

An underwater photograph of a fish, possibly a rockfish, with a mottled pattern of orange and white on its body. The fish is positioned in the center-left of the frame, partially obscured by large, dark red kelp blades. The background is a vibrant, colorful reef with various green and orange organisms. The top of the image has a semi-transparent white banner containing text.

Channel Islands Marine Protected Areas

First 5 Years of Monitoring: 2003–2008

California Department of
Fish and Game

Partnership for Interdisciplinary
Studies of Coastal Oceans

Channel Islands
National Marine Sanctuary

Channel Islands
National Park

The California Department of Fish and Game produced this report in collaboration with the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Channel Islands National Marine Sanctuary, and Channel Islands National Park. The contributing authors are scientists from research institutions and government agencies who conducted biological and socioeconomic monitoring in the Channel Islands region. The report is based on preliminary results from selected projects conducted during the first 5 years of monitoring the Channel Islands marine protected areas (MPAs), presented by scientists at a public symposium in Oxnard, California, on February 7–8, 2008. The selected projects relate to Department of Fish and Game priorities in the Channel Islands Marine Protected Areas Monitoring Plan.

For more information about the results from monitoring the Channel Islands MPAs and to download a PDF version of this report, go to www.dfg.ca.gov/marine. To request printed copies of this report, please contact one of the addresses listed on the back cover. Copying and distributing this report is permissible, provided copies are not sold and the material is properly credited.

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Overview:

The Channel Islands—sometimes called the Galapagos of North America—are known for their great beauty, rich biodiversity, cultural heritage, and recreational opportunities. In 1980, in recognition of the islands' importance, the United States Congress established a national park encompassing 5 of California's Channel Islands (Santa Barbara, Anacapa, Santa Cruz, Santa Rosa, and San Miguel Islands) and waters within 1 nautical mile of the islands. In the same year, Congress declared a national marine sanctuary around each of these islands, including waters up to 6 nautical miles offshore.

Approximately 60,000 people visit the Channel Islands each year for aquatic recreation such as fishing, sailing, kayaking, wildlife watching, surfing, and diving. Another 30,000 people visit the islands for hiking, camping, and sightseeing. Dozens of commercial fishing boats based in Santa Barbara, Ventura, Oxnard, and other ports go to the Channel Islands to catch squid, spiny lobster, sea urchin, rockfish, crab, sheephead, flatfish, and sea cucumber, among other species.

In the past few decades, advances in fishing technology and the rising number of fishermen, in conjunction with changing ocean conditions and diseases, have contributed to declines in some marine fishes and invertebrates at the Channel Islands. In 1998, citizens from Santa Barbara and Ventura proposed establishment of no-take marine reserves at the Channel Islands, beginning a 4-year process of public meetings, discussions, and scientific analyses. In 2003, the California Fish and Game Commission designated a network of marine protected areas (MPAs) in state waters around the northern Channel Islands. In 2006 and 2007, the National Oceanic and Atmospheric Administration (NOAA) extended the MPAs into the national marine sanctuary's deeper, federal waters.

To determine if the MPAs are protecting marine species and habitats, scientists are monitoring ecological changes. They are studying changes in habitats; abundance and size of species of interest; the ocean food web and ecosystem; and movement of fish and invertebrates from MPAs to surrounding waters. Additionally, scientists are monitoring human activities such as commercial and recreational fisheries, and compliance with MPA regulations.

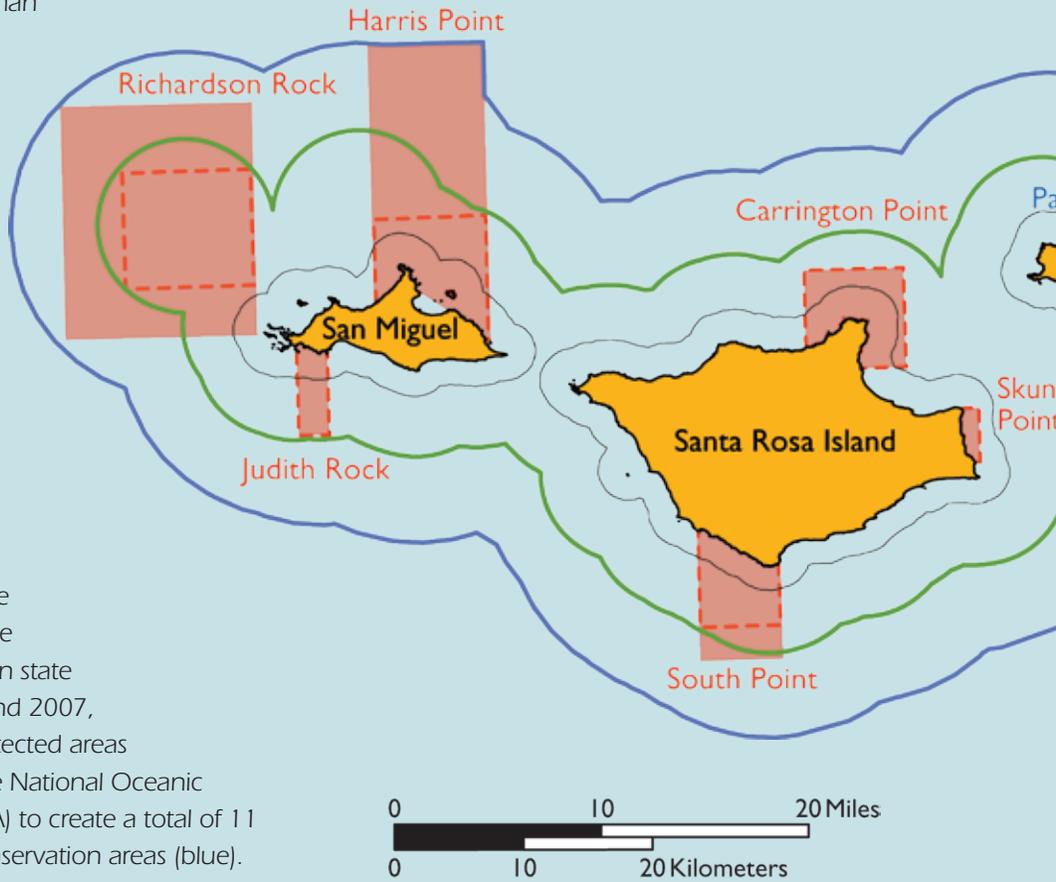
This booklet describes some results from the first 5 years of monitoring the Channel Islands MPAs. Although 5 years is not long enough to determine if the MPAs will accomplish all of their goals, this booklet offers a glimpse of the changes that are beginning to take place and illustrates the types of information that will eventually be used to assess the MPAs' effectiveness.

monitoring MPAs



Calls for Protection

In 1998, a group of concerned recreational anglers urged the State of California to provide greater protection for marine resources at the Channel Islands. Recognizing an increase in human impacts, government agencies and a public working group came to consensus that one important strategy was to establish marine protected areas (MPAs) that prohibit or restrict taking of marine life. At the same time, the California State Legislature passed the Marine Life Protection Act, requiring the Department of Fish and Game to improve the state's MPAs to protect habitats and preserve ecosystem integrity. In 2003, based on public input, scientific guidance, and socioeconomic considerations, the State of California designated 10 marine reserves (red dashed lines) and 2 marine conservation areas (blue dashed lines) in state waters within the sanctuary. In 2006 and 2007, the originally proposed network of protected areas was completed in federal waters by the National Oceanic and Atmospheric Administration (NOAA) to create a total of 11 marine reserves (red) and 2 marine conservation areas (blue).



Definitions

A **marine protected area (MPA)** is an area of the ocean where human activities such as fishing are limited or restricted in order to protect or conserve marine life or habitats.

A **marine reserve** is a type of MPA that prohibits all extractive uses. Marine reserves do not allow any human activity that alters habitats or removes animals, plants, or seaweeds, except as needed for scientific monitoring and research.

