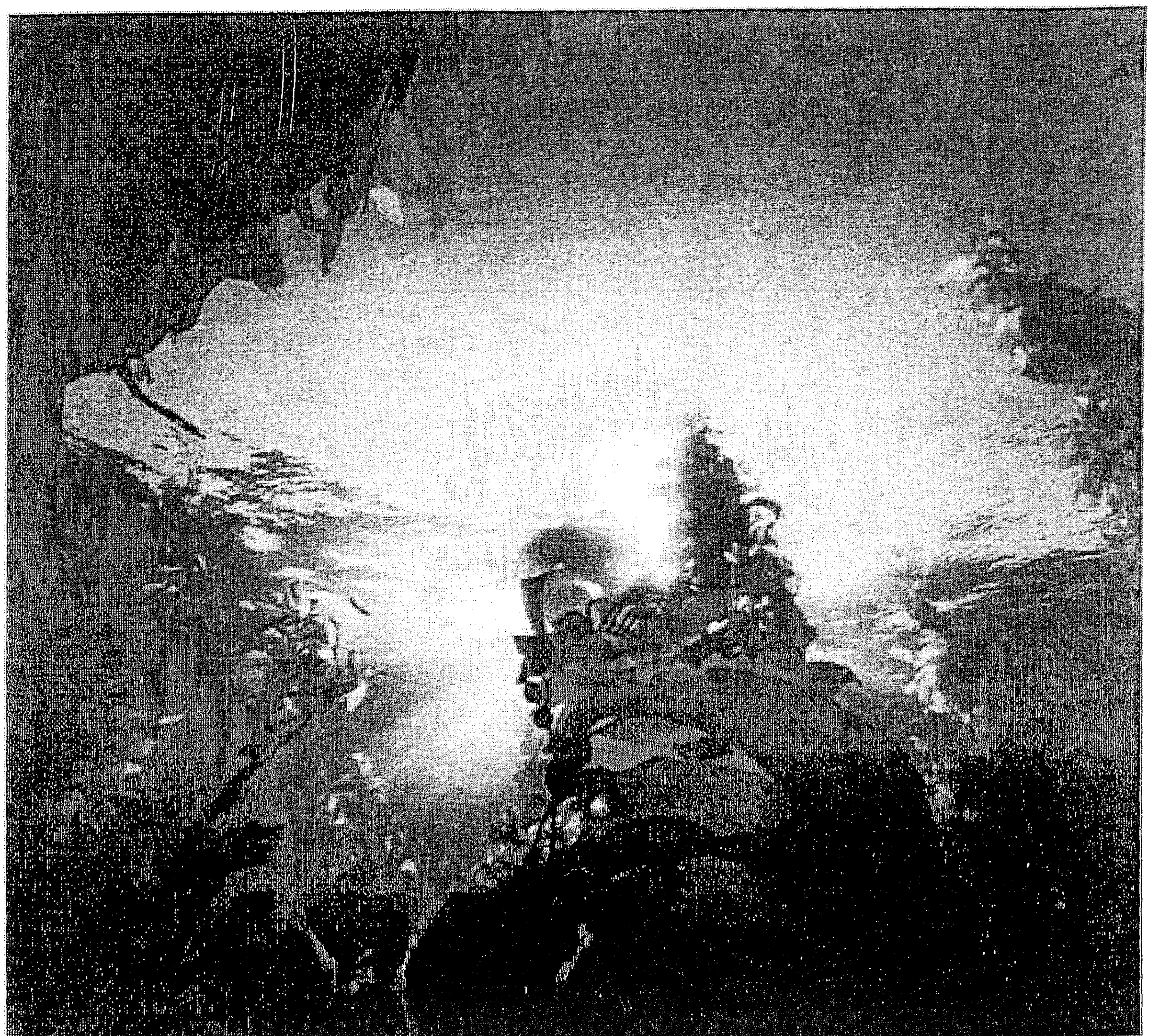
Exhibit C.1.b
Supplemental CINMSP Report
April 2001

Channel Islands Marine Reserves Process



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Sanctuary Advisory Council

Channel Islands Marine Reserves Process

PACKET CONTENTS

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or visit the Sanctuary's website at **www.cinms.nos.noaa.gov/nmpreserves**

Background and Process Overview

What are Marine Reserves?

Marine reserves, or "no take" zones, are a type of Marine Protected Area that prohibit all extraction or harvesting of marine resources. Marine reserves are not intended to limit access or anchoring.

Where are Marine Reserves being considered?

Marine reserves are being considered within the Channel Islands National Marine Sanctuary (Sanctuary). The Sanctuary is a federally designated Marine Protected Area that encompasses 1252 square nautical miles, from the shoreline out six nautical miles around San Miguel, Santa Rosa, Santa Cruz, Anacapa and Santa Barbara Islands. Sanctuary waters overlap State waters (shoreline out three miles) and the Channel Islands National Park (shoreline out one mile around the Islands).

How does the process work?

The Sanctuary and the California Department of Fish and Game developed a joint federal and state process to consider establishing marine reserves in the Sanctuary. The process is based on both extensive stakeholder input and the best available ecological and economic data.

The Channel Islands National Marine Sanctuary Advisory Council (SAC) created a Marine Reserve Working Group (MRWG) and Science Panel, to engage additional experts and community members not on the SAC.

The MRWG membership represents a broad range of community perspectives, including the general public, commercial fishing and diving, recreational fishing and diving, federal and state agencies and national, state and local environmental interests.

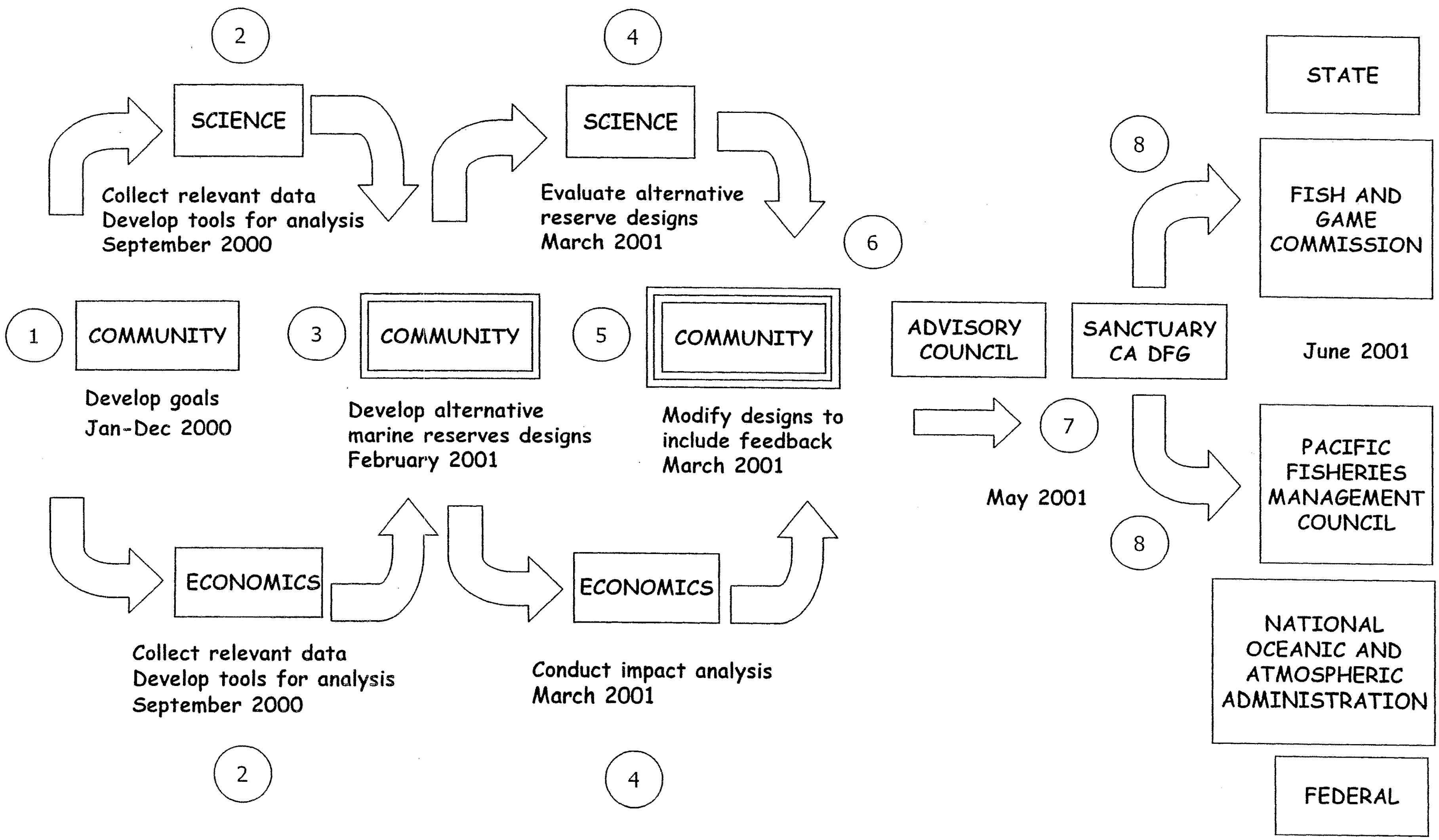
Two additional groups were formed to support the MRWG by providing additional expertise: a Science Panel and an Socio-Economic Panel. The Science Panel is composed of 15 members with expertise in disciplines relevant to the reserve issue. Included in this blue-ribbon panel are physical and biological oceanographers, ichthyologists, invertebrate zoologists, fishery managers, statisticians, ecologists, modelers, and more. The Socio-economic Panel, composed of economists from NOAA and local contractors, will prepare an impact analysis of reserve designs by utilizing existing socio-economic information accumulated from various studies and new information collected on the use and value of local resources.

The MRWG will provide a recommendation to the SAC regarding the size and location of marine reserves by May 23, 2001. The SAC will evaluate and forward the recommendation to the Sanctuary Manager. The Sanctuary Manager and Dept of Fish and Game will then provide this recommendation to the California Fish and Game Commission and Pacific Fisheries Management Council (PFMC) and work with these and other agencies to integrate and implement marine reserves into existing management, such as the California Marine Life Protection Act.

The Working Group meets monthly in Santa Barbara, CA all meetings are open to the public. Additionally, evening forums are held to seek direct interaction with the general public.

Overview of the Marine Reserves Process

Progress to date (Step 5) and projected schedule



MISSION STATEMENT

adopted by consensus of the
Marine Reserves Working Group

Using the best available ecological, socioeconomic, and other information, the Marine Reserves Working Group will collaborate to seek agreement on a recommendation to the Sanctuary Advisory Council regarding the potential establishment of marine reserves within the Channel Islands National Marine Sanctuary Area.

PROBLEM STATEMENT

adopted by consensus of the
Marine Reserves Working Group

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, as well as 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. In addition, new technologies have increased the efficiency, effectiveness, and yield of sport and commercial fisheries. Concurrently there have been wide scale natural phenomena such as El Nino weather patterns, oceanographic regime shifts, and dramatic fluctuations in pinniped populations.

In recognizing the scarcity of many marine organisms relative to past abundance, any of the above factors could play a role. Everyone concerned desires to better understand 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.

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.

GOALS FOR MARINE RESERVES
adopted by consensus of the Marine Reserves Working Group

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

2. Sustainable Fisheries
To achieve sustainable fisheries by integrating marine reserves into fisheries management.

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

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

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

IMPLEMENTATION RECOMMENDATIONS

In order to effectively implement and manage new marine reserves:

1. Agency coordination and accountability for marine reserves is essential.
2. Community oversight of reserve administration is encouraged.
3. Reserves need to be adequately funded for administration and management.
4. Reserves require coordinated and adequate enforcement to function.
5. Monitoring, evaluation and assessment programs should be developed and implemented.

SCIENCE PANEL RECOMMENDATION TO ACHIEVE GOALS

FOR ECOSYSTEM BIODIVERSITY

For conservation, the benefit of a reserve increases continuously with size. Larger reserves protect more habitats and populations, providing a buffer against losses from environmental fluctuations or other natural factors that may increase death rates or reduce population growth rates.

A reserve designed purely for conservation of populations of interest would include the entire CINMS. Reserves less than 100% of the CINMS would conserve fewer sustainable populations of interest.

FOR SUSTAINABLE FISHERIES

For fisheries, the benefit of a reserve does not increase directly with size. The maximum benefit of no-take reserves for fisheries, in terms of larval export and adult spillover, occurs when the size of the reserve is large enough to sustain local production leading to export and spillover, but is small enough to minimize the economic impact to fisheries.

Given the available empirical data, a minimum reserve size of 30% would sustain approximately 70% of the species for which data are currently available. To meet the minimum requirements for all species of interest, the fraction set aside in reserves would need to exceed 70% of the CINMS.

Channel Islands National Marine Sanctuary Advisory Council

Marine Reserves Working Group

Name	Affiliation	Representation
Patricia Wolf	Chair, Fish and Game	CDFG
Matthew Pickett	Co-chair, Sanctuary Manager	CINMS
Greg Helms	Center for Marine Conservation	Conservation
Michael McGinnis	UCSB, Ocean Coastal Policy Center	Conservation
Steve Roberson	Marine Resource Restoration	Conservation
Shawn Kelly	Surfrider Foundation	Conservation
Chris Miller	Lobster Trappers Association	Consumptive
Neil Guglielmo	Squid Seiner and processor	Consumptive
Dale Glanz	ISP Alginates	Consumptive
Tom Raftican	United Anglers	Consumptive
Marla Daily	Sanctuary Advisory Council	Public at large
Craig Fusaro	Sanctuary Advisory Council	Public at large
Gary Davis	National Park Service	National Park Service
Mark Helvey	National Marine Fisheries Service	NMFS
Deborah McArdle	California Sea Grant	California Sea Grant
Locky Brown		Diving
Robert Fletcher	Sportfishing Assoc. of CA	Marinas/Businesses

Science Advisory Panel

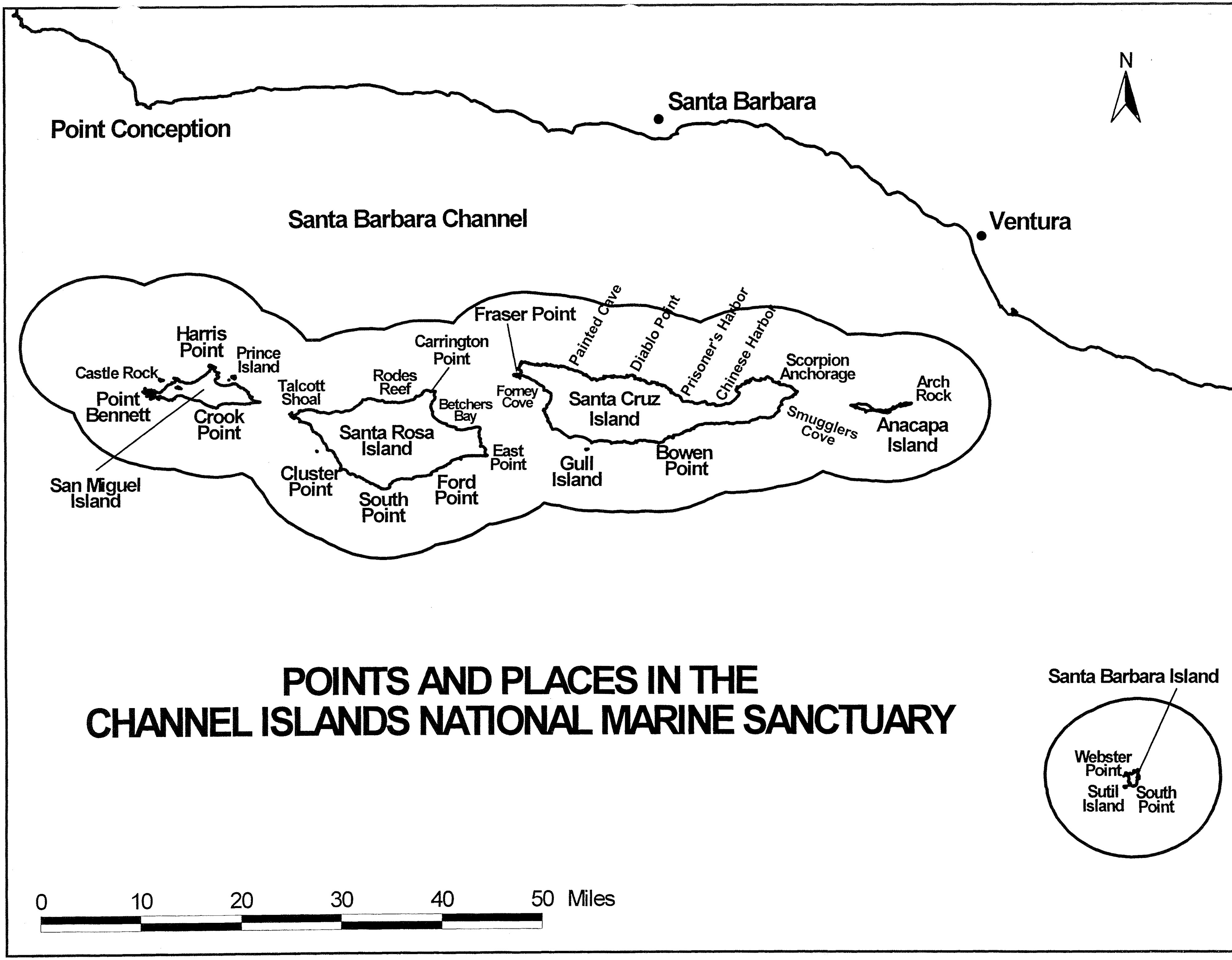
Dr. Matthew Cahn, Chair	CSU Channel Islands	Public Policy
Dr. Bruce Kendall	UC Santa Barbara	Population Dynamics
Dr. Steve Schroeter	UC Santa Barbara	Invertebrate Zoology
Dr. Mark Carr	UC Santa Cruz	Icthyology
Dr. Steve Murray	CSU Fullerton	Invertebrate Zoology
Dr. Dave Siegel	UC Santa Barbara	Physical Oceanography
Dr. Robert Warner	UC Santa Barbara	Marine Ecology
Dr. Daniel Reed	UC Santa Barbara	Marine Ecology
Dr. Allan Stewart-Oaten	UC Santa Barbara	Population Dynamics
Dr. Ed Dever	Scripps Institute	Physical Oceanography
Dan Richards	C.I. National Park	Invertebrate Zoology
Dr. Russ Vetter	NMFS	Icthyology
Dr. Steve Gaines	UC Santa Barbara	Invertebrate Zoology
Dr. Joan Roughgarden	Stanford University	Invertebrate Zoology
Dr. Libe Washburn	UC Santa Barbara	Physical Oceanography
Peter Haaker	CADFG	Invertebrate Zoology

Science Panel members were selected using the following criteria: (1) local knowledge, (2) no published "agenda" on reserves, (3) breadth of disciplines, (4) geographic and institutional balance, (5) participation in the NCEAS Reserve Theory Working Group, and (6) time available.

Socioeconomic Panel

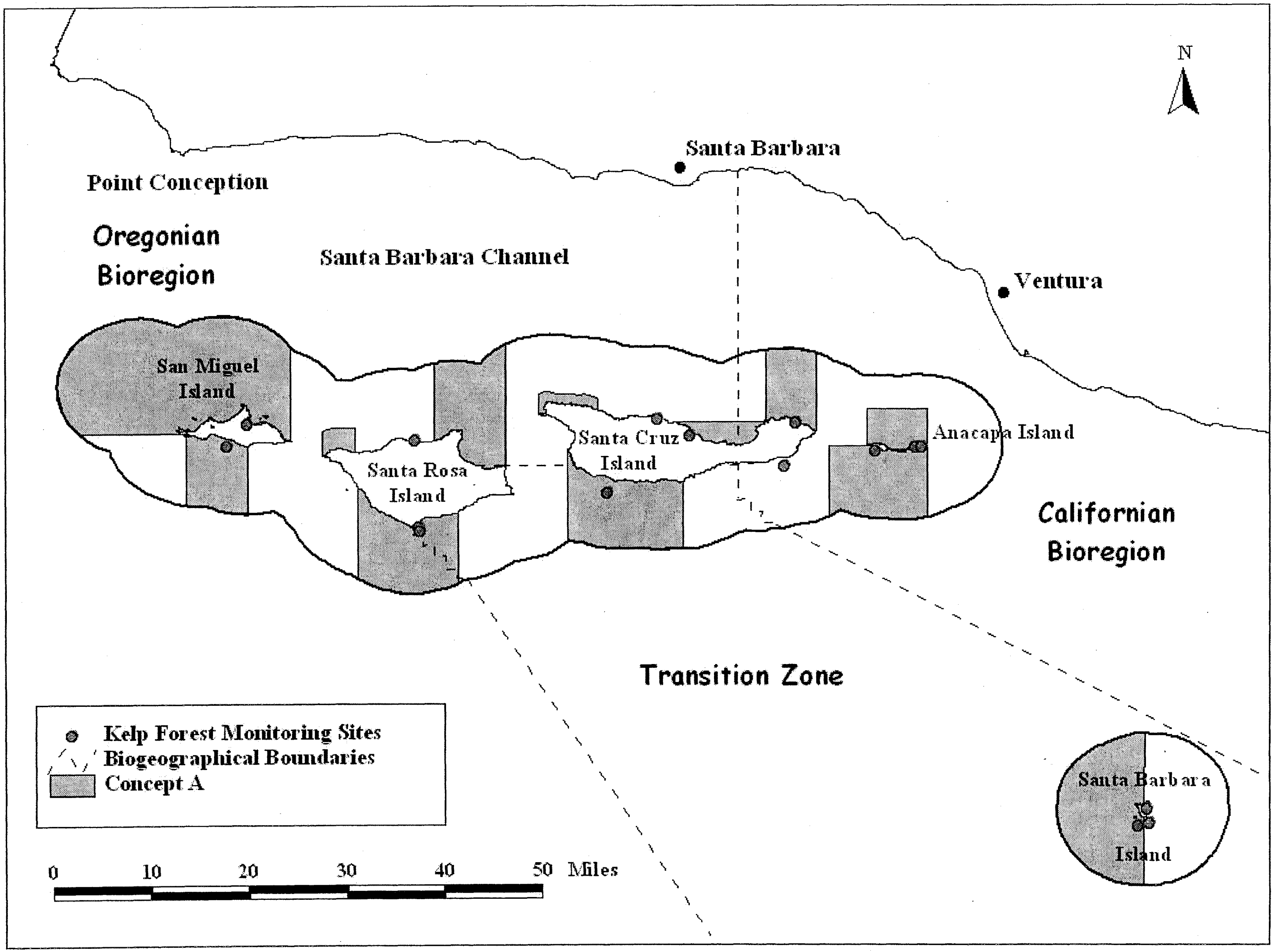
Dr. Bob Leeworthy	NOAA Coastal Services Center	Commercial Fisheries
Peter Wiley	NOAA Coastal Services Center	Recreational Fisheries
Dr. Charles Kolstad	UC Santa Barbara	Charter/Party Boats
Mick Kronman	Fisheries Consultant	User Groups Survey
Dr. Craig Barilotti	Sea Foam Enterprises	Commercial Fisheries
Dr. Carolyn Pomeroy	UC Santa Cruz	Squid Fishery

The Panel collects and synthesizes existing studies, records of catch or harvest, and other public information sources, and develops an economic impact analysis.

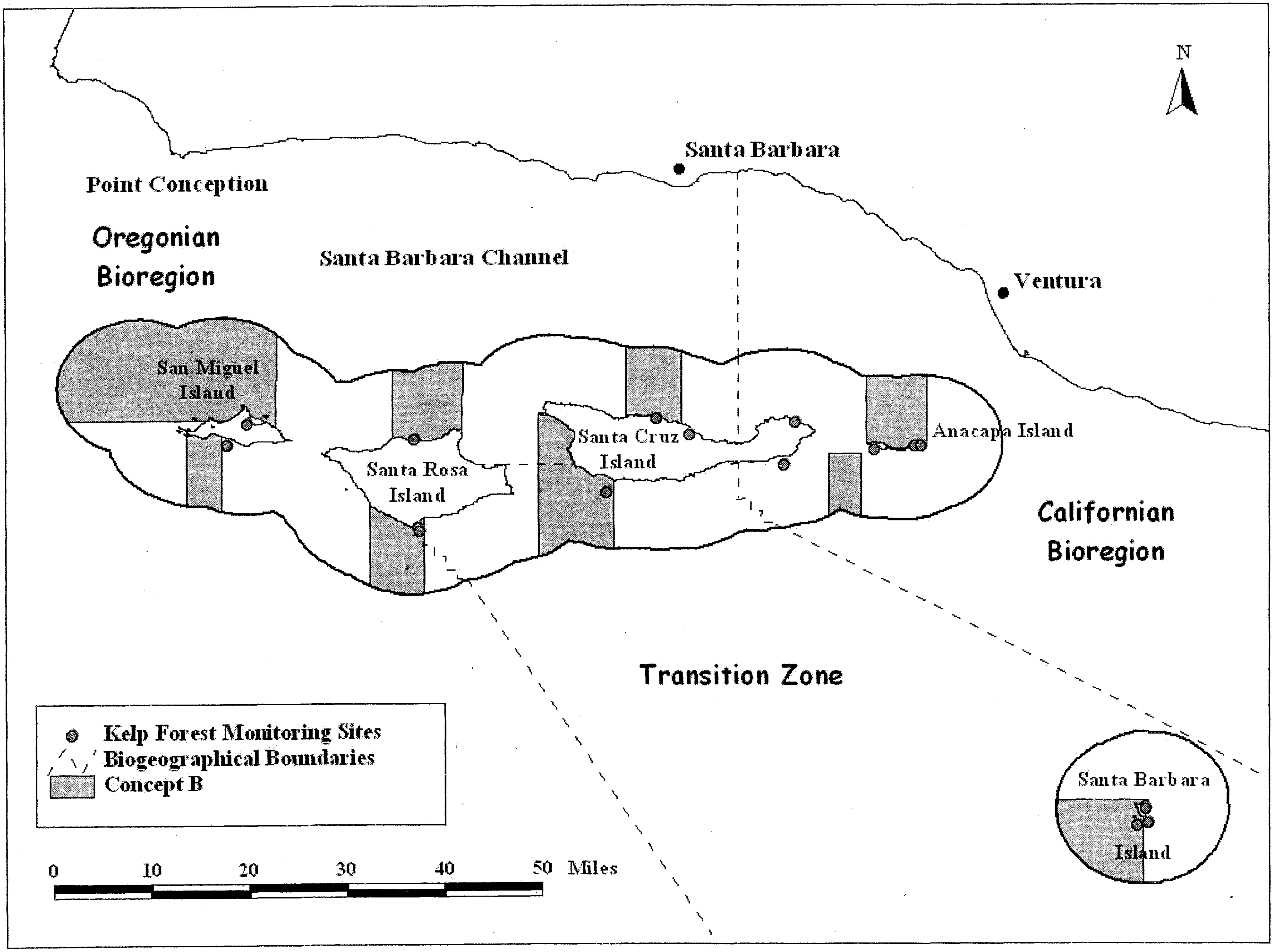


POINTS AND PLACES IN THE CHANNEL ISLANDS NATIONAL MARINE SANCTUARY

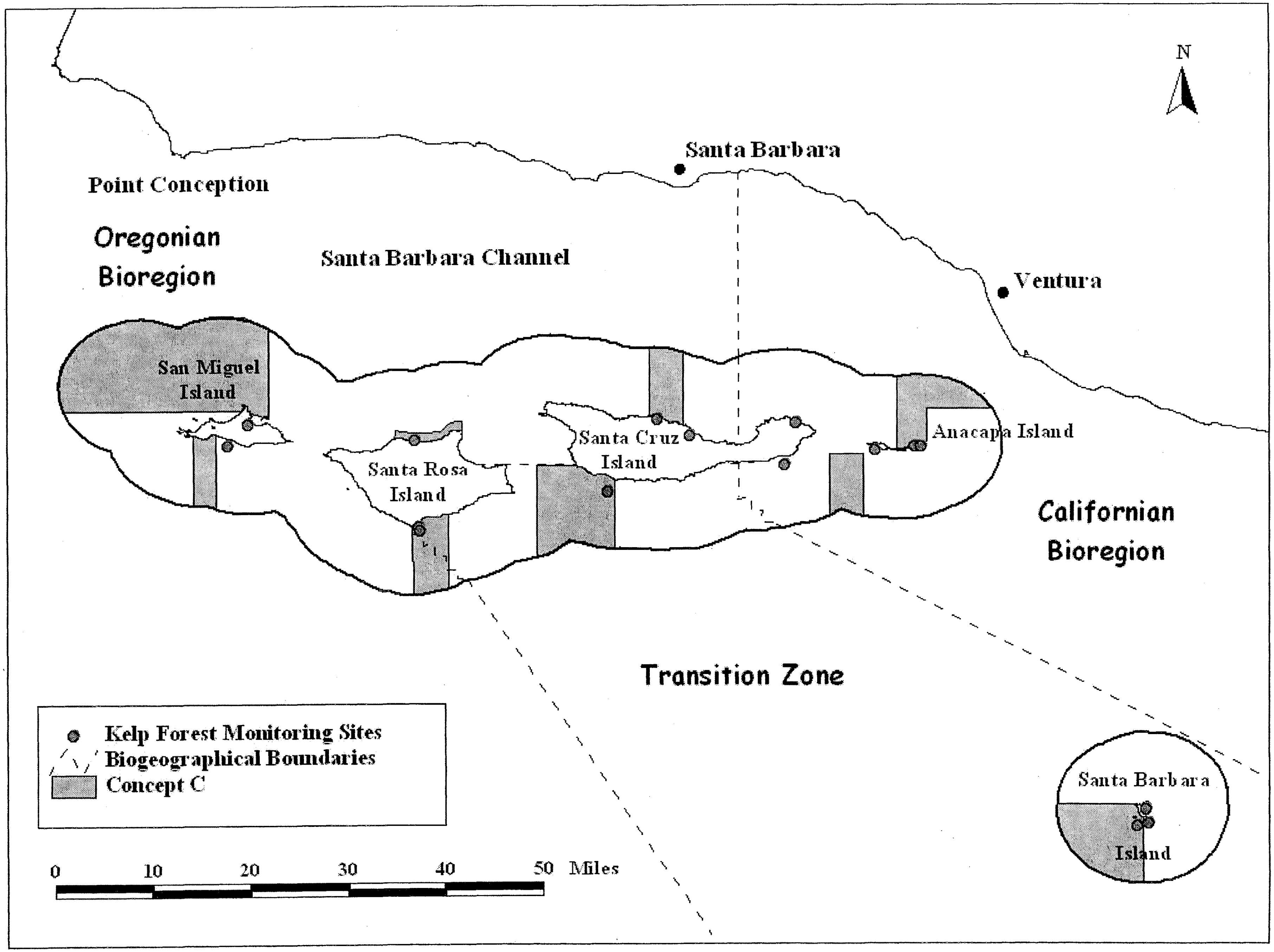
Marine Reserves Working Group
Reserve Concept A



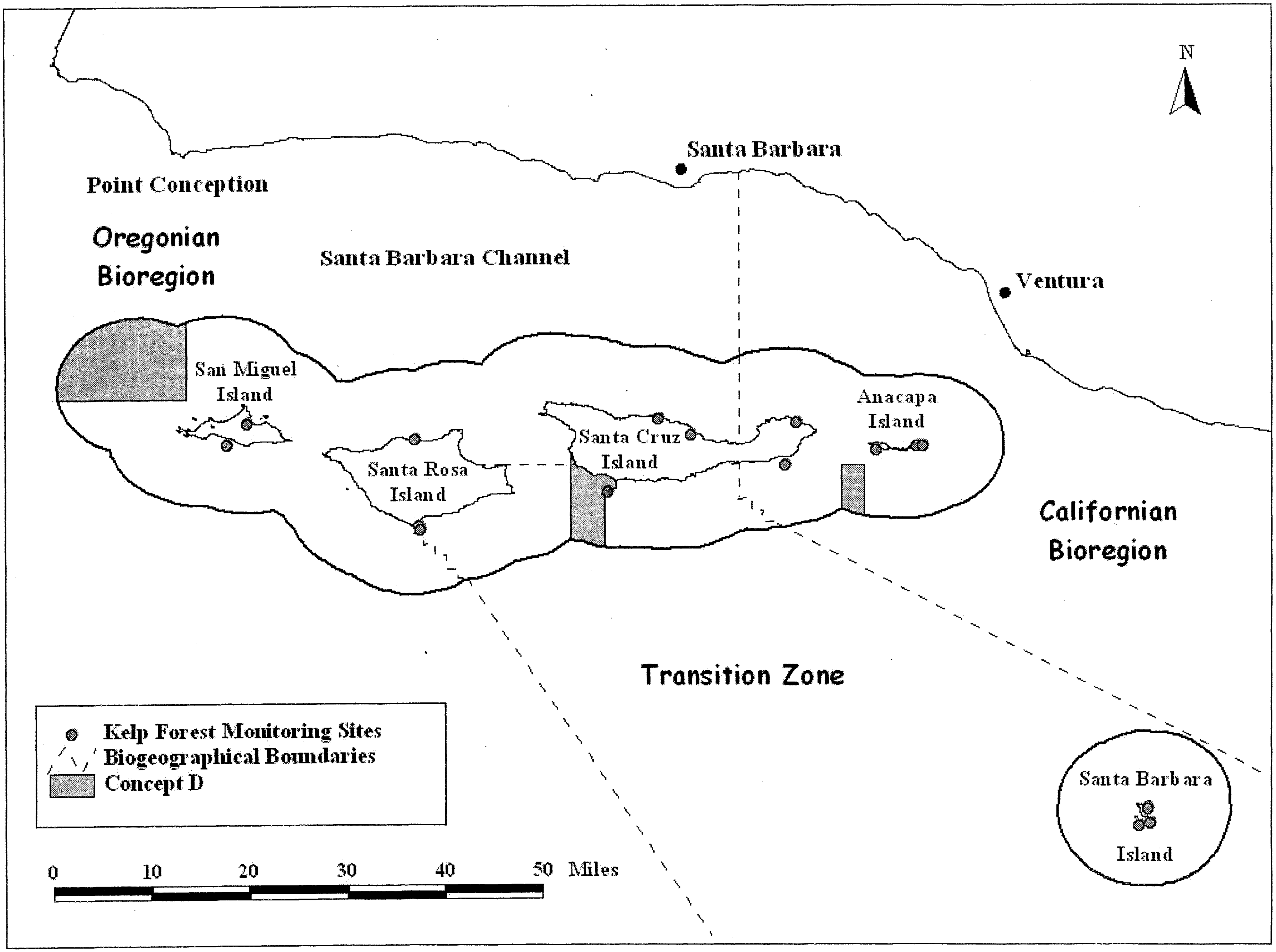
Marine Reserves Working Group
Reserve Concept B



Marine Reserves Working Group
Reserve Concept C



Marine Reserves Working Group
Reserve Concept D



ECOLOGICAL ANALYSIS OF RESERVE CONCEPTS

Potential benefits of reserve concepts (A-D)

Goals	A	B	C	D
Ecosystem Biodiversity	Excellent conservation benefits. Reserve network will protect approximately 50% of representative habitats in all biogeographical provinces.	Good conservation benefits. Reserve network will protect approximately 39% of representative habitats in all biogeographical provinces.	Fair conservation benefits. Reserve network will protect approximately 30% of representative habitats in all biogeographical provinces.	Limited conservation benefits.
Sustainable Fisheries	Limited fisheries benefits because individual reserve sizes may exceed potential dispersal of some fished species. For fishers, more, smaller reserves would provide greater benefits than fewer large reserves. Large closures will have a disproportionate impact on Santa Barbara and Ventura fishers relative to the rest of the state.	Maximum long-term benefits for fisheries through spillover of adult fish and export of larvae from reserves into fished areas.	Does not provide sufficient protection for nearshore species such as rockfish, particularly around San Miguel Island. Consequently, nearshore species will be exposed to higher mortality due to recreational and commercial fishing, and populations will be slow to recover.	No expected benefits for fisheries. Small reserves simply take habitat out of use and do not provide benefits to fisheries outside of reserves.

ECOLOGICAL CRITERIA

1. **Biogeographical representation.** The complex geography of the Channel Islands influences ocean circulation and, consequently, the distributions of habitats and species. Three main bioregions emerged when the Channel Islands National Marine Sanctuary was subdivided according to physical and biological differences: the Oregonian Province (OR) characterized by cooler waters, the Californian Province (CA) characterized by warmer waters, and the Transition Zone (TR) between the two provinces.

2. **Individual reserve size and distribution.** Given the constraints of risk management, experimental design, monitoring, and enforcement, scientists recommended at least one, but no more than four, reserves in each biogeographical region. In general, the percentage of area to be included in a reserve network depends on the goals, and in the Channel Islands, scientists recommended reserving an area of no less than 30%, and possibly 50%, of all representative habitats in each biogeographical region.

3. **Human Threats and Natural Catastrophes.** To minimize the impact of human threats and natural catastrophes, scientists recommended reserving a larger area (1.2-1.8 times) than required to meet goals for conservation and fisheries management under stable conditions.

4. **Habitat representation.** Scientists evaluated the level of protection in each reserve concept for all suitable habitats for species of interest (including rocky and sandy habitats at different depths).

5. **Vulnerable habitats.** To ensure adequate representation in reserves, scientists evaluated the level of protection for vulnerable habitats (including eelgrass and surfgrass) in each reserve concept.

6. **Existing monitoring sites.** Scientists recommended that reserves include some existing monitoring sites to allow researchers to track changes associated with protection over time. Scientists recommended that reserve borders be adjusted, if necessary, to include an appropriate proportion of the monitoring sites.

7. **Reserve connectivity.** Scientists evaluated the potential for dispersal of adult fish and larvae in to and out of marine reserves in each design concept. The most effective reserve design for achieving some level of connectivity among populations is to distribute reserves throughout the planning region and to vary the distance between reserves in a network.

Ecological Criteria Analysis of Reserve Concepts (A-D)

Ecological Criteria	A	B	C	D
1. Biogeographical Representation	Excellent. OR: 6 reserve areas TR: 2 reserve areas CA: 3 reserve areas	Excellent OR: 6 reserve areas TR: 2 reserve areas CA: 2 reserve areas	Good OR: 4 reserve areas TR: 3 reserve areas CA: 2 reserve areas	Poor OR: 1 reserve area TR: 1 reserve area CA: 1 reserve area
2. Individual Reserve Size	Excellent for conservation. Adequate, but not optimal, for fisheries.	Good for conservation and fisheries.	Adequate, but risky, for conservation and fisheries.	Inadequate for conservation and fisheries.
3. Human Threats and Natural Catastrophes	Design incorporates the precautionary principle. It is unlikely that all reserves will be impacted at once by human threats or natural catastrophes.	Design incorporates the precautionary principle. It is unlikely that all reserves will be impacted at once by human threats or natural catastrophes.	Design assumes stable environment with little threat from human activities or natural catastrophes.	Design does not incorporate the precautionary principle.
4. Habitat Representation	Number of criteria met: OR: 14 (out of 15) TR: 15 (out of 17) CA: 11 (out of 17)	Number of criteria met: OR: 14 (out of 15) TR: 9 (out of 17) CA: 6 (out of 17)	Number of criteria met: OR: 2 (out of 15) TR: 9 (out of 17) CA: 4 (out of 17)	Number of criteria met: OR: 1 (out of 15) TR: 0 (out of 17) CA: 1 (out of 17)
4a. Nearshore Habitats --Rocky Intertidal --Sandy Beach	Fairly well represented. Habitats not represented sufficiently: --rocky intertidal (CA).	Fairly well represented. Habitats not represented sufficiently: --sandy beach (CA) --rocky intertidal(TR/CA)	Fairly well represented. Habitats not represented sufficiently: --sandy beach (CA) --rocky intertidal(TR/CA)	Rocky intertidal and sandy beach habitats are poorly represented.
4b. Photic Zone (0-30m) --Soft (Mud, Sand, Gravel) --Hard (Boulder, Bedrock)	Fairly well represented.	Habitats not represented sufficiently: --soft sediments (TR).	Habitats not represented sufficiently: --soft sediments (TR/CA) --all sediments (OR)	All sediments are poorly represented.
4c. Continental Shelf (30-100 m) --Soft (Mud, Sand, Gravel) --Hard (Boulder, Bedrock)	Fairly well represented.	Habitats not represented sufficiently: --all sediments (TR) --hard sediments(TR/CA)	Habitats not represented sufficiently: --soft sediments (OR) --all sediments (TR/CA)	All sediments are poorly represented.
4d. Continental Shelf (100-200 m) --Soft (Mud, Sand, Gravel) --Hard (Boulder, Bedrock)	Fairly well represented. Habitats not represented sufficiently: --all sediments (CA).	Habitats not represented sufficiently: --hard sediments (TR) --all sediments (CA).	Habitats not represented sufficiently: --hard sediments (TR) --all sediments (CA).	All sediments are poorly represented.
4e. Continental Slope (>200 m) --Soft (Mud, Sand, Gravel) --Hard (Boulder, Bedrock)	Fairly well represented.	Habitats not represented sufficiently: --soft sediments (TR) --all sediments (CA).	Habitats not represented sufficiently: --soft sediments (TR/OR) --all sediments (CA).	All sediments are poorly represented.
5. Vulnerable Habitats --Giant Kelp --Eelgrass --Surfgrass	Well represented.	Fairly well represented. Habitats not represented sufficiently: --eelgrass (OR) --surfgrass (TR).	Fairly well represented. Habitats not represented sufficiently: --eelgrass (OR) --surfgrass (OR).	Kelp, eelgrass, and surfgrass are not represented sufficiently.
6. Monitoring Sites	Too many monitoring sites within reserves. Design will not allow comparison of existing monitoring sites inside and outside of reserves.	Excellent distribution of monitoring sites. Reserve network contains approximately 50% of the existing monitoring sites.	Good distribution of monitoring sites. Reserve network contains approximately 40% of the existing monitoring sites.	One monitoring site is captured in the reserve design. Design does not allow comparison using the historical monitoring sites.
7. Connectivity	Excellent connectivity among reserve sites.	Excellent connectivity among reserve sites.	Potential connectivity among reserve sites.	Poor connectivity between sites.

*OR=Oregonian Province; TR=Transition Zone; CA=Californian Province

STEP 1*
SOCIOECONOMIC ANALYSIS OF RESERVE CONCEPTS

Maximum Potential Loss – All Consumptive Activities: Total Income (millions $)

Activity	Baseline	Reserve Concepts A	B	C	D
Consumptive Recreation	$47.6 (100.00%)	$21.3 (44.7%)	$14.6 (30.7%)	$9.4 (19.7%)	$2.4 (5.0%)
Commercial Fishing & Kelp	$82.9 (100.00%)	$34.1 (41.1%)	$21.8 (26.3%)	$10.8 (13.0%)	$1.3 (1.6%)
All Consumptive Activities	$130.5 (100.00%)	$55.4 (42.5%)	$36.4 (27.9%)	$20.2 (15.5%)	$3.7 (2.8%)

- Baseline is 1999 for consumptive recreation and the 1996-1999 annual average for commercial fishing and kelp.
- Percents of Baseline income impacts associated with each activity are in parentheses.
- Dollar values presented do not include the benefits or inherent value of the marine environment, including the value of resources contained within reserve areas. Dollar amounts are not available for these values.

* Step 1 of Socioeconomic Impact Analysis. All activity and associated economic measures are simply the sum of what currently exists in the boundary alternative areas.

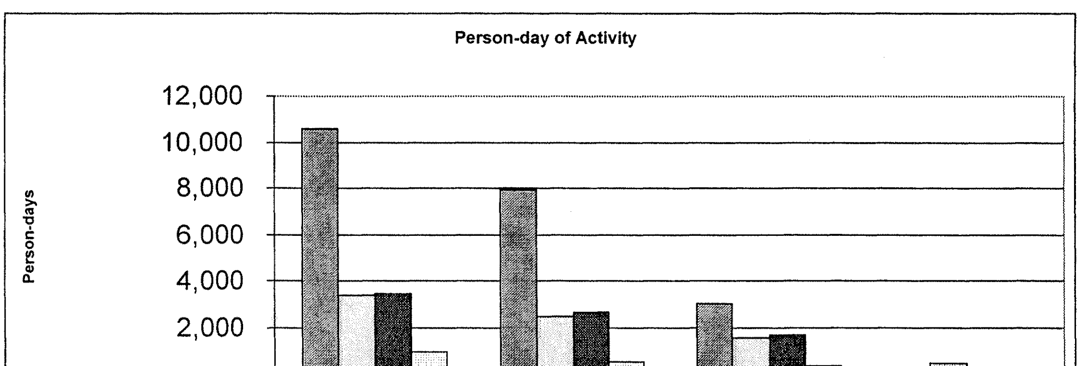
As a starting point, we call this "Maximum Potential Loss".

Step 1 does not take into account other management strategies/regulations and human behavioral changes that may mitigate, offset, or make matters better or worse.

In the case where other factors make matters worse, Step 1 estimates are not the "Maximum Potential Loss".

Step 2 of the Socioeconomic Impact Analysis will take into account other factors and provide a qualitative assessment as to the likelihood that the above estimated losses are real.

Recreation Industry
Non-Consumptive Activities – Person-Days**



	Boundary A	Boundary B	Boundary C	Boundary D
Whale Watching	10,560	7,953	3,017	32
NC Diving	3,364	2,470	1,515	449
Sailing	3457	2656	1658	211
Kayaking	904	519	298	0

** Person days are measured as a single person spending all or part of a day in the study areas. For example, 4 people in the study area for three days = 12 person days.

- The above estimates activities that can still occur, and may benefit from reserves.

MEETINGS AND PUBLIC FORUMS TO DATE

Meeting Dates	Major Meeting Topics
March 21, 2001	**Meeting and Public Forum - 300 + in attendance**
February 21, 2001	Developed Marine Reserve Scenarios
February, 15, 2001	Dealt with Unresolved Issues
January 12, 2001	Discussion with Science and Socioeconomic Panels
December 14, 2000	Closure on Goals and Objectives, developed questions for the Science and Socio-economic Panels
November 15, 2000	Worked on Goals and Objectives
October 18, 2000	Worked on Goals and objectives
October 12, 2000	**Public Forum – Approximately 300 in attendance**
September 26-27, 2000	Received Socio-economic and Science panel data and recommendations / Crafted Preliminary reserve scenarios
August 22, 2000	Discussed data, worked on Goals and Objectives
July 18, 2000	Re-worked Goals and objectives, Science panel progress, refined overall process
June 22, 2000	Adopted Goals and Objectives / Discussed data
June 8, 2000	Worked on Goals and Objectives
April 13, 2000	Data discussion, set future meeting dates
March 16, 2000	Task groups, Goals and Objectives
February 23, 2000	Response to Science Panel, worked on goals and objectives
January 20, 2000	**Public Forum – Approximately 200 in attendance**
January 10-11, 2000	Joint meeting with Science and Socio economic panels, crafted goals & objectives
December 9, 2000	Presentation from MWRG members regarding major issues
November 10, 1999	Discussed revisions and finalized groundrules
October 21, 1999	Adopted draft groundrules
July 7, 1999	Introduction to MWRG process

PUBLIC MEETING SCHEDULE

Channel Islands National Marine Sanctuary Advisory Council
Marine Reserves Working Group

(as of March 21, 2001)

April 18, 2001. **Marine Reserves Working Group**. 8 a.m. - 5:00 p.m. Veterans Memorial Building, 112 W. Cabrillo Ave., Santa Barbara, CA. Anticipated meeting topics: Create a preferred reserve map and finalize issues related to implementation and assurances.

Marine Reserves Public Forum. Date/time TBA. To seek input on a preferred marine reserve recommendation including a map.

May 16, 2001. Marine Reserves Working Group. Chase Palm Park Center, 236 E. Cabrillo Blvd, Santa Barbara. Anticipated meeting topics: Finalize consensus recommendation package.

May, 23, 2001. Sanctuary Advisory Council and Marine Reserves Working Group. Afternoon + evening. Chase Palm Park Center, 236 E. Cabrillo Blvd, Santa Barbara. Anticipated meeting topics: MRWG presentation of marine reserves consensus recommendation to SAC.

June 19, 2001. Sanctuary Advisory Council. Time and location details TBA. Anticipated meeting topics: SAC recommendation to CINMS on MRWG recommendation. For more information: www.cinms.nos.noaa.gov/sachome1 or contact Mike Murray at (805) 884-1464, michael.murray@noaa.gov.

For more information: www.cinms.nos.noaa.gov/nmpreserves or contact

Sean Hastings (805) 884-1472, sean.hastings@noaa.gov.

NOTE: Meeting dates, times, locations and agenda items listed below are subject to change. Please check the CINMS web site prior to meetings: WWW.CINMS.NOS.NOAA.GOV.

Receive advance notice of sanctuary-related meetings by signing up on the CINMS mailing list and e-mail list. Three ways to sign up:
(1) fill out the form on this web page: www.rain.org/mailman/listinfo/ci-sanctuary-l,
(2) send an e-mail note to michael.murray@noaa.gov, or
(3) call the Sanctuary office at (805) 966-7107 and leave your e-mail address and/or mailing address.

Exhibit C.1.c
Supplemental HSG Report
April 2001

HABITAT STEERING GROUP COMMENTS ON THE CHANNEL ISLANDS MARINE SANCTUARY PROGRAM

The Habitat Steering Group (HSG) received a presentation from staff of the Channel Islands National Marine Sanctuary and others on the current process for development of marine reserves within the Sanctuary. The HSG recommends that the Council become actively involved in the Channel Islands process to ensure that marine reserves proposed for federal waters meet the Council's goals and objectives. The HSG recognizes the need for coordination between the process that the Council has developed and the emerging Channel Islands process and recommends that the Marine Reserve Development Team serve as the coordinating body.

The final product of this Channel Islands process, proposed to be available for review some time in early summer, should be evaluated by the Council through all appropriate advisory bodies (e.g., HSG, Groundfish Advisory Subpanel, Salmon Advisory Subpanel). Further, we believe that the Council should identify criteria to evaluate marine reserves proposed outside of its process. The HSG felt that these criteria should include evaluation of a proposed reserve for its contribution to rebuilding overfished species and therefore recommend that the Channel Islands proposal include habitat of ecological importance to overfished rockfish. The HSG notes the useful analysis and modeling tools that have resulted from the Channel Islands process. This information could prove beneficial to the Council as the Council continues to move through its own process on marine reserves.

PFMC
04/03/01

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON
MARINE RESERVES

The Scientific and Statistical Committee (SSC) heard a presentation of the process to establish marine reserves in the Channel Islands National Marine Sanctuary (CINMS). The process described seems to be well designed, with guidance from scientists who are experts in their fields. Recommendations are scheduled to be forwarded to the Sanctuary Advisory Committee in May, the Channel Islands National Marine Sanctuary and California Department of Fish and Game in June, and agencies including the Council, National Oceanic and Atmospheric Administration, and the California Fish and Game Commission in the Fall of 2001.

The Council is currently exploring the possibility of establishing marine reserves. Reserves established under the Channel Islands Marine Reserves Process (CIMRP) are likely to be the first substantial reserves to be incorporated under Council management.

Much of the SSC discussion focused on the role of the Council in this process. Given the advanced state of design, negotiation, and consensus building in the marine reserves process it would be difficult for the SSC or the Council to provide much substantive input for the immediate proposal. The CIMRP presentors indicated their interest in coordinating marine reserve proposals with existing management systems that have been implemented by the Council. There is a critical need to evaluate the interaction of closed areas with existing controls. The SSC can review the products of the science and socio-economics panels to verify that their work represents sound science, keeping in mind that the science and economics of marine reserve design is a young field with much uncertainty. The Council must be present during future stages of reserve design to ensure effective integration of reserve design with fishery management.

The Council, upon determining that it supports the recommendations coming out of the process, can work to modify fishery management plans (FMPs) and other Council documents and procedures to enable implementation of the plan. Accomplishing these tasks may take one or two years and constitute a significant work load for the Council.

Following are brief notes on some observations and concerns.

- The Council has jurisdiction only over species with FMPs. Protection for other species will need to come from other authorities.

- Management of the reserves will likely require amendments to all of the Council's FMPs (Coastal Pelagic Species, Groundfish, Salmon). It will take time once reserves are designed to modify FMPs and regulations to accommodate reserves. This also provides opportunity for baseline monitoring of reserves.

- The CIMRP science panel recommended a reserve size of 30-50% of the area in their jurisdiction. They indicated that regulations prohibiting catch would be required in the reserve and that effort outside the reserve would require additional controls. The SSC requests documentation regarding the basis for the recommendations for reserve size, siting and effort control.

- Two of the goals of the process are to (1) maintain fisheries benefits and (2) maintain long-term socio-economic viability while minimizing short-term losses. The SSC requests documentation of the cost-benefit analysis relative to these goals.

- Enforcement requirements depend on the areas designated. The CIMRP science panel recommends a network of reserves ranging in size from 10 to 100 square kilometers. This recommendation will need to be reconciled with enforcement considerations: enforcement may or may not be easier with fewer, larger reserve areas.

- Performance criteria based on appropriate monitoring programs have to be identified to maximize information gain from the reserve system and to evaluate its effectiveness. The presenters acknowledged that this has not yet been done, and solicited suggestions.

March 26, 2001

Exhibit C.1.d
Supplemental Public Comment
April 2001

Pacific Fisheries Management Council
2130 SW Fifth Avenue, Suite 224
Portland, Oregon 97201

Dear Council Members,

I am writing this letter concerning NOAA's intentions to establish harvest refuggio around the Channel Islands in California. My wife and I have fished commercially around these islands for 18 years. Fishing is our sole source of income. This week the National Marine Sanctuary people introduced maps to close half our fishing grounds. We fish lobster and crab. These are good healthy fisheries. We take these shellfish using traps which have escape ports which allow the juveniles to escape. These fisheries will last hundreds of years if the government would just let us keep doing what we're doing. The concept of shutting down half the worlds oceans has developed into an industry of commercial environmentalists who are essentially paid lobbyists supporting a position behind the sheild of environmentalism. The amount of money being thrown at this issue is staggering. Commercial Fisheries are a valuable food resource which should be managed in a manner which provides renewability of the resource. Each fishery is different. To date fisheries management has taken the variations into account when regulating individual fisheries. And I think that in many cases regulators have done an excellent job. This concept of just randomly shutting down huge swaths of the ocean is an experiment which will cause great hardship to the fishing industry.

In California there are several harvest reffugio's which have already been established. None of which have undergone any truly scientific study to determine whether or not there are any real benefits. Every thing coming out of Marine Sanctuary people seems to be anecdotal. They talk a lot about the big fish they saw in the Anacapa Reserve. There are a lot of big fish around these Islands. You just have to know where to look.

The National Park Service studies an area in Johnson's Lee at Santa Rosa Island. We see them there usually around the month of August. They anchor their boat and send down divers. The divers record what they see . It turns out that they are using this particular spot as a study area to determine the undersea health of Santa Rosa Island. The problem is they are looking at a dead spot. The spot they're studying isn't a good spot for anything. I have set traps on that spot for both lobster and crab and never caught anything. I've also set nets there for halibut, angel shark, and white seabass and never caught anything. I've discussed this spot with urchin and abalone divers who tell me there's nothing down there. The National Park Service study is bogus. Certain areas are more attractive to undersea life than others. There are good spots and bad spots. In addition all fish migrate. There is a time and place for all species. That's what makes a good fisherman. He knows the migration patterns. Many marine biologists don't know this. And apparently neither does the National Park Service.

Last year the National Marine Sanctuary people convinced some of the fisherman to come to the table and work out a deal. The fisherman were led to believe that if we gave up 10% of our grounds, than that would be it. The government would leave us alone. At the eleventh hour the Sanctuary people declared that they would have to take 30 to 50 %. In effect they reneged on their original proposal. The Sanctuary people bargained in bad faith. If the government closes down this much area these people will in effect be destroying healthy fisheries. These are not fisheries in crises. These are sustainable, renewable, healthy fisheries.

The Sanctuary people have not adequately addressed the economic impact of these closures. Even their economic analysis is anecdotal. They have also not adequately addressed the impact that these closures are going to have on the area's which are not closed. Frankly, I believe that these closures are going to have a devastating effect on fisheries which are healthy. The Sanctuary people have not told us what is wrong with the lobster and crab fisheries. If they're not broken why are they trying to fix it. The seafood resource is a valuable food resource. To go and destroy one of the healthiest fisheries out there is idiotic.

Council Members, I ask that you take no action to advance the formation of these harvest reserves. I also ask that you require, under the Magnuson Act, a complete detailed economic analysis of these closures.Thank you for your consideration.

Sincerely,

J. Kevin McCeney

PFMC Chairman Jim Lone
2130 SouthWest 5th, Suite 224
Portland, OR 97201

RECEIVED
MAR 2 3 2001
PFMC

March 12, 2001

Dear Chairman Lone,

As you are aware, a diverse group of ocean resource managers and stakeholders are currently reviewing options to establish a system of fully protected marine reserves within the boundaries of the Channel Islands National Marine Sanctuary. For the last 20 months I have followed the progress of this group, the Marine Reserve Working Group (MRWG). I believe the concept of community based consensus groups is commendable. In this case however, it has failed to adequately represent community interests and protect our public resources. I call upon you to support the immediate establishment of a network of Marine Reserves at the Channel Islands.

For decades resource managers have struggled with science and legal mandates to maximize yields from our fisheries yet ensure that those yields are sustainable. Our best efforts thus far have failed. However, over 150 of the world's leading scientists have recently concluded that systems of fully protected marine reserves are necessary to ensure healthy oceans. Notable, these scientists endorsed not only the conservation value of reserves, but stated that reserves can provide benefits in the form of higher yields from our fisheries and insurance against fishery collapses caused by over-fishing and catastrophic events. It is rare that one single measure can provide both economic and environmental benefits.

The MRWG process has cost taxpayers nearly a quarter of a million dollars ($250,000). Early on in the process, the MRWG made a promise to the people of this community to base its decisions on the best available science. Under that assumption, the cost to the taxpayer was fully justified. However, in spite of the overwhelming local and international scientific support for reserves, certain special interests and agency representatives within the MRWG refuse to accept the science. Our tax dollars, and the natural resources of the Channel Islands, can not be subject to the whims of these individuals. Establishing a network of Marine Reserves that does not meet minimum scientific requirements, or makes exceptions for special interests, undermines the potential for success, inequitably distributes the benefits, and fails to account for the interests of the community.

Given what we know, there is no excuse for inaction. Again, I urge you to support science and establish 30-50% Marine Reserves at the Channel Islands National Marine Sanctuary.

Thank you,

Greg Helms 120 W. Mission St. Santa Barbara, CA 93101

3/12/01

PFMC Chairman Jim Lone
2130 SouthWest 5th, Suite 224
Portland, OR 97201

RECEIVED
MAR 2 6 2001
PFMC

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Thank you,

Diane Conn

6765 C Sabado Tarde
Isla Vista, CA 93117

PFMC Chairman Jim Lone
2130 SouthWest 5th, Suite 224
Portland, OR 97201

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PFMC

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Thank you,

Jenna Garmon

332-A W. Figueroa St.
Santa Barbara, CA 93101

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2130 SouthWest 5th, Suite 224
Portland, OR 97201

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Thank you,

[signature]

2448 San Marcos Pass Rd.
Santa Barbara, CA 93105

5

PFMC Chairman Jim Lone
2130 SouthWest 5th, Suite 224
Portland, OR 97201

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MAR 2 2 2001
PFMC

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Thank you,

Ldakp

5290 Overpass Rd #6, Santa Barbara, CA 93111

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2130 SouthWest 5th, Suite 224
Portland, OR 97201

RECEIVED
MAR 2 2 2001
PFMC

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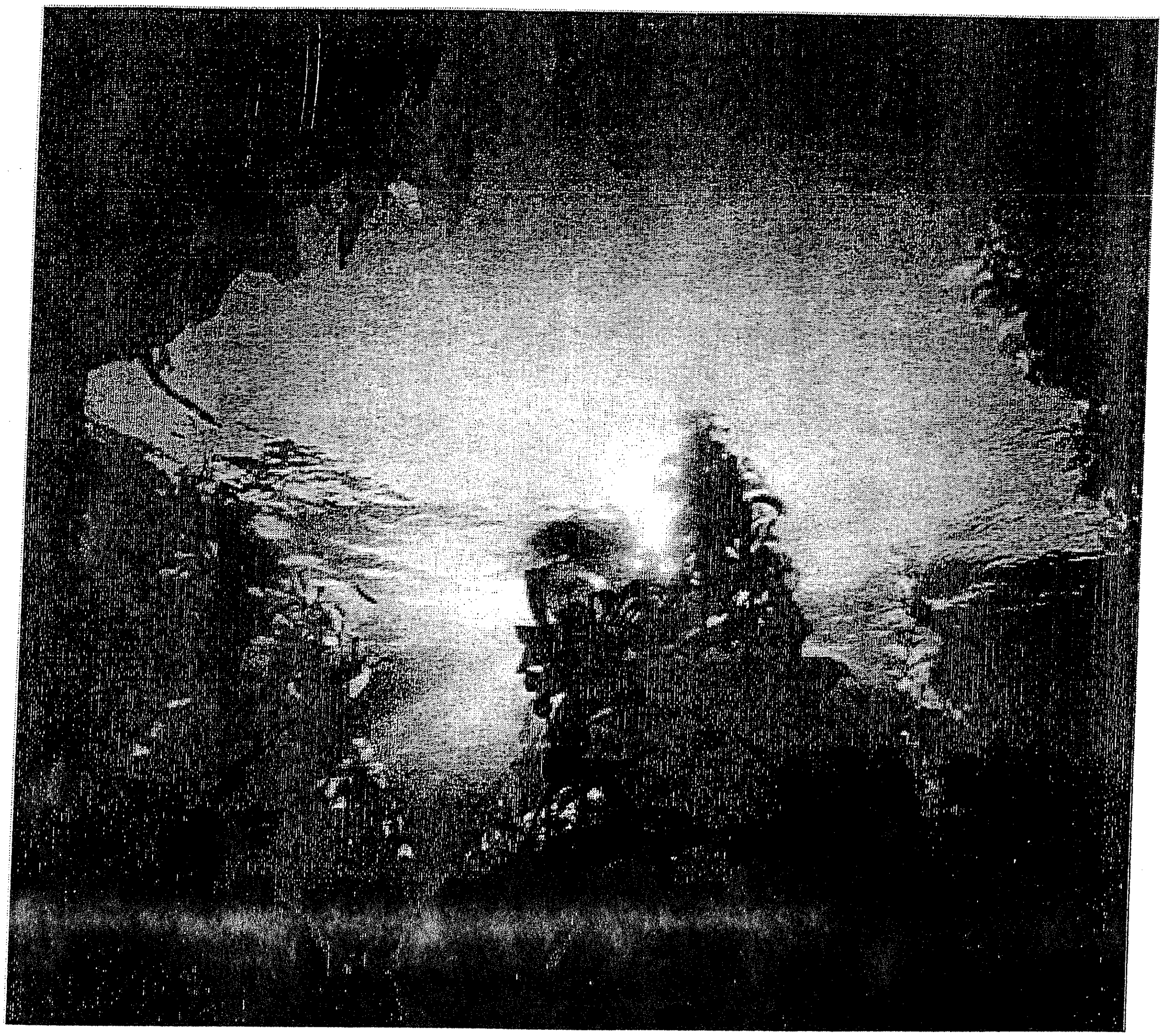
Thank you,

Pete Oklen 3566 Brinkerhoff Santa Ynez CA 93460

Exhibit C.1
Attachment 1
April 2001

Channel Islands Marine Reserves Process



© Ernie Brooks

Sanctuary Advisory Council

Channel Islands
Marine Reserves Process

PACKET CONTENTS

For additional information contact

Sean Hastings
Channel Islands National Marine Sanctuary
Sean.hastings@noaa.gov
805-966-7107 x 472

John Ugoretz
Department of Fish and Game
jugoretz@dfg2.ca.gov
805-560-6758

or visit the Sanctuary website at www. cinms.noaa.gov

Background and Process Overview

What are Marine Reserves?

Marine reserves, or "no take" zones, are a type of Marine Protected Area that prohibit all extraction or harvesting of marine resources. Marine reserves are not intended to limit access or anchoring.

Where are Marine Reserves being considered?

Marine reserves are being considered within the Channel Islands National Marine Sanctuary (Sanctuary). The Sanctuary is a federally designated Marine Protected Area that encompasses 1252 square nautical miles, from the shoreline out six nautical miles around San Miguel, Santa Rosa, Santa Cruz, Anacapa and Santa Barbara Islands. Sanctuary waters overlap State waters (shoreline out three miles) and the Channel Islands National Park (shoreline out one mile around the Islands).

How does the process work?

The Sanctuary and the California Department of Fish and Game developed a joint federal and state process to consider establishing marine reserves in the Sanctuary. The process is based on both extensive stakeholder input and the best available biological and economic science.

The Channel Islands National Marine Sanctuary Advisory Council (SAC) is considered the heart of the process. The development of a Marine Reserve Working Group and Science Panel, under SAC oversight, permits the involvement of additional experts and community members not on the SAC.

The Marine Reserves Working Group membership was designed by the SAC to represent the full range of community perspectives. These include the general public, commercial fishing and diving, recreational fishing and diving, federal and state agencies and national, state and local environmental interests.

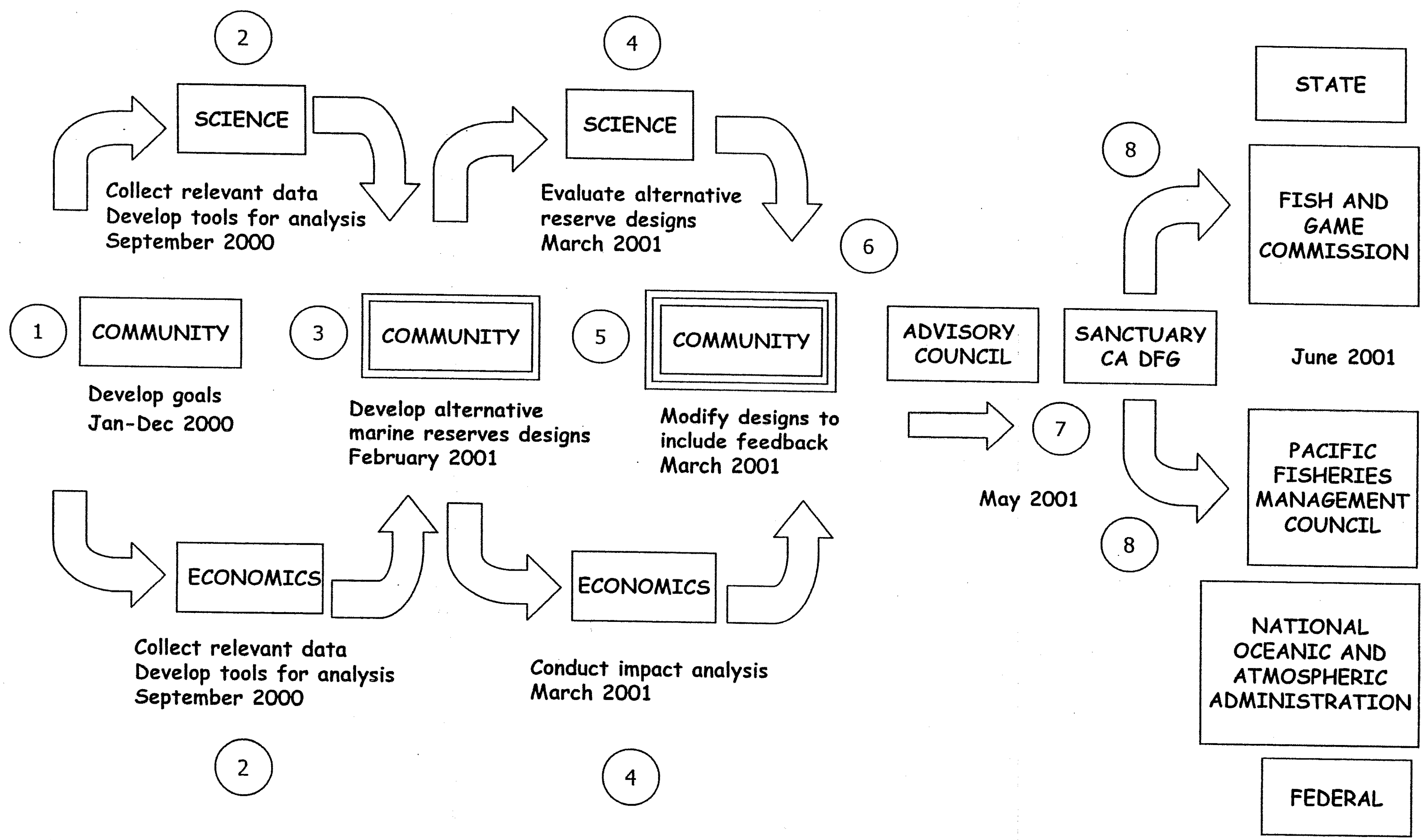
Two additional groups were formed to support the work of the Marine Reserves Working Group by providing additional expertise: a Science Panel and an Socio-economic Panel. The Science Panel, also created by the SAC, is composed of 15 members with expertise in disciplines relevant to the reserve issue. Included in this blue-ribbon panel are physical and biological oceanographers, ichthyologists, invertebrate zoologists, fishery managers, statisticians, ecologists, modelers, and more. The Socio-economic Panel, composed of economists from NOAA and local contractors, will prepare an impact analysis of reserve designs by utilizing existing socio-economic information accumulated from various studies. The Panel has collected new information on the use and value of local resources.

The Working Group will provide a recommendation to the Sanctuary Advisory Council (SAC) regarding the size and location of marine reserves by May 23, 2001. The SAC will evaluate and forward the recommendation to the Sanctuary Manager. The Sanctuary Manager and Dept of Fish and Game will then provide this recommendation to the California Fish and Game Commission and Pacific Fisheries Management Council (PFMC) and work with these and other agencies to integrate and implement marine reserves into existing management, such as the California Marine Life Protection Act.

The Working Group meets monthly in Santa Barbara, CA all meetings are open to the public. Additionally, evening forums are held to seek direct interaction with the general public.

Overview of the Marine Reserves Process

Progress to date (Step 5) and projected schedule



MISSION STATEMENT
adopted by consensus of the
Marine Reserves Working Group

Using the best available ecological, socioeconomic, and other information, the Marine Reserves Working Group will collaborate to seek agreement on a recommendation to the Sanctuary Advisory Council regarding the potential establishment of marine reserves within the Channel Islands National Marine Sanctuary Area.

PROBLEM STATEMENT
adopted by consensus of the
Marine Reserves Working Group

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, as well as 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. In addition, new technologies have increased the efficiency, effectiveness, and yield of sport and commercial fisheries. Concurrently there have been wide scale natural phenomena such as El Nino weather patterns, oceanographic regime shifts, and dramatic fluctuations in pinniped populations.

In recognizing the scarcity of many marine organisms relative to past abundance, any of the above factors could play a role. Everyone concerned desires to better understand 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.

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.

GOALS FOR MARINE RESERVES IN THE CHANNEL ISLANDS

adopted by consensus of the
Marine Reserves Working Group

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

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

3. Sustainable Fisheries
To achieve sustainable fisheries by integrating marine reserves into fisheries management.

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

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

RECOMMENDATIONS FOR THE IMPLEMENTATION OF MARINE RESERVES

In order to effectively implement and manage new marine reserves:

1. Agency coordination and accountability for marine reserves is essential.

2. Community oversight of reserve administration is encouraged.

3. Reserves need to be adequately funded for administration and management.

4. Reserves require coordinated and adequate enforcement to function.

5. Monitoring, evaluation and assessment programs should be developed and implemented.

Channel Islands National Marine Sanctuary Advisory Council

Marine Reserves Working Group

Name	Affiliation	Representation
Patricia Wolf	Chair, Fish and Game	CDFG
Matthew Pickett	Co-chair, Sanctuary Manager	CINMS
Warner Chabot	Center for Marine Conservation	Conservation
Michael McGinnis	UCSB, Ocean Coastal Policy Center	Conservation
Steve Roberson	Marine Resource Restoration	Conservation
Sean Kelley	Surfrider Foundation	Conservation
Chris Miller	Lobster Trappers Association	Consumptive
Neil Guglielmo	Squid Seiner and processor	Consumptive
Dale Glanz	ISP Alginates	Consumptive
Tom Raftican	United Anglers	Consumptive
Marla Daily	Sanctuary Advisory Council	Public at large
Craig Fusaro	Sanctuary Advisory Council	Public at large
Gary Davis	National Park Service	National Park Service
Mark Helvey	National Marine Fisheries Service	NMFS
Deborah McArdle	California Sea Grant	California Sea Grant
Locky Brown		Diving
Robert Fletcher	Sportfishing Assoc. of Ca.	Marinas/Businesses

Science Advisory Panel

Dr. Matthew Cahn, Chair	CSU Channel Islands	Public Policy
Dr. Bruce Kendall	UC Santa Barbara	Population Dynamics
Dr. Steve Schroeter	UC Santa Barbara	Invertebrate Zoology
Dr. Mark Carr	UC Santa Cruz	Icthyology
Dr. Steve Murray	CSU Fullerton	Invertebrate Zoology
Dr. Dave Siegel	UC Santa Barbara	Physical Oceanography
Dr. Robert Warner	UC Santa Barbara	Marine Ecology
Dr. Daniel Reed	UC Santa Barbara	Marine Ecology
Dr. Allan Stewart-Oaten	UC Santa Barbara	Population Dynamics
Dr. Ed Dever	Scripps Institute	Physical Oceanography
Dan Richards	C.I. National Park	Invertebrate Zoology
Dr. Russ Vetter	NMFS	Icthyology
Dr. Steve Gaines	UC Santa Barbara	Invertebrate Zoology
Dr. Joan Roughgarden	Stanford University	Invertebrate Zoology
Dr. Libe Washburn	UC Santa Barbara	Physical Oceanography
Peter Haaker	CADFG	Invertebrate Zoology

Science Panel members were selected using the following criteria: (1) local knowledge, (2) no published "agenda" on reserves, (3) breadth of disciplines, (4) geographic and institutional balance, (5) participation in the NCEAS Reserve Theory Working Group, and (6) time available.

Socioeconomic Panel

Bob Leeworthy	NOAA Coastal Services Center	Commercial Fisheries
Peter Wiley	NOAA Coastal Services Center	Recreational Fisheries
Charles Kolstad	UC Santa Barbara	Charter/Party Boats
Mick Kronman	Fisheries Consultant	User Groups Survey
Dr. Craig Barilotti	Sea Foam Enterprises	Commercial Fisheries
Dr. Carolyn Pomeroy	UC Santa Cruz	Squid Fishery

The Panel collects and synthesizes existing studies, records of catch or harvest, and other public information sources, and develops an economic impact analysis

PUBLIC MEETING SCHEDULE

Channel Islands National Marine Sanctuary Advisory Council Marine Reserves Working Group

March 21, 2001 Marine Reserves Working Group Meeting and Public Forum 12-5:00 p.m. meeting, 6-10 p.m. public forum Fess Parker Doubletree, Santa Barbara CA. To receive feedback and input from the Science and Socioeconomic Panels and general public on four marine reserve concept maps.

April 18, 2001. Marine Reserves Working Group. Veterans Hall, Santa Barbara, CA. Anticipated meeting topics: Finalize issues related to implementation and assurances. For more information: www.cinms.nos.noaa.gov/nmpreserves or contact Sean Hastings at (805) 884-1472, sean.hastings@noaa.gov.

Marine Reserves Public Forum. Date/time TBA. MRWG Presentation of preferred marine reserve map. For more information: www.cinms.nos.noaa.gov/nmpreserves or contact Sean Hastings at (805) 884-1472, sean.hastings@noaa.gov.

May 16, 2001. Marine Reserves Working Group. Chase Palm Park Center, 236 E. Cabrillo Blvd, Santa Barbara. Anticipated meeting topics: Finalize consensus recommendation package. For more information: www.cinms.nos.noaa.gov/nmpreserves or contact Sean Hastings at (805) 884-1472, sean.hastings@noaa.gov.

May, 23, 2001. Sanctuary Advisory Council and Marine Reserves Working Group. Afternoon + evening. Chase Palm Park Center, 236 E. Cabrillo Blvd, Santa Barbara. Anticipated meeting topics: MRWG presentation of marine reserves consensus recommendation to SAC. For more information: www.cinms.nos.noaa.gov/sachome1 or contact Mike Murray at (805) 884-1464, michael.murray@noaa.gov.

June 19, 2001. Sanctuary Advisory Council. Time and location details TBA. Anticipated meeting topics: SAC recommendation to CINMS on MRWG recommendation. For more information: www.cinms.nos.noaa.gov/sachome1 or contact Mike Murray at (805) 884-1464, michael.murray@noaa.gov.

NOTE: Meeting dates, times, locations and agenda items listed below are subject to change. Please check the CINMS web site prior to meetings: WWW.CINMS.NOS.NOAA.GOV.

Receive advance notice of sanctuary-related meetings by signing up on the CINMS mailing list and e-mail list. Three ways to sign up:

(1) fill out the form on this web page: www.rain.org/mailman/listinfo/ci-sanctuary-l.

(2) send an e-mail note to michael.murray@noaa.gov, or

(3) call the Sanctuary office at (805) 966-7107 and leave your e-mail address and/or mailing address.

DRAFT SUMMARY

ESTIMATING RESERVE SIZE

FOR CONSERVATION AND FISHERIES MANAGEMENT

Science Advisory Panel

January 17, 2001

Flying A Studio
University Center
University of California
Santa Barbara

DRAFT SUMMARY

Estimating reserve size for conservation and fisheries management

TABLE OF CONTENTS

DRAFT SUMMARY

Estimating reserve size for conservation and fisheries management

EXECUTIVE SUMMARY

Marine reserves are important tools for marine conservation and fisheries management, with the potential to provide ecosystem protection, improved fisheries yields, expanded understanding of marine environments, and improved non-consumptive opportunities. The degree to which a reserve will provide certain benefits or achieve specific goals will vary with the species, depending on life-history characteristics and various aspects of reserve design. One of the most important questions in conservation and resource management is how large reserves must be to provide specific benefits and how can we predict this size given a lack of information about the area of interest. For conservation, the benefit of a reserve increases with size. Larger reserves protect more habitats and populations, providing a buffer against losses from environmental fluctuations or other natural factors that may increase death rates or reduce population growth rates. For fisheries management, the benefit of a reserve does not increase directly with size. The maximum benefit of no-take reserves for fisheries, in terms of sustainability and yield, occurs when the reserve is large enough to export sufficient larvae and adults, and small enough to minimize the initial economic impact to fisheries. Data from harvested populations indicate that species differ greatly in the degree to which they can be reduced below normal carrying capacity before they are not self-sustainable in the long term. Given the available empirical data, a minimum reserve size of 30% of the suitable habitat in a management area would sustain approximately 80% of the species for which data are currently available (Table 2 and Figure 5). To meet the minimum habitat requirements for all species, the fraction set aside in reserves would need to exceed 70% of the suitable habitat in the management area. If reserves are designed for fisheries enhancement and sustainability, numerous theoretical studies and limited empirical data indicate that protecting approximately 35% of fishing grounds will maximize catches (Table 1). Thus a reserve area of 30-50% of an area of interest will achieve some measure of protection for both conservation and fisheries goals. Because of the complexity upon which these estimates are based, continued evaluation of their effectiveness is necessary to determine whether subsequent alteration of reserve design (reduction or increase) is appropriate.

Figure 2. Production expressed as a function of stock size (blue), fishing mortality (green), or reserve set aside (black). Stock size varies from 0 to k (carrying capacity), corresponding to the fishing mortality varying from *r* (the intrinsic rate of growth) to 0. Maximum sustainable yield occurs at a stock size of 0.5k, corresponding to a fishing mortality of 0.5*r*. Reserve set aside is defined as a fraction of the stock's area where no fishing is allowed, assuming that the fishing mortality outside the reserve remains at 0.5*r*.

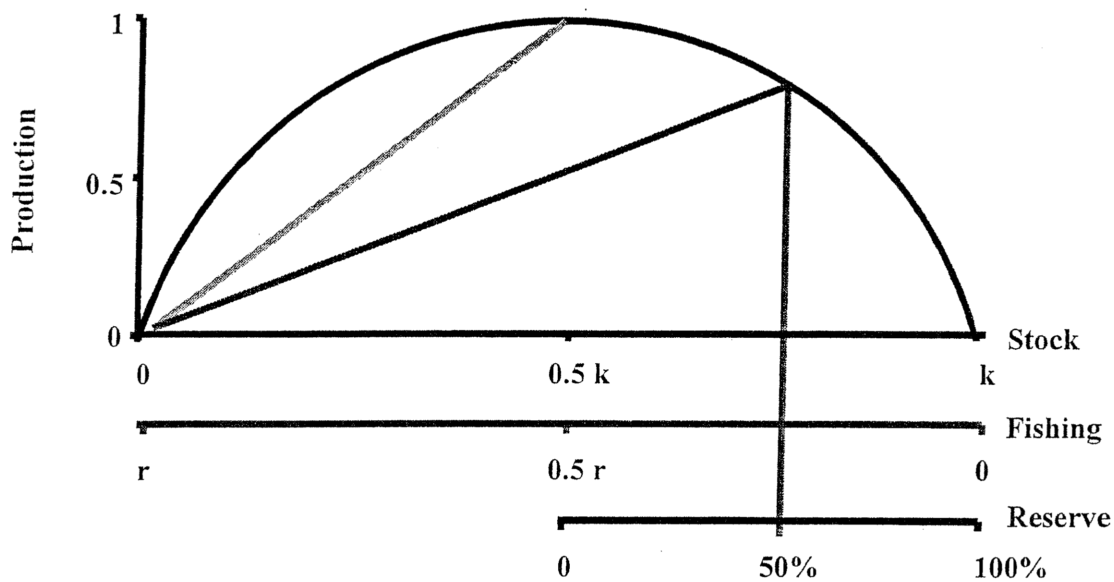


Figure 3. Probability of fishery collapse over 50 years as a function of stock size (blue), fishing mortality (green), or reserve set-aside (black). Harvesting involves a random component (e.g. environmental variation) superimposed on the deterministic policy target (e.g. MSY). Probability of collapse drops to zero at a stock of 0.75k, corresponding to a fishing mortality of 0.25*r*, or a reserve set-aside of 50%.

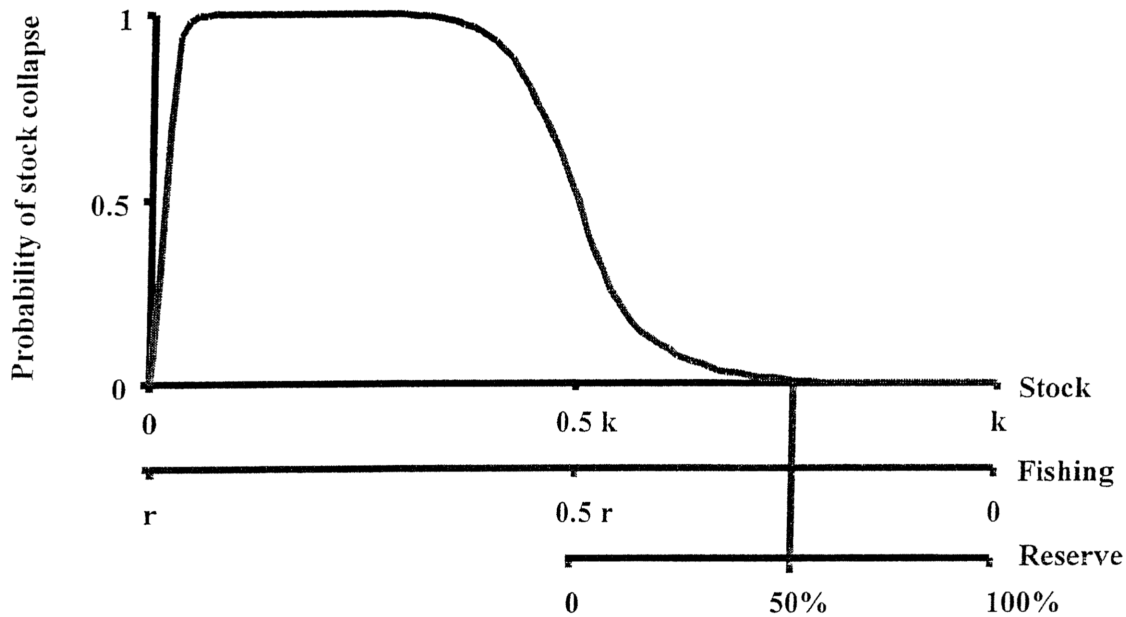


Figure 4. History of the Newfoundland cod fishery (divisions 2J, 3K, and 3L), comprising approximately 400,000 km^2 (modified from Roughgarden and Smith 1996). The annual harvest in thousands of tons is plotted as a solid line, the annual stock size as a dashed line, and the annual quotas as solid dots. The fishery shows three phases, 1960-1980, 1981-1990, and 1991-1993. The harvest was higher in the first phase. In the second phase, the harvest matched the annual quotas and the fishery appeared to be well managed with relatively constant harvest and stock. The cod fishery collapsed in the third phase.

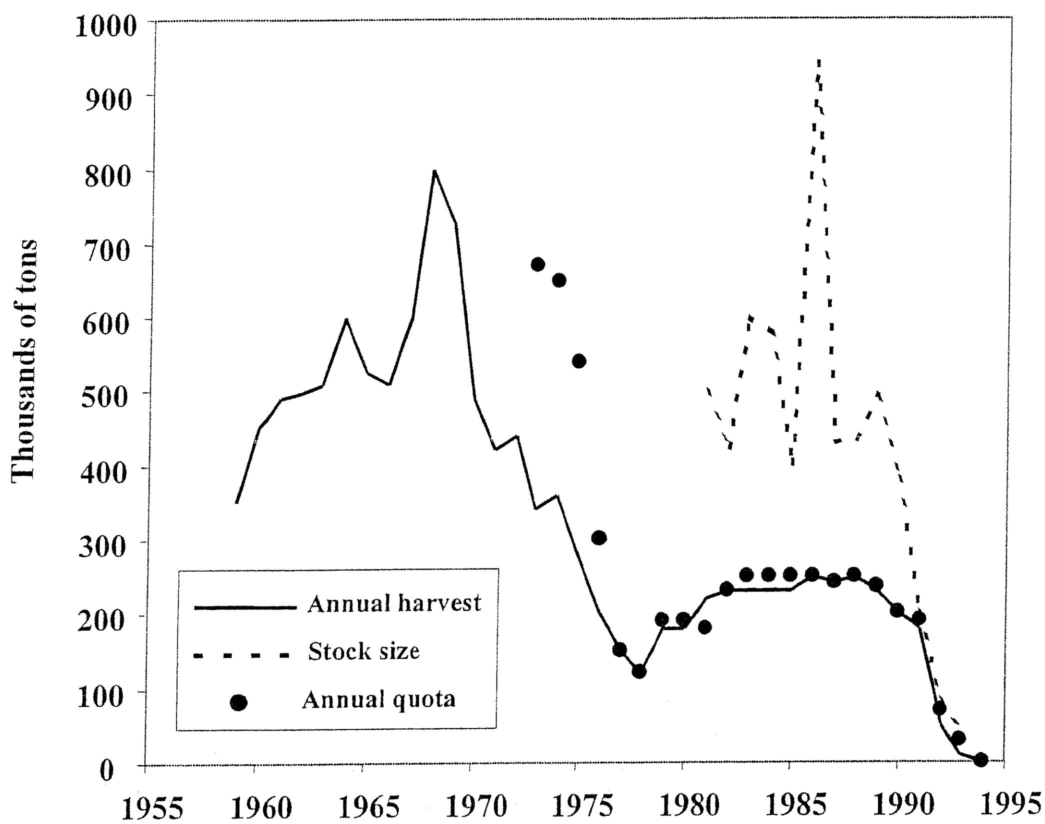


Figure 5. Estimates of replacement threshold levels for 85 populations of 27 fish species from North America and Europe (modified from Mace and Sissenwine 1993).

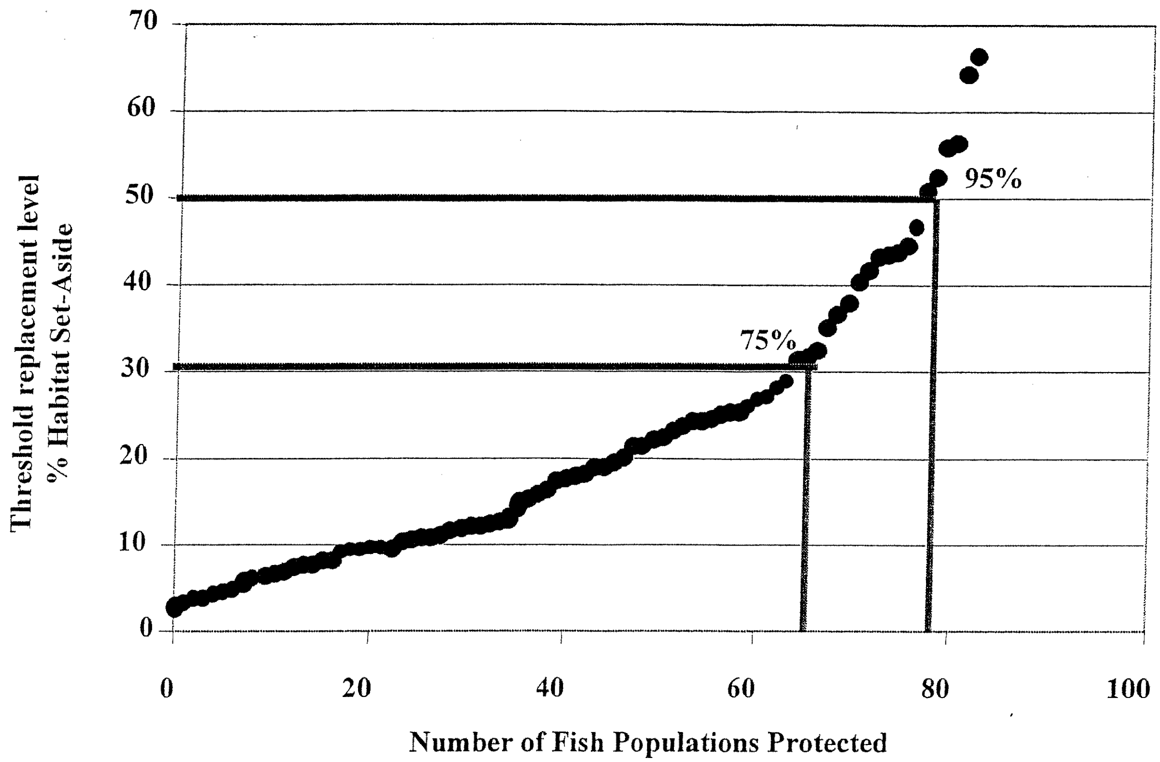


Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Sladek-Nowlis and Roberts (1997, 1999)	75-80%	Maintain long-term sustainability yields of fish species with high fishing mortalities.
Hannesson (1999)	50-80%	To produce catches and spawning stock levels of cod *(Gadus morhua)* equivalent to those of an optimally contrilled fishery (one where stock size is held at 50% of the unexploited level).
Mace and Sissenwine (1993)	20-80%	Maintain sustainable populations of fished species.
Roughgarden (1998)	30-50%	Maintain exploited populations at 75% of their unexploited size.
Clark et al. (1989)	25-75%	Reduce the likely time to extinction of an exploited population with no reserve. A reserve of 25% increased time to extinction by 8 times, one of 50% by 40 times, and one of 75% reduced extinction risk to the level of unexploited populations.
Lauck *et al.* (1998)	31-70%	Maintain populations above 60% of their carrying capacity over a 40 year time horizon. The reserve area required increased with fishing intensity.
Lauck *et al.* (1999)	>50%	Ensure high probability of stock persistence under variable levels of harvest.
Allison *et al.* (2000)	35-50%	Ensure high probability of stock persistence under variable environmental conditions with periodic catastrophic events.
Carr *et al.* (1998)	35-50%	Maximize long-term sustainable yields of fished species and reduce annual catch variability.

Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Roughgarden (2000)	30-50%	Ensure high probability of stock persistence under variable levels of harvest and under varying environmental conditions.
Sumaila (1998)	30-50%	Protect stocks without greatly reducing economic benefits. The size depends on the degree of risk managers are willing to accept.
DeMartini (1993)	20-50%	Increase spawning stock size to provide insurance against uncertainties associated with fisheries management.
Quinn *et al.* (1993)	50%	To maximize population sizes and sustain existing levels of catch of the California red sea urchin (*Strongylocentrotus franciscanus*).
Dahlgren and Sobel (2000)	40%	Elevate stocks to sustainable target levels.
Sladek-Nowlis and Roberts (1999)	40%	Elevate stocks from current levels of overfishing.
Mace (1994)	40%	Maintain sustainable populations of fished species.
Man et al. (1995)	20-40%	Maintain sustainable populations of fished species in networks of reserves.
Roberts (2000)	20-40%	Reduce the risk of overexploitation and fishery collapse. Maximize long-term yields of over-exploited species.
Polacheck (1990)	10-40%	Maintain long-term sustainability yields of Georges Bank cod (*Gadus morhua*) under variable levels of harvest and varying environmental conditions.

Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Turpie *et al.* (2000)	36%	To maximize long-term persistence of species along the South African coast.
Bustamente *et al.* (2000)	36%	To represent all coastal habitat types in each of five biogeographic zones encompassed by the Galapagos Islands.
Stockhausen *et al.* (2000)	>35% in a network of reserves	Elevate stocks from current levels of overfishing.
Mangel (2000)	>35%	Maintain long-term sustainability yields of stock persistence under variable levels of harvest and varying environmental conditions.
Botsford et al. (2000)	35%	Maintaining adequate reproduction for all species.
Hastings and Botsford (1999)	35%	Maintain adequate reproduction for all species. For species that reproduce over long lifespans, the fraction of area set aside is smaller than the fraction of the adult population that needs to be protected under conventional management.
Dahlgren and Sobel (2000)	30%	Elevate stocks from current levels of overfishing.
Guenette and Pitcher (1999)	>30%	To provide more robust biomass of spawning cod (*Gadus morhua*) and to reduce the number of years with poor recruitment.
Pezzey et al. 2000	21% in moderately fished areas 36% in heavily fished areas 40% in intensively fished areas	To enhance fish catches of mixed species reef fisheries in the Caribbean.

Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Attwood and Bennett (1995)	25-30%	Increase catches of galjoen (*Dichistius capensis*) and blacktail (*Diplodus sargus*) and to reduce the risk of recruitment overfishing of surf zone species in South Africa.
Holland and Brazee 1996	15-29%	To enhance fish catches of red snapper (*Lutjanus campechanus*) in the Gulf of Mexico.
Sladek-Nowlis and Yoklavich (1998)	20-27%	Maximize long-term sustainable yields of bocaccio (*Sebastes paucispinis*) and reduce annual catch variability.
Foran and Fujita (1999)	10-25%	To rebuild the egg output by stocks of Pacific Ocean Perch (*Sebastes alutus*), and improve catch per effort.
	25%	Reduce mortality of cod (*Gadus morhua*) in the North Sea by 10-14%.
Goodyear 1993	>20	To lower the risk that a fishery will collapse due to over-exploitation.
Trexler and Travis (2000)	10-20%	To decrease directional selection due to fishing.
Botsford, in press	17% of the California coast	To increase long-term catches of California red sea urchins (*Strongylocentrotus franciscanus*).
Ballantine 1997	10%	To fulfill our ethical obligation to protect a minimum proportion of the world's seas.

Table 2. Estimates of replacement threshold levels for 85 populations of 27 fished species, grouped by geographic location (modified from Mace and Sissenwine,1993).

Common Name	Scientific Name	Replacement Threshold Level (%)
ICES Stocks (NE Atlantic)		
1. Irish Sea cod	*Gadus morhua*	3.9
2. Irish Sea whiting	*Merlangius merlangus*	11.4
3. Irish Sea plaice	*Pleuronectes platessa*	10.1
4. Irish Sea sole	*Solea vulgaris*	23.5
5. Celtic Sea cod	*Gadus morhua*	6.6
6. Celtic Sea whiting	*Merlangius merlangus*	6.9
7. Celtic Sea plaice	*Pleuronectes platessa*	5
8. Celtic Sea sole	*Solea vulgaris*	19.2
9. Blue whiting, southern stock	*Merlangius merlangus*	7.4
10. NE Arctic cod	*Gadus morhua*	5.8
11. NE Arctic haddock	*Melanogrammus aeglefinus*	24.3
12. NE Arctic saithe	*Pollachius virens*	9.8
13. Redfish in areas IIA and B	*Sebastes marinus*	18.2
14. Greenland halibut in areas I and II	*Reinhardtius hippoglossodes*	21.6
15. Icelandic summer herring	*Clupea harengus*	18.6
16. North Sea sole	*Solea vulgaris*	12.3
17. North Sea plaice	*Pleuronectes platessa*	11.2
18. Div VIId sole	*Solea vulgaris*	11.5
19. Div VIIe sole	*Solea vulgaris*	25.8
20. Bay of Biscay sole	*Solea vulgaris*	5.6
21. Div VIIe plaice	*Pleuronectes platessa*	7.3
22. North Sea cod	*Gadus morhua*	3.4
23. Div Via cod	*Gadus morhua*	11
24. Div VIId cod	*Gadus morhua*	5.3
26. North Sea haddock	*Melanogrammus aeglefinus*	15.5
27. Div Via haddock	*Melanogrammus aeglefinus*	18.2
28. North Sea whiting	*Merlangius merlangus*	50.1
29. Div. VIa whiting	*Merlangius merlangus*	37.2
30. Div VIId whiting	*Merlangius merlangus*	42.7
31. North Sea saithe	*Pollachius virens*	16.7
32. Div. VI saithe	*Pollachius virens*	24.6
33. Kattegat cod	*Gadus morhua*	8.2
34. Skagerrak Cod	*Gadus morhua*	6.1
35. Kattegat plaice	*Pleuronectes platessa*	8.7
36. North Sea herring	*Clupea harengus*	10.8
37. Celtic Sea herring	*Clupea harengus*	27.9
38. Div. VIa north herring	*Clupea harengus*	16.8
39. Clyde herring	*Clupea harengus*	23

*Table 2. Estimates of replacement threshold levels for 85 populations of 27 fished species, grouped by geographic location.

Common Name	Scientific Name	Replacement Threshold Level (%)
40. Div. VIa south and VIIb,c herring	*Clupea harengus*	23.4
41. Div. VIIa herring	*Clupea harengus*	14.6
42. Baltic cod in area 22	*Gadus morhua*	2.5
43. Baltic cod in area 22 and 24	*Gadus morhua*	2.9
44. Baltic cod in areas 25-32	*Gadus morhua*	8.8
45. Western Baltic and Kattegat herring	*Clupea harengus*	6.8
46. Gulf of Riga and areas 25-29 herring	*Clupea harengus*	30.4
47. Herring in coastal areas 25-27	*Clupea harengus*	39.5
48. Herring in the Gulf of riga	*Clupea harengus*	27.1
49. Herring in areas 30E	*Clupea harengus*	63.5
50. Herring in area 31E	*Clupea harengus*	63.5
51. Herring in area 31E	*Clupea harengus*	65.4
52. Herring in the Gulf of Finland	*Clupea harengus*	17.5
53. Sprat in areas 26 and 28	*Sprattus sprattus*	45.8
54. Sprat in areas 22-32	*Sprattus sprattus*	35.7
55. Mackerel, western stock	*Scomer scombrus*	42.8
56. Greenland halibut in areas V and XIV	*Reinhardtius hippoglossodes*	8.5
57. Icelandic saithe	*Pollachius virens*	24.9
58. Faroe saithe	*Pollachius virens*	21.4
59. Faroe Plateau cod	*Gadus morhua*	17.2
60. Faroe haddock	*Melanogrammus aeglefinus*	31.5
61. Hake, northern stock	*Merluccius merluccius*	51.5
62. Hake, southern stock	*Merluccius merluccius*	34.1
63. Megrim in areas VII and VIII	*Lepidorhombus whiffragonis*	55.1
64. Sardine in areas VIIIe and IXa	*Sardina pilchardis*	55.4
65. Horse mackerel, southern stock	*Trachurus trachurus*	22.3
Northwest Atlantic Stock (Canada)		
66. Pollock in NAFO areas 4VWX and 5Zc	*Theragra chalcogramma*	23.7
67. Haddock in NAFO area 4X	*Melanogrammus aeglefinus*	26
68. Herring in NAFO area 4T	*Clupea harengus*	9.5

*Modified from Mace and Sissenwine (1993)

*Table 2. Estimates of replacement threshold levels for 85 populations of 27 fished species, grouped by geographic location.

Common Name	Scientific Name	Replacement Threshold Level (%)
Northwest Atlantic Stock (USA)		
69. Georges Bank cod	*Gadus morhua*	11.9
70. Gulf of Maine cod	*Gadus morhua*	8.4
71. Georges Bank haddock	*Melanogrammus aeglefinus*	20.6
72. Silver hake, northern stock	*Merluccius bilinearis*	30.8
73. Silver hake, southern stock	*Merluccius bilinearis*	42.4
74. Georges Bank yellowtail flounder	*Limanda ferruginea*	14.2
75. Southern New England yellowtail flounder	*Limanda ferruginea*	10.3
76. Summer flounder	*Paralichthys dentatus*	3.7
77. Gulf of Maine herring	*Clupea harengus*	14.9
78. NW Atlantic mackerel	*Scomer scombrus*	40.7
79. Georges Bank scallops	*Placopecten magellanicus*	2
80. Mid-Atlantic scallops	*Placopecten magellanicus*	2.9
Atlantic Stocks		
81. North Atlantic swordfish	*Xiphias gladius*	8.6
82. NW Atlantic swordfish	*Xiphias gladius*	10.1
Pacific Coast Stocks		
83. Bering Sea walleye pollock	*Theragra chalcogramma*	43.8
84. Pacific halibut	*Hippoglossus sternolepis*	24.6
85. Bering sea yellowfin sole	*Limanda aspera*	20.4

*Modified from Mace and Sissenwine (1993)

Table 3. Examples of the effects of marine reserves on species diversity, biomass, abundance, and size (modified from Table 1 in Roberts and Hawkins 2000).

Reserve Name Location	Years of Protection	Habitat Type	Effects Reported
Leigh Marine Reserve, New Zealand	21	Warm-temperate rocky reef	The most common predatory fish *Pagrus auratus* was 6 times more common in the reserve than outside, while the spiny lobster *Jasus edwardsii* was 1.6 times more abundant and had a bigger carapace. In 18 years, sea urchin densities declined from 4.9 m2 to 1.4 m^2 in the reserve while urchin cover rose from 14% to 40% in unprotected areas (Babcock 1999).
Tawharanui Marine Park, New Zealand	14	Temperate rocky reef	The most common predator fish *pagnus auratus* was 9 times more common in the reserve than outside, while the spiny lobster *Jasus edwardsii* was 3.7 times more abundant, with a larger carapace (Babcock 1999).
Mayotte Island, Indian Ocean	3	Coral reef	Species richness did not differ between protected and unprotected areas, however, most large carnivores were more diverse and abundant in the reserve. The mean biomass of commercial species was 202 g/m^2 in the reserve compared to 79 g/m^2 outside (Letourneur 1996).
Looe Key, Florida, USA	2	Coral reef	15 species that were targets of spear fishers increased in abundance after spearfishing was banned; snappers by 95%, grunts by 439% (Clark et al. 1989).
Cousin Island, Seychelles	15+	Coral reef	Groupers, emperors, and snappers were more abundant and diverse within the reserve than in fished sites (Jennings 1998).
Sainte Anne, Seychelles	11	Coral reef	The diversity of target species and total fish biomass was higher in the reserve than in heavily fished areas (Jennings *et al.* 1995, 1996).
Merritt Island National Wildlife Refuge, Florida, USA	28	Sub-tropical estuary	Experiment catch per unit effort was 2.6 times greater in the reserve for all game fish combined; 2.4 time greater for spotted sea trout (*Cynoscion nebulosus*), 6.3 times for red drum (*Sciaenops ocellata*), 12.8 for black drum (*Pogonius cromis*), 5.3 for snook (*Centropomus undecimalis*) and 2.6 for striped mullet (*Mugil cephalus*). Fish in the refuge were larger and more abundant, and anglers were preferentially targeting the reserve boundary (Johnson *et al.* 1999).

Table 3. Examples of the effects of marine reserves on species diversity, biomass, abundance, and size (modified from Table 1 in Roberts and Hawkins 2000).

Reserve Name Location	Years of Protection	Habitat Type	Effects Reported
Kisite Marine National Park, Kenya	5	Coral reef	Groupers, emperors, and snappers were more abundant within the park and appear to be spilling over into fishing grounds. Protection did not affect species number (Watson *et al.* 1996).
Punta El Lacho, Chile	2	Temperate rocky intertidal	The commercially important marine snail, the loco (*Concholepas concholepas*), increased in density from 5 to 14 times and doubled in body size following protection (Castilla and Duran 1985).
Barbados Marine Reserve	11	Coral reef	Large fish were approximately twice as abundant in the protected area, and 18 of 24 species were bigger (Rakitin and Kramer 1996, Chapman and Kramer 1999).
Exuma Cays Land and Sea Park, Bahamas	36	Tropical seagrass meadow	The average density of adult queen conch (*Strombus gigas*) was 15 times higher in the reserve and late stage larval densities were 4-17 times higher (Stoner and Ray 1996).
Exuma Cays Land and Sea Park, Bahamas	10	Coral reef	The reproductive output of Nassau grouper (*Epinephelus striatus*) was 6 times greater in the reserve (Sluka et al. 1997).
Hawaii Marine Life Conservation Districts	Not reported	Coral reef	Fishes were 63% more abundant in areas protected from fishing (Grigg 1994).
De Hoop Marine Reserve, South Africa	2	Warm temperate rocky reef	Experiment catch per unit effort increased by up to 5-fold for 6 out of 10 of the most commercially important species (Bennett and Attwood 1991).
Saba Marine Park, Saba, Netherlands Antilles	4	Coral reef	In the no-take zone the biomass of target species was over twice that in fishing grounds (Polunin and Roberts 1993).
Hotel Chan Marine Reserve, Belize	4	Coral reef	Biomass of target species in the reserve was almost double that in fished areas, while in certain parts of the reserve it was ten times greater (Polunin and Roberts 1993, Roberts and Polunin 1994).
Anse Chastanet Reserve, Santa Lucia	2	Coral reef	Total biomass of commercially important species was more than double that in fished areas and the reserve contained 3 species found nowhere else (Roberts and Hawkins 1997).

Table 3. Examples of the effects of marine reserves on species diversity, biomass, abundance, and size (modified from Table 1 in Roberts and Hawkins 2000).

Reserve Name Location	Years of Protection	Habitat Type	Effects Reported
Ras Mohammed Marine Park, Egypt	15	Coral reef	Mean biomass of fish was 1.2 times greater on protected reefs, while differences for seven target species were much greater. Individuals of the lunartail grouper (*Variola louti*) were three times larger in the reserve (Roberts and Polunin 1993a, 1993b).
Kisite Marine National Park and Mpuguti Marine National Reserve, Kenya	Kisite 20 Mpuguti 0	Coral reef	Abundances of key commercial species (groupers, snappers, and emperors) were up to 10 times higher in the fully protected Kisite Marine National Park compared to the fished Mpunguti reserve. Keystone species such as triggerfish (a predator of urchins) were also more abundant in Kisite Park, while their urchin prey were much more abundant in Mpunguti (Watson and Ormond 1994).
Three Kenyan Marine Parks: Malindi, Watamu, Kisite	Malindi 24 Watamu 20 Kisite 19	Coral reef	Reserve helped support regional diversity by protecting species that were unable to persist in fished areas. Of the 110 species recorded in protected reefs, 52 were not found in fished areas (McClanahan 1994).
South Lagoon Marine Park, New Caledonia	5	Coral reef	Within protected areas, the species richness of fish populations increased by 67%, density by 160%, and biomass by 246% but the average size of most species did not increase (Wantiez et al. 1997).
Banyuls-Cerbere Marine Reserve, France	6	Warm-temperate rocky reef	18 target species were bigger in reserve (Bell 1983).
Shady Cove, San Juan Islands, Washington, USA	7	Temperate rocky reef	Lingcod (*Ophiodon elongatus*) were nearly three times more abundant in the reserve (Palsson and Pacunski 1995).
Edmonds Underwater Park, Washington, USA	27	Temperate rocky reef	The number of rockfish eggs and larvae originating in the park is 55 times greater than outside. For lingcod (*Ophiodon elongatus*), egg and larval production in the park is 20 times greater than outside (Palsson and Pacunski 1995).
Anacapa Island, Channel Islands, California, USA	20	Warm-temperate rocky reef	Densities of comercially exploited red sea urchin (*Strongylocentrotus franciscanus*) were 9 times higher in the reserve than in nearby fished areas (Fujita 1998).

Table 3. Examples of the effects of marine reserves on species diversity, biomass, abundance, and size (modified from Table 1 in Roberts and Hawkins 2000).

Reserve Name Location	Years of Protection	Habitat Type	Effects Reported
Tsitsikamma National Park, South Africa	22	Rocky reef	Of three species studied, one was 4 times more abundant in the reserve, and another was 13 times more. Bream (*Petrus rupestris*) were on average twice as large when protected (Buxton and Smale 1989).
Sumilon Island Reserve, The Philippines	10	Coral reef	Eighteen months after fishing resumed in the reserve, catch per unit effort fell by half, and the total yield of fish was 54% less, despite a greater area available for fishing (Alcala and Russ 1990).
Apo Island Reserve, The Philippines	6	Coral reef	The biomass of large predators increased 8-fold in the reserve. In fishing grounds, mean density and species richness of large predators also increased (Russ and Alcala 1996a,b).
Kyoto Precture Closure, Japan	4	Temperate sand and mud bottom	The proportion of large male snow crabs (*Chionoecetes opilio*) rose by 32% in the closed area (Yamasaki and Kuwahara 1990).
Maria Island Reserve, Tasmania	6	Temperate rocky reef	The densities of rock lobster (*Jas rubra*) and bastard trumpeter fish (*Latridopsis forsteri*) increased by 1 and 2 orders of magnitude respectively within the reserve (Edgar and Barrett 1999).

Table [illegible] ummary of some of the studies that provide evidence for sp[illegible]over from marine reserves into fished areas.

Species	Scientific Name	Location	Evidence	Reference
All target species		Barbados Marine Reserve	Catches increased approaching the reserve boundary from both the north and the south.	Ratikin and Kramer (1996)
All target species		Apo Island Reserve, Philippines	There was a gradual increase (over 9 years) in densities of fish outside, but very close to the reserve.	Russ and Alcala (1996b)
All target species		Mombasa Marine National Park, Kenya	110% enhancement of catch per unit effort in fishing grounds close to the reserve.	McClanahan and Kaunda-Arara (1996)
All target species		Sumilon Island Reserve, The Philippines	Catch per unit effort and total catches decreased by half after reserve protection broke down, despite a larger area of fishing grounds becoming available.	Alcala and Russ (1990)
All target species		Tabarca Marine Reserve, Spain	Fishers report 50-85% higher catches close to the reserve after 6 years of protection.	Ramos-Espla and McNeill (1994)
Conch Lobster		Hol Chan Marine Reserve, Belize	Conch and lobster fishers in Belize preferentially fish close to the edge of the reserve.	Polunin and Roberts (1993)
Galjoen	*Dichistius capensis*	De Hoop Reserve, South Africa	18% of 828 tagged fish were recovered at least 25 km from where they were released, and the maximum distance that any fish traveled was 1040 km.	Attwood and Bennett (1994)
Red drum Spotted seatrout Black drum Striped mullet Common snook Sheepshead	*Sciaenops ocellatus* *Cynoscion nebulosus* *Pogonias cromis* *Mugil cepalus* *Centropomus undecimalis* *Archosargus probatocephalus*	Merritt Island National Wildlife Refuge, Florida, USA	Tagged fish moved from reserve to fished areas. Several world record fish were caught near the Refuge, including four red drum, and one black drum, and three spotted seatrout.	Johnson et al. (1999)
Sea scallops	*Placopecten magellanicus*	Georges Bank USA	Satellite tracking shows that scallop fisheries are concentrated near reserves, and total landings are 150% of 1994 levels.	Murawski *et al.* (2000)
Spiny lobster	*Panulirus argus*	Biscayne Bay Spiny Lobster Sanctuary, Florida, USA	As they grow, the lobsters move to fishing grounds in the Florida Keys where they may be harvested by commercial trappers.	Davis and Dodrill (1980)
Snow crab		Japan	Closures for snow crab led to higher catches nearby.	Yamaski and Kuwahara (1990)

REFERENCES

Agardy, T. 2000. Information needs for marine protected areas: scientific and societal. Bulletin of Marine Science 66(3):875-888.

Alcala, A.C. and G.R. Russ. 1990. A direct test of the effects of protective management on abundance and yield of tropical marine resources. Journal du Conseil International pour l'Exploration de la Mer 46:40-47.

Allison, G.W., S.D. Gaines, J. Lubchenco, H.P. Possingham. In press. Taking the long view of marine reserves: Catastrophes and an insurance factor.

Alward, G.L. 1932. The Sea Fisheries of Great Britain and Ireland. Alberta Gait, Grimsby, UK.

Attwood, C.G. and B.A. Bennett. 1994. Variation in dispersal of galjoen (*Coracinus capensis*) (Teleostei: Coracinidae) from a marine reserve. Canadian Journal of Fisheries and Aquatic Science 51:1247-1257.

Attwood, C.G., and B.A. Bennett. 1995. Modeling the effect of marine reserves on the recreational shore-fishery of the south-western cape, South Africa. South African Journal of Marine Science 16:227-240.

Babcock, R.C., S. Kelley, N.T. Shears, J.W. Walker, and T.J. Willis. 1999. Changes in community structure in temperate marine reserves. Marine Ecology Progress Series 189:125-134.

Ballantine, W.J. 1997. Design principles for systems of "no-take" marine reserves. In The Design and Monitoring of Marine Reserves, Fisheries Centre, University of British Columbia, Canada.

Bell, J.D. 1983. Effects of depth and marine reserve fishing restrictions on the structure of a rocky reef fish assemblage in the north-western Mediterranean Sea. Journal of Applied Ecology 20:357-369.

Bennett, B.A. and C.G. Attwood. 1991. Evidence for recovery of a surf-zone fish assemblage following the establishment of a marine reserve on the south coast of South Africa. Marine Ecology Progress Series 75:173-181.

Biodiversity Unit. 1993. Biodiversity and its value. Department of the Environment, Sport and Territories. Australia. http://kaos.erin.gov.au/life/general_info/op1.html.

Bohnsack, J.A. 1992. Reef resource habitat protection: the forgotten factor. In R.H. Stroud (ed). Stemming the Tide of Coastal Fish Habitat Loss. Marine Recreational Fisheries 14. Pp. 117-129.

Bohnsack, J.A. 1996. Maintenance and recovery of reef fishery productivity. In N.V.C. Polunin and C.M. Roberts (eds). Reef Fisheries. Chapman and Hall. London. Pp. 283-313.

Botsford, L.W., L.E. Morgan, D.R. Lockwood, and J.E. Wilen. In press. Marine reserves and management of the northern California red sea urchin fishery. Calcofi Reports.

Bustamente, R.H., P. Martinez, F. Rivera, R. Bensted-Smith, and L. Vinueza. 1999. A proposal for the initial zoning of the Galapagos Marine Reserve. Charles Darwin Research Station Technical Report. October 1999.

Buxton, C.D. and M.J. Smale. 1989. Abundance and distribution patterns of three temperate marine reef fish (Teleostei: Sparidae) in exploited and unexploited areas off the southern cape coast. Journal of Applied Ecology 26:441-451.

Carr, M.H., J.E. Neigel, S.J. Andelman, J.A. Estes, R.R. Warner, J.L. Largier, and J. Lubchenco. Manuscript. Comparing marine and terrestrial ecosystems: implications for principles of reserves design in marine systems.

Carr, M.H., and D.C. Reed. 1993. Conceptual issues relevant to marine harvest refuges: examples from temperate reef fishes. Canadian Journal of Fisheries and Aquatic Science 50:2019-2028.

Carr, M.H., J.E. Neigel, S.J. Andelman, J.A. Estes, R.R. Warner, J.L. Largier, and J. Lubchenco. In press. Comparing marine and terrestrial ecosystems: implications for principles of reserve design in marine systems. Ecological Applications.

Castilla, J.C. and L.R. Duran. 1985. Human exclusion from the rocky intertidal zone of central Chile: the effects on *Concholepas concholepas* (Gastropoda). Oikos 45:391-399.

Chapman, M.R. and D.L. Kramer. 1999. Gradients in coral reef fish density and size across the Barbados marine reserve boundary: effects of reserve protection and habitat characteristics. Marine Ecology Process Series 181:81-96.

Clark, J.R., B. Causey and J.A. Bohnsack. 1989. Benefits of coral reef protection: Looe Key reef, Florida. 6th Symposium on Coastal and Ocean Management. Charleston, South Carolina.

Daan, N. 1993. Simulation study of the effects of closed areas to all fishing, with particular reference to the North Sea ecosystem. Pages 252-258 in K. Sherman, LM Alexander, and BD Gold (eds). Larger Marine Ecosystems: Stress, Mitigation, and Sustainability. AAAS Press, Washington, DC.

Dahlgren, C.P. and J. Sobel. 2000. Designing a Dry Tortugas Ecological Reserve: How big is big enough?...To do what? Bulletin of Marine Science 66(3):707-719.

Davis, G.E. and J.W. Dodrill. 1980. Marine parks and sanctuaries for spiny lobster fisheries management. Proceedings of the Gulf of Caribbean Fisheries Institute 32:194-207.

Dayton, P.K., M.J. Tegner, P.B. Edwards, and K.L. Riser. 1998. Sliding baselines, ghosts, and reduced expectations in kelp forest communities. Ecological Applications 8:309-322.

Dayton, P.K., S.F. Thrush, M.T. Agardy, R.J. Hofman. 1995. Environmental effects of marine fishing. Aquatic conservation: Marine and Freshwater Ecosystems 5:1-28.

DeMartini, E.E. 1993. Modeling the potential of fishery reserves for managing Pacific coral reef fishes. Fishery Bulletin 91:414-427.

Dugan, J.E. and G.E. Davis. 1993. Applications of marine refugia to coastal fisheries management. Canadian Journal of Fisheries and Aquatic Science 50:2029-2042.

Edgar, G.J. and N.S. Barrett. 1999. Effects of the declaration of marine reserves on Tasmanian reef fishes, invertebrates, and plants. Journal of Experimental Marine Biology and Ecology 242:107-144.

Fisheries Resource Conservation Council. 1994. Conservation Requirements for Atlantic Groundfish. Report to the Minister of Fisheries and Oceans. Ottawa, Canada.

Foran, T., and R.M. Fujita. 1999. Modeling the Biological Impact of No-take Reserve Policy on Pacific Continental Slope Rockfish. Environmental Defense Fund, Oakland, California.

Fujita, R.M. 1998. A review of the performance of some US west coast marine reserves. Environmental Defense Fund, 5655 College Avenue, Suite 304, Oakland, CA 94618. USA.

Goodyear, C.P. 1993. Spawning stock biomass per recruit in fisheries management: foundation and current use. Canadian Special Publications in Fisheries and Aquatic Science 120: 25-34.

Grigg, R.W. 1994. Effects of sewage discharge, fishing pressure, and habitat complexity on coral ecosystems and reef fishes in Hawaii. Marine Ecology Progress Series 103:25-34.

Guenette, S., and T.J. Pitcher. 1999. An age-structured model showing the benefits of marine reserves in controlling overexploitation. Fisheries Research 39:295-303.

Halliday, R.G. 1988. Use of seasonal spawning area closures in the management of haddock fisheries in the Northwest Atlantic. NAFO Scientific Council Studies 12:27-35.

Halpern, B. In press. The impact of marine reserves: does size matter? Ecological Applications.

Hannesson, R. 1998. Marine reserves: what would they accomplish? Marine Resource Economics 13:159-170.

Hastings, A., and L. Botsford. 1999. Equivalence in yield from marine reserves and traditional fisheries management. Science 284:1-2.

Holland, D.S. and R.J. Brazee. 1996. Marine reserves for fisheries management. Marine Resource Economics 11:157-171.

Horwood, J. 2000. No-take zones: a management context. In M.J. Kaiser and S.J. de Groot. The effects of fishing on non-target species and habitats: Biological, conservation and socio-economic issues. Blackwell Science Ltd. Oxford. Pp 302-311.

Jennings, S., E.M. Grandcourt, and N.V.C. Polunin. 1995. The effects of fishing on the diversity, biomass, and trophic structure of Seychelles' reef fish communities. Coral Reefs 14:225-235.

Jennings, S., S.S. Marshall, and N.V.C. Polunin. 1996. Seychelles' marine protected areas: comparative structure and status of reef fish communities. Biological Conservation 75:201-209.

Jennings, S. 1998. Cousin Island, Seychelles: a small, effective, internationally-managed marine reserve. Coral Reefs 17:190.

Johnson, D.R., N.A. Funicelli, and J.A. Bohnsack. 1999. Effectiveness of an existing estuarine no-take fish sanctuary within the Kennedy space center, Florida. American Journal of Fisheries Management 19:436-453.

Lauck, T., C.W. Clark, M. Mangel, and G.R. Munro. 1998. Implementing the precautionary principle in fisheries management through marine reserves. Ecological Applications 8:S72-S78.

Letourneur, Y. 1996. Reponses des peuplements et populations de poissons aux reserves marines: le cas de l'ile de Mayotte, Ocean Indien occidental. Ecoscience 3:442-450.

Mace, P.M., and M.P. Sissenwine. 1993. How much spawning per recruit is enough? Canadian Special Publication of Fisheries and Aquatic Sciences 120:110-118.

Mace, P.M. 1994. Relationships between common biological reference points used as thresholds and targets of fisheries management strategies. Canadian Journal of Fisheries and Aquatic Sciences 51:110-122.

Magurran, A.E. 1988. Ecological Diversity and Its Measurement. Croom-Helm, London.

Man, A., R. Law, and N.V.C Polunin. 1995. Role of marine reserves in recruitment into reef fisheries: a metapopulation model. Biological Conservation 71:197-204.

Mangel, M. 2000. Trade-offs between fish habitat and fishing mortality and the role of reserves. Bulletin of Marine Science 66(3):663-674.

McClanahan, T.R. 1994. Kenyan coral reef lagoon fish. Effects of fishing, substrate complexity and sea urchins. Coral Reefs 13:231-241.

McClanahan, T.R. and B. Kaunda-Arara. 1996. Fishery recovery in a coral reef marine park and its effects on the adjacent fishery. Conservation Biology 10:1187-1199.

McGarvey, R. and J.H.M. Willison. 1995. Rationale for a marine protected area along the international boundary between U.S. and Canadian waters in the Gulf of Maine. In N.L. Shackell and J.H.M. Willison (eds). Marine Protected Areas and Sustainable Fisheries. Science and Management of Protected Areas Association, Wolfville, Canada. Pp. 74-81.

Murawski, S.A., R. Brown, H.L. Lai, P.J. Rago, and L. Hendrickson. 2000. Large-scale closed areas as fishery-management tool in temperate marine systems: The Georges Bank experience. Bulletin of Marine Science.

Musick, J.A., M.M. Harbin, S.A. Berkeley, G.H. Burgess, A.M. Eklund, L. Findley, R.G. Gilmore, J.T. Golden, D.S. Ha, G.R. Huntsman, J.C. McGovern, S.J. Parker, S.G. Poss, E. Sala, T.W. Schmidt, G.R. Sedberry, H. Weeks, and S.G. Wright. 2000. Marine, Estuarine, and Diadromous Fish Stocks at Risk of Extinction in North America (Exclusive of Pacific Salmonids). Endangered Species 25(11):6-29.

Palsson, W.A. and R.E. Pacunski. 1995. The response of rocky reef fishes to harvest refugia in Puget Sound. Proceedings: Volume 1: Puget Sound Research '95. Puget Sound Water Quality Authority, Olympia, Washington, U.S.A.

Polunin, N.V.C. and C.M. Roberts. 1993. Greater biomass and value of target coral reef fishes in two small Caribbean marine reserves. Marine Ecology Progress Series 100:167-176.

Pezzey, J.C.V., C.M. Roberts, and B.T. Urdal. 2000. A simple bioeconomic model of a marine reserve. Ecological Economics 33:77-91.

Piet, G.J., and A.D. Rjinsdorp. 1998. Changes in the demersal fish assemblage in the southeastern North Sea following establishment of the protected areas ("plaice box"). ICES Journal of Marine Science 55:420-429.

Polacheck, T. 1990. Year around closed areas as a management tool. Natural Resource Modeling 4:327-354.

Polunin, N.V.C. and C.M. Roberts. 1993. Greater biomass and value of target coral reef fishes in two small Caribbean marine reserves. Marine Ecology Progress Series 100:167-176.

Quinn, J., S.R. Wing and L.W. Botsford. 1993. Harvest refugia in marine invertebrate fisheries: models and applications to the red sea urchin, *Strongylocentrotus franciscanus.* American Zoologist 33:537-550.

Quinn, J.F. 1997. Considerations for Marine Protected Areas: Sizing and Spacing. California and the World Ocean '97. Taking a Look at California's Ocean Resources: An agenda for the Future. Vol. 1:260.

Rakitin, A. and D.L. Kramer. 1996. Effect of a marine reserve on the distribution of coral reef fishes in Barbados. Marine Ecology Progress Series 131:97-113.

Ramos-Espla, A.A. and S.E. McNeill. 1994. The status of marine conservation in Spain. Ocean and Coastal Management 24:125-138.

Roberts, C.M. and N.V.C. Polunin. 1991. Are marine reserves effective in management of reef fisheries? Review in Fish Biology and Fisheries 1:65-91.

Roberts, C.M. and N.V.C. Polunin. 1993a. Effects of marine reserve protection on northern Red Sea fish populations. Proceedings of the 7th International Coral Reef Symposium, Guam 2:969-977.

Roberts, C.M. and N.V.C. Polunin. 1993b. Marine Reserves: Simple solutions to managing complex fisheries? Ambio 22:363-368.

Roberts, C.M. and N.V.C. Polunin. 1994. Hol Chan: demonstrating that marine reserves can be remarkably effective. Coral Reefs 13:90.

Roberts, C.M. and J.P. Hawkins. 1997. How small can a marine reserve be and still be effective? Coral Reefs 16:150.

Roberts, C.M. and J.P. Hawkins. 2000. Fully-protected marine reserves: a guide. WWF Endangered Seas Campaign. 1250 24th Street, NW. Washington, DC 20037, USA and Environment Department, University of York, York YO10 5DD, UK.

Roberts, C.M., G. Branch, R.H. Bustamante, J.C. Castilla, J. Dugan, B. Halpern, K.D. Lafferty, H. Leslie, J. Lubchenco, D. McArdle, M. Ruckelshaus, and R. Warner. In press. Application of ecological criteria in selecting marine reserves and developing reserve networks. Ecological Applications.

Roughgarden, J. 1998. How to manage fisheries. Ecological Applications S8:160-164.

Roughgarden, J. Manuscript. Models of marine reserves: status relative to the Marine Reserves Working Group goals.

Roughgarden, J. and F. Smith. 1996. Why fisheries collapse and what to do about it. Proceedings of the National Academy of Science, USA. 93:5078-5083.

Rowley, R.J. 1994. Case studies and reviews. Marine reserves in fisheries management. Aquatic Conservation: Marine and Freshwater Ecosystems 4:233-254.

Russ, G.R. and A.C. Alcala. 1996a. Marine reserves: rates and patterns of recovery and decline of large predatory fish. Ecological Applications 6:947-961.

Russ, G.R. and A.C. Alcala. 1996b. Do marine reserves export adult fish biomass? Evidence from Apo Island, Central Philippines. Marine Ecology Progress Series 132:1-9.

Sladek-Nowlis, J.J., and C.M. Roberts. 1997. You can have your fish and eat it too: theoretical approaches to marine reserve design. Proceedings of the 8th International Coral Reef Symposium, Panama 2:1907-1910.

Sladek-Nowlis, J.J., and C.M. Roberts. 1999. Fisheries benefits and optimal design of marine reserves. Fisheries Bulletin US 67:604-616.

Sladek-Nowlis, J.J., and M.M. Yoklavich. 1998. Design criteria for rockfish harvest refugia from models of fish transport. Pages 32-40 in MM Yoklavich (ed). Marine harvest refugia for west coast rockfish: a workshop. NOAA Technical Memorandum NMFS-SWFSC-255, Silver Springs, Maryland.

Sluka, R., M. Chiappone, K.M. Sullivan, and R. Wright. 1997. The benefits of a marine fishery reserve for Nassau grouper (*Epinephelus striatus*) in the central Bahamas. Proceedings of the 8th International Coral Reef Symposium, Panama 2:1961-1964.

Stockhausen, W.T., R.N. Lipcius and B.M. Hickey. 2000. Factors shaping reserve design. Bulletin of Marine Science 66(3):661-690.

Stoner, A.W. and M. Ray. 1996. Queen conch, *Strobus gigas*, in fished and unfished locations of the Bahamas: effects of a marine fishery reserve on adults, juveniles, and larval production. Fishery Bulletin 94:551-565.

Sumaila, U.R. 1998. Protected marine reserves as fisheries management tools: a bioeconomic analysis. Chr. Michelsen Institute. Fantoftvegen 38, N-5036 Fantoft, Bergen, Norway.

Trexler, J., and J. Travis. 2000. Can marine protected areas conserve stock attributes? Bulletin of Marine Science.

Turpie, J.K., L.E. Beckley and S.M. Katua. 2000. Biogeography and the selection of priority areas for conservation of South African coastal fishes. Biological Conservation 92:59-72.

Wantiez, L., P. Thollot, and M. Kulbicki. 1997. Effects of marine reserves on coral reef fish communities from five islands in New Caledonia. Coral Reefs 16:215-224.

Watson, M. and R.F.G. Ormond. 1994. Effect of an artisanal fishery on the fish and urchin populations of a Kenyan coral reef. Marine Ecology Progress Series 109:115-129.

Watson, M., D. Righton, T. Austin, and R. Ormond. 1996. The effects of fishing on coral reef abundance and diversity. Journal of Marine Biological Association of the United Kingdom 76:229-233.

Yamaski, A. and A. Kuwahara. 1990. Preserved area to effect recovery of overfished Zuwai crab stocks off Kyoto Prefecture. In Proceedings of the International Symposium on King and Tanner Crabs, November 1989, Anchorage, Alaska. Alaska Sea Grant College Program, University of Alaska, Fairbanks, Alaska, U.S.A. Pp. 575-585.

QUESTIONS FOR THE SCIENCE ADVISORY PANEL

What guidance or direction did the Science Panel use to craft its recommendation?

The Science Advisory Panel used the goals and objectives for Ecosystem Biodiversity, Sustainable Harvested Populations and Research to guide their deliberations of reserve location and size in the Channel Islands National Marine Sanctuary. The goals for Ecosystem Biodiversity, Sustainable Harvest Populations and Research were ratified by the MRWG at their June 8, 2000 meeting.

Ecosystem Biodiversity:

To protect representative and unique marine habitats, ecological processes, and populations of interest.

Objectives -
1. To include representative marine habitats, ecological processes, and populations of interest.
2. To identify and protect multiple levels of diversity (e.g. species, habitats, biogeographic provinces, trophic structure).
3. To provide a buffer for species of interest against the impacts of environmental fluctuations.
4. To identify and incorporate representative and unique marine habitats.
5. To set aside areas which provide physical, biological, and chemical functions.
6. To enhance long-term biological productivity.
7. To minimize short-term loss of biological productivity.
8. To develop methods for evaluating ecosystem integrity.

Sustainable Harvested Populations:

To provide a buffer against impacts of environmental fluctuations on commercial and recreationally important species.

Objectives -
1. To facilitate recovery and sustainability of harvested populations.
2. To enhance spillover into non-reserve areas.
3. To establish long-term monitoring programs in, adjacent to, and distant from reserves.
4. To monitor impacts of reserves on commercial and recreational industries.
5. To document changes of catch characteristics of users adjacent to and distant from reserves.
6. To study and evaluate the effects of predators on marine populations in, adjacent to and distant from reserves.
7. To evaluate the effectiveness of reserves as a tool in the context of integrated fishery management.
8. To develop an adaptive management design for reserves as an experimental fishery management tool.

9. To assess the short- and long-term effectiveness of reserves as an experimental fishery management tool.

Research

1. **To monitor ecosystem functions and acquire baseline data to assess natural and human impacts between reserve and other areas; and**

2. **To evaluate the short- and long-term effectiveness of reserves as resource and fishery management tools.**

Objectives -

1. To design reserves that will be tractable for monitoring of biological and physical processes.
2. To develop a monitoring and evaluation program that will provide enough information for adaptive management.
3. To establish long-term monitoring of ecological patterns and processes in, adjacent to, and distant from marine reserves.
4. To establish areas for systematic study of nearshore marine species, including (1) larval export, (2) adult migration, (3) relative abundances, (4) size-frequency distributions, and (5) other topics of interest.
5. To evaluate short- and long-term differences between reserve and non-reserve areas.
6. To provide long-term continuity in effort, expertise, and funding during reserve monitoring and evaluation.

QUESTIONS FOR THE SCIENCE ADVISORY PANEL

Beyond the ecosystem biodiversity and sustainable fisheries goals and objectives, what was the basis of your recommendations?

The Science Advisory Panel reviewed the scientific literature on marine reserves. In particular, Panel members considered papers that addressed the question of reserve size and location for conservation and fisheries management. The following bibliography contains papers that were considered by members of the Science Advisory Panel.

References

Agardy, T. 2000. Information needs for marine protected areas: scientific and societal. Bulletin of Marine Science 66(3):875-888.

Alcala, A.C. and G.R. Russ. 1990. A direct test of the effects of protective management on abundance and yield of tropical marine resources. Journal du Conseil International pour l'Exploration de la Mer 46:40-47.

Allison, G.W., S.D. Gaines, J. Lubchenco, H.P. Possingham. In press. Taking the long view of marine reserves: Catastrophes and an insurance factor.

Alward, G.L. 1932. The Sea Fisheries of Great Britain and Ireland. Alberta Gait, Grimsby, UK.

Attwood, C.G. and B.A. Bennett. 1994. Variation in dispersal of galjoen (*Coracinus capensis*) (Teleostei: Coracinidae) from a marine reserve. Canadian Journal of Fisheries and Aquatic Science 51:1247-1257.

Attwood, C.G., and B.A. Bennett. 1995. Modeling the effect of marine reserves on the recreational shore-fishery of the south-western cape, South Africa. South African Journal of Marine Science 16:227-240.

Babcock, R.C., S. Kelley, N.T. Shears, J.W. Walker, and T.J. Willis. 1999. Changes in community structure in temperate marine reserves. Marine Ecology Progress Series 189:125-134.

Ballantine, W.J. 1997. Design principles for systems of "no-take" marine reserves. In The Design and Monitoring of Marine Reserves, Fisheries Centre, University of British Columbia, Canada.

Bell, J.D. 1983. Effects of depth and marine reserve fishing restrictions on the structure of a rocky reef fish assemblage in the north-western Mediterranean Sea. Journal of Applied Ecology 20:357-369.

Bennett, B.A. and C.G. Attwood. 1991. Evidence for recovery of a surf-zone fish assemblage following the establishment of a marine reserve on the south coast of South Africa. Marine Ecology Progress Series 75:173-181.

Biodiversity Unit. 1993. Biodiversity and its value. Department of the Environment, Sport and Territories. Australia. http://kaos.erin.gov.au/life/general_info/op1.html.

Bohnsack, J.A. 1992. Reef resource habitat protection: the forgotten factor. In R.H. Stroud (ed). Stemming the Tide of Coastal Fish Habitat Loss. Marine Recreational Fisheries 14. Pp. 117-129.

Bohnsack, J.A. 1996. Maintenance and recovery of reef fishery productivity. In N.V.C. Polunin and C.M. Roberts (eds). Reef Fisheries. Chapman and Hall. London. Pp. 283-313.

Botsford, L.W., L.E. Morgan, D.R. Lockwood, and J.E. Wilen. In press. Marine reserves and management of the northern California red sea urchin fishery. Calcofi Reports.

Bustamente, R.H., P. Martinez, F. Rivera, R. Bensted-Smith, and L. Vinueza. 1999. A proposal for the initial zoning of the Galapagos Marine Reserve. Charles Darwin Research Station Technical Report. October 1999.

Buxton, C.D. and M.J. Smale. 1989. Abundance and distribution patterns of three temperate marine reef fish (Teleostei: Sparidae) in exploited and unexploited areas off the southern cape coast. Journal of Applied Ecology 26:441-451.

Carr, M.H., J.E. Neigel, S.J. Andelman, J.A. Estes, R.R. Warner, J.L. Largier, and J. Lubchenco. Manuscript. Comparing marine and terrestrial ecosystems: implications for principles of reserves design in marine systems.

Carr, M.H., and D.C. Reed. 1993. Conceptual issues relevant to marine harvest refuges: examples from temperate reef fishes. Canadian Journal of Fisheries and Aquatic Science 50:2019-2028.

Carr, M.H., J.E. Neigel, S.J. Andelman, J.A. Estes, R.R. Warner, J.L. Largier, and J. Lubchenco. In press. Comparing marine and terrestrial ecosystems: implications for principles of reserve design in marine systems. Ecological Applications.

Castilla, J.C. and L.R. Duran. 1985. Human exclusion from the rocky intertidal zone of central Chile: the effects on *Concholepas concholepas* (Gastropoda). Oikos 45:391-399.

Chapman, M.R. and D.L. Kramer. 1999. Gradients in coral reef fish density and size across the Barbados marine reserve boundary: effects of reserve protection and habitat characteristics. Marine Ecology Process Series 181:81-96.

Clark, J.R., B. Causey and J.A. Bohnsack. 1989. Benefits of coral reef protection: Looe Key reef, Florida. 6th Symposium on Coastal and Ocean Management. Charleston, South Carolina.

Daan, N. 1993. Simulation study of the effects of closed areas to all fishing, with particular reference to the North Sea ecosystem. Pages 252-258 in K. Sherman, LM Alexander, and BD Gold (eds). Larger Marine Ecosystems: Stress, Mitigation, and Sustainability. AAAS Press, Washington, DC.

Dahlgren, C.P. and J. Sobel. 2000. Designing a Dry Tortugas Ecological Reserve: How big is big enough?...To do what? Bulletin of Marine Science 66(3):707-719.

Davis, G.E. and J.W. Dodrill. 1980. Marine parks and sanctuaries for spiny lobster fisheries management. Proceedings of the Gulf of Caribbean Fisheries Institute 32:194-207.

Dayton, P.K., M.J. Tegner, P.B. Edwards, and K.L. Riser. 1998. Sliding baselines, ghosts, and reduced expectations in kelp forest communities. Ecological Applications 8:309-322.

Dayton, P.K., S.F. Thrush, M.T. Agardy, R.J. Hofman. 1995. Environmental effects of marine fishing. Aquatic conservation: Marine and Freshwater Ecosystems 5:1-28.

DeMartini, E.E. 1993. Modeling the potential of fishery reserves for managing Pacific coral reef fishes. Fishery Bulletin 91:414-427.

Dugan, J.E. and G.E. Davis. 1993. Applications of marine refugia to coastal fisheries management. Canadian Journal of Fisheries and Aquatic Science 50:2029-2042.

Edgar, G.J. and N.S. Barrett. 1999. Effects of the declaration of marine reserves on Tasmanian reef fishes, invertebrates, and plants. Journal of Experimental Marine Biology and Ecology 242:107-144.

Fisheries Resource Conservation Council. 1994. Conservation Requirements for Atlantic Groundfish. Report to the Minister of Fisheries and Oceans. Ottawa, Canada.

Foran, T., and R.M. Fujita. 1999. Modeling the Biological Impact of No-take Reserve Policy on Pacific Continental Slope Rockfish. Environmental Defense Fund, Oakland, California.

Fujita, R.M. 1998. A review of the performance of some US west coast marine reserves. Environmental Defense Fund, 5655 College Avenue, Suite 304, Oakland, CA 94618. USA.

Goodyear, C.P. 1993. Spawning stock biomass per recruit in fisheries management: foundation and current use. Canadian Special Publications in Fisheries and Aquatic Science 120: 25-34.

Grigg, R.W. 1994. Effects of sewage discharge, fishing pressure, and habitat complexity on coral ecosystems and reef fishes in Hawaii. Marine Ecology Progress Series 103:25-34.

Guenette, S., and T.J. Pitcher. 1999. An age-structured model showing the benefits of marine reserves in controlling overexploitation. Fisheries Research 39:295-303.

Halliday, R.G. 1988. Use of seasonal spawning area closures in the management of haddock fisheries in the Northwest Atlantic. NAFO Scientific Council Studies 12:27-35.

Halpern, B. In press. The impact of marine reserves: does size matter? Ecological Applications.

Hannesson, R. 1998. Marine reserves: what would they accomplish? Marine Resource Economics 13:159-170.

Hastings, A., and L. Botsford. 1999. Equivalence in yield from marine reserves and traditional fisheries management. Science 284:1-2.

Holland, D.S. and R.J. Brazee. 1996. Marine reserves for fisheries management. Marine Resource Economics 11:157-171.

Horwood, J. 2000. No-take zones: a management context. In MJ Kaiser and SJ de Groot. <u>The effects of fishing on non-target species and habitats, Biological, conservation and socio-economic issues</u>. Blackwell Science Ltd. Oxford. Pp 302-311.

Jennings, S., E.M. Grandcourt, and N.V.C. Polunin. 1995. The effects of fishing on the diversity, biomass, and trophic structure of Seychelles' reef fish communities. Coral Reefs 14:225-235.

Jennings, S., S.S. Marshall, and N.V.C. Polunin. 1996. Seychelles' marine protected areas: comparative structure and status of reef fish communities. Biological Conservation 75:201-209.

Jennings, S. 1998. Cousin Island, Seychelles: a small, effective, internationally-managed marine reserve. Coral Reefs 17:190.

Johnson, D.R., N.A. Funicelli, and J.A. Bohnsack. 1999. Effectiveness of an existing estuarine no-take fish sanctuary within the Kennedy space center, Florida. American Journal of Fisheries Management 19:436-453.

Lauck, T., C.W. Clark, M. Mangel, and G.R. Munro. 1998. Implementing the precautionary principle in fisheries management through marine reserves. Ecological Applications 8:S72-S78.

Letourneur, Y. 1996. Reponses des peuplements et populations de poissons aux reserves marines: le cas de l'ile de Mayotte. Ocean Indien occidental. Ecoscience 3:442-450.

Mace, P.M., and M.P. Sissenwine. 1993. How much spawning per recruit is enough? Canadian Special Publication of Fisheries and Aquatic Sciences 120:110-118.

Mace, P.M. 1994. Relationships between common biological reference points used as thresholds and targets of fisheries management strategies. Canadian Journal of Fisheries and Aquatic Sciences 51:110-122.

Magurran, A.E. 1988. Ecological Diversity and Its Measurement. Croom-Helm, London.

Man, A., R. Law, and N.V.C Polunin. 1995. Role of marine reserves in recruitment into reef fisheries: a metapopulation model. Biological Conservation 71:197-204.

Mangel, M. 2000. Trade-offs between fish habitat and fishing mortality and the role of reserves. Bulletin of Marine Science 66(3):663-674.

McClanahan, T.R. 1994. Kenyan coral reef lagoon fish. Effects of fishing, substrate complexity and sea urchins. Coral Reefs 13:231-241.

McClanahan, T.R. and B. Kaunda-Arara. 1996. Fishery recovery in a coral reef marine park and its effects on the adjacent fishery. Conservation Biology 10:1187-1199.

McGarvey, R. and J.H.M. Willison. 1995. Rationale for a marine protected area along the international boundary between U.S. and Canadian waters in the Gulf of Maine. In N.L. Shackell and J.H.M. Willison (eds). Marine Protected Areas and Sustainable Fisheries. Science and Management of Protected Areas Association, Wolfville, Canada. Pp. 74-81.

Murawski, S.A., R. Brown, H.L. Lai, P.J. Rago, and L. Hendrickson. 2000. Large-scale closed areas as fishery-management tool in temperate marine systems: The Georges Bank experience.

Musick, J.A., M.M. Harbin, S.A. Berkeley, G.H. Burgess, A.M. Eklund, L. Findley, R.G. Gilmore, J.T. Golden, D.S. Ha, G.R. Huntsman, J.C. McGovern, S.J. Parker, S.G. Poss, E. Sala, T.W. Schmidt, G.R. Sedberry, H. Weeks, and S.G. Wright. 2000. Marine, Estuarine, and Diadromous Fish Stocks at Risk of Extinction in North America (Exclusive of Pacific Salmonids). Endangered Species 25(11):6-29.

Palsson, W.A. and R.E. Pacunski. 1995. The response of rocky reef fishes to harvest refugia in Puget Sound. Proceedings: Volume 1: Puget Sound Research '95. Puget Sound Water Quality Authority, Olympia, Washington, U.S.A.

Pezzey, J.C.V., C.M. Roberts, and B.T. Urdal. 2000. A simple bioeconomic model of a marine reserve. Ecological Economics 33:77-91.

Piet, G.J., and A.D. Rjinsdorp. 1998. Changes in the demersal fish assemblage in the southeastern North Sea following establishment of the protected areas ("plaice box"). ICES Journal of Marine Science 55:420-429.

Polacheck, T. 1990. Year around closed areas as a management tool. Natural Resource Modeling 4:327-354.

Polunin, N.V.C. and C.M. Roberts. 1993. Greater biomass and value of target coral reef fishes in two small Caribbean marine reserves. Marine Ecology Progress Series 100:167-176.

Quinn, J., S.R. Wing and L.W. Botsford. 1993. Harvest refugia in marine invertebrate fisheries: models and applications to the red sea urchin, *Strongylocentrotus franciscanus.* American Zoologist 33:537-550.

Quinn, J.F. 1997. Considerations for Marine Protected Areas: Sizing and Spacing. California and the World Ocean '97. Taking a Look at California's Ocean Resources: An agenda for the Future. Vol. 1:260.

Rakitin, A. and D.L. Kramer. 1996. Effect of a marine reserve on the distribution of coral reef fishes in Barbados. Marine Ecology Progress Series 131:97-113.

Ramos-Espla, A.A. and S.E. McNeill. 1994. The status of marine conservation in Spain. Ocean and Coastal Management 24:125-138.

Roberts, C.M. and N.V.C. Polunin. 1991. Are marine reserves effective in management of reef fisheries? Review in Fish Biology and Fisheries 1:65-91.

Roberts, C.M. and N.V.C. Polunin. 1993a. Effects of marine reserve protection on northern Red Sea fish populations. Proceedings of the 7th International Coral Reef Symposium, Guam 2:969-977.

Roberts, C.M. and N.V.C. Polunin. 1993b. Marine Reserves: Simple solutions to managing complex fisheries? Ambio 22:363-368.

Roberts, C.M. and N.V.C. Polunin. 1994. Hol Chan: demonstrating that marine reserves can be remarkably effective. Coral Reefs 13:90.

Roberts, C.M. and J.P. Hawkins. 1997. How small can a marine reserve be and still be effective? Coral Reefs 16:150.

Roberts, C.M. and J.P. Hawkins. 2000. Fully-protected marine reserves: a guide. WWF Endangered Seas Campaign. 1250 24th Street, NW. Washington, DC 20037, USA and Environment Department, University of York, York YO10 5DD, UK.

Roberts, C.M., G. Branch, R.H. Bustamante, J.C. Castilla, J. Dugan, B. Halpern, K.D. Lafferty, H. Leslie, J. Lubchenco, D. McArdle, M. Ruckelshaus, and R. Warner. Application of ecological criteria in selecting marine reserves and developing reserve networks. Unpublished manuscript.

Roughgarden, J. 1998. How to manage fisheries. Ecological Applications S8:160-164.

Roughgarden, J. Manuscript. Models of marine reserves: status relative to the Marine Reserves Working Group goals.

Roughgarden, J. and F. Smith. 1996. Why fisheries collapse and what to do about it. Proceedings of the National Academy of Science, USA. 93:5078-5083.

Rowley, R.J. 1994. Case studies and reviews. Marine reserves in fisheries management. Aquatic Conservation: Marine and Freshwater Ecosystems 4:233-254.

Russ, G.R. and A.C. Alcala. 1996a. Marine reserves: rates and patterns of recovery and decline of large predatory fish. Ecological Applications 6:947-961.

Russ, G.R. and A.C. Alcala. 1996b. Do marine reserves export adult fish biomass? Evidence from Apo Island, Central Philippines. Marine Ecology Progress Series 132:1-9.

Sladek-Nowlis, J.J., and C.M. Roberts. 1997. You can have your fish and eat it too: theoretical approaches to marine reserve design. Proceedings of the 8th International Coral Reef Symposium, Panama 2:1907-1910.

Sladek-Nowlis, J.J., and C.M. Roberts. 1999. Fisheries benefits and optimal design of marine reserves. Fisheries Bulletin US 67:604-616.

Sladek-Nowlis, J.J., and M.M. Yoklavich. 1998. Design criteria for rockfish harvest refugia from models of fish transport. Pages 32-40 in MM Yoklavich (ed). Marine harvest refugia for west coast rockfish: a workshop. NOAA Technical Memorandum NMFS-SWFSC-255, Silver Springs, Maryland.

Sluka, R., M. Chiappone, K.M. Sullivan, and R. Wright. 1997. The benefits of a marine fishery reserve for Nassau grouper (*Epinephelus striatus*) in the central Bahamas. Proceedings of the 8th International Coral Reef Symposium, Panama 2:1961-1964.

Stockhausen, W.T., R.N. Lipcius and B.M. Hickey. 2000. Factors shaping reserve design. Bulletin of Marine Science 66(3):661-690.

Stoner, A.W. and M. Ray. 1996. Queen conch, *Strobus gigas*, in fished and unfished locations of the Bahamas: effects of a marine fishery reserve on adults, juveniles, and larval production. Fishery Bulletin 94:551-565.

Sumaila, U.R. 1998. Protected marine reserves as fisheries management tools: a bioeconomic analysis. Chr. Michelsen Institute. Fantoftvegen 38, N-5036 Fantoft, Bergen, Norway.

Trexler, J., and J. Travis. 2000. Can marine protected areas conserve stock attributes? Bulletin of Marine Science.

Turpie, J.K., L.E. Beckley and S.M. Katua. 2000. Biogeography and the selection of priority areas for conservation of South African coastal fishes. Biological Conservation 92:59-72.

Wantiez, L., P. Thollot, and M. Kulbicki. 1997. Effects of marine reserves on coral reef fish communities from five islands in New Caledonia. Coral Reefs 16:215-224.

Watson, M. and R.F.G. Ormond. 1994. Effect of an artisanal fishery on the fish and urchin populations of a Kenyan coral reef. Marine Ecology Progress Series 109:115-129.

Watson, M., D. Righton, T. Austin, and R. Ormond. 1996. The effects of fishing on coral reef abundance and diversity. Journal of Marine Biological Association of the United Kingdom 76:229-233.

Yamaski, A. and A. Kuwahara. 1990. Preserved area to effect recovery of overfished Zuwai crab stocks off Kyoto Prefecture. In Proceedings of the International Symposium on King and Tanner Crabs, November 1989, Anchorage, Alaska. Alaska Sea Grant College Program, University of Alaska, Fairbanks, Alaska, U.S.A. Pp. 575-585.

Explain how the ecosystem biodiversity and sustainable fisheries goals are compatible? Review the step from single species models to ecosystem model.

Although there is a positive relationship between reserve area and diversity of species protected, there is no clear method of determining how much area is enough for conservation purposes. The conservation of ecosystem biodiversity requires the maintenance of ecological roles of all species, including those that are fished, in natural population densities and size structures. Populations of fished species are more vulnerable than other species because their rates of mortality increase proportionally with the fishing effort. If the rate of natural plus fishing mortality exceeds the rate of birth plus immigration, fished populations will decline. As population sizes decrease, the populations become more susceptible to environmental fluctuations, catastrophic events, and demographic stochasticity. Consequently, estimates of the minimum area required sustain fished species are likely to provide the best basis for the size of reserves for conservation of biodiversity. If no-take reserves are designed to sustain the natural populations of fished species, the reserve is likely to protect the necessary habitat for other, non-fished species in the ecosystem. Consequently, estimates of the reserve area required to sustain fished species are likely to provide the best basis for determining the percentage of habitat or stock required for protecting ecosystem biodiversity.

Because species diversity increases with area, and because some species require larger areas to maintain self-sustainability, marine reserves for conservation must be as large as possible within the constraints imposed by fishers and other users. Data from harvested populations indicate that species differ greatly in the degree to which they can be reduced below normal carrying capacity before they are not self-sustainable in the long term. Given the available empirical data, a minimum reserve size of 30% would sustain approximately 75% of the species for which data are currently available. To meet the minimum requirements for all species, the fraction set aside in reserves would need to exceed 70%. If reserves are designed for fisheries enhancement and sustainability, numerous theoretical studies and limited empirical data indicate that protecting approximately 35% of fishing grounds will maximize catches (Table 1). Thus a reserve area of 30-50% of an area of interest will achieve some measure of protection for both conservation and fisheries goals. Because of the complexity upon which this estimate is based, continued evaluation of reserve effectiveness is absolutely necessary to determine whether alteration (reduction or increase) is appropriate.

Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Sladek-Nowlis and Roberts (1997, 1999)	75-80%	Maintain long-term sustainability yields of fish species with high fishing mortalities.
Hannesson (1999)	50-80%	To produce catches and spawning stock levels of cod *(Gadus morhua)* equivalent to those of an optimally contrilled fishery (one where stock size is held at 50% of the unexploited level).
Mace and Sissenwine (1993)	20-80%	Maintain sustainable populations of fished species.
Roughgarden (1998)	30-50%	Maintain exploited populations at 75% of their unexploited size.
Clark et al. (1989)	25-75%	Reduce the likely time to extinction of an exploited population with no reserve. A reserve of 25% increased time to extinction by 8 times, one of 50% by 40 times, and one of 75% reduced extinction risk to the level of unexploited populations.
Lauck *et al.* (1998)	31-70%	Maintain populations above 60% of their carrying capacity over a 40 year time horizon. The reserve area required increased with fishing intensity.
Lauck *et al.* (1999)	>50%	Ensure high probability of stock persistence under variable levels of harvest.
Allison *et al.* (2000)	35-50%	Ensure high probability of stock persistence under variable environmental conditions with periodic catastrophic events.
Carr *et al.* (1998)	35-50%	Maximize long-term sustainable yields of fished species and reduce annual catch variability.

Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Roughgarden (2000)	30-50%	Ensure high probability of stock persistence under variable levels of harvest and under varying environmental conditions.
Sumaila (1998)	30-50%	Protect stocks without greatly reducing economic benefits. The size depends on the degree of risk managers are willing to accept.
DeMartini (1993)	20-50%	Increase spawning stock size to provide insurance against uncertainties associated with fisheries management.
Quinn *et al.* (1993)	50%	To maximize population sizes and sustain existing levels of catch of the California red sea urchin (*Strongylocentrotus franciscanus*).
Dahlgren and Sobel (2000)	40%	Elevate stocks to sustainable target levels.
Sladek-Nowlis and Roberts (1999)	40%	Elevate stocks from current levels of overfishing.
Mace (1994)	40%	Maintain sustainable populations of fished species.
Man et al. (1995)	20-40%	Maintain sustainable populations of fished species in networks of reserves.
Roberts (2000)	20-40%	Reduce the risk of overexploitation and fishery collapse. Maximize long-term yields of over-exploited species.
Polacheck (1990)	10-40%	Maintain long-term sustainability yields of Georges Bank cod (*Gadus morhua*) under variable levels of harvest and varying environmental conditions.

Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Turpie *et al.* (2000)	36%	To maximize long-term persistence of species along the South African coast.
Bustamente *et al.* (2000)	36%	To represent all coastal habitat types in each of five biogeographic zones encompassed by the Galapagos Islands.
Stockhausen *et al*. (2000)	>35% in a network of reserves	Elevate stocks from current levels of overfishing.
Mangel (2000)	>35%	Maintain long-term sustainability yields of stock persistence under variable levels of harvest and varying environmental conditions.
Botsford et al. (2000)	35%	Maintaining adequate reproduction for all species.
Hastings and Botsford (1999)	35%	Maintain adequate reproduction for all species. For species that reproduce over long lifespans, the fraction of area set aside is smaller than the fraction of the adult population that needs to be protected under conventional management.
Dahlgren and Sobel (2000)	30%	Elevate stocks from current levels of overfishing.
Guenette and Pitcher (1999)	>30%	To provide more robust biomass of spawning cod (*Gadus morhua*) and to reduce the number of years with poor recruitment.
Pezzey et al. 2000	21% in moderately fished areas 36% in heavily fished areas 40% in intensively fished areas	To enhance fish catches of mixed species reef fisheries in the Caribbean.

Table 1. Recommended reserve sizes as a proportion of the managed area.

Reference	Percent Set-Aside	Objective
Attwood and Bennett (1995)	25-30%	Increase catches of galjoen (*Dichistius capensis*) and blacktail (*Diplodus sargus*) and to reduce the risk of recruitment overfishing of surf zone species in South Africa.
Holland and Brazee 1996	15-29%	To enhance fish catches of red snapper (*Lutjanus campechanus*) in the Gulf of Mexico.
Sladek-Nowlis and Yoklavich (1998)	20-27%	Maximize long-term sustainable yields of bocaccio (*Sebastes paucispinis*) and reduce annual catch variability.
Foran and Fujita (1999)	10-25%	To rebuild the egg output by stocks of Pacific Ocean Perch (*Sebastes alutus*), and improve catch per effort.
Daan 1993	25%	Reduce mortality of cod (*Gadus morhua*) in the North Sea by 10-14%.
Goodyear 1993	>20	To lower the risk that a fishery will collapse due to over-exploitation.
Trexler and Travis (2000)	10-20%	To decrease directional selection due to fishing.
Botsford, in press	17% of the California coast	To increase long-term catches of California red sea urchins (*Strongylocentrotus franciscanus*).
Ballantine 1997	10%	To fulfill our ethical obligation to protect a minimum proportion of the world's seas.

QUESTIONS FOR THE SCIENCE ADVISORY PANEL

Part of the Science Panel recommendation included a 30% to 50% reduction of harvest effort – The MRWG would like to know from what level? (current fishing effort? Take into account there is different effort for different fisheries. Note that some fisheries have a limited entry program already) Also, reduction in effort from which area? (i.e. Sanctuary waters only or broader range, such as Southern Calif. Bight?)

The Science Panel recommends a reduction of 30-50% of the current harvest effort for species that are harvested at the maximum sustainable yield (1/2k where k is the "carrying capacity" or the natural population size in the absence of fishing). The recommendation is necessarily restricted to the waters of the Channel Islands National Marine Sanctuary. Ideally, the benefits of reserves would not exceed the study area, but the potential impacts depend on the dispersal characteristics of the fished species.

To maintain an entire stock at sustainable levels would require additional protection equal to 30-50% of the geographical area the stock inhabits.

QUESTIONS FOR THE SCIENCE ADVISORY PANEL

What assumptions does the Science Panel make and how do they affect the recommendation?

Model Assumptions

1. The population of interest occupies a much larger area than the potential dispersal distance of a single individual.

2. Population processes are density dependent and the population growth rate is exponential. The models vary the intrinsic rate of growth (r) and the carrying capacity of the population (K).

3. The models assume that catch is variable. The absolute level of catch may vary from year to year.

4. The models assume that recruitment from outside the CINMS is unpredictable, with some probability of reaching zero. In general mortality differences inside and outside of reserves will be the greatest for fished species. Therefore, we can not depend on outside production supplying recruits to reserve areas.

5. The models assume that the stock is well-mixed (or that any individual can disperse to any location within the management unit), and that populations within the CINMS can be treated as distinct management units.

6. The models assume that distributions of harvested populations are directly porportional to suitable habitat. There is empirical evidence that marine populations are relatively evenly distributed throughout suitable habitats (Vetter, pers. comm).

7. The fisheries model assumes that fisheries of interest are maintained at the maximum sustainable yield, or (1/2)K.

8. In order to succeed, the model requires maintenance of the current level of fishing outside no-take reserves. In other words, fishing effort outside reserves should not increase due to displacement of effort.

How specific can the Science Panel be about what is lost (what is not achieved) at less than a 30% set aside?

Threshold replacement levels of populations approximate the percent of the carrying capacity (or natural population size in the absence of fishing) required to sustain populations over the long term. Threshold replacement levels of 85 populations of 27 fish species in Europe and North America varied widely among species (Mace and Sissenwine 1993) (Table 2). Some species (e.g. Atlantic cod and most flatfish) exhibited consistently low levels of threshold replacement levels (indicating a high resilience to fishing), while the smaller gadoids and many of the small pelagic species had values as high threshold replacement levels (indicating low resilience) (Table 3). The threshold replacement levels ranged from 2.0 to 65.4% with a mean of 18.7% (Table 2). However, 18.7% should be considered too low for use as the default threshold replacement level since it is risky to assume that a stock is "average" when nothing is known about the spawning-recruitment relationship. A more conservative approach to management would require default threshold replacement levels of poorly known fisheries stocks to exceed the 80th percentile of the cases in this study (approximately 30%). Although a 30% estimate may be conservative for an "average" stock, 20% of the cases in this study (or 18 populations) exhibited threshold replacement levels above 30%. To sustain all 27 species in the study, the level of protection must equal the threshold replacement level of the most sensitive population (65.4%).

Given the available empirical data, a minimum reserve size of 30% would sustain approximately 79% of the species for which data are currently available (Figure 1). A minimum reserve size of 50% would sustain approximately 95% of the species for which data are currently available. To meet the minimum requirements for all species, the fraction set aside in reserves would need to exceed 65%. Setting aside 20% of the habitat would protect approximately 57% of the species; and setting aside 10% of the habitat would protect 30% of the species for which data are available (Figure 1).

Note that most of the species in the Mace and Sissenwine (1993) data set do not occur in the CINMS. We use the full data set as the best estimate available for the variety of life histories of fished species in the CINMS.

Table 2. Estimates of replacement threshold levels for 85 populations of 27 fished species, grouped by geographic location (Mace and Sissenwine 1993).

Common Name	Scientific Name	Replacement Threshold Level (%)
ICES Stocks (NE Atlantic)		
1. Irish Sea cod	*Gadus morhua*	3.9
2. Irish Sea whiting	*Merlangius merlangus*	11.4
3. Irish Sea plaice	*Pleuronectes platessa*	10.1
4. Irish Sea sole	*Solea vulgaris*	23.5
5. Celtic Sea cod	*Gadus morhua*	6.6
6. Celtic Sea whiting	*Merlangius merlangus*	6.9
7. Celtic Sea plaice	*Pleuronectes platessa*	5
8. Celtic Sea sole	*Solea vulgaris*	19.2
9. Blue whiting, southern stock	*Merlangius merlangus*	7.4
10. NE Arctic cod	*Gadus morhua*	5.8
11. NE Arctic haddock	*Melanogrammus aeglefinus*	24.3
12. NE Arctic saithe	*Pollachius virens*	9.8
13. Redfish in areas IIA and B	*Sebastes marinus*	18.2
14. Greenland halibut in areas I and II	*Reinhardtius hippoglossodes*	21.6
15. Icelandic summer herring	*Clupea harengus*	18.6
16. North Sea sole	*Solea vulgaris*	12.3
17. North Sea plaice	*Pleuronectes platessa*	11.2
18. Div VIId sole	*Solea vulgaris*	11.5
19. Div VIIe sole	*Solea vulgaris*	25.8
20. Bay of Biscay sole	*Solea vulgaris*	5.6
21. Div VIIe plaice	*Pleuronectes platessa*	7.3
22. North Sea cod	*Gadus morhua*	3.4
23. Div Via cod	*Gadus morhua*	11
24. Div VIId cod	*Gadus morhua*	5.3
26. North Sea haddock	*Melanogrammus aeglefinus*	15.5
27. Div Via haddock	*Melanogrammus aeglefinus*	18.2
28. North Sea whiting	*Merlangius merlangus*	50.1
29. Div. VIa whiting	*Merlangius merlangus*	37.2
30. Div VIId whiting	*Merlangius merlangus*	42.7
31. North Sea saithe	*Pollachius virens*	16.7
32. Div. VI saithe	*Pollachius virens*	24.6
33. Kattegat cod	*Gadus morhua*	8.2
34. Skagerrak Cod	*Gadus morhua*	6.1
35. Kattegat plaice	*Pleuronectes platessa*	8.7
36. North Sea herring	*Clupea harengus*	10.8
37. Celtic Sea herring	*Clupea harengus*	27.9
38. Div. VIa north herring	*Clupea harengus*	16.8
39. Clyde herring	*Clupea harengus*	23

Table 2. Estimates of replacement threshold levels for 85 populations of 27 fished species, grouped by geographic location.

Common Name	Scientific Name	Replacement Threshold Level (%)
40. Div. VIa south and VIIb,c herring	*Clupea harengus*	23.4
41. Div. VIIa herring	*Clupea harengus*	14.6
42. Baltic cod in area 22	*Gadus morhua*	2.5
43. Baltic cod in area 22 and 24	*Gadus morhua*	2.9
44. Baltic cod in areas 25-32	*Gadus morhua*	8.8
45. Western Baltic and Kattegat herring	*Clupea harengus*	6.8
46. Gulf of Riga and areas 25-29 herring	*Clupea harengus*	30.4
47. Herring in coastal areas 25-27	*Clupea harengus*	39.5
48. Herring in the Gulf of riga	*Clupea harengus*	27.1
49. Herring in areas 30E	*Clupea harengus*	63.5
50. Herring in area 31E	*Clupea harengus*	63.5
51. Herring in area 31E	*Clupea harengus*	65.4
52. Herring in the Gulf of Finland	*Clupea harengus*	17.5
53. Sprat in areas 26 and 28	*Sprattus sprattus*	45.8
54. Sprat in areas 22-32	*Sprattus sprattus*	35.7
55. Mackerel, western stock	*Scomer scombrus*	42.8
56. Greenland halibut in areas V and XIV	*Reinhardtius hippoglossodes*	8.5
57. Icelandic saithe	*Pollachius virens*	24.9
58. Faroe saithe	*Pollachius virens*	21.4
59. Faroe Plateau cod	*Gadus morhua*	17.2
60. Faroe haddock	*Melanogrammus aeglefinus*	31.5
61. Hake, northern stock	*Merluccius merluccius*	51.5
62. Hake, southern stock	*Merluccius merluccius*	34.1
63. Megrim in areas VII and VIII	*Lepidorhombus whiffragonis*	55.1
64. Sardine in areas VIIIe and IXa	*Sardina pilchardis*	55.4
65. Horse mackerel, southern stock	*Trachurus trachurus*	22.3
Northwest Atlantic Stock (Canada)		
66. Pollock in NAFO areas 4VWX and 5Zc	*Theragra chalcogramma*	23.7
67. Haddock in NAFO area 4X	*Melanogrammus aeglefinus*	26
68. Herring in NAFO area 4T	*Clupea harengus*	9.5

Table 2. Estimates of replacement threshold levels for 85 populations of 27 fished species, grouped by geographic location.

Common Name	Scientific Name	Replacement Threshold Level (%)
Northwest Atlantic Stock (USA)		
69. Georges Bank cod	*Gadus morhua*	11.9
70. Gulf of Maine cod	*Gadus morhua*	8.4
71. Georges Bank haddock	*Melanogrammus aeglefinus*	20.6
72. Silver hake, northern stock	*Merluccius bilinearis*	30.8
73. Silver hake, southern stock	*Merluccius bilinearis*	42.4
74. Georges Bank yellowtail flounder	*Limanda ferruginea*	14.2
75. Southern New England yellowtail flounder	*Limanda ferruginea*	10.3
76. Summer flounder	*Paralichthys dentatus*	3.7
77. Gulf of Maine herring	*Clupea harengus*	14.9
78. NW Atlantic mackerel	*Scomer scombrus*	40.7
79. Georges Bank scallops	*Placopecten magellanicus*	2
80. Mid-Atlantic scallops	*Placopecten magellanicus*	2.9
Atlantic Stocks		
81. North Atlantic swordfish	*Xiphias gladius*	8.6
82. NW Atlantic swordfish	*Xiphias gladius*	10.1
Pacific Coast Stocks		
83. Bering Sea walleye pollock	*Theragra chalcogramma*	43.8
84. Pacific halibut	*Hippoglossus sternolepis*	24.6
85. Bering sea yellowfin sole	*Limanda aspera*	20.4

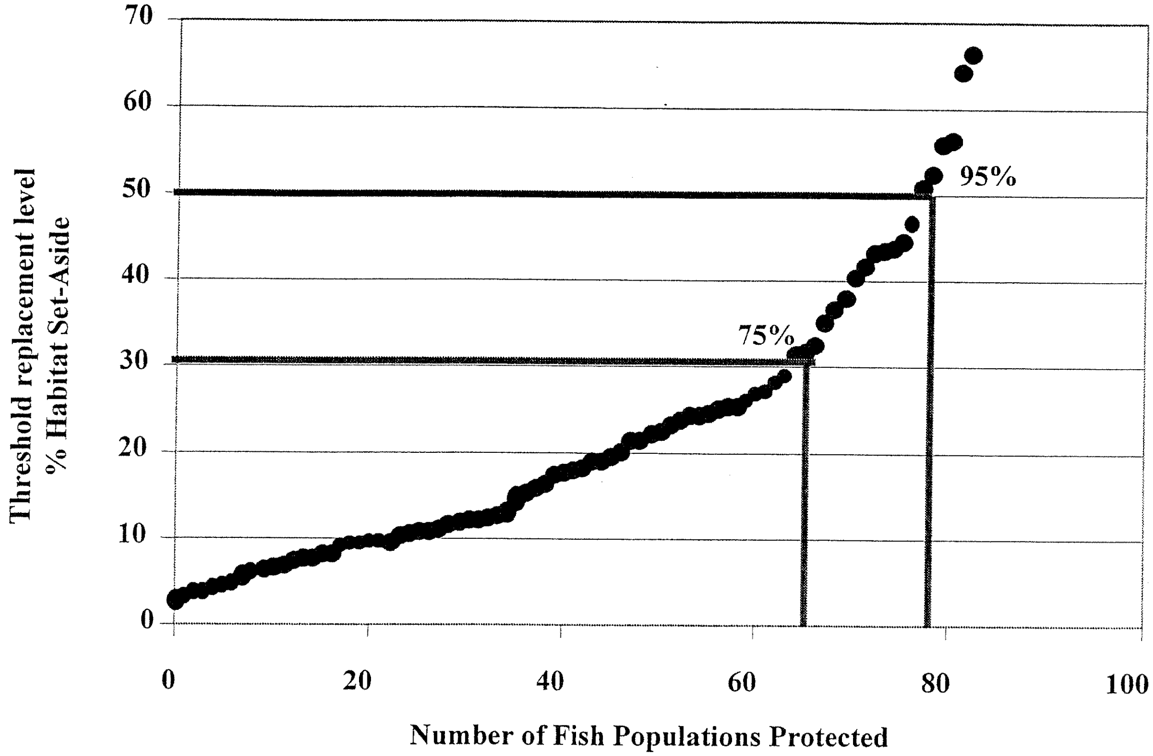
Table 3. Minimum threshold replacement levels (which approximates percent habitat set-aside) for protection of fish populations (Mace and Sissenwine 1993).

Reserve Size (% habitat)	% Populations Protected	Populations Protected	Vulnerable Populations
10	30	Scallops Summer Flounder Cod Plaice	Atlantic Swordfish Yellowtail Flounder Halibut Sole Redfish Saithe Yellowfin Sole Horse Mackerel Haddock Pacific Halibut Whiting Herring Walleye Pollock Silver Hake Sprat Mackerel Hake Megrim Sardine
20	57	Scallops Summer Flounder Cod Plaice Atlantic Swordfish Yellowtail Flounder Halibut Sole Redfish	Saithe Yellowfin Sole Horse Mackerel Haddock Pacific Halibut Whiting Herring Walleye Pollock Silver Hake Sprat Mackerel Hake Megrim Sardine
30	79	Scallops Summer Flounder Cod Plaice Atlantic Swordfish Yellowtail Flounder Halibut Sole Redfish Saithe Yellowfin Sole Horse Mackerel Haddock Pacific Halibut Whiting Herring	Walleye Pollock Silver Hake Sprat Mackerel Hake Megrim Sardine

Table 3. Minimum threshold replacement levels (which approximates percent habitat set-aside) for protection of fish populations (Mace and Sissenwine 1993).

Reserve Size (% habitat)	% Populations Protected	Populations Protected	Vulnerable Populations
40	86	Scallops Summer Flounder Cod Plaice Atlantic Swordfish Yellowtail Flounder Halibut Sole Redfish Saithe Yellowfin Sole Horse Mackerel Haddock Pacific Halibut Whiting Herring Walleye Pollock Silver Hake	Sprat Mackerel Hake Megrim Sardine
50	95	Scallops Summer Flounder Cod Plaice Atlantic Swordfish Yellowtail Flounder Halibut Sole Redfish Saithe Yellowfin Sole Horse Mackerel Haddock Pacific Halibut Whiting Herring Walleye Pollock Silver Hake Sprat Mackerel Hake	Megrim Sardine

Figure 1. Estimates of threshold replacement levels for 85 populations of 27 fish species in North America and Europe (Mace and Sissenwine 1993).



As reserve size is decreased, which objectives are not met?
In what order do they "fall away"?
How does the probability of success decrease?
Please rank how large the reserves have to be [to achieve goals for conservation and fisheries management]..

Table 4. *Relationship between marine protected area objectives, size, and design complexity.

Objective	Relative Size	Complexity
Conserving biodiversity	Large (or a network)	Simple to complex
Protecting a migratory species	Large (or a network)	Simple to complex
Providing sites for scientific research	Network of small, medium, and large	Simple to complex
Protecting habitat from multiple threats	Medium to large	Complex
Protecting habitat from a single threat	Medium	Simple
Preventing overfishing	Small to medium (or a network)	Simple
Enhancing stocks	Small to medium (or a network)	Simple
Protecting an endangered species	Small to medium	Simple
Promoting marine ecotourism	Small to medium	Simple
Protecting areas of historic or cultural interest	Small	Simple

*Modified from Table 2 in Agardy, T. 2000. Information needs for marine protected areas: scientific and societal. Bulletin of Marine Science 66(3):875-888.

Is a 20% reserve set aside + a 10% reduction in harvest effort comparable to a 30% reserve?

Twenty percent reserve set aside plus 10% reduction in harvest effort is NOT comparable to a 30% reserve.

First, reduced effort does not translate into reduced catch. As technology improves, catch often increases as effort decreases. This is true particularly for bottom fishing, with technological improvements such as bottom maps and fish finders.

Second, if the rate of removals already exceeds the replacement, a 10% reduction in harvest effort may not be sufficient to sustain the fished population of over the long term. The population will continue to decline in fished areas, but at a slower rate than before the reduction in fishing effort.

Third, one of the primary objectives of a reserve is to reestablish stable age structure and allow adult fish to live longer and reach larger sizes than in fished areas. Effort regulations kill either (1) a cross-section of all sizes, or (2) focus on retaining larger, more valuable fish (e.g. minimum size limit). In the present study, fishing reduces the average age of individuals in the population until there are few reproductive adults. Consequently, recruitment limitation can reduce population growth.

If effort is not reduced outside the reserve, what happens and does this affect the Science Panel recommendation?

If effort is not reduced outside reserves, then the target of sustaining fished populations at 2/3 to 3 /4 k (of their natural carrying capacity in the absence of fishing) is not met. Larger reserves would be required to compensate for additional fishing effort outside reserve areas.

Fish populations can exhibit extremely variable recruitment from year to year. In spite of large fluctuations in recruitment, small populations can remain stable. With no reduction in fishing effort outside the reserve, but a large and fully-protected population within the reserve, juveniles produced by the spawners inside the reserve could settle and grow inside (through larval retention) and outside the reserve area (through larval export). Larvae outside reserves would grow until they were the minimum size to enter the fishery (e.g. bite the hook!). Without a reduction in effort, most (if not all) fish that originated in reserve areas would be removed prior to reproduction. The result would be a stable population within reserves, supporting a stable fishery in unprotected areas.

Can other current management measures (i.e. the cowcod closure that includes Santa Barbara Island) reduce the recommended reserve size?

Other current management measures cannot reduce the recommended reserve size of 30-50% of the Channel Islands National Marine Sanctuary for ecosystem conservation. With the exception of the Anacapa Reserve, closures in the Channel Islands region have been limited to a single or several species, or a single or several gear types. Single (or several) species (or gear type) closures do not meet the Marine Reserves Working Group goal of protecting ecosystem biodiversity. One of the primary objectives for marine reserves is to "protect representative and unique marine habitats, ecological processes, and populations of interest". The Marine Reserves Working Group and the Science Panel have identified 20 representative and unique marine habitats (Table 5) and 119 populations of interest (Table 6). Ecological processes link the species with their habitats and with other species through direct and indirect interactions.

In response to stock status classified as over-fished, the Pacific Fisheries Management Council adopted tentative guidelines for the development of draft rebuilding plans for canary rockfish and cowcod. For canary rockfish, the tentative guidelines include substantially reduced take limits that would be in place for several decades or until the populations are rebuilt. Reduced limits on canary rockfish do not prevent accidental or by-catch of canary rockfish during other fishing efforts. To protect cowcod, found almost exclusively in waters off southern and central California, large area closures in the best cowcod areas will be closed to all groundfish fishing below 120 ft, and retention of cowcod will be restricted in all fisheries in open areas. Fishing will be permitted at depths shallower than the officially recognized cowcod habitat (>120 ft). Consequently, there is little benefit to most rockfish species (including the occasional cowcod) that inhabit kelp beds and to depths of 120 ft.

The cowcod closure does not satisfy the Marine Reserves Working Group goal "to protect [all] populations of interest".

The cowcod closure does not reduce the recommended size of reserves for conservation and fisheries management in the Channel Islands National Marine Sanctuary.

Table 5. Representative and unique marine habitats in the Channel Islands region

Habitat Type	Units
1. Rocky coastline	Linear miles
2. Sandy coastline	Linear miles
3. Wave-cut coastline	Linear miles
4. Nearshore sandy habitat (0-30 m)	Square nautical miles
5. Nearshore rocky habitat (0-30 m)	Square nautical miles
6. Sandy shallow continental shelf (30-100 m)	Square nautical miles
7. Rocky shallow continental shelf (30-100 m)	Square nautical miles
8. Sandy deep continental shelf (100-200 m)	Square nautical miles
9. Rocky deep continental shelf (100-200 m)	Square nautical miles
10. Sandy continental slope (>200 m)	Square nautical miles
11. Rocky continental slope (>200 m)	Square nautical miles
12. Emergent nearshore rocks	Number
13. Emergent offshore rocks	Square nautical miles
14. Submerged rocky features and pinnacles	Square nautical miles
15. Submarine canyons	Square nautical miles
16. Kelp forest	Square nautical miles
17. Eelgrass	Square nautical miles
18. Surfgrass	Square nautical miles
19. Bird rookeries	Linear miles
20. Marine mammal haulouts	Linear miles

Table 6. Species of interest in the Channel Islands National Marine Sanctuary

	Species	Scientific Name
	PLANTS	
1	Giant Kelp	*Macrocystis pyrifera*
2	Feather Boa Kelp	*Egregia menziesii and laevigata*
3	Elk Kelp	*Pelagophycus porra*
4	Oar Weed	*Laminaria farlowii*
5	*Agarum fimbriatum*	*Agarum fimbriatum*
6	*Eisenia arborea*	*Eisenia arborea*
7	*Pterygophora californica*	*Pterygophora californica*
8	Scoulder Surfgrass	*Phyllospadix scoulei*
9	Torrey Surfgrass	*Phyllospadix torreyi*
10	Eelgrass	*Zostera spp.*
	INVERTEBRATES	
11	California Hydrocoral	*Allopora californica*
12	Hydroid	*Abietinaria spp.*
13	Ostich-Plume Hydroid	*Aglaophenia latirostris*
14	Ostich-Plume Hydroid	*Aglaophenia struthionides*
15	Hydroid	*Clytia bakeri*
16	Hydroid	*Garveia annulata*
17	Hydroid	*Obelia spp.*
18	Hydroid	*Sarsia spp.*
19	Hydroid	*Sertularella turgida*
20	Hydroid	*Sertularia frucata*
21	Hydroid	*Tubularia crocea*
22	Red Gorgonian	*Lophogorgia chilensis*
23	California Golden Gorgonian	*Muricea californica*
24	Brown Gorgonian	*Muricea fructicosa*
25	Colonial Sand Tube Worm	*Phragmatopoma californica*
26	Giant Acorn Barnacle	*Balanus nubilus*
27	Aggregating Anemone	*Anthopleura elegantisima*
28	Giant Starfish	*Pisaster giganteus*
29	Ochre Starfish	*Pisaster ochraceus*
30	California Sea Cucumber	*Parastichopus californicus*
31	Warty Sea Cucumber	*Parastichopus parvamensis*
32	Red Sea Urchin	*Strongylocentrotus franciscanus*
33	Purple Sea Urchin	*Strongylocentrotus purpuratus*
34	Pink Abalone	*Haliotis corrugata*
35	Black Abalone	*Haliotis cracherodii*
36	Green Abalone	*Haliotis fulgens*

Table 6. Species of interest in the Channel Islands National Marine Sanctuary

	Species	Scientific Name
	INVERTEBRATES	
37	Red Abalone	*Haliotis rufescens*
38	White Abalone	*Haliotis sorenseni*
39	Owl Limpet	*Lottia gigantea*
40	Wavy Turban Snail	*Lithopoma undosum*
41	Kellet's Whelk	*Kelletia kellettii*
42	California Mussel	*Mytilus californianus*
43	Rock Scallop	*Hinnites giganteus*
44	Pismo Clam	*Tivela stultorum*
45	Geoduck Clam	*Panopea generosa*
46	Market Squid	*Loligo opalescens*
47	California Spiny Lobster	*Panulirus interruptus*
48	Red Rock Shrimp	*Lysmata californica*
49	Spot Prawn	*Pandalus platyceros*
50	Ridgback Prawn	*Sicyonia ingentis*
51	Red Crab	*Cancer productus*
52	Rock Crab	*Cancer antennarius*
53	Sheep Crab	*Loxorhynchus grandis*
	FISH	
54	Leopard Shark	*Triakis semifasciata*
55	Pacific Angel Shark	*Squatina californica*
56	Soupfin Shark	*Galeorhinus galeus*
57	Thornback Ray	*Platyrhinoidis triseriata*
58	Pacific Herring	*Clupea pallasii*
59	Pacific Sardine	*Sardinops sagax*
60	Northern Anchovy	*Engraulis mordax*
61	Pacific Cod	*Gadus macrocephalus*
62	California Grunion	*Leuresthes tenuis*
63	California Scorpionfish	*Scorpaena guttata*
64	Pacific Ocean Perch	*Sebastes alutus*
65	Kelp Rockfish	*Sebastes atrovirens*
66	Brown Rockfish	*Sebastes auriculatus*
67	Gopher Rockfish	*Sebastes carnatus*
68	Copper Rockfish	*Sebastes caurinus*
69	Greenspotted Rockfish	*Sebastes chlorostictus*
70	Black and Yellow Rockfish	*Sebastes chrysomelas*
71	Dark-blotched Rockfish	*Sebastes crameri*
72	Starry Rockfish	*Sebastes constellatus*
73	Calico Rockfish	*Sebastes dallii*
74	Widow Rockfish	*Sebastes entromelas*

Table 6. Species of interest in the Channel Islands National Marine Sanctuary

	Species	**Scientific Name**
	FISH	
75	Cowcod	*Sebastes levis*
76	Black Rockfish	*Sebastes melanops*
77	Vermilion Rockfish	*Sebastes miniatus*
78	Blue Rockfish	*Sebastes nystinus*
79	Speckled Rockfish	*Sebastes ovalis*
80	Bocaccio	*Sebastes paucispinis*
81	Canary Rockfish	*Sebastes pinniger*
82	Grass Rockfish	*Sebastes rastrelliger*
83	Yelloweye Rockfish	*Sebastes ruberrimus*
84	Flag Rockfish	*Sebastes rubrivinctus*
85	Olive Rockfish	*Sebastes serranoides*
86	Treefish	*Sebastes serriceps*
87	Honeycomb Rockfish	*Sebastes umbrosus*
88	Shortspine Thornyhead	*Sebastolobus alascanus*
89	Lingcod	*Ophiodon elongatus*
90	Cabezon	*Scorpaenichthys marmoratus*
91	Giant Seabass	*Stereolepis gigas*
92	Broomtail Grouper	*Mycteroperca xenarcha*
93	Kelp Bass	*Paralabrax clathratus*
94	Ocean Whitefish	*Caulolatilus princeps*
95	White Seabass	*Atractoscion nobilis*
96	Halfmoon	*Medialuna californiensis*
97	Black Surfperch	*Embiotoca jacksoni*
98	Barred Surfperch	*Amphistichus argenteus*
99	Shiner Surfperch	*Cymatogaster aggregata*
100	Walleye Surfperch	*Hyperprosopon argenteum*
101	Silver Surfperch	*Hyperprosopon ellipticum*
102	Rubberlip Surfperch	*Rhacochilus toxotes*
103	Blacksmith	*Chromis punctipinnis*
104	Garibaldi	*Hypsypops rubicundus*
105	California Sheephead	*Semicossyphus pulcher*
106	Tidewater Goby	*Eucylogobius newberryi*
107	California Halibut	*Paralichthys californicus*
108	Starry Flounder	*Platichthys stellatus*
109	CO-Turbot	*Pleuronichthys coenosus*

Table 6. Species of interest in the Channel Islands National Marine Sanctuary

	Species	Scientific Name
	BIRDS	
110	Ashy Storm Petrel	*Oceanodroma homochroa*
111	California Brown Pelican	*Pelecanus occidentalis californicus*
112	Snowy Plover	*Charadrius alexandrinus*
113	California Least Tern	*Sterna antillarum browni*
114	Pigeon Guillemot	*Cepphus columba*
115	Xantus' Murrelet	*Synthliboramphus hypoleucus*
116	Cassin's Auklet	*Ptychoramphus aleuticus*
	MAMMALS	
117	Harbor Seal	*Phoca vitulina*
118	Northern Fur Seal	*Callorhinus ursinus*
119	Southern Sea Otter	*Enhydra lutris nereis*

What is the catastrophic insurance multiplier (e.g. 1.5) and how does it affect the recommendation?

Marine reserves can help to protect species and habitats from catastrophic disturbances. Most marine habitats are vulnerable to disturbances of one kind or another. When viewed across long temporal and large spatial scales, severe disturbances in marine ecosystems are not uncommon. Events such as large storms and oil spills can impact populations and habitats on local or even regional scales. Consequently, designers of marine reserves must consider the rate of occurrence of catastrophic events and the rate of recovery of species or communities after a catastrophic event. For marine reserves to be effective, the total area protected must not be disturbed simultaneously by catastrophes.

A simple way to increase performance of a reserve network is to allow for the effects of catastrophic disturbance by inclusion of additional area. The minimum effective reserve size is the size of a reserve network that will meet the goals for the reserve (e.g. conservation) in a stable environment multiplied by an "insurance factor" that takes into account the frequency of severe disturbance to the environment. Allison *et al.* (in press) developed a method of determining this "insurance factor": a multiplier to calculate the additional reserve area necessary to ensure the functional goals of reserves can be met within a given area.

The simplest estimate of the "insurance factor" (M) is

$$M=1/U$$

where $U=(1-h)^T$ and
U is the fraction of coastline unaffected by catastrophes,
h is the fraction of the coastline that is affected by catastrophes each year, and
T is the number of years required for a site to recover from a catastrophe.

This estimate requires the assumptions that catastrophes strike coasts evenly and randomly so that the probability of any point being affected is constant. However, these assumptions may be relaxed and the insurance factor may be estimated (1) with temporally and spatially variable h, and (2) with a variety of types of catastrophes, each with unique h and T.

In the Santa Barbara region, the insurance factor varied from 1.2 to 1.8, suggesting that the minimum sustainable reserve size in the Santa Barbara region should be 1.2-1.8 times larger than the minimum sustainable reserve size in a stable environment (with no unpredictable catastrophic events) (Allison *et al.,* in press).

Can you identify sources of high rockfish production at the islands?

Either Dr. Milton Love or Donna Schroeder will attend the MRWG meeting. One of the rockfish experts will give a 10 minute overview of areas in the Channel Islands that support rockfish larvae and adults.

What if there are changes in the boundary?
Are [the Science Panel members] *assuming that fishing outside does not change?*

Changes in the Sanctuary boundary are unrelated to marine reserves process. The Science Panel recommended a reduction of 30-50% of the fishing effort within the current Sanctuary boundaries. The Science Panel recommended that, in order to achieve the reduction in fishing effort, reserve areas be designated in 30-50% of each of the habitats within each of the biogeographic regions with the Channel Island National Marine Sanctuary, while maintaining the current level of fishing outside the reserve areas.

Given the limited target area of the marine reserves process, the benefits of reserves are assumed to be concentrated mainly within the Sanctuary boundaries. To maintain an entire stock at sustainable levels would require additional protection equal to 30-50% of the total geographic area of that stock.

What species, if any, are unique to the Channel Islands? Where are they located?

Most marine species found in the Channel Islands have the potential to disperse into other regions. For some species (e.g. California spiny lobster), the Channel Islands form the northern limit of their geographical distribution. For other species (e.g. black rockfish) the Channel Islands form the southern limit of their geographical distribution. The marine ecosystem differs fundamentally from the terrestrial system because marine species have greater potential for passive or active dispersal. Many marine species have pelagic dispersal phases. Their eggs or larvae are released into open water where they develop over periods of days to a few months. Some larvae drift passively with currents, while others may be able to influence or control dispersal. Consequently, replenishment of populations may depend on reproduction that occurs in other places. Tundi Agardy (1997) eloquently describes the marine system as "dynamic and without defined boundaries. Living things are suspended in a moving, fluid three dimensions, where even plants—the foundation for large and complex food chains—can move."

The marine ecosystems around the Channel Islands are unique, not in terms of species identities, but in terms of interactions among species. The Channel Islands form the boundary between two vast biogeographical regions, the cold-water Oregonian Province to the north, and the warm-water California Province to the south. Species that range from the Bering Sea to Point Conception (e.g. darkblotched rockfish) overlap in the Channel Islands with species that are found from Point Conception to Baja California (e.g. calico rockfish).

San Miguel Island supports six species of pinnipeds, more than anywhere in the North Pacific. They included the California sea lion (*Zalophus californianus*), Northern seal lion (*Eumetopias jubatus*), Northern fur seal (*Callorhinus ursinus*), Guadalupe fur seal (*Artocephalus townsendi*), Northern elephant seal (*Mirounga angustirostris*), and harbor seal (*Phoca vitulina*). At certain times of the year, the Point Bennett area supports more than 10,000 animals in one of the most outstanding displays of marine mammal life found on the Southern California Islands. California sea otters (*Enhydra lutris nereis*) were a common around the Channel Islands in the early 19th century but they were exterminated in this region due to excessive hunting.

The ocean itself forms a barrier to dispersal of terrestrial species that inhabit the Channel Islands. Numerous animal and plant species found on the Channel Islands are *endemic,* in other words, they occur no where else in the world.

There are four endemic species and subspecies of terrestrial mammals which occur on Santa Cruz Island, the Santa Cruz Island fox (*Urocyon littoralis santacruzae*), the spotted skunk (*Spilogale gracilis amphialus*), the deer mouse (*Peromyscus maniculatus santacruzae*), and the western harvest mouse (*Reithrodontomys megalotis santacruzae*).

There is one terrestrial mammal on Santa Barbara Island, the endemic subspecies of deer mouse (*Peromyscus maniculatus elusus*).

The Island night lizard (*Xantusia riversiana*) is found only on Santa Barbara, San Nicholas and San Clemente Islands. The Island night lizard was listed as endangered in 1967.

There are 10 birds which are Channel Island subspecies or races, including Allen's hummingbird, western flycatcher, horned lark, Santa Cruz Island jay, Bewick's wren, loggerhead shrike, orange-crowned warbler, house finch, rufous-sided towhee and the Catalina quail (introduced). Anacapa and Santa Barbara Islands support a variety of endangered and vulnerable breeding seabird species, including the two major rookeries of the endangered California brown pelican (*Pelecanus occidentalis californicus*), and breeding populations of the ashy storm-petrel (*Oceanodroma homochroa*), black storm-petrel (*Oceanodroma melania*), Leach's storm-petrel (*Oceanodroma leucorhoa*), Cassin's auklet (*Ptychoramphus aleuticus*), and Xantus's murrelet (*Synthliboramphus hypoleucus*). The endemic Santa Barbara Island song sparrow (*Melospiza melodia graminea*) is thought to be extinct. In 1959, a fire destroyed much of the bird's habitat and the population of Santa Barbara Island song sparrows survived only eight years after the fire.

There are over 650 different plants on Santa Cruz Island, including both native and introduced species. Forty-two of these plants are endemic to the Channel Islands and 9 are endemic to Santa Cruz Island, in particular. There are four plants restricted to Santa Rosa Island: Live-forever (*Dudleya blochmanae insularis*), manzanita (*Arctostaphylos confertiflora*), gilia (*Gilia tenuiflora hoffmannii*), and a variety of Torrey Pine (*Pinus torreyana insularis*). Torrey pines are found on the northeast side of Santa Rosa Island at elevations between 200-500 feet. This is the only native stand of Torrey pines on any Channel Island. Another subspecies of Torrey Pine occurs naturally at only one other location, on the southern California coast just south of Del Mar in San Diego County.

Although there are no endemic plant species on San Miguel Island, there is a subspecies of buckwheat (*Eriogonum grande dunklei*) known only from this island.

There are three plants restricted to Santa Barbara Island, including a shrubby buckwheat (*Eriogonum giganteum compactum*), a small succulent (*Duleya traskiae*), and the annual poppy (*Platystemon californicus ciliatus*).

How will reserves affect kelp abundance?

Populations of predators on juvenile urchins (including adult sheephead, octopus, and lobster) will likely increase in reserve areas, limiting the abundance of small purple urchins. In response to potential declines in urchin densities, the size of the existing kelp forest may increase. Denser kelp growth would contribute to increased resistance and resilience of kelp beds, reducing the susceptibility of kelp forests and contributing to kelp recruitment following storms and El Nino damage.

Can the panel estimate reserve size for specific species of concern? If not, how can the MRWG socio-economic objective: To equitably share loss among all users – be achieved? There was concern regarding the necessary size of reserves for certain species.

Reserves targeted for specific species (such as the cowcod closure) ignore the fact that every species is embedded within an ecosystem, interacting directly and indirectly with an array of other species. Ecosystem protection requires equal protection of each species within the system.

If reserves function as expected, there should be no net loss to stakeholders over the long-term. To minimize short-term losses of fished areas, the Science Panel recommended that all habitats be set aside in equal proportion to their occurrence in the Channel Islands National Marine Sanctuary.

Marine Reserves Working Group
Analysis of Reserve Concepts Using Ecological Criteria

Background

The Marine Reserves Working Group developed four reserve concepts on February 21, 2001.

The group attempted to incorporate the best available scientific and socioeconomic information into the design of reserve concepts to address a variety of issues, including conservation, fisheries management, economic viability of fisheries, education, cultural heritage, and research.

Concept A was developed to meet the goal for conservation of ecosystem biodiversity in the Channel Islands National Marine Sanctuary while accounting for unpredictable catastrophic events (such as oil spills) or changes in the environment.

Concept B was developed to meet the goal for conservation of ecosystem biodiversity and to sustain fisheries over the long term, with some consideration of economic impacts to commercial and recreational users.

Concept C was developed to maximize potential conservation and fisheries benefits while minimizing the impact to commercial and recreational users.

Concept D was developed to minimize the impact to commercial and recreational users. All members of the Marine Reserves Working Group agree that these areas should be included in reserves.

For additional information, contact

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Marine Reserves Working Group
Analysis of Reserve Concepts Using Ecological Criteria

List of Tables

Marine Reserves Working Group
Analysis of Reserve Concepts Using Ecological Criteria

Table 1. Summary of the ecological analysis of reserve concepts developed by the Marine Reserves Working Group on February 21, 2001.

Reserve Concept	A	B	C	D
Nearshore Habitats				
Oregonian	Well represented.	Well represented.	Rocky intertidal and sandy beach habitats are fairly well represented.	Rocky intertidal and sandy beach habitats are poorly represented.
Transition	Well represented.	Fairly well represented. High energy rocky intertidal habitat is not represented sufficiently.	Fairly well represented. High energy rocky intertidal habitat is not represented sufficiently.	Rocky intertidal and sandy beach habitats are poorly represented.
Californian	Fairly well represented. High energy rocky intertidal habitat is not represented sufficiently.	Fairly well represented. Sandy beach and high energy rocky intertidal habitat is not represented sufficiently.	Fairly well represented. Sandy beach and high energy rocky intertidal habitat is not represented sufficiently.	Rocky intertidal and sandy beach habitats are poorly represented.
Sediments and Depth Ranges				
Oregonian	Well represented.	Well represented.	Does not represent sufficiently all sediments (0-30 m), soft sediments (30-100), soft sediments (>200 m).	Does not represent sufficiently all sediments at all depths.
Transition	Well represented.	Does not represent sufficiently soft sediments (0-30 m), all sediments (30-100 m), soft sediments (>200 m).	Does not represent sufficiently soft sediments (0-30 m), all sediments (30-100 m), soft sediments (>200 m).	All sediments at all depths are poorly represented.
Californian	Fairly well represented. Does not represent sufficiently all sediments (100-200).	Does not represent sufficiently hard sediments (30-200), all sediments (100-200) all sediments (>200 m).	Does not represent sufficiently all sediments at all depths, except hard sediment (0-30 m).	All sediments at all depths are poorly represented.
Emergent Rocky Habitat				
Oregonian	Well-represented.	Well represented.	Nearshore rocks are not represented sufficiently. Does not represent emergent submarine canyon.	Nearshore rocks are not represented sufficiently. Does not represent emergent submarine canyon.
Transition	Fairly well represented.	Fairly well represented.	Fairly well represented.	Emergent rocks and submarine canyons are not represented sufficiently.
Californian	Well represented.	Well represented.	Emergent offshore rocks are not represented sufficiently.	Emergent rocks are not represented sufficiently.

Marine Reserves Working Group
Analysis of Reserve Concepts Using Ecological Criteria

Table 1. Summary of the ecological analysis of reserve concepts developed by the Marine Reserves Working Group on February 21, 2001.

Reserve Concept	A	B	C	D
Kelp Forest				
Oregonian	Well represented.	Well represented.	Well represented.	Kelp is not represented sufficiently.
Transition	Well represented.	Well represented.	Fairly well represented.	Kelp is not represented sufficiently.
Californian	Fairly well represented.	Well represented.	Fairly well represented.	Kelp is not represented sufficiently.
Eelgrass				
Oregonian	Well represented.	Eelgrass is not represented sufficiently.	Eelgrass is represented poorly.	Eelgrass is represented poorly.
Californian	Fairly well represented.	Fairly well represented.	Fairly well represented.	Not represented.
Surfgrass				
Oregonian	Well represented.	Well represented.	Surfgrass is not represented sufficiently.	Surfgrass is represented poorly.
Transition	Well represented.	Surfgrass is not represented sufficiently.	Well represented.	Surfgrass is not represented sufficiently.
Californian	Well represented.	Well represented.	Well represented.	Surfgrass is not represented sufficiently.

Oregonian Province

Table 2. Total, 30% target, and actual representation of ecological criteria in each reserve concept developed by the Marine Reserves Working Group on February 21, 2001.

Criteria	Total	30% Target	A	B	C	D
1. Sandy Beach Habitat (miles)	25	7.5	14.5	10.6	3.0	0.3
2. Protected Rocky Intertidal (miles)	28.2	8.5	17.9	13.2	6.1	0.6
3. Exposed Rocky Intertidal (miles)	27.4	8.2	17.5	16.5	4.5	1.0
4. Soft Sediment (0-30 m) (nmi^2)	38.9	11.7	22.4	13.4	4.9	0.3
5. Hard Sediment (0-30 m) (nmi^2)	34.3	10.3	17.6	11.4	4.7	0.4
6. Soft Sediment (30-100 m) (nmi^2)	211.6	63.5	91.8	92.2	56.7	24.0
7. Hard Sediment (30-100 m) (nmi^2)	23.4	7	11.0	10.6	6.8	1.1
8. Soft Sediment (100-200 m) (nmi^2)	157	47.1	97	85	68.5	38
9. Hard Sediment (100-200 m) (nmi^2)						
10. Soft Sediment (>200 m) (nmi^2)	227	68.1	104	99	56	19
11. Hard Sediment (>200 m) (nmi^2)						
12. Emergent Nearshore Rocks (no.)	216	64.8	139	104	24	12
13. Emergent Offshore Rocks (0/1)	12	3.6	11	9	6	4
14. Submarine Canyons (0/1)	1	0.3	1	1	0	0
15. Kelp Forest (nmi^2)	16.1	4.8	8.7	4.8	0.8	0.1
16. Eelgrass (nmi^2)	0.3	0.1	0.3	0	0	0
17. Surfgrass (nmi^2)	13.4	4	7.8	6.5	2.4	0.1

nmi = nautical miles; 0/1 = absent or present in each 1x1 planning unit

Transition Zone

Table 3. Total, 30% target, and actual representation of ecological criteria in each reserve concept developed by the Marine Reserves Working Group on February 21, 2001.

Criteria	Total	30% Target	A	B	C	D
1. Sandy Beach Habitat (miles)	13.8	4.1	7.9	4.0	3.9	3.5
2. Protected Rocky Intertidal (miles)	11.6	3.5	7.5	5.2	4.4	0
3. Exposed Rocky Intertidal (miles)	13.6	4.1	6.2	1.9	2.8	0.5
4. Soft Sediment (0-30 m) (nmi^2)	29.6	8.9	13.6	5.4	5.7	1.8
5. Hard Sediment (0-30 m) (nmi^2)	7.2	2.1	4.0	2.4	1.9	0.9
6. Soft Sediment (30-100 m) (nmi^2)	63.6	19.1	17.6	10.5	12.3	1.8
7. Hard Sediment (30-100 m) (nmi^2)	10.1	3	4.0	2.0	1.2	0.3
8. Soft Sediment (100-200 m) (nmi^2)	62.9	18.9	29.9	26.7	25.9	3.5
9. Hard Sediment (100-200 m) (nmi^2)	7.3	2.2	7.3	4.8	4.6	1.5
10. Soft Sediment (>200 m) (nmi^2)	176.9	53.1	81.1	44.6	41.6	8.9
11. Hard Sediment (>200 m) (nmi^2)	14.6	4.4	10.9	8.9	8.9	2.6
12. Emergent Nearshore Rocks (no.)	208	62.4	147	102	96	40
13. Emergent Offshore Rocks (0/1)	27	8.1	5	5	4	4
14. Submarine Canyons (0/1)	30.6	10.2	15	16	16	7
15. Kelp Forest (nmi^2)	6	1.8	4.6	3.6	2.5	0.7
16. Eelgrass (nmi^2)	0.1		0.1	0.02	0.03	0
17. Surfgrass (nmi^2)	6.7	2	3.8	1.7	2.2	0.9

nmi = nautical miles; 0/1 = absent or present in each 1x1 planning unit

Californian Province

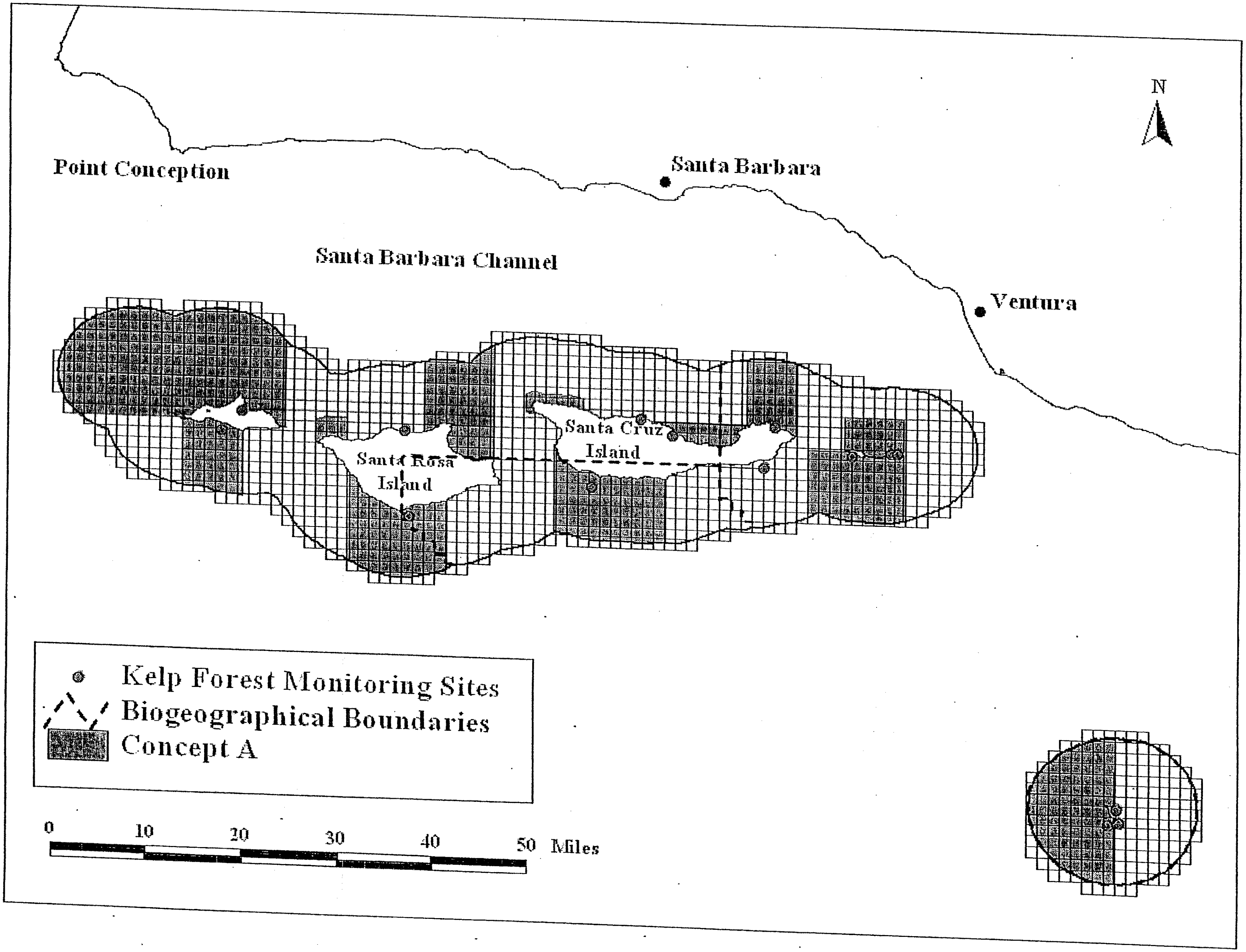
Table 4. Total, 30% target, and actual representation of ecological criteria in each reserve design developed by the Marine Reserves Working Group on February 21, 2001.

Criteria	Total	30% Target	A	B	C	D
1. Sandy Beach Habitat (miles)	4.7	1.4	1.7	0.6	0.6	0
2. Protected Rocky Intertidal (miles)	21.3	6.4	16	11.0	7.6	0
3. Exposed Rocky Intertidal (miles)	1.4	0.4	0	0	0	0
4. Soft Sediment (0-30 m) (nmi^2)	16.4	4.9	10.2	3.7	2.5	0
5. Hard Sediment (0-30 m) (nmi^2)	6.6	2	4.5	4.6	2.8	0
6. Soft Sediment (30-100 m) (nmi^2)	56.2	16.9	29.2	23.5	14.0	1
7. Hard Sediment (30-100 m) (nmi^2)	3.9	1.2	1.9	0.5	0.5	0
8. Soft Sediment (100-200 m) (nmi^2)	27.2	8.2	7	6	4.5	1
9. Hard Sediment (100-200 m) (nmi^2)	1.1	0.3	0	0	0	0
10. Soft Sediment (>200 m) (nmi^2)	160.7	48.2	58.2	14.5	22.5	7
11. Hard Sediment (>200 m) (nmi^2)	2.3	0.7	0.3	0	0	0
12. Emergent Nearshore Rocks (no.)	95	28.5	68	53	43	0
13. Emergent Offshore Rocks (0/1)	1	0.3	1	1	0	0
14. Submarine Canyons (0/1)	5	1.5	5	5	5	4
15. Kelp Forest (nmi^2)	1.8	0.6	0.4	0.5	0.4	0
16. Eelgrass (nmi^2)	0.2	0.06	0.02	0.02	0.02	0
17. Surfgrass (nmi^2)	3.2	0.9	1.2	0.9	0.8	0

nmi = nautical miles; 0/1 = absent or present in each 1x1 planning unit

Table 5. Area (mi^2) set-aside in reserve concepts developed by the Marine Reserves Working Group on February 21, 2001.

Reserve Size (1x1 nmi^2)	**Total Size**	A	B	C	D
Oregonian	786	461	378	268	96
Transition	402	194	139	121	28
Californian	316	147	65	59	11
Total Reserve Size	1500	802	582	448	135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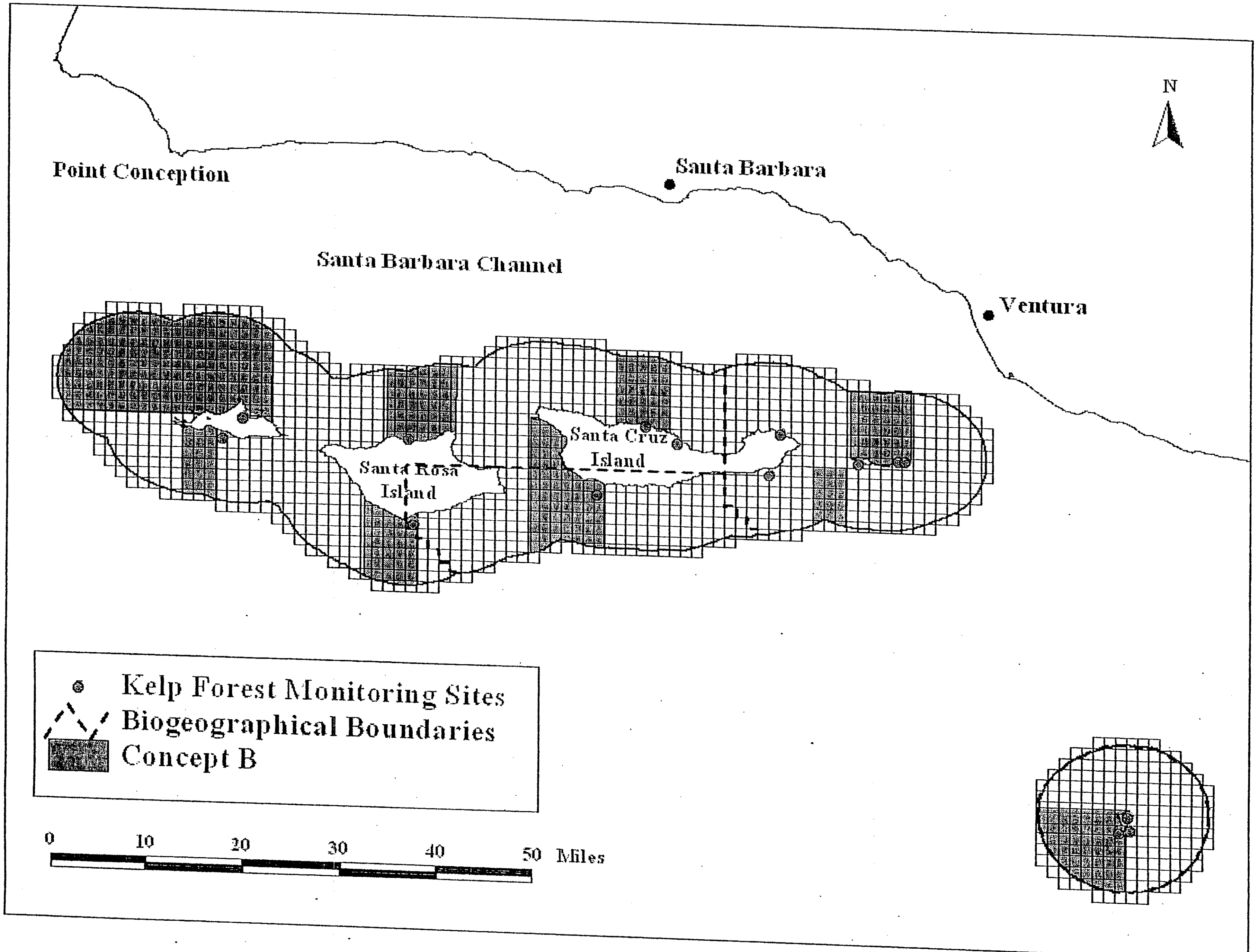
Point Conception
Santa Barbara
Ventura
Santa Barbara Channel
Santa Rosa Island
Santa Cruz Island
Kelp Forest Monitoring Sites
Biogeographical Boundaries
Concept A
0
10
20
30
40
50 Miles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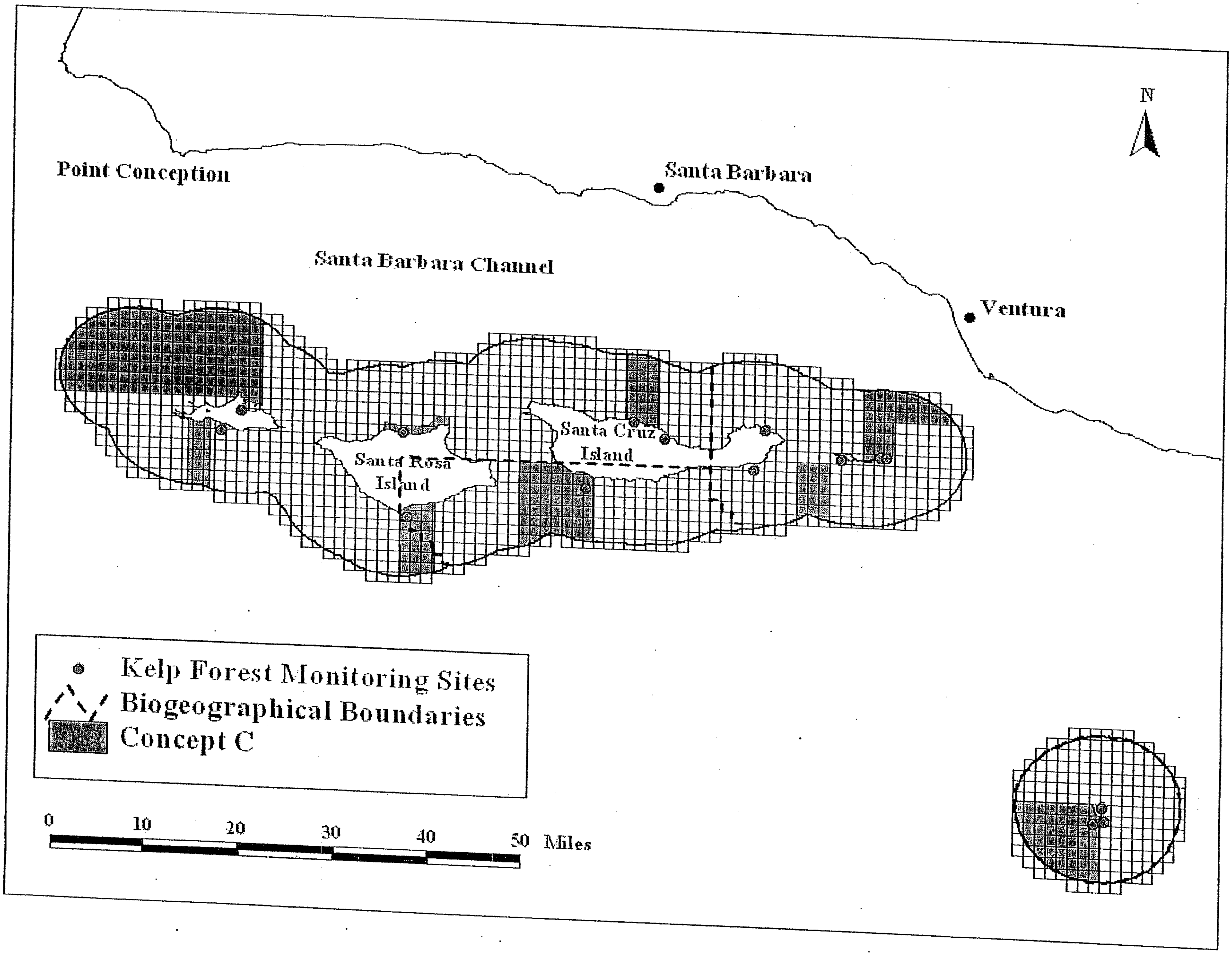
Point Conception
Santa Barbara
Ventura
Santa Barbara Channel
Santa Rosa
Island
Santa Cruz
Island
Kelp Forest Monitoring Sites
Biogeographical Boundaries
Concept B
0
10
20
30
40
50
Miles

Marine Reserves Working Group
Analysis of Reserve Concepts Using Ecological Criteria



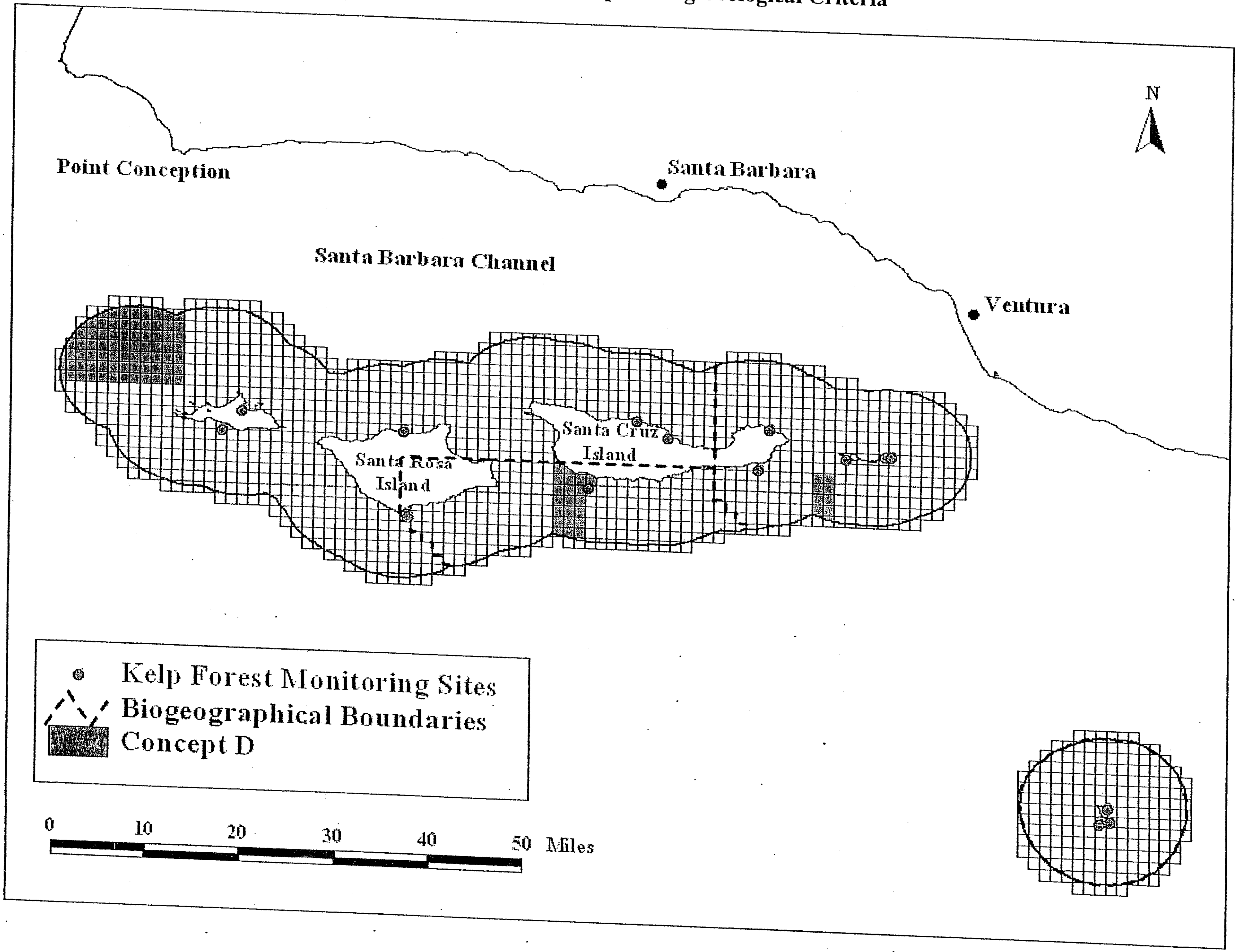

N
Point Conception
Santa Barbara
Santa Barbara Channel
Ventura
Santa Rosa Island
Santa Cruz Island
Kelp Forest Monitoring Sites
Biogeographical Boundaries
Concept D
0
10
20
30
40
50 Miles

Exhibit C.1
Situation Summary
April 2001

CHANNEL ISLAND NATIONAL MARINE SANCTUARY PROGRAM

Situation: The Channel Island National Marine Sanctuary Program (CINMSP) has been facilitating a process for the consideration of marine reserves within its boundaries. The process was initiated in December 1998 with the establishment of the Channel Islands National Marine Sanctuary Advisory Council (SAC). Advising this group are a Marine Reserves Working Group, representing the full range of interests in the affected communities, and a Marine Reserves Science Panel.

Presently there are a number of alternative reserve configurations under consideration. The reserves would be no fishing areas. The CINMSP does not have the authority to control fishing within its boundaries. Once the SAC develops a consensus around a single marine reserve proposal, the CINMSP sanctuary manager will approach the Council and the California Department of Fish and Game with a request for adoption of the needed fishing restrictions.

At this meeting, representatives from the CINMSP will present the Council with additional background on the CINMSP process (Attachments 1-4) and the alternatives developed to date. This agenda item provides the Council with an opportunity to comment on the proposals prior to the SAC's development of a consensus recommendation.

Council Action:

1. Provide comment to the CINMSP.

Reference Materials:

1. Channel Islands Marine Reserves Process (Exhibit C.1, Attachment 1).
2. Draft Summary Estimating Reserve Size (Exhibit C.1, Attachment 2).
3. Questions for the Science Advisory Panel (Exhibit C.1, Attachment 3).
4. Marine Reserves Working Group Analysis of Reserve Concepts Using Ecological Criteria (Exhibit C.1, Attachment 4).

PFMC
03/21/01