. However, we would like the opportunity to present more information on this matter and discuss potential actions to prevent any problems if time permits at the Council meeting in Foster City, California, in June 2004. Our initial request is that the Council considers prohibiting the harvesting of krill under the authority of the Magnuson-Stevens Fishery Conservation and Management Act along the West Coast, or at least within the portions of the EEZ within the boundaries of the Sanctuaries we represent. Alternatively, regulations prohibiting krill harvest within these Sanctuaries could be promulgated under the authority of the National Marine Sanctuaries Act. In that case, we would provide the Council the opportunity to draft appropriate National Marine Sanctuary regulations pursuant to §304(a)(5) of the National Marine Sanctuaries Act, and we would work closely with the Council if it chose to do so.

We appreciate your consideration of this request and look forward to continued collaboration as these Sanctuaries conclude the Joint Management Plan Review process. If you or any of the Council members have questions we will be happy to address them at that meeting or, in the interim, please contact Dr. Holly Price at 831-647-4201.

Sincerely,

William J. Douros	Maria Brown	Dan Howard
Superintendent	Manager	Manager
Monterey Bay	Gulf of the Farallones	Cordell Bank
National Marine Sanctuary	National Marine Sanctuary	National Marine Sanctuary

cc: Dr. Don McIsaac, Executive Director, Pacific Fishery Management Council
Ryan Broddrick, Director, California Department of Fish and Game

[1] Benson, S.R., D. A. Croll, and B. Marinovic. Whales, Krill, and Variability of Two Coastal Upwelling Centers. Quality Review Board Minutes of Meeting 7. Tech. Report No. 01-1. 2001.

[2] Starr, R.M., Cope, J.M., Kerr, L.A., Trends in Fisheries and Fishery Resources Associated with the Monterey Bay National Marine sanctuary from 1981-2000. California sea Grant Publication No. T-046.

[3] Benson, S.R., D. A. Croll, and B. Marinovic. Whales, Krill, and Variability of Two Coastal Upweling Centers. Quality Review Board Minutes of Meeting 7. Tech. Report No. 01-1. 2001.

[4] Croll, D.A., B. Marinovic, S. Benson, F.P. Chavez, N. Black, R. Temullo, B.R. Tershy. 2000. From Wind to Whales: Trophic Links in a Coastal Upwelling System. Final Report to the Monterey Bay National Marine Sanctuary, Contract No. 50ABNF500153

[5] Karpov, K.A., Pand G.M. Cailliet. 1979. Prey composition of the market squid, *Loligo opalescens* in relation to depth and location of capture, size of squid, and sex of spawning squid. CalCOFI Rep. 20: 51-57.

[6] Livingston, P.A. 1983. Food habits of Pacific whiting, *Merluccius productus*, off the west coast of North America, 1967 and 1980. Fish. Bull., U.S. 81:629-636. *Note: Seasonal study conducted in Fall. Other studies have found a reduced reliance on krill in other seasons*

[7] Reilly, C.A., 1992. Interannual variation and overlap in the diets of pelagic juvenile rockfish (Genus: Sebastes) off central California.. Fish. Bull. 90(3):505-515.

[8] Dark, T.A., M.E. Wilkins, and K. Edwards. 1983. Bottom trawl survey of canary rockfish (S. *pinniger*), yellowtail rockfish (S.*flavidus*), bocaccio (S. *paucispinis*), and chilipepper (S. *goodei*) off Washington-California, 1980. U.S. NOAA/NMFS Tech. Memo. 48. 40p.

[9] Pereyra, W.T., W.G. Pearcy and F.E. Carvey Jr., 1969. S.*flavidus*, a shelf rockfish feeding on mesopelagic fauna, with consideration on the ecological implications.. J. Fish. Res. Board Can. 26(8): 2211-2215.

The Ecological and Economic Basis for Pursuing a Krill Harvesting Ban in the National Marine Sanctuaries of Central California

Purpose

As per the requirements of the National Marine Sanctuary Act (16 U.S.C. et seq., as amended by Public Law 106-513) and as stipulated in a 1992 Memorandum of Understanding between the National Ocean Service and National Marine Fisheries Service (NMFS), the Monterey Bay, Cordell Bank, and the Gulf of the Farallones National Marine Sanctuaries seek to work with NMFS and the Pacific Fisheries Management Council (Council) in an effort to permanently prohibit the harvesting of krill in the federal waters within sanctuary jurisdictions. The focus of this document is the ecological, economic, and practical rationale for seeking this action within these sanctuaries. However, as krill are vital forage for stocks throughout federal waters, and the impacts of a krill fishery could have far reaching effects, it is also intended to encourage the Council to prohibit krill harvesting throughout the Exclusive Economic Zone of the West coast.

Introduction

These marine sanctuaries are nationally recognized areas of unique ecological significance and beauty. They operate under a congressional mandate to protect the resources within their jurisdictions from a broad, ecosystem-based perspective. This requires consideration of a complex array of habitats, species, and interconnected processes and their relationship to human activities. Krill are a critical component of the marine ecosystem and fundamental to the trophic structure of the marine community within the sanctuaries. Studies of the central California coast have confirmed that krill have the highest biomass of all zooplankton grazers in the central coast upwelling system.[1] They form a key trophic link in coastal upwelling systems between primary production and higher trophic level consumers. Most species, including humans, are only one or two trophic levels away from krill and it is the primary prey of 7 of the 10 most important nearshore commercial fishes on the central California coast.[2] It also makes up over 90% of the diet of endangered blue and fin whales.

The two principal species of krill that exist within these sanctuaries and throughout the California current are *Euphausia pacifica* and *Thysanoessa spinifera*. However during

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[1] Field, J. C., R. C. Francis, and A. Strom. 2001. Toward a fisheries ecosystem plan for the northern California Current. CalCOFI Rep. 42:74-87.

[2] Benson, S.R., D. A. Croll, and B. Marinovic. Whales, Krill, and Variability of Two Coastal Upwelling Centers. Quality Review Board Minutes of Meeting 7. Tech. Report No. 01-1. 2001

strong El Nino times *Nyctiyphanes simplex* comprise a large component of krill biomass. These species are preyed upon by salmon, rockfish, squid, sardine, mackerel and flatfish. Numerous seabirds including Sooty Shearwaters, Cassin's Auklets, and Common Murres are also dependent on krill as forage. Reliable regional estimates of krill biomass and prey requirements of predators do not exist. However, it has been estimated that krill makes up between 15 and 60 percent of the diet of commercially significant fishes in ecosystems with comparable trophic structures.[3] Krill are not currently harvested within the sanctuaries, however, the potential exists for this fishery to develop in the future due to an increasing need for aquaculture feed. A krill fishery could severely impact the integrity of the marine ecosystem and adversely affect commercial and recreational fisheries.

Potential for a Regional Krill Fishery

The Pacific Coast Federation of Fishermen's Associations (PCFFA) and the state of California have recognized the threat that a krill fishery poses to the health of the marine ecosystem. In 2000, California became the first state to ban fishing for krill in state waters. AB 2482 was aimed at protecting the marine food web by stopping any krill fishery before it could be started in the state. The bill was supported by PCFFA and conservation groups after a krill fishery was established off British Columbia and was implicated in the poor recovery of cod in the region. The law prohibits taking krill for commercial purposes from state waters or the landing of krill at any state port. The prohibition was expanded in 2003 and now prevents the harvesting of krill out to 200 miles in the absence of federal regulation. However, this law does not prevent vessels registered outside of California from harvesting krill outside of state waters and landing the krill outside of California. Consequently, any potential krill fishery in federal waters on the California coast would most likely consist of large out of state factory-style trawlers. In the Southern Pacific Ocean, similar vessels have harvested krill at a rate as high as thirty-five tons in eight minutes. There has been no federal action prohibiting or limiting krill fishing in federal waters by the regional councils, NMFS, or Congress.

The only significant current market for krill on the west coast exists in Oregon and Washington where salmon farms use krill meat to give farm raised fish their pinkish color. Most of the supply currently comes from the British Columbia fishery. However, federal waters may soon be open to fish farming, outside the reach of the state prohibition. These operations raising fish in net pens will likely demand krill as feed stock and a fishery could develop around the needs of these aquaculture facilities. If these offshore facilities are developed, local krill would be an obvious source of food for pen-reared fishes. This may significantly increase the likelihood of a krill fishery developing within sanctuary waters.

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[3] Nicol, S. & Endo, Y. Krill Fisheries: Development, Management and Ecosystem Implications. Aquat. Living Resour. 12 (2) (1999) 105-120.

Why is the Central Coast a Likely Target for a Krill Fishery?[4]

The oceanographic and bathymetric features of the central coast and their effect on krill behavior make it particularly susceptible to the adverse effects of krill fishing. The submarine canyons and upwelling zones provide krill with a distinctive habitat that contributes to their abundance and degree of aggregation. This makes the region a critical feeding ground for numerous forms of wildlife. These include predators like the blue whale, dense concentrations of seabirds, and commercially important fish species such as salmon and rockfish. There are also a number of endangered species which feed directly on the krill populations of these sanctuaries including four species of marine mammals and two species of seabirds (blue, humpback, sei, and fin whales and Marbled and Xantus Murrelets).

Oceanographic Conditions

Pt. Reyes, Ano Nuevo, and Pt. Sur are major upwelling centers in the California Current upwelling system. These upwelling centers provide the needed nutrient input to support dense concentrations of krill. The productive marine environment supported by upwelling in these areas was a major reason that these sanctuaries were designated. This productivity is due to the coastal upwelling that occurs seasonally within these sanctuaries. This upwelling of nutrient-rich water supports high primary production and, in turn, higher trophic levels. Studies have shown the importance of the central coast upwelling centers to krill abundance and that the long-term survival of many marine bird and mammal populations depend upon the summer/fall productivity of these areas.

Physical and biological oceanographic studies in the area have confirmed these seasonal patterns and demonstrated linkages between physical forcing, sea surface temperature, and productivity. Moderate krill abundance has been found to exist through February, with distinct scattering layers near the surface and below 150 m. However, by March, krill abundance is considerably reduced, and the deeper backscatter layer is no longer present. It is not until July, several months after the seasonal increase in primary production and the initiation of the summer/fall period, that krill abundance dramatically increases. At this time both the shallow and deeper backscatter layers reappear, persist through September and begin to taper off in October. The seasonal arrival of blue whales in the region appears to be linked to this dramatic increase in krill in July. Krill abundance is typically highest in the late spring to summer period.

The upwelling centers are not the only feature that make these sanctuaries pelagic hotspots. The bathymetry also plays a role in the abundance and aggregation of marine life. There are several factors that may lead to the association of krill with the edge of submarine canyons such as that found off Monterey. Krill are generally found in regions of high primary productivity. In most areas they have been studied, adult epipelagic krill

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[4] Adapted from: Benson, S.R., D. A. Croll, and B. Marinovic. Whales, krill, and variability of two coastal upwelling centers. Tech. Report No. 01-1. 2001. *and* Croll, D.A., B. Marinovic, S. Benson, F.P. Chavez, N. Black, R. Temullo, B.R. Tershy. 2000. From Wind to Whales: Trophic Links in a Coastal Upwelling System. Final Report to the Monterey Bay National Marine Sanctuary, Contract No. 50ABNF500153

such as *E. pacifica* and *T. spinifera* undergo diel migrations to depths in excess of 100 m. Along the central California coast, the continental shelf break occurs at a depth of around 100-150 m. Some of the most productive coastal waters along the California coast are found inshore of the shelf break, downstream from upwelling centers. Topographic breaks in the shelf such as the Monterey Submarine Canyon bring water depths in excess of 1,000 m within 10 miles of shore. These breaks provide krill that aggregate in the canyon the opportunity to undergo diel migrations in excess of 100 m (presumably to minimize predation in daylight hours) while remaining in the highly productive, recently upwelled, nearshore waters.

Krill Behavior and Aggregation

The current dynamics of canyons may also help krill reduce the energetic costs for swimming in currents during the day. Below 100 m over the continental slope off central California, the dominant current is the northward-flowing California Undercurrent. Ramp et al. (1997) found that northward currents at 100 m depth off Pt. Sur, were approximately five times greater than those found in the Monterey Submarine Canyon where krill were aggregated. Thus, canyon habitats provide: 1) the opportunity for high energy gain during nighttime surface feeding due to its location downstream from an upwelling center; 2) a refuge from daytime predation as krill can migrate to depths in excess of 100 m in the canyon, and 3) reduced swimming energy output during daytime schooling at depth due to reduced canyon slope currents. Additionally, during spring and summer, *T. spinifera* can form dense daytime swarms at the surface. This behavior makes them particularly susceptible and these swarms are easily spotted by locating feeding flocks of birds. Both krill species exhibit diel migrations concentrating at depth during the day and moving up into the water column at night. During daytime hours, discreet layers of krill at depth are easily identified with an echo sounder and easily sampled with nets. Both of these aggregating behaviors make them vulnerable to over-harvest because there are large concentrations of krill located in predictable areas.

The same predictable aggregating behavior that would make these krill populations susceptible to fishing also makes them susceptible to predation. Fishes, marine mammals and seabirds all prey heavily on krill aggregations. Salmon fishermen often locate fish by looking for feeding flocks of seabirds on the ocean surface. The large, fine mesh nets needed to catch krill would indiscriminately harvest everything larger than two centimeters associated with the krill aggregation. Since predators of all types are attracted to areas with dense aggregations of krill, the likelihood of significant by-catch is high. Mixed groups of filter feeding blue and humpback whales often aggregate in areas with high krill concentrations. Energetic demands and filter feeding require a substantial prey density for efficient feeding activity in these large marine predators. If krill harvesters were in the same area targeting the same prey as the whales, disturbance would be unavoidable.

Critical Role of Krill as Prey

Recent results from an ecosystem model developed for the northern California Current System, extending from Cape Mendocino to Vancouver Island, illustrate the importance of krill in the west coast marine ecosystem and as a trophic conduit to support commercially important resources.[5] Results show that of the four basic consumers of primary production in the model (microzooplankton, benthos, mesozooplankton, and krill) krill accounted for 20.4% of all consumption. Moreover, krill were extremely important is passing this production on to commercially and recreationally significant fisheries, including demersal stocks (e.g., rockfish), pelagics (e.g., salmon), forage fish (e.g., sardine), and squid. In fact, with the exception of mesozooplankton, the consumption of krill by higher trophic level predators was greater than any other component of the system, and accounted for 35% of all the secondary production passed to tertiary and higher trophic levels.

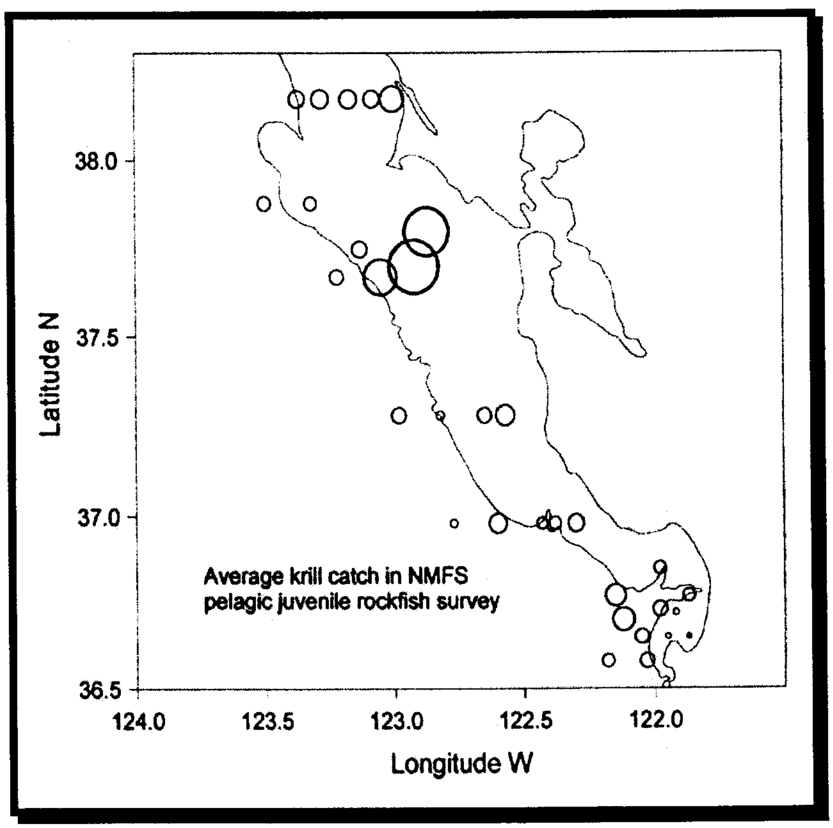

Figure 1
From Field et al. 2001. Relative abundance of krill in a NMFS survey.

[5] Field, J. C., R. C. Francis, and A. Strom. 2001. Toward a fisheries ecosystem plan for the northern California Current. CalCOFI Rep. 42:74-87.

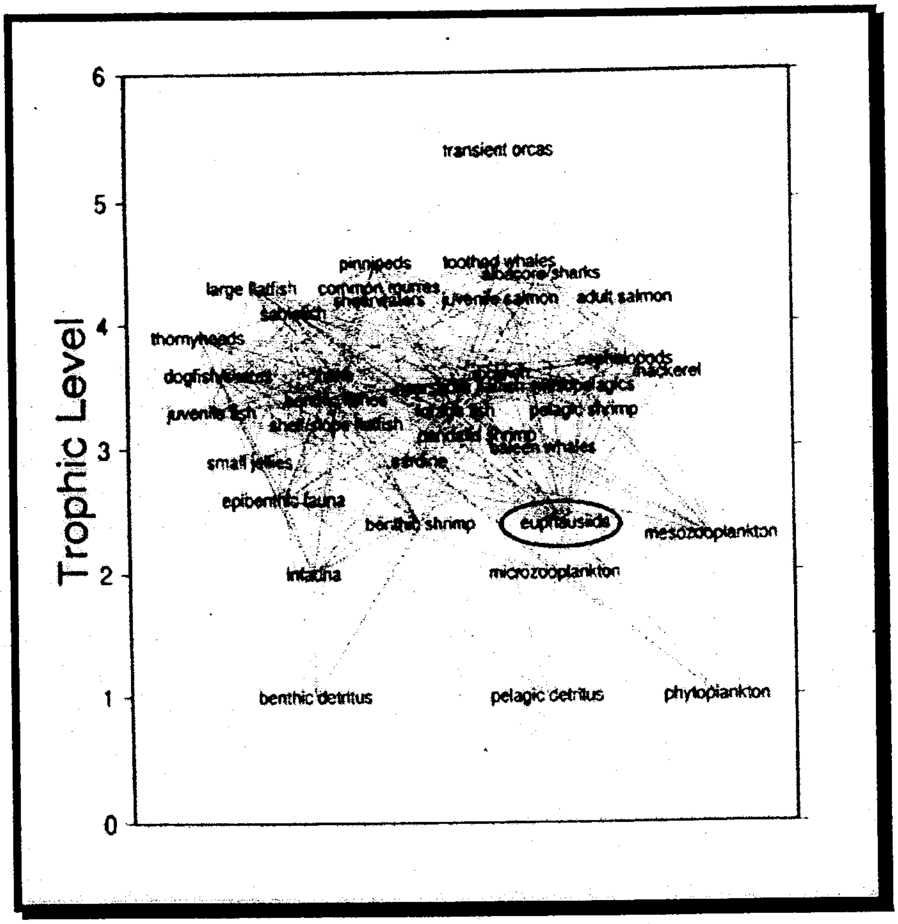

Figure 2

From Field et al. 2001. Krill's role in the trophic structure of the California Current

Commercial Stocks and Economic Impacts[6]

(This section has been adapted from an important summary of commercial landings within the MBNMS and, while focused on central California, most of the conclusions are illustrative of the importance of krill as prey to commercial fish stocks of GFNMS and CBNMS.)

Many economically important species are dependent on krill as forage. However, the trophic interactions for these species are not always completely understood and the percentage of krill in a given species diet may not be quantifiable, particularly on a local level. A krill fishery off the central coast could be expected to compete with the dietary needs of these species to varying extents. A description of the diet and local fishery and status of some of these species are summarized below. In addition, while the Council is

[6] Adapted From: Trends in Fisheries and Fishery Resources Associated with the Monterey Bay National Marine Sanctuary From 1981–2000. R. Starr, J. Cope, L. Kerr . California Sea Grant College Program Publication No. T-046.

familiar with the status of these stocks on a coast wide basis, a discussion of their respective significance to the local fishery may be useful and is therefore included. Landings data are from the ports of Monterey, Moss Landing, Half Moon Bay, and Morro Bay. Landings in the port of San Francisco are not included unless otherwise noted.

Pacific Hake *(Merluccius productus)*

Recently declared overfished, Pacific hake is an abundant groundfish populations in the California current system. Most of the landings were delivered into San Francisco ports, however, and are not reflected in the landings for ports near the MBNMS. Landings have fluctuated over the past twenty years, declining from a high of over 9,000 lb in 1984 and followed by years with increasing trends and years with little to no commercial landing of Pacific hake.

Because of its large biomass, Pacific hake is an important predator in the California Current ecosystem, and its impact on other commercially valuable species has been the object of several studies. Hake have been found to be highly dependent on krill. During a 1995 survey, the stomach contents of 377 Pacific hake were collected from waters over the outer continental shelf and upper continental slope in the Eureka area (approx. Cape Mendocino, California to Cape Blanco, Oregon). By weight, the stomach contents consisted mostly of krill (31%), flatfishes (25%), sergestid shrimp (13%), lanternfishes (13%), cannibalized Pacific hake (8%) and pink shrimp (3%). Similar to other studies, the importance of krill in the diet decreased with increasing size of Pacific hake.

Market Squid (*Loligo opalescens*)

Market squid is the top commercial fishery in California by pounds landed and by value. Commercial landings of market squid for all of California in 1999 totaled nearly 200 million lb and were worth nearly $35 million. From 1981–82, squid catches on the central coast were relatively high, with annual landings totaling more than 20 million lb but landings decreased drastically to a low of 1 million lb in 1984, a result of the 1982-83 El Niño conditions. From 1985–88, annual landings stabilized at approximately 10 million lb, then increased. In 1994, landings reached the highest level since 1946. The fishery for market squid was the largest and most profitable fishery in the Monterey Bay area in 1994. A total of 35.8 million lb of squid worth over $5.2 million was landed at the ports near the MBNMS during 1994. The ports of Moss Landing and Monterey accounted for 30% and 57% of this catch, respectively. The diet composition of *Loligo opalescens* in Monterey Bay (Karpov and Cailliet 1978) reflects a heavy dependence on krill which makes up as much as 97% of squid diet.[7]

Chinook Salmon (*Oncorhynchus tshawytscha*)

Most of the Chinook salmon caught off the central coast region originated in the Sacramento River or its tributaries. In the Sacramento River system, there are four

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[7] Karpov, K.A. and G.M. Cailliet. 1978. Feeding Dynamics of *Loligo opalescens*. Pages 45-65. In Recksiek, C.W. and H.W. Frey, ed. Biological, Oceanographic, and Acoustic Aspects of the Market Squid, Loligo opalescens Berry. State of California The Resources Agency Department of Fish and Game Fish Bulletin 169.

distinct runs of Chinook salmon fall, late-fall, winter, and spring. The Sacramento River fall and late fall runs are more robust than the other two runs, which are listed under the Endangered Species Act (ESA). Sacramento River winter run Chinook salmon abundance dropped from more than 100,000 fish in 1979 to a historic low of 191 fish in 1991, and that run received federal protection under the ESA in 1994. Since 1996, when the spawning population was estimated to be 800 individuals, the size of the winter run has dramatically increased, reaching around 11,000 individuals by 2001.

Today, the number of spring run Chinook returning to these river systems has declined relative to historic abundances. Population estimates of spring run Chinook in 1999 were low enough to cause them to be listed as threatened under the ESA. Chinook salmon is the most commonly caught anadromous species in the central coast region, and accounted for 11% of all landings from open water habitats from 1981–2000. Alteration or loss of spawning grounds of several runs through water diversion has dramatically affected population abundance and contributed significantly to the current declines. Commercial Chinook landings in 2000 within the three sanctuaries were just under a million lb and had an ex-vessel value of $2.1 million.

Chinook are highly dependant on krill as prey. Diet composition has been found to fluctuate between seasons and from year to year. However studies have found that diet composition consists of up to 25% krill.[8]

Rockfish[9]

Krill are an important component in the diet of many rockfish found within the central California sanctuaries. Included among these are species that have been identified by the Council as overfished such as widow rockfish and bocaccio. On a local level, the species that have faced the greatest declines in mean length between 1959 and 1994 are chilipepper (-27%), and yellowtail rockfish (-12%). As a group, rockfish commercial landings in 2000 within the three sanctuaries was $1.2 million. Below are descriptions of the diet composition of these species.

Bocaccio (*Sebastes paucispinis*)
Bocaccio is important in the commercial trawl and hook-and-line fisheries in Monterey Bay. They are also important in the sport catch, comprising 7% of the CPFV catch from 1959 to 1994. Commercial landings at ports near the MBNMS averaged 2.55 million lb/yr from 1980–2000, with an unusually large catch in 1980 of 7.2 million lb from gill net catches in Half Moon Bay. Since 1982, bocaccio catches have consistently declined each year to just over 26,000 lb in 2000, primarily due to severe limitations on allowable

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[8] Healey, M. C. 1991. Life history of chinook salmon. Vancouver, BC: University of British Columbia Press.

[9] Adapted From: Trends in Fisheries and Fishery Resources Associated with the Monterey Bay National Marine Sanctuary From 1981–2000. R. Starr, J. Cope, L. Kerr . California Sea Grant College Program Publication No. T-046.

catch. The percentage of krill in juvenile bocaccio diet in central California is between 21-50%.[10]

Chilipepper *(Sebastes goodei)*
Chilipepper are a very important component of the commercial trawl and sport fisheries in central California. Commercial landings at ports near the MBNMS fluctuate around an average of about 3 million lb/yr from 1980–98, but a sharp decline in catches followed in 1999 and 2000. The diet composition of juvenile chilipepper rockfish in central California consists of between 21-50% krill.[11]

Widow Rockfish (*Sebastes entomelas*)
Widow rockfish are the third most frequently caught scorpaenid in California commercial fisheries, with landings less than that of chilipepper and thornyheads. They are also a significant component of the sport landings. Commercial landings at ports near the MBNMS averaged 1.3 million lb/yr from 1981–2000. The diet composition of juvenile widow rockfish in central California consists of between 21-50% krill.[12]

Yellowtail Rockfish (*Sebastes flavidus*)
Yellowtail rockfish are landed commercially in both the central California trawl and hook-and-line fisheries. Coastwide, yellowtail rockfish landings increased from 2.6 million lb in 1967 to 21.2 million lb in 1983, then declined after trip limits were implemented. From 1990–99, coastwide landings averaged 13 million lb/yr. Because yellowtail rockfish are centered off Northern California and Oregon, landings of this species in the MBNMS contribute a small portion of California landings. The diet composition of juvenile yellowtail rockfish of Washington and Oregon consists over 50% krill.[13]

Pacific Ocean Perch (*Sebastes alutus*)
Krill are the dominant prey for juvenile and adult pacific ocean perch, comprising more than 50% of diet composition as measured in the Gulf of Alaska.[14]

Whales[15]

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[10] Reilly, C.A., 1992. Interannual variation and overlap in the diets of pelagic juvenile rockfish (Genus: Sebastes) off central California.. Fish. Bull. 90(3):505-515.
[11] Reilly, C.A., 1992
[12] Ibid
[13] Pereyra, W.T., W.G. Pearcy and F.E. Carvey Jr., 1969. Sebastodes flavidus, a shelf rockfish feeding on mesopelagic fauna, with consideration on the ecological implications.. J. Fish. Res. Board Can. 26(8): 2211-2215.
[14] Carlson, H.R. and R.E. Haight, 1976. Juvenile life of Pacific Ocean perch, <>Sebastes alutus, in coastal fjords of southeastern Alaska: their environment, growth, food habits, and schooling behavior.. Trans. Am. Fish. Soc. 105:191-201.
[15] Adapted from: Croll, D.A., B. Marinovic, S. Benson, F.P. Chavez, N. Black, R. Temullo, B.R. Tershy. 2000. From Wind to Whales: Trophic Links in a Coastal Upwelling System. Final Report to the Monterey Bay National Marine Sanctuary, Contract No. 50ABNF500153

Whales and seabirds are also critical components of the marine ecosystem which rely extensively on krill. In addition, wildlife viewing of these animals is an important contribution to the region's nine billion dollar coastal tourism revenues. Over 30,000 visitors chartered whale watching boats in the MBNMS in 2003.

Over the last twenty years there has been a steady increase in the abundance of large baleen whales in California waters during spring, summer and fall, with current estimates of 2,200 blue whales and nearly 1,000 humpback whales. As discussed, many prime feeding areas lie within the sanctuaries. These whales along with sei and fin whales, draw thousands of whale watchers each year, who make a substantial contribution to the local economy. Theses planktivores consume enormous amounts of krill. Blue whales are almost completely dependent on the resource, consuming up to three metric tons per day. Sei whales eat 0.8 mt of krill per day and fin whales consume 1.8 mt/day. Humpbacks in Monterey Bay switch opportunistically from krill to schooling fish such as anchovy, but on average consume 1.3 mt/day.

Ultimately, the health of these predators depends upon reliably available concentrations of krill in coastal upwelling centers. The distribution of blue whale sightings and krill densities and the daytime vertical distribution of whale dives and krill indicate that whale foraging effort is concentrated on dense krill schools associated with the Monterey Submarine Canyon. Schoenherr (1991) first reported the association of blue whales with the steep topography of the Monterey Submarine Canyon, and further studies have confirmed this observation. This association could result from whales directly responding to physical patterns in water temperature or currents in this region, but it is likely that they are associating indirectly via patterns in the distribution krill that are directly responding to the canyon edge habitat.

The annual migratory movements of the blue whale likely reflect seasonal patterns in productivity in other foraging areas similar to those described for the central coast. Regions with different seasonal upwelling patterns and krill species with different life history traits will show temporal differences in peak krill abundance. Due to their high total prey requirements, California blue whales likely migrate seasonally between dense, ephemeral krill patches that appear in southern/central California in the summer and fall, the Gulf of California in the winter, and the central Baja California Pacific coast in the spring. California blue whales foraging in the coastal upwelling zone seek extremely dense patches of krill such as those aggregated on the edge of the Monterey Bay Submarine Canyon, around the Farallon Islands, and on the edges of Cordell Bank.

Seabirds[16]

Below is a list of krill-eating seabirds in the sanctuaries. This list includes non-vagrant seabirds listed by Ainley and Terril (http://montereybay.nos.noaa.gov/sitechar/bird.html). Birds are grouped below according to the relative quantity of krill they consume and the importance of krill to their diet. Krill is the principle prey of Cassin's Auklets year

[16] Compiled by staff from Point Reyes Bird Observatory

round. Other common seabird species in the MBNMS, such as Common Murre and Western Gull, consume krill as a major part of their diet on a seasonal basis (early spring). Still, other species are known to consume some krill, but not as a major part of their diet (e.g., Sooty Shearwater). The diet composition of many commonly occurring seabird species in the sanctuaries is not well known, so the list of species consuming krill is probably larger than that summarized below. Notably, of the many piscivorous (fish-eating) seabirds that occur in the sanctuaries, most feed on fish that feed on krill (e.g., rockfish, herring, hake, salmon). Therefore, practically all marine birds of the sanctuaries either consume krill directly, or are part of the krill food web. It is also important to estimate the quantity of krill taken by migrant seabirds in sanctuary waters, but that is beyond the scope of this review.

Krill probably comprises >=50% diet:

- Cassin's Auklet (*Ptychoramphus aleuticus*) - all year
- Western Gull (*Larus occidentalis) -* spring only
- Common Murre (*Uria aalge*) - spring only

Krill may comprise 1% to 20% of the diet:

- Northern Fulmar (*Fulmarus glacialis*)
- Pink-footed Shearwater (*Puffinus creatopus)*
- Short-tailed Shearwater (*Puffinus tenuirostris)*
- Sooty Shearwater (*Puffinus griseus*)
- Ashy Storm-petrel (*Oceanodroma homochroa*)
- Black Storm-petrel (*Oceanodroma melania*)
- Fork-tailed Storm-petrel (*Oceanodroma furcata*)
- Leach's Storm-petrel *(Oceanodroma leucorhoa)*
- Cook's Petrel (*Pterodroma cooki)*
- Red Phalarope (*Phalaropus fulicaria*)
- Red-necked Phalarope (*Phalaropus lobatus*)
- Xantus' Murrelet (*Synthliboramphus hypoleucus)*

Other species that eat krill occasionally, or that consume fish that eat krill:

- Black-vented Shearwater (*Puffinus opisthomelas)*
- Buller's Shearwater (*Puffinus bulleri)*
- Bonaparte's Gull (*Larus Philadelphia)*
- California Gull (*Larus californicus*)
- Franklin's Gull (*Larus pipixcan)*
- Glaucous-winged Gull (*Larus glaucescens)*
- Heermann's Gull (*Larus heermanni)*
- Mew Gull (*Larus canus)*
- Sabine's Gull (*Xema sabini)*
- Black-legged Kittiwake (*Rissa tridactyla)*
- Arctic Tern (*Sterna paradisaea)*
- Ancient Murrelet (*Synthliboramphus antiquus)*

Review of the Antarctic Krill Fishery[17]

In anticipating the potential consequences of a krill fishery, it is useful to look at the impacts in other regions where krill fishing is well established. Estimates of krill abundance in the Southern Ocean suggested a sustainable krill harvest of around 150 million tons a year, 1.5 times greater than the total number of fish and shellfish harvested annually from the world's oceans. The desire to tap into this vast resource led to the birth of commercial krill fishing in the early 1970s which has continued unabated ever since. The current catch is a little under 300,000 tons a year which although down from the peak years of the early 1980s, is still by far the largest catch in Antarctic waters. Krill are caught by large freezer trawlers and processed on board into products for human consumption, domestic animals (cattle, poultry, pigs and mink) and farmed fish. Currently only six nations are actively involved in the fishery: South Korea, Chile, Poland, Japan, Russia and the Ukraine, with the last three accounting for 96 percent of the catch.

Concern over a fishery that targets the foundation of the Antarctic trophic structure led to the signing of a unique fishing treaty in 1981. This was the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), designed to protect the Antarctic ecosystem from the consequences of a rapidly expanding krill fishery. CCAMLR set a limit of 1.5 million tons on the catch of krill in the South Atlantic (where almost all of the krill has been caught recently) and a limit of 390,000 tons for the Indian Ocean. These limits are much higher than the current catch levels but this is a reflection of the huge size of the resource and of the pre-emptive approach to management that CCAMLR was designed to take. Market demand has been the limiting factor since the fishery began and catch has remained at a fraction of what are considered highly precautionary limits.

While the overall take of Antarctic krill is a small percentage of the total abundance, concerns have been raised over fishing's regional effects. CCAMLR has instituted an ecosystem monitoring program to detect and record significant changes in critical components of the ecosystem. It has been assumed that it is possible to assess the effects of fishing on krill availability through an index of predator performance. Predator data has therefore been incorporated into the management scheme. Accordingly, a system to regularly record selected life history parameters of key seabird and seal populations has been in place since 1986. Despite calculations of krill yield that take into account krill and predator requirements, CCAMLR has been aware of the potential for local competition between predators and the krill fishery. On a global scale, fishing mortality might remain within the limits set by management and so provide sufficient escapement for predator needs. However, on a local level mortality may be much greater and

[17] Adapted from: Reid, K. & Croxall, J. P. Environmental response of upper trophic-level predators reveals a system change in an Antarctic marine ecosystem. Proceedings of the Royal Society of London B 268, 377 - 384 (2001).

escapement too low to support predators with restricted foraging ranges, or may cause a shift in the behavior and distribution of more widely ranging species. This concern is exacerbated by the timing of the krill fishery during months where many species of breeding bird and seal predators are dependent on the resource.

It has been reported that in South Georgia, seals, penguins and albatrosses are having difficulty rearing offspring successfully as demand for krill by wildlife has begun to exceed supply in some areas. Twenty years of long-term monitoring of seabirds and seals on South Georgia has revealed an increase in the frequency of years when there is insufficient krill to feed seal pups and seabird chicks. The animals did well in the 1980s while stocks of krill were abundant but demand began to exceed local supply in the 1990s. The extent to which these changes result from a decrease in the amount of krill or an increase in predator demand is uncertain. However, the similarity between the supply and demand is a new discovery and throws into question the apparent super-abundance of krill over all of the Southern Ocean. Seals and seabirds now consume such a large proportion of the krill population at South Georgia that they amplify the effects of gradual, underlying environmental changes. The discovery provides a new insight into the status of krill at South Georgia and highlights a vital need to re-examine the scales at which krill stocks are managed through CCAMLR.

Conclusion

The 1996 re-authorization of the Magnuson-Stevens Act required the Secretary of Commerce to appoint an ecosystem advisory panel which developed recommendations for implementing ecosystem principles into federally created fisheries management plans. The panel has considered threats to the ecosystem posed by overfishing and has generally advocated a more risk averse policy of management. The prohibition of krill harvesting is a potential way to take precautionary, ecosystem based action and meet the recommendations made by the advisory panel. These sanctuaries therefore requests that the Council ban the harvesting of krill and achieve the mutual goal of effective management and protection of marine resources.

Given the vital role that krill play in the ecosystem and in the health of the region's fisheries and other important and growing marine businesses, it is important that this link in the marine trophic structure be protected. A krill harvesting ban in all federal waters off the west coast would be the most effective means of eliminating the threat of an emerging krill fishery. At a minimum, we request that the Council ban krill harvesting within the Gulf of the Farallones, Cordell Bank and Monterey Bay National Marine Sanctuaries. We recognize that the Council deals with a large spectrum of complex issues and that a precautionary prohibition may not appear to be a workload priority. However, we urge the Council to follow the steps taken by the state of California at the request of fishermen, and consider the benefits of implementing such a ban before a fishery begins. Taking this action is an important step towards safeguarding the region's fisheries.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Monterey Bay National Marine Sanctuary
299 Foam Street
Monterey, California 93940

June 10, 2004

Mr. Donald K. Hansen
Chairman
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, Oregon 97220

Dear Mr. Hansen:

Our letter of May 19, 2004 emphasized the importance of krill to the Pacific Coast marine ecosystem and its critical role in the diet of many commercially and recreationally important fishes on the central California coast. That letter requested that the Council prohibit the harvesting of krill in all of the west coast EEZ or, at a minimum, within the boundaries of the Monterey Bay, Cordell Bank, and the Gulf of the Farallones National Marine Sanctuaries (Sanctuaries). The Sanctuaries wish to amend our request and limit its extent to the prohibition of krill harvesting within the three Sanctuaries on the central California coast. We apologize for any confusion that may have resulted from our previous letter.

Thank you for your consideration of this important issue, and we look forward to discussing the potential for such a prohibition at your June 17th meeting.

Sincerely,

Holly J. Price
Acting Superintendent
Monterey Bay
National Marine Sanctuary

Maria Brown
Manager
Gulf of the Farallones
National Marine Sanctuary

Dan Howard
Manager
Cordell Bank
National Marine Sanctuary

CC: Dr. Don McIsaac, Executive Director, Pacific Fishery Management Council
Ryan Broddrick, Director, California Department of Fish and Game

Exhibit G.4.b
Supplemental PowerPoint Presentation
June 2004

A Request to the Pacific Fishery Management Council

To prohibit krill harvesting
in the Monterey Bay, Gulf of the
Farallones, and Cordell Bank
National Marine Sanctuaries
under Magnuson-Stevens

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Krill Harvesting

Development of Strategies

- Raised as an issue during the Joint Management Plan review for MBNMS, GFNMS, and CBNMS
- Addressed by working groups and Sanctuary Advisory Councils
- Draft action plan for inclusion in Draft JMPR/EIS

The Sanctuaries Request:

- The Council prohibits krill harvesting within the 3 sanctuaries under Magnuson-Stevens

Krill Harvesting

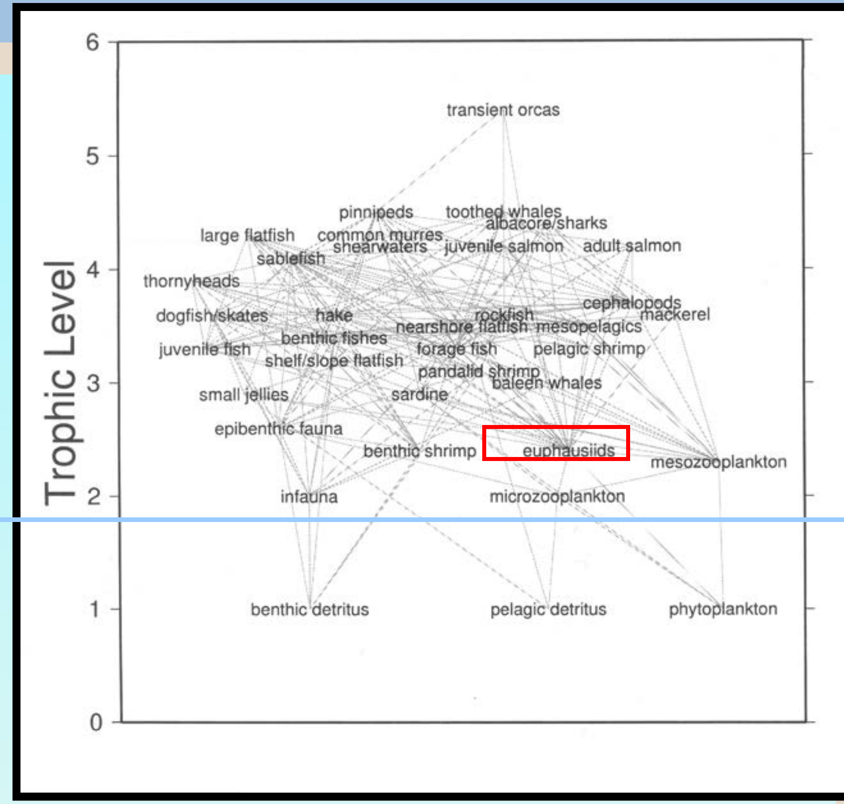
Why is it an Issue?

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

The Role of Krill in the Ecosystem

Field, J. C., R. C. Francis, and A. Strom. 2001. Toward a fisheries ecosystem plan for the northern California Current. CalCOFI Rep. 42:74-87.

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.



- Of the four consumers of primary production in the model, krill accounted 20.4% of all consumption.

- Krill are extremely important in passing this production on to commercially significant fisheries, including rockfish, salmon, sardine, and squid.

- Aside from mesozooplankton, the consumption of krill by predators was greater than any other component of the system, and accounted for 35% of all the secondary production passed to tertiary and higher levels.

MONTEREY BAY NATIONAL MARINE SANCTUARY

Current Krill Harvesting Restrictions off California

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

State AB 2482

State recognized the legitimacy of the threat and imposed a legislative ban on harvesting krill in state waters and landing in state port until 2011. Sponsored by PCFFA

State AB 1296

Eliminated the sunset date of 2011. Prohibits California vessels from harvesting krill to 200 miles in absence of Federal regulation. Also sponsored by PCFFA

Threat Remains

Off California, out of state vessels can still harvest krill outside of three miles where krill abundance and aggregation is highest.

Potential For a Regional Krill Fishery

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

- High level of local abundance and degree of aggregation off the west coast could make for profitable fishery
- Developing land based global aquaculture markets need krill for food
- Ocean pen aquaculture needs krill for food
- According to FAO report, demand for krill products expected to increase

Krill Harvesting

Supporting Document

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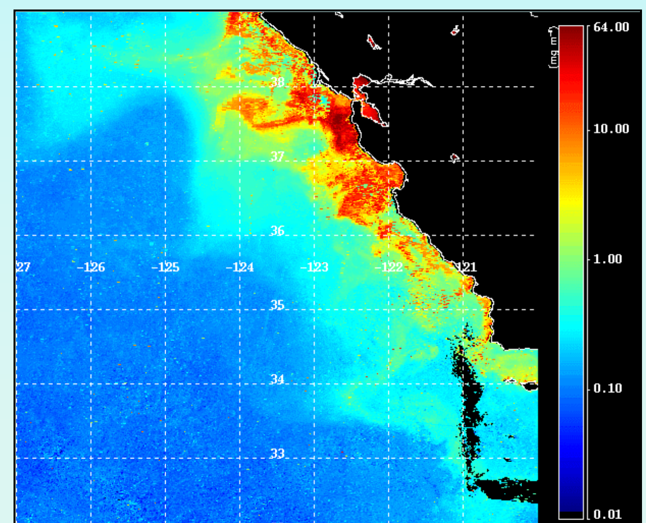
- Local researchers and NMFS representatives assisted in compiling information regarding importance to ecosystem and economy

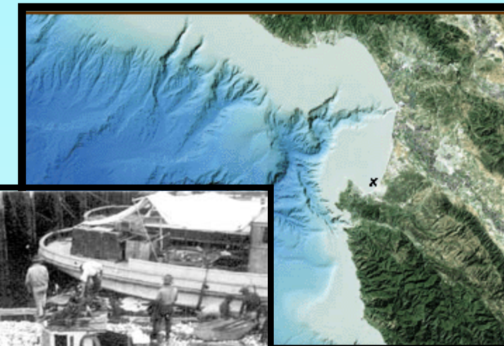
- Much is relevant to managed stocks but also addresses the importance of krill to other species and ecosystem in general.

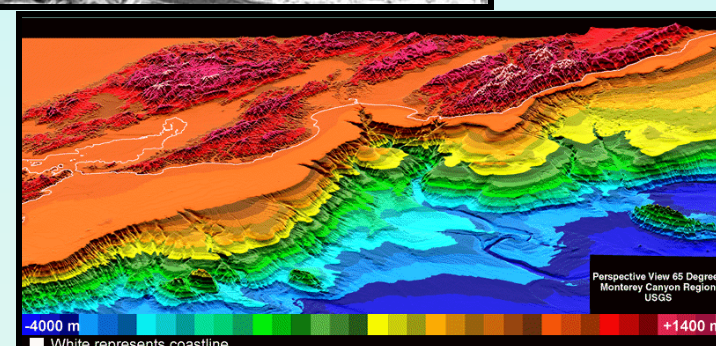


Productive Krill Habitat off the Central California Coast

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

- ➢Upwelling patterns
- ➢Bathymetry
- ➢Current patterns
- ➢Pelagic hotspots
- ➢Biological link





Commercial Stocks Dependent on Krill

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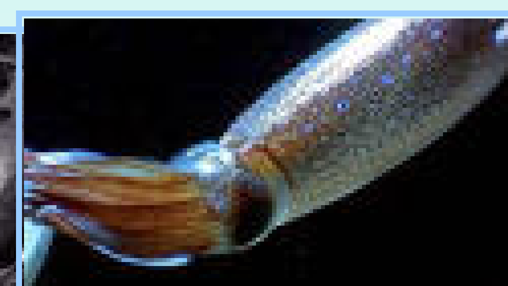
Stock	Krill Diet %	Average Landings in MBNMS 1981-2000 (1000lbs)
Squid	96.6 %	13,960
Herring	32.6%	155
Anchovy	72%	4,297
Salmon	25%	2,210
Hake	31%	2(→S.F.)
Sardine	20-50%?	8,098



Recovering or Locally Declining Rockfish Species

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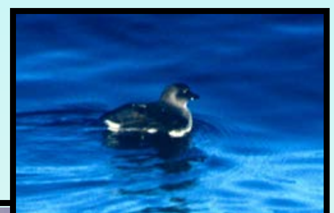
SPECIES		LENGTH in MBNMS 59-94 (Starr 02)	KRILL DIET % (Reilly 1992)
Bocaccio		-12.3%	21-50%
Widow		-11.4%	21-50%
Chilipepper		-27%	21-50%
Yellowtail		-12%	>50% (Pereyra et al 1969)

Seabirds/Cassin's Auklet Profile

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

Percentage of Krill in the Diet of Cassin's Auklet (1977-2001)

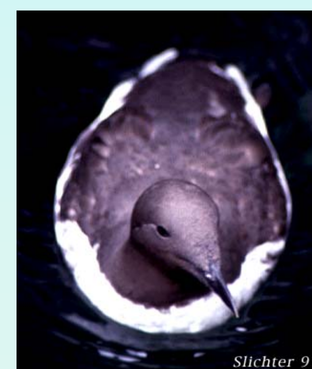
Year	*T. spinifera*	*E. pacifica*
1977	85	14
1979	45	21
1980	03	43
1981	45	37
1985	22	70
1986	27	62
1987	43	53
1988	37	60
1989	37	61
1990	22	58
1991	15	42
1993	28	48
1994	35	50
1995	36	25
1996	08	82
1997	37	27
1998	69	10
1999	22	52
2000	61	18
2001	51	35
Avg	**36.4**	**52.15**



Other Seabird Krill Consumption

Krill comprise over 50% of diet:
Western Gull
Common Murre

Krill may comprise 1% to 20% of the diet:
Northern Fulmar
Pink-footed Shearwater
Short-tailed Shearwater Sooty Shearwater
Ashy Storm-petrel
Black Storm-petrel
Fork-tailed Storm-petrel
Leach's Storm-petrel
Cook's Petrel
Red Phalarope
Red-necked Phalarope
Xantus' Murrelet



Whales Krill Consumption

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

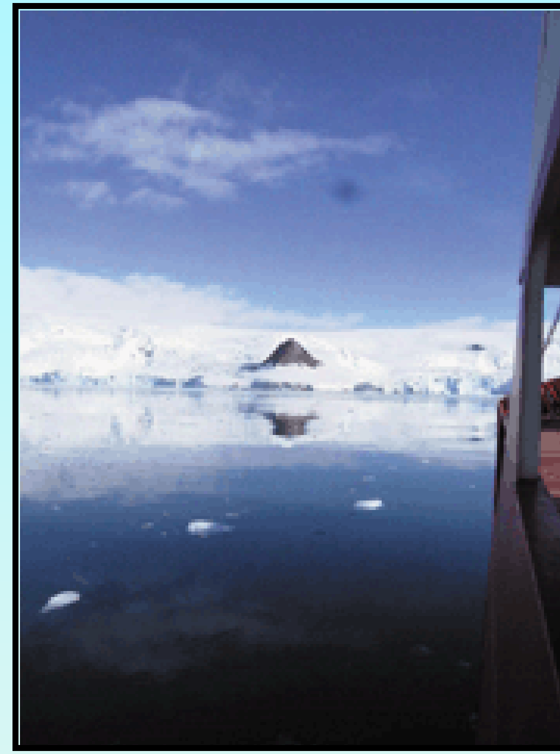
Species	Daily Consumption
Humpback	1.2 mt/day
Blue	3 mt/day
Sei	.8 mt/day
Fin	1.8 mt/day

Antarctic Fishery

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture.

- Catch of 300,000 tons a year
- Products (animal feed)
- 35 tons in eight minutes
- CCAMLR sets precautionary limits
- Regional effects

  - shift in seabird/seal distribution
  - insufficient forage for predators with restricted foraging ranges
  - fishery occurs when many species are dependent on krill



Conclusion

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- We recognize and appreciate the breadth of pressing issues the Council deals with
- Given the importance of krill we encourage the Council to stop a krill fishery before it can begin
- Precedent for addressing the issue under Magnuson exists
  - NPFMC prohibition on targeting certain forage fish
- Alternatively, the Council may be given the opportunity to draft regulations under the National Marine Sanctuaries Act

Exhibit G.4.c
Supplemental GAP Report
June 2004

GROUNDFISH ADVISORY SUBPANEL STATEMENT ON MONTEREY BAY NATIONAL MARINE SANCTUARY KRILL HARVEST BAN PROPOSAL

The Groundfish Advisory Subpanel (GAP) received a presentation by Mr. Huff McGonigal of the Monterey Bay National Marine Sanctuary regarding a proposed ban on the harvest of krill. The Sanctuary is asking the Council to ban the harvest of krill in federal waters, either within the entire exclusive economic zone or within the Monterey Bay Sanctuary.

The GAP appreciates the Sanctuary's efforts to present this proposal to the Council rather than arbitrarily taking action without consultation. The GAP has previously expressed concerns about unilateral Sanctuary actions affecting fisheries management, which only weaken fishing community support for the Sanctuaries.

The GAP notes that all three West Coast states have banned krill harvest in state waters, and a federal ban would merely parallel state action. At the same time, the GAP is not swayed by a sense of urgency, as there is no evidence that massive offshore krill harvesting is being contemplated.

Since krill are not included as a species under the Pacific Groundfish Fishery Management Plan, the GAP is not forwarding any collective opinion on this proposal and would defer to the Scientific and Statistical Committee as to the need for taking such action.

PFMC
06/17/04

Exhibit G.4.c
Supplemental HC Report
June 2004

HABITAT COMMITTEE COMMENTS ON MONTEREY BAY NATIONAL MARINE SANCTUARY KRILL HARVEST BAN PROPOSAL

In June 2003, the Council charged the Habitat Committee (HC) with tracking a krill harvest ban being proposed in the central California national marine sanctuaries. At this meeting, the HC heard a presentation from Huff McGonigal of the National Marine Sanctuary Program on a proposal to prohibit krill harvest in three national marine sanctuaries: Monterey Bay, Gulf of the Farallones and Cordell Bank.

Krill is an important forage component of many Council-managed species such as market squid, rockfishe, salmon, sardines, as well as marine mammals and seabirds. Prey species are defined as an important component of essential fish habitat (EFH).

The HC supports protecting this key prey species by preventing commercial harvest in the Exclusive Economic Zone (EEZ), and further recommends that the Council begin the scoping process for a plan amendment to the coastal pelagic species or the groundfish Fishery Management Plans (FMPs) to affect this prohibition. We also suggest the Council include a broader range of non-managed prey species in a harvest prohibition (as was done by the North Pacific Fishery Management Council in 1997).

This proposal represents a proactive opportunity to engage in the type of ecosystem-based management proposed by the Pew Commission, the U.S. Commission on Ocean Policy, and the NMFS Ecosystem Advisory Panel, while preserving the health of regional fisheries.

PFMC
06/15/04

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

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DEPARTMENT OF ECOLOGY & EVOLUTIONARY BIOLOGY
DIVISION OF NATURAL SCIENCES
CENTER FOR OCEAN HEALTH, LONG MARINE LABORATORY
100 SHAFFER RD.

SANTA CRUZ, CALIFORNIA 95060

Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, OR 97220-1384

June 4, 2004

Dear Pacific Fishery Management Council Members,

The West coast of the United States supports some of the world's most important commercial fisheries. These fisheries are made possible by the extremely productive waters of the California Current System off the coast of Washington, Oregon, and California and the Alaska Current in the Gulf of Alaska. Euphausiids, or krill, play a central role in these marine ecosystems. Krill form a key link between phytoplankton (the microscopic "plants" of the ocean) and commercial and recreationally important fish, marine mammals, and seabirds. Most species (including humans) are only one or two feeding levels away from krill, and it is the primary prey of most of the commercial fish, marine mammal, and seabird species of Alaska, Washington, Oregon, and California. Commercially important species that directly or indirectly depend upon krill include salmon, pollock, rockfish, hake, flatfish, squid, mackerel and herring. The combined economic value of these resources exceeds $5 billion annually.

Krill production in these waters support some of the most diverse marine mammal and seabird communities in the world including 8 species of endangered marine mammals and 2 species of endangered seabirds – all of which either directly or indirectly depend upon krill resources. As marine biologists that has spent over 20 years studying zooplankton and the foraging ecology of seabirds and marine mammals off the West coast of the U.S., we believe that krill is a trophic key for coastal ecosystems. In order to effectively protect these important marine resources and the ecosystem upon which they depend, it is critical to protect the integrity and health of krill off the West coast of the United States. ***Commercial fisheries can only recover if the ecosystems upon which they depend are intact.***

With the Strom-Martin Bill, California became the first state in the Union to protect krill resources by banning fishing for krill in all state waters. This bill was aimed at "protecting the marine food web by stopping any krill fishery before it could be started in the state." The Pacific Coast Federation of Fisherman's Associations and conservation groups requested the Strom-Martin bill after a krill fishery was established off British Columbia. A commercial harvest of krill off the Canadian East Coast has been implicated in the poor recovery of cod in the region; the BC krill fishery is the first off the Pacific coast. PCFFA and others were concerned that "fishing for this essential link in the food chain would prevent the recovery of highly valuable and threatened commercial fish."

"Krill are an important food source for our salmon and other marine life, including some whales," said PCFFA President Pietro Parravano. "We are extremely grateful for Assemblywoman Strom-Martin's leadership in helping us protect these forage organisms that nourish the fish our industry depends upon."

It is now time to extend protection of this fundamental prey resource to krill populations in all Pacific U.S. waters.

Worldwide, krill is commercially fished in fisheries off Japan, Canada, and the Southern Oceans of Antarctica. The current annual catch is over 150,000 metric tons, but few potential fisheries are being exploited. However, over the last 20 years krill fisheries have developed from experimental to full-scale commercial fisheries of regional importance (it is one of the most important coastal fisheries off Japan). While there are currently no commercial krill fisheries in the U.S. EEZ, interest in expanding krill fishing is growing.

New markets, particularly as feed in aquaculture, are being developed. ***Expansion of the commercial krill fishery has the potential to seriously disrupt the food webs upon which existing recreational and commercial fisheries and non-commercial marine species of Alaska, Washington, Oregon, and California depend.*** It is therefore imperative to protect this critical marine resource from all commercial harvest.

To accomplish the protection of U.S. krill resources, we urge the PFMC to adopt a commercial krill fishing ban for waters of the EEZ off the West Coast. At a minimum, we urge you to ban krill fishing in the Monterey Bay, Gulf of the Farallons, and Cordell Bank National Marine Sanctuaries. While this measure will have no economic impact on existing commercial or recreational marine resources, the initiation of a fishery may have severe impacts. While not particularly controversial, this proactive step will help preserve and maintain the health of the marine ecosystem upon which commercial and recreational users depend. Thank you for your consideration.

Sincerely,

Donald A. Croll, Ph.D.
Assistant Professor

Baldo Marinovic, Ph.D.
Research Biologist

Bernie Tershy, Ph.D.
Research Biologist

G4

Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, OR 97220-1384

Captain Heidi Tiura
Sanctuary Cruises
25515 Hidden Mesa Road
Monterey, CA 93940

June 5, 2004

To: Donald Hansen, Chair and Members of the Pacific Fisheries Management Council

I would like to strongly voice support for a continued ban on krill harvesting in the EEZ which includes the Monterey Bay, Gulf of the Farallones and Cordell Banks National Marine Sanctuaries. The ramifications of krill harvesting are extensive.

Blue whales and humpback whales come here to feed. Both feed on krill. Humpbacks also feed on the bait fish that feed on krill.

We are visited midsummer through fall by the only stable population of blue whales in the world. Because of this, people come here from around the world to see them, along with the other cetaceans found here in abundance. The financial impact of the whale watching industry in terms of dollars brought into the area's lodging, restaurants and ancillary businesses is substantial.

This captive audience of whales and other cetaceans is studied extensively by researchers. Research money isn't easy to find and the gift of a large population of whales and other cetaceans within easy reach is just that. A gift.

In order for the fishing industry to thrive--something it's not doing well at as it is--the food chain can't afford to lose a portion of the krill, a major building block.

Please don't allow krill harvesting in the EEZ.

Thank you,

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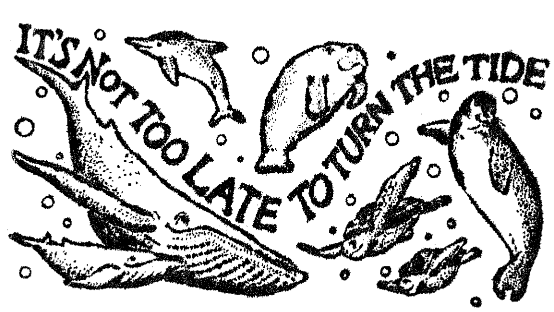

Subject: [Fwd: Save Our Shores Letter of support for a Ban on Krill Harvesting]
From: "PFMC Comments" <pfmc.comments@noaa.gov>
Date: Tue, 08 Jun 2004 13:02:58 -0700
To: Daniel Waldeck <Daniel.Waldeck@noaa.gov>

-------- Original Message --------
Subject: Save Our Shores Letter of support for a Ban on Krill Harvesting
Date: Tue, 8 Jun 2004 10:20:11 -0700
From: Jane De Lay <JDeLay@saveourshores.org>
To:<pfmc.comments@noaa.gov>

Dear Mr. Hansen:

Save Our Shores requests the support of the PFMC for a full ban on krill harvesting in the west coast EEZ. I understand that the issue will be a topic of discussion at the June 17, 2004, PFMC meeting in Foster City, CA. Our letter of support for the ban is attached.

Please do not hesitate to contact me at (831) 462-5660 if you have any comments or questions.

Warm regards,

Jane M. De Lay
Executive Director
Save Our Shores
345 Lake Avenue, Suite A
Santa Cruz, CA 95062
(831) 462-5660
jdelay@saveourshores.org

The mission of Save Our Shores is to protect and conserve the marine ecosystems of California's central coast for all generations.

Advocates for Wild, Healthy Oceans

Pacific Regional Office
116 New Montgomery Street
Suite 810
San Francisco, CA 94105

415.979.0900 Telephone
415.979.0901 Facsimile
www.oceanconservancy.org

Formerly the Center for
Marine Conservation

Public Comment
Agenda Item G.4
MPAs -Krill

The Ocean Conservancy

June 9, 2004

Mr. Donald K. Hansen
Chair, Pacific Fishery Management Council
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 200
Portland, OR 97220

RE: Agenda Item G.4 – Krill Harvest

Dear Chairman Hansen and Council Members:

On behalf of The Ocean Conservancy, we are writing to support a permanent prohibition on the harvesting of krill for commercial purposes in the West Coast Exclusive Economic Zone (EEZ). Krill are an important part of the oceanic food web, providing food for whales, squid, threatened and endangered sea birds, such as Cassin's Auklet, and many Pacific coast fish species, such as salmon, rockfish, hake and sardines. In order to maintain the health and abundance of our coastal marine environment, it is important that commercial harvesting of krill be prohibited.

The Pacific Fishery Management Council has an incredible opportunity to take a pro-active approach to managing our fish resources, which will help continue the rebuilding efforts of depleted fish populations and prevent a future crisis. Krill play a significant ecosystem role in the marine food web, and commercial fishing operations for krill on the West Coast could result in a decline of many fish populations that are important to sport and commercial fisheries, as well as marine mammals and sea birds that draw tourists from all over the world to our coast.

Furthermore commercial krill fishing operations have begun in British Columbia, where krill are caught and sold as meal for farm-raised salmon. NOAA Fisheries has already started to implement a plan to increase U.S. aquaculture production of carnivorous fish, and aquaculture operations worldwide have been expanding exponentially over the past decade. With these expansions comes increased demand to harvest krill, and added pressure to move this fishery into U.S. waters.

The time for action is now. The Ocean Conservancy supports a ban on krill harvesting under the authority of the Magnuson-Stevens Fishery Conservation and Management Act, and we strongly urge you to immediately move forward with drafting regulations to ban krill fishing off the West Coast EEZ. Thank you for consideration of our views.

Sincerely,

Karen Reyna
California Fish Program Manager

Kaitilin Gaffney
California Central Coast
Program Manager

The Ocean Conservancy strives to be the world's foremost advocate for the oceans. Through science-based advocacy, research, and public education, we inform, inspire and empower people to speak and act for the oceans.