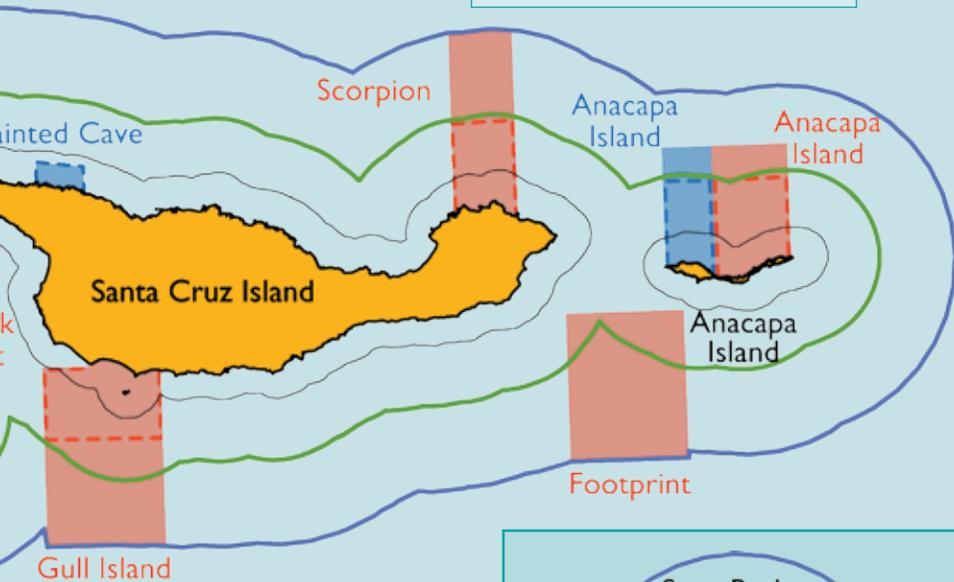
A **marine conservation area** is a less restrictive type of MPA. Commercial and/or recreational fishing may be allowed in these areas with restrictions that provide some protection for animals, plants, and habitats.

- Marine Reserve
- Marine Conservation Area
- Marine Reserve (2003)
- Marine Conservation Area (2003)
- California State Waters
- Channel Islands National Marine Sanctuary
- Channel Islands National Park

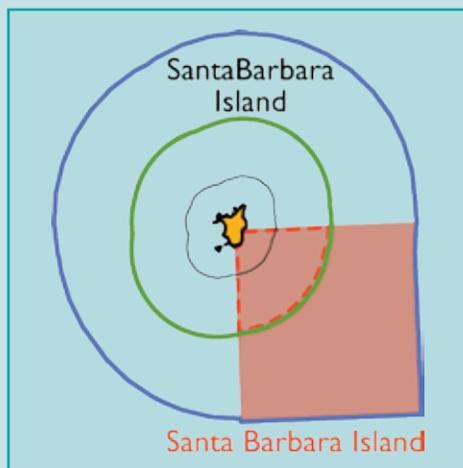
channel islands marine protected areas

Effective MPA Management

Conducting long-term monitoring, outreach, and enforcement is important for effective management of MPAs. Monitoring reveals changes that occur inside and outside MPAs. The Channel Islands Marine Protected Area Monitoring Plan was released in 2004 and incorporates recommendations from scientists, recreational and commercial fishermen, conservationists, government agencies, and the public. The monitoring plan is designed to detect changes in biology, economic factors, and people's activities in areas that are within, nearby, and distant from the MPAs. During the last several years, scientists from many different institutions, organizations, and agencies have conducted surveys of the marine habitats, animals, and plants of the Channel Islands using scuba, traps, remotely operated vehicles, submersibles, and other tools. To keep track of human activities, scientists interviewed fishermen, analyzed fishery logbooks and landings, and conducted aerial surveys of vessels. This booklet summarizes results from monitoring, outreach, and enforcement of the Channel Islands MPAs, conducted during the past 5 years



This map shows the Channel Islands marine protected areas (MPAs). No-take marine reserves are shown in red. Marine conservation areas, which allow limited commercial and/or recreational take, are shown in blue.



Facts About Channel Islands Marine Protected Areas

- In 1978, a small, no-take marine reserve was established by the State of California on the north side of Anacapa Island in an area protected by National Park regulations since 1968.
- A network of MPAs, encompassing the historical reserve, was established in state waters in 2003. The MPAs were expanded into federal waters in 2006 and 2007.
- There are 11 marine reserves and 2 marine conservation areas in state and federal waters around the 4 northern Channel Islands and Santa Barbara Island.
- MPAs encompass approximately 21% of the Channel Islands National Marine Sanctuary, leaving 79% open to consumptive recreational and commercial activities regulated by state and federal agencies.

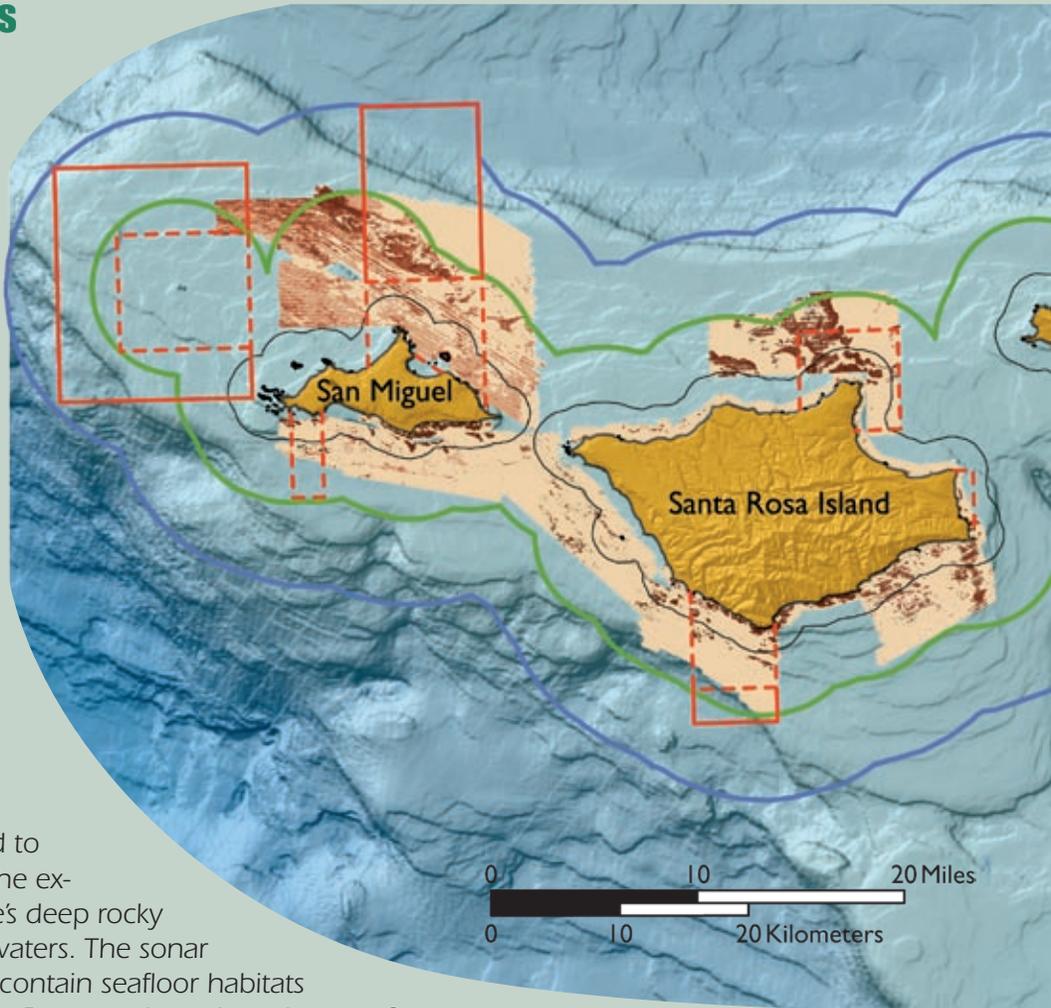
biological and habitat monitoring

Mapping Seafloor Habitats

One goal for design of MPAs at the Channel Islands was to include portions of each seafloor habitat type to protect distinct biological communities associated with the habitats. Scientists from the U.S. Geological Survey and California State University, Monterey Bay, have used swath sonar to map seafloor habitats at varying depths around the Channel Islands. As of 2008, the scientists had mapped approximately 30% of the Channel Islands National Marine Sanctuary (see map).

All MPAs surveyed to date contain both rocky reefs and soft bottom areas. Mapped rocky reefs tend to be located in shallow waters with the exception of Footprint Marine Reserve's deep rocky ridge, which lies mainly in federal waters. The sonar mapping data show that the MPAs contain seafloor habitats that are representative of the region. Representing a broad array of habitats and their associated species was a goal for the Channel Islands MPAs and is required for comparing MPAs with surrounding areas.

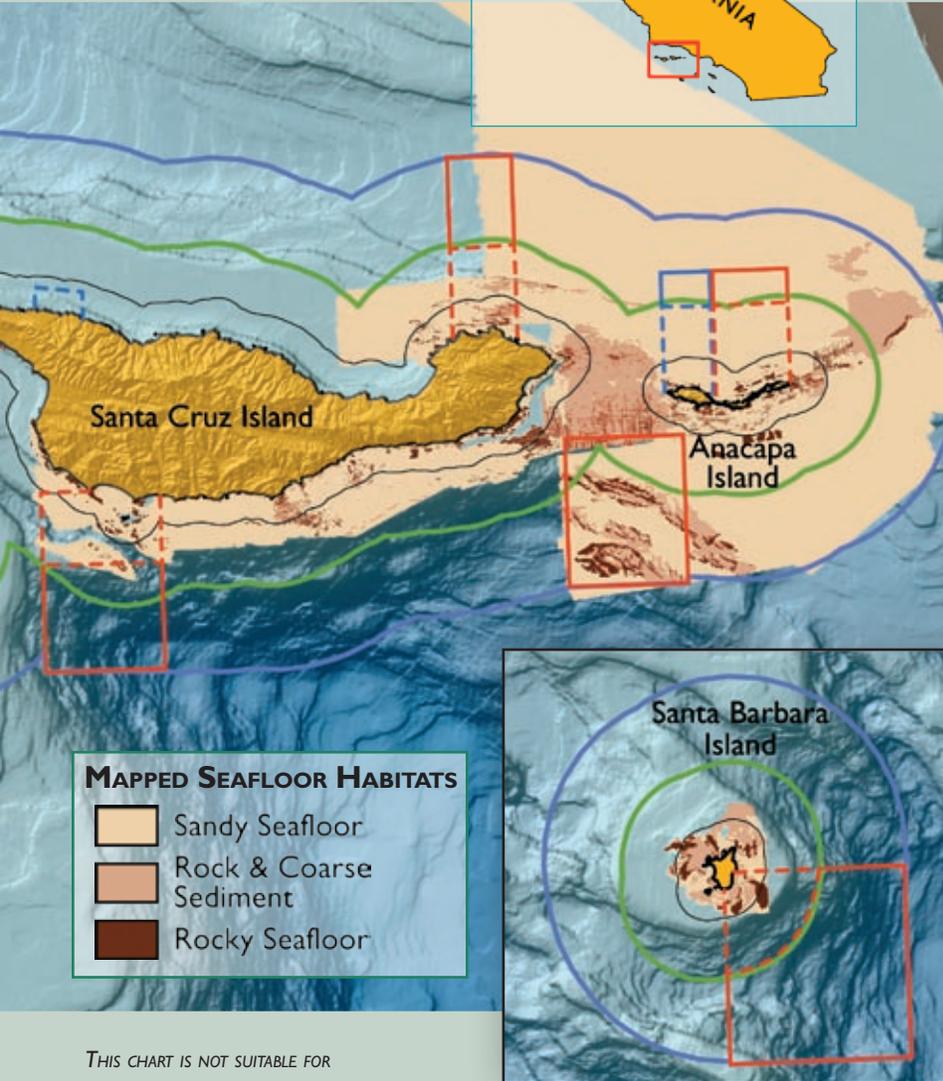
Data: United States Geological Survey and California State University, Monterey Bay. Analysis: G. Cochrane and R. Kvitek.



Long-term Monitoring of Marine Ecosystems

In the ocean, habitats are connected through movements of animals, plants, and nutrients. Most marine fishes and invertebrates use more than one habitat during their lives. Areas with diverse habitats also tend to be biologically diverse. The Channel Islands region supports a wide array of habitats and species including habitat-forming species, such as giant kelp, species targeted by fishing, such as lobster and rockfish, and non-targeted species, such as sea anemones and garibaldi fish. The surrounding waters support at least 27 species of whales and dolphins, and the islands are home to feeding and breeding colonies of seals, sea lions, and more than 60 species of marine birds.

Monitoring the ecosystem that supports these species is critical to understanding changes over time. Long-term monitoring data are not common in marine systems, but the Channel Islands are an exception. Since 1982, the Channel Islands National Park (CINP) has been conducting comprehensive surveys of the kelp forest habitat and associated species. CINP also conducts monitoring of intertidal areas, beaches, and onshore animals. These surveys and other ongoing monitoring and research programs provide substantial baseline information, and they allow for better comparisons before and after implementation of MPAs.



THIS CHART IS NOT SUITABLE FOR NAVIGATIONAL PURPOSES

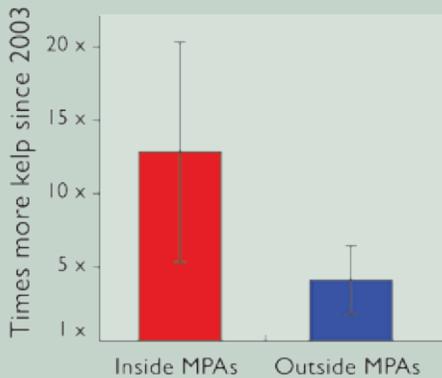


Reef at Harris Point. Photo: © Jim Knowlton

Key Findings

- Kelp forests, rocky reefs, and sandy areas are common seafloor habitats around the Channel Islands.
- The Channel Islands MPAs contain amounts of rocky and soft-bottom seafloor habitats that are representative of the region.
- The MPAs protect a diverse community of fishes, invertebrates, mammals, and birds representative of the Channel Islands.
- Kelp forests have expanded around the Channel Islands since 2003.

Relative Change in Kelp



Change in kelp from before (1998-2002) to after (2003-2007) establishment of MPAs. Proportional increase in kelp was greater in MPAs (red bar) than other areas (blue bar).

Changes in Kelp Forests

Giant kelp forms extensive underwater forests firmly attached to rocky reefs in shallow waters around the Channel Islands. Giant kelp forests provide food and habitat for many associated fishes and invertebrates. The fronds of giant kelp, which can grow as fast as 2 feet per day, float at the ocean surface making it possible to map surface area of kelp from aerial photographs. For many years, scientists from the California Department of Fish and Game mapped kelp forests at the Channel Islands. A scientist from the

University of California, Santa Barbara, used historical aerial surveys, infrared aerial photography, and recent advances in satellite remote sensing to evaluate changes in kelp forests in the region. He found that kelp abundance increased substantially throughout the Channel Islands region during the 5 years since MPAs were established as compared to the previous 5 years. Additionally, these increases were greater in MPAs than other areas.

Data and analysis: B. Kinlan.

Do More Fish and Invertebrates Live Inside Marine Reserves?

Scientific Scuba Surveys

According to scuba surveys, fish species actively targeted by fishermen outside reserves tend to be bigger and more plentiful inside reserves than in fished areas at the Channel Islands. The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and the Channel Islands National Park (CINP) conducted dive surveys at more than 80 shallow, rocky sites inside and outside of marine reserves. They studied 14 fish species that are targeted by commercial and recreational fishermen, such as rockfish, kelp bass, and lingcod, and 19 fish species that are not targeted, such as bat ray, garibaldi, and señorita. At each site, divers counted and estimated sizes of fish, allowing calculation of biomass, or total weight of fish in a defined area. Twelve of the 14 species fished outside reserves had greater biomass inside marine reserves. In contrast, biomass of almost all non-targeted species was similar or greater outside reserves. Most dramatically, ocean whitefish and lingcod—both of which are fished outside reserves—had more than 3 times greater biomass inside reserves. Similarly, invertebrates targeted by fishing tended to be more abundant in reserves. Researchers are examining possible reasons for these patterns, such as differences in habitat. However, strong differences between targeted and non-targeted species suggest that protection from fishing is a likely cause.

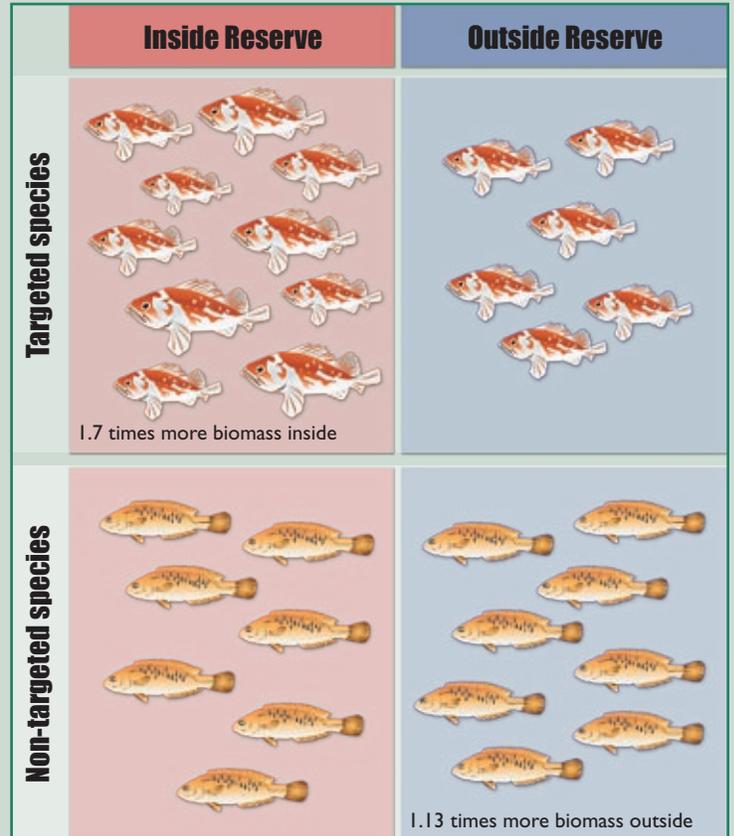
Data: PISCO & CINP Analysis: J. Caselle, S. Hamilton, D. Malone, D. Kushner, and M. Carr.

Fish Species from PISCO Surveys

Non-targeted species	Targeted species
Rock wrasse (1.66)	Ocean whitefish (4.53)
Island kelpfish (1.15)	* Lingcod (3.21)
Rubberlip surfperch (1.09)	* California sheephead (1.88)
Painted greenling (1.06)	Kelp bass (1.70)
Pile surfperch (1.04)	* Copper rockfish (1.66)
Blacksmith (0.97)	Cabezon (1.59)
Bat ray (0.97)	* Olive rockfish (1.52)
Black surfperch (0.96)	* Blue rockfish (1.50)
Opaleye (0.96)	* Vermillion rockfish (1.31)
Striped surfperch (0.94)	Kelp rockfish (1.19)
Kelp surfperch (0.91)	Brown rockfish (1.14)
Shiner surfperch (0.83)	Black and yellow rockfish (1.08)
Garibaldi (0.78)	* Gopher rockfish (0.90)
Halfmoon (0.77)	* Treefish (0.64)
Giant kelpfish (0.76)	
*Señorita (0.74)	
Rainbow surfperch (0.50)	
Silverside (0.44)	
Tubesnout (0.34)	

Green: species with more biomass inside reserves.
Black: species with less biomass in reserves. Number in parentheses is ratio of biomass inside to outside reserves. Ratio above 1 indicates more biomass inside reserves.

Effects of Reserves on Average Fish Biomass



The figure above illustrates the differences in fish biomass inside and outside marine reserves at the Channel Islands. Top 2 panels: On average, the biomass of fish species targeted by fishing was approximately 1.7 times greater inside reserves than outside. Bottom 2 panels: In contrast, the average biomass of non-targeted fish species was almost the same inside and outside reserves. Similar patterns were observed for targeted and non-targeted invertebrates.

Differences in fish biomass and invertebrate density inside versus outside reserves.

	Fish	Invertebrates
Targeted	1.7 ± 0.27	1.43 ± 0.50
Non-targeted	0.87 ± 0.07	0.95 ± 0.22

Values greater than 1 indicate more biomass inside reserves. Values less than 1 indicate more biomass outside reserves.

Key Findings

- Fish and invertebrate species targeted by fishermen outside reserves had greater average biomass and density inside marine reserves.
- The average biomass and density of species not targeted by fishermen were similar or slightly greater outside reserves than inside reserves.



Research vessel at Santa Cruz Island.
Photo: Robert Schwemmer/NOAA



Remotely operated vehicle (ROV) used for deep-water surveys. Photo: Donald Baldwin/DFG



A diver conducts a fish survey for the Reef Environmental Education Foundation (REEF).
Photo: Pete Naylor

Remotely Operated Vehicle (ROV) Surveys

Since 2004, California Department of Fish and Game scientists have used a remotely operated vehicle (ROV) to survey fish in deeper, rocky habitats around the Channel Islands. These surveys have covered a total of 150 miles (240 kilometers) at 10 different sites at depths of 45 to 220 feet (14 – 67 meters), extending beyond the maximum practical scuba survey depth of about 80 feet (24 meters, see opposite page for scuba surveys). Although it is too soon to see long-term changes, the ROV surveys have found that 8 out of 12 fish species are more numerous in marine reserves. Seven of those 8 species are targeted by fishermen outside the reserves. This finding is consistent with data from scuba surveys in shallower waters.

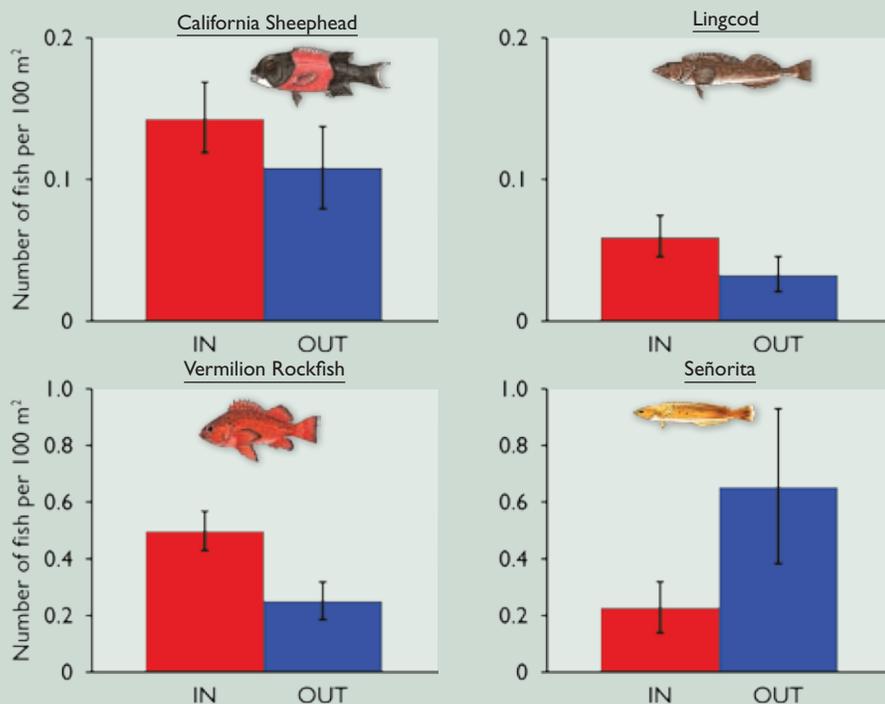
Data: California Department of Fish and Game, National Oceanic and Atmospheric Administration, Pacific States Marine Fisheries Commission, Marine Applied Research and Exploration, The Nature Conservancy, and Ocean Protection Council. Analysis: K. A. Karpov, A. Lauermann, and J. J. Geibel.

Volunteer Reef Survey

Since 1996, volunteer scuba divers have carried out more than 1,700 fish counts at the Channel Islands under the Reef Environmental Education Foundation (REEF) survey program. Prior to establishment of marine reserves in 2003, the REEF divers performed 767 surveys at more than 100 sites around the islands. Subsequently, they have conducted 984 surveys inside and outside the reserves. Scientists are using the data to help understand how marine reserves affect fish abundance. Preliminary results suggest that most fish species in the surveys have increased since the reserves were established.

Data: REEF. Analysis: B. X. Semmens, S. L. Katz, and K. V. Pattengill-Semmens.

Fish Density Inside and Outside Reserves



ROV Survey Results

- Density in reserves (IN)
- Density in fished areas (OUT)

Vermilion rockfish, sheephead, and lingcod were more abundant inside no-take reserves (red bars) than outside (blue bars). These 3 species are targeted by fishermen outside reserves. Fishermen do not target the señorita, which was more abundant outside reserves. Data are averages from 2005 through 2007. Many factors might have caused the differences, such as historical abundance, habitat characteristics, interactions among species, or the protection provided in reserves. Scientists may be able to identify the cause of these differences with additional monitoring.

Numbers, Body Sizes, and Movement of Lobster



Lobster trap buoy at Gull Island State Marine Reserve. Photo: Matt Kay



Collaborative reserve sampling aboard commercial vessel. Photo: Kristine Faloon



California spiny lobster. Photo: Matt Kay

Collaborative Reserve Monitoring

CALobster is a research collaboration of commercial fishermen and marine biologists from the University of California, Santa Barbara. The researchers use traps to monitor California spiny lobster around the eastern Channel Islands. They deploy commercial lobster traps inside, nearby, and approximately 2 miles away from 4 reserves. Every trapped lobster is measured and then released with a numbered tag, which stays attached even after the lobster molts.

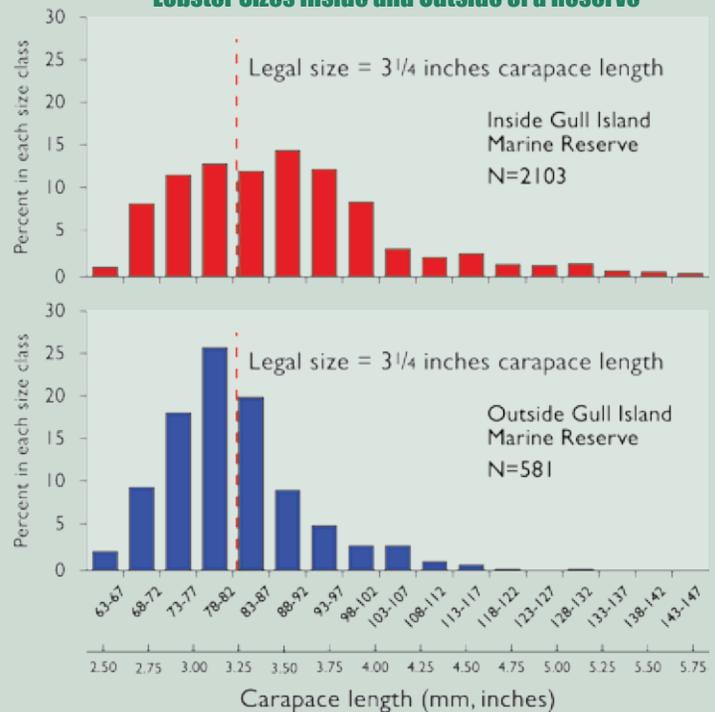
The short-term goals of CALobster are to determine:

1. sizes of spiny lobster and population age structure inside versus outside reserves,
2. number of lobster per trap inside versus outside reserves, and
3. movement patterns near reserve borders and over greater distances.

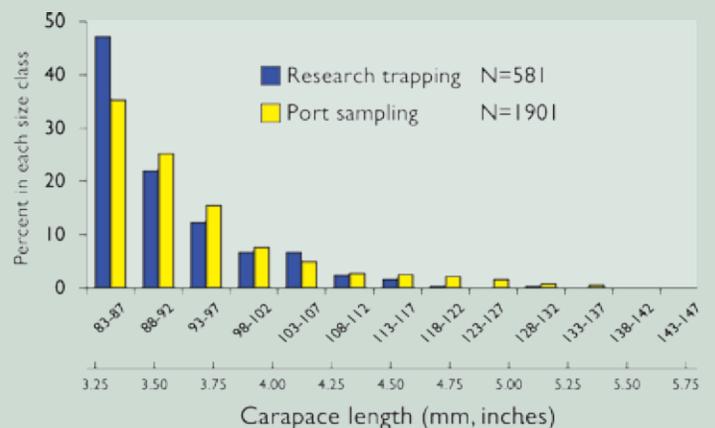
At the Gull Island Marine Reserve, for example, the monitoring program's traps inside the reserve (top graph) consistently caught more legal-sized lobster than traps outside (middle graph). Additionally, the largest lobster sampled during surveys were found inside the reserve. Monitoring at other reserves produced similar results, suggesting that the reserves affect lobster populations at the Channel Islands. Scientists expect this trend to become even more apparent as time passes and lobster in reserves continue to grow.

At mainland ports, CALobster works with commercial fishermen to collect data on their lobster catch. Port sampling helps CALobster relate monitoring data from the islands to fishery data from a larger region and longer time periods. It also enables lobstermen to contribute to the monitoring and management of fishery resources. The bottom graph shows that port sampling (yellow bars) and research sampling (blue bars) produced similar results.

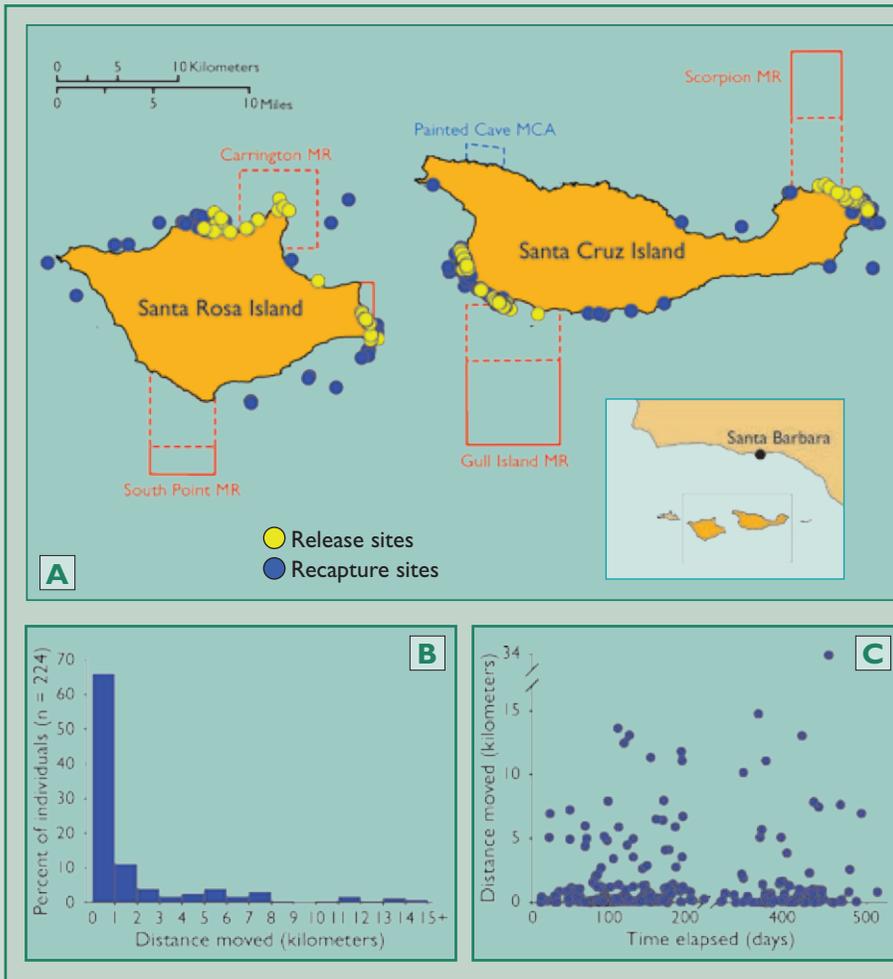
Lobster Sizes Inside and Outside of a Reserve



Research and Port Sampling of Lobster Outside Reserves



NUMBERS DO NOT REPRESENT ABUNDANCE



Lobster Movement

A. Over a period of 2 years, scientists tagged and released lobster inside and outside 4 marine reserves at the Channel Islands. Sites where tagged lobster were released are indicated by yellow dots. When commercial fishermen caught tagged lobster outside reserves, they reported the locations (blue dots) to the scientists.

MR is Marine Reserve.

MCA is Marine Conservation Area.

B. This graph shows the distances that lobster had moved after being tagged. More than 60% traveled 1 kilometer or less, but some moved 15 or more kilometers.

C. This graph shows the distance that individual lobster traveled from the time they were tagged to the time they were caught in a commercial fisherman's trap. Some lobster were recaptured near their release sites even after 2 years, whereas other lobster traveled several kilometers within a hundred days. The graph covers 2 lobster fishing seasons; the break in the x-axis indicates the closed season.

Collaboration of Fishermen and Scientists

CALobster strives to advance fishery research and management by fostering collaboration among scientists and fishermen. As part of these collaborative efforts, CALobster conducts studies in which lobster are tagged, released, and eventually recaptured. The studies provide information about where lobster go and how fast they grow. The data may be valuable for understanding how marine reserves affect the lobster fishery, developing lobster population models, and integrating marine reserves into stock assessments.

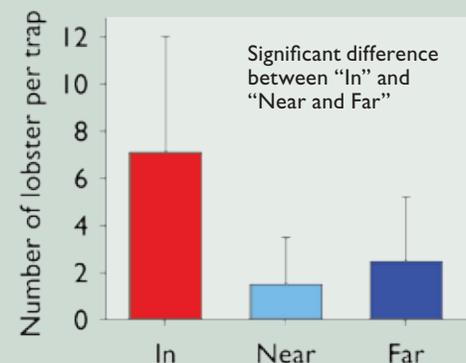
During a 2-year period, researchers tagged 14,000 lobster and studied movement across reserve borders. Commercial fishermen recaptured and reported the exact location of 224 of these tagged lobster. The map above shows the recapture locations, as well as initial release points. This study revealed that most lobster traveled only short distances, even after two years (see figures, above).

CALobster researchers put lobster traps inside reserves and at different distances from the reserves. Although the number of lobster captured per trap varied, the difference between reserves and fished areas was significant. On average, the number of lobster captured per trap inside reserves (red bar, right) was more than twice the number captured in fished areas near and distant from the reserves (light and dark blue bars, right). The researchers are investigating potential causes of these patterns, including reserve protection, historical distribution of lobster, and differences in habitats.

Data from CALobster. Analysis by M. Kay, H. Lenihan, C. Miller, and K. Barsky.

Key Findings

- Lobster populations inside reserves have higher proportions of large individuals.
- Traps inside reserves consistently had equal or higher yields than traps outside.
- Recaptures suggest most movement is less than 1 kilometer, but some lobster move long distances.



Average number of lobster per trap inside, near, and farther (up to 2 miles) from reserves.

How Much Time Do Fish Spend in Marine Protected Areas?



California sheephead. Photo: Robert Schwemmer/NOAA



Cabezon. Photo: Chad King/MBNMS



Giant seabass. Photo: © Douglas Klug

Fish Move into and out of Reserves

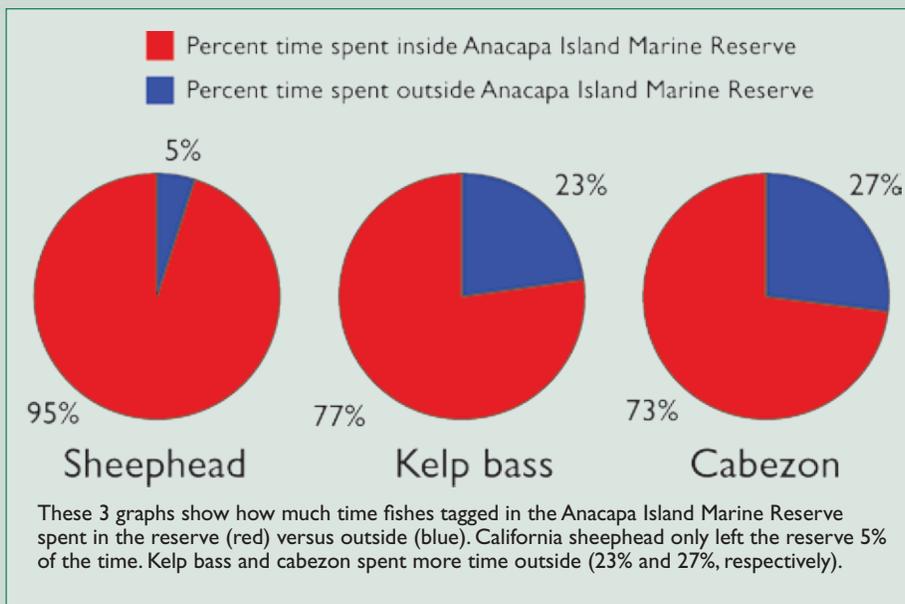
Some fish species roam over great distances, while others tend to stay in a relatively small area. Because fish at the Channel Islands are protected from fishing only while in marine reserves, their travel habits are a key factor in how well they are protected. In 2000, scientists began tracking fish movements around the islands. They tagged 224 fish with small transmitters and then monitored the fishes' movements using 98 listening stations on the seabed. The study included 4 fish species: California sheephead, kelp bass, cabezon, and giant sea bass. Some individuals of each species moved from reserves to surrounding waters, but the species varied greatly in how far they traveled. California sheephead tagged inside a marine reserve at Anacapa Island stayed in the no-fishing area 95% of the time. Many tagged kelp bass and cabezon stayed in the reserve, but some left and did not return. Giant sea bass tended to move farthest, traveling more than 50 miles among the islands and the mainland. Even so, they were in marine reserves about 25% of the occasions on which scientists knew their whereabouts. Because these fish species vary in time spent inside marine reserves, they receive differing amounts of protection from the reserves.

Data and analysis: J. Lindholm, A. Knight, D. Kline, M. Domeier, and J. Caselle.

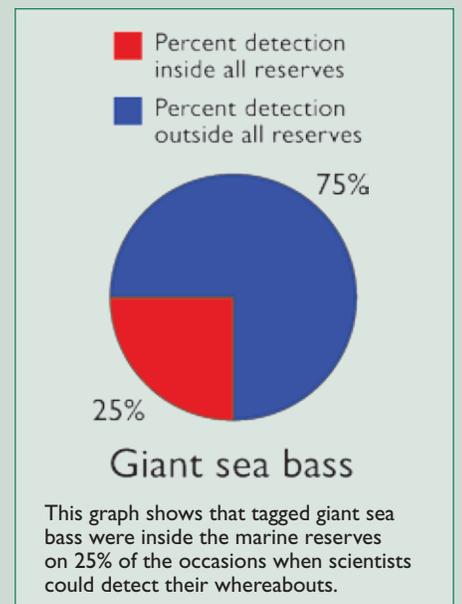
Key Findings

- After fish were tagged in a marine reserve, at least some individuals of each of 4 species moved out of the reserve.
- California sheephead stayed in the reserve 95% of the time.
- Cabezon and kelp bass stayed in the reserve 73% and 77% of the time, respectively.
- Although giant sea bass moved long distances, tagged fish were detected frequently in reserves.

Fish Movements at Anacapa Island



All Islands



Changes in Marine Communities Inside Marine Reserves



Forest of giant kelp. Photo: Laura Francis



Purple urchins and a garibaldi. Photo: Claire Fackler/NOAA



Sunflower sea star. Photo: Claire Fackler/NOAA

Lobster, Scallops, and Some Fish Thrive in Reserves

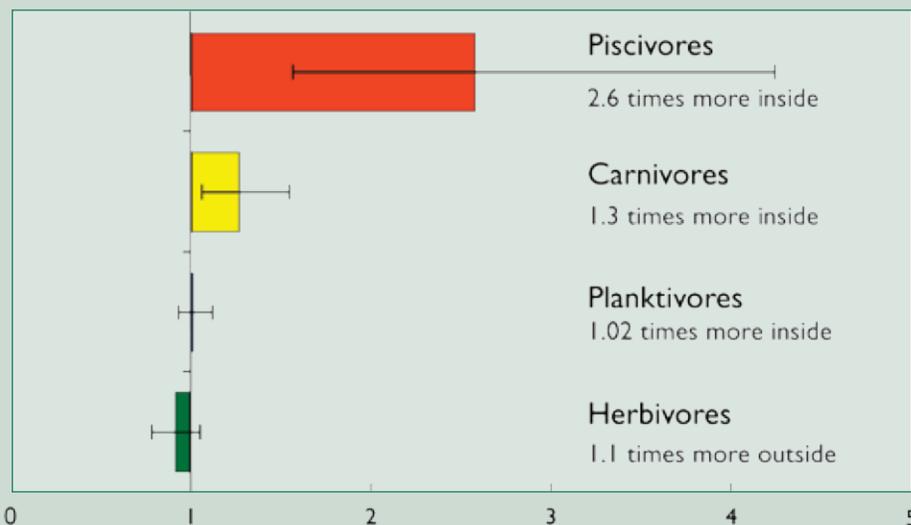
Marine reserves throughout California tend to host different fish, invertebrates, and seaweeds than areas that are open to fishing, but these differences can take years to develop. Lobster, turban snails, and sponges are abundant in the marine reserves, while purple urchins, sunflower stars, and Kellet's whelk are more common outside. These differences may have broad effects on the ecosystem. Monitoring conducted since 1982 by the Channel Islands National Park (CINP) shows that lobster, rock scallops, and sea cucumbers have become plentiful; different fish species dominate; and kelp forest and seaweed communities are less variable in a long-established marine reserve at Anacapa Island than in nearby fished areas. More recent monitoring by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) is detecting similar ecological changes in reserves established in 2003. In addition to finding more fish species in reserves than in non-reserve areas, PISCO's surveys show that on average reserves harbor 2.6 times more biomass of predatory fish (red bar, below), which are targeted by fishermen outside reserves.

Data: PISCO and CINP. Analysis: S. Hamilton, J. Caselle, D. Malone, D. Kushner, and M. Carr.

Key Findings

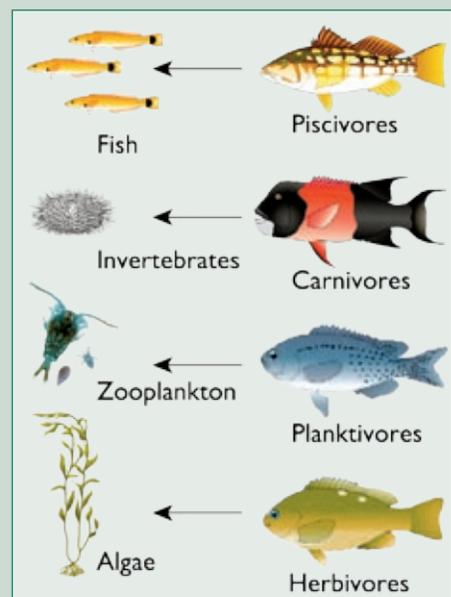
- The number of fish species in marine reserves is greater than other areas.
- Reserves protect a more natural food web structure, including greater numbers of predatory fish and lobster, than fished areas.
- Kelp forest communities in reserves are less variable than those in places where fishing occurs.

Biomass of Fish Inside and Outside Marine Reserves



The graph above shows average ratios of fish biomass inside reserves versus outside reserves. Average ratios are given with one standard error.

Roles in the Food Web



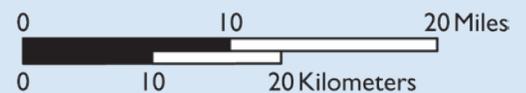
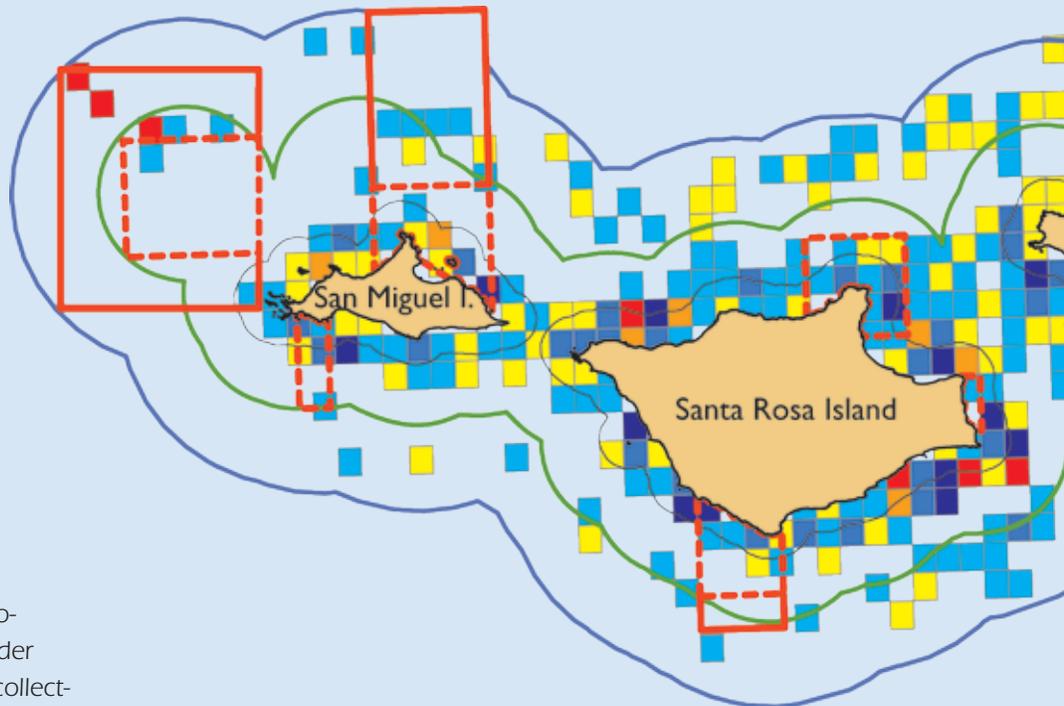
socioeconomic monitoring

Overview

Establishment of MPAs at the Channel Islands not only affects fish, invertebrates, and kelp, but people too.

For example, fishermen may no longer cast their lines and nets in marine reserves. Recreational divers might begin to visit the protected areas more often. And the region's economy might be positively or negatively affected. The California Department of Fish and Game, Channel Islands National Marine Sanctuary, and Channel Islands National Park are committed to monitoring the relationship between MPAs and humans.

The sanctuary hired a social science coordinator who, with years of stakeholder input, developed a scientific plan for collecting data on human uses. The goal is to identify the effects of marine reserves on where human activities occur; local and regional economic values; and knowledge, attitudes, and perceptions of users. Monitored human activities fall into 4 categories: consumptive (such as commercial fishing, recreational fishing, and spear fishing), non-consumptive (such as kayaking, sailing, and diving), passive (such as learning about the MPAs through reading), and education and research (such as lectures and field trips).



For legend of jurisdictional boundaries, see map on page 2.

Key Questions

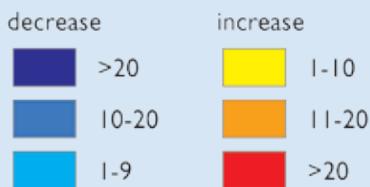
- Where have fishing and other activities occurred at the Channel Islands before and after MPAs were established?
- How have commercial and recreational fisheries changed since implementation of MPAs, including distribution of boats, numbers of fishermen, and value of fisheries?
- How have MPAs affected where recreational boaters go and what they do at the Channel Islands?



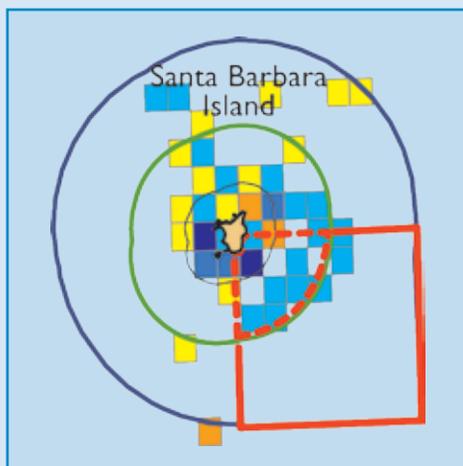
Ocean kayaker at the Channel Islands. Photo: Claire Fackler/NOAA



CHANGE IN NUMBER OF BOATS BEFORE AND AFTER MPAs*



*This map shows changes in total number of boats per block from before (1997-2003) and after (2003-2008) the establishment of MPAs.



Aerial survey over the Channel Islands.
Photo: NOAA

Key Findings

- The western Channel Islands tended to have more commercial boats than recreational boats. Most recreational boats went to the eastern Channel Islands, which are closer to mainland harbors.

After MPAs were established:

- Slightly fewer commercial fishing vessels were seen at the Channel Islands, while numbers of recreational vessels stayed about the same.
- The numbers of recreational and commercial fishing boats increased slightly in waters outside the MPAs. For example, more recreational fishing boats went to the south side of Anacapa Island, which is open to fishing.
- Conversely, the number of non-fishing recreational boats increased in a marine reserve at Santa Cruz Island.

Changes in Boat Distribution

Since 1997, scientists regularly conducted aerial surveys over the Channel Islands National Marine Sanctuary to monitor the numbers and locations of commercial and recreational boats. The Sanctuary Aerial Monitoring and Spatial Analysis Program (SAMSAP) also tracks whales and unusual conditions, such as oil spills. Observers distinguish between consumptive and non-consumptive, and recreational and commercial activities,

and they note the kinds of fishing gear that they see.

SAMSAP conducted 175 surveys between 1997 and 2006. Of those, 97 occurred before the state established MPAs in 2003, and 78 after. Most commercial vessels were seen near San Miguel and Santa Rosa Islands, while most recreational vessels were found near Anacapa and eastern Santa Cruz Islands, which are closer to harbors and

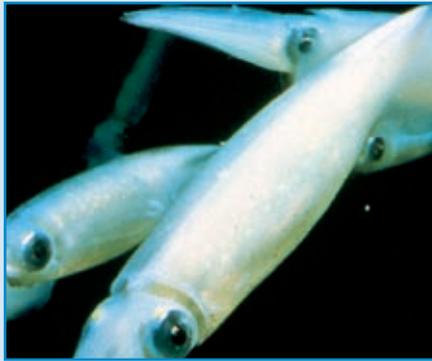
ports. After MPAs were established, the number of recreational fishing boats increased along the south side of Anacapa Island outside the MPAs. The number of non-consumptive recreational vessels, such as sailboats, increased in Scorpion Marine Reserve along the northeastern shore of Santa Cruz Island.

Data: SAMSAP. Analysis: N. Senyk, D. Greenberg, and B. Waltenberger.

Effects of MPAs on Commercial Fisheries



Gopher rockfish. Photo: © Annie Crawley



Market squid. Photo: Monterey Bay National Marine Sanctuary/NOAA



Commercial fishing vessel at the Channel Islands. Photo: Robert Schwemmer/NOAA

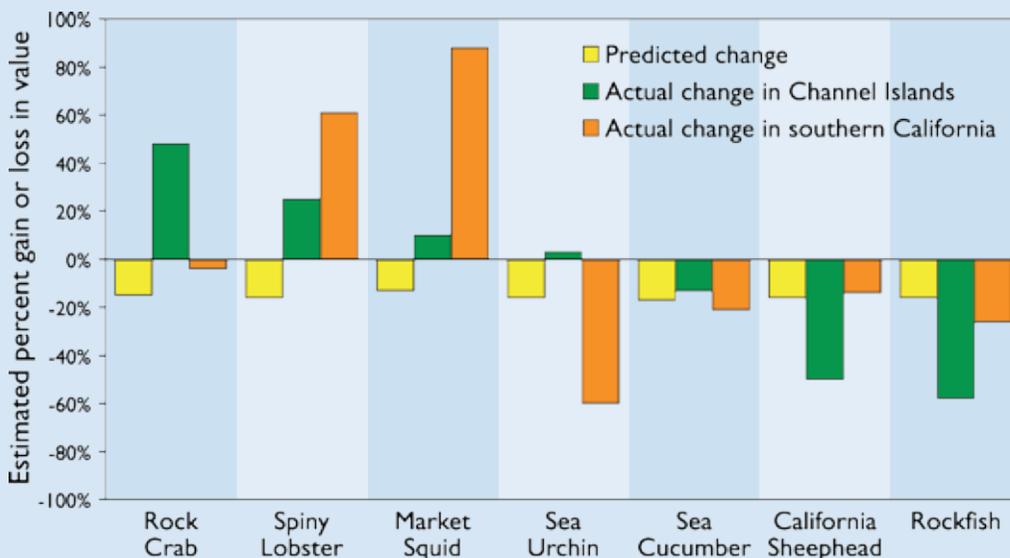
Some Fisheries Fared Well, Others Declined

The Channel Islands region has a long history of fishing and boating, with working harbors in Santa Barbara, Ventura, and Oxnard. Squid, spiny lobster, red sea urchin, rockfish, crab, California sheephead, flatfish, and sea cucumber now are the most valuable fisheries. Prior to the establishment of MPAs in 2003, economists predicted that these major commercial fisheries at the Channel Islands would decline in ex-vessel value up to 17% after the closures took effect.

Five years after MPA establishment, changes in 7 fisheries were analyzed. Three fisheries declined, including 2 that decreased more than predicted, and 4 fisheries increased, instead of declining as predicted. However, many factors beyond the MPAs played a role in these changes, including other regulations, environmental changes, and market forces.

To help take those factors into account, the scientists analyzed how well the fisheries in the Channel Islands fared compared to fisheries in the rest of southern California. The study determined that 2 of the 7 fisheries (sheephead and rockfish) declined in value more in the Channel Islands than they did in the rest of southern California, while 2 (California spiny lobster and squid) rose in value, but did so less than elsewhere. The remaining 3 fisheries fared better in the Channel Islands than the rest of southern California: Rock crab and sea urchin fisheries increased in the Channel Islands, while they decreased in the rest of California, and sea cucumber decreased less in the Channel Islands than elsewhere.

Data: California Department of Fish and Game. Analysis: M. Bergen, D. Aseltine-Neilson, and C. Valle.



Key Findings

- Changes in commercial fisheries are linked to environmental shifts, market forces, and changes in fishery regulations.
- Predictions suggested that MPAs would cause decreases in commercial fisheries, but these decreases were not realized for all fisheries.
- Of 7 fisheries studied, 4 fisheries increased and 3 declined in value since MPAs were established in 2003.
- Compared to the rest of southern California, at the Channel Islands after MPAs were established: rock crab and sea urchin fisheries increased more; lobster and squid fisheries increased less; the sea cucumber fishery declined less; and sheephead and rockfish fisheries declined more.

- Maximum potential loss, assuming loss of all fishery activity in proposed MPAs, estimated in 2002, before MPAs were implemented (from Leeworthy and Wiley 2002).
- Actual changes in value of fisheries at the Channel Islands, comparing 5-year averages before and after MPAs were established at the Channel Islands in 2003.
- Actual changes in value of fisheries in southern California, comparing 5-year averages before and after MPAs were established at the Channel Islands in 2003.

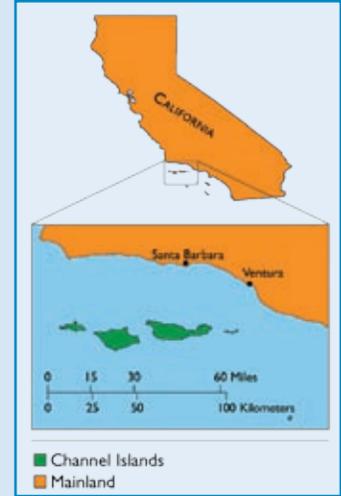
Case Study: Changes in the Commercial Spiny Lobster Fishery



California spiny lobster. Photo: Claire Fackler/NOAA



Commercial fisherman showing his catch. Photo: Carla Guenther



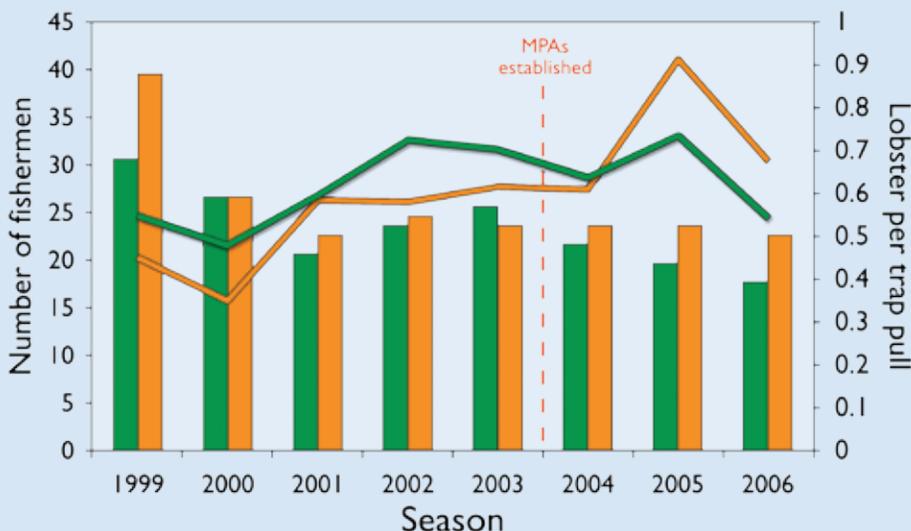
Study region at California's Channel Islands

Number of Fishermen and Catch per Unit Effort

Have state MPAs established in 2003 affected the commercial fishery for spiny lobster around the Channel Islands? To answer this question, a University of California, Santa Barbara, graduate student compiled 8 years of commercial lobster fishery logbook data from the California Department of Fish and Game and interviewed 70% of the fishermen in the region's lobster fleet. The logbooks spanned 5 years before and 3 years after MPA establishment.

The total number of lobster fishermen who fished at the Channel Islands and along the mainland coast in the vicinity of Santa Barbara and Ventura decreased from 43 to 36 during the 8-year period. Many fishermen used both the mainland and islands (graph, below). But since 2003, when MPAs were established at the Channel Islands, the number of fishermen operating at the islands (green bars) steadily decreased, while the number of fishermen along the mainland (orange bars) remained approximately the same. Prior to 2004, the seasonal average catch per unit effort (CPUE)—measured as number of lobster per trap pull—was higher at the Channel Islands than along the mainland. After 2004, the pattern reversed, and the seasonal average CPUE increased less at the Channel Islands as compared to the mainland. For example, fishermen at Santa Cruz Island caught 7–30% fewer lobster per trap pull after MPAs were established at the island. Changes in CPUE, effort, and fishing profits may be linked to experience, environmental fluctuations, and fishery regulations including MPAs.

Data: California Department of Fish and Game. Analysis: C. Guenther.



Key Findings

- The total number of lobster fishermen in the Santa Barbara region decreased between 1999 and 2002; the number of lobster fishermen around the Channel Islands decreased more than at the mainland since 2003.
- Before 2004, the seasonal average number of lobster per trap pull was higher at the islands, but since 2004 it has been higher along the mainland.
- Changes in the lobster fishery may be linked to changes in regulations, market forces, and environmental fluctuations.

Changes in Recreational Fishing



Fishermen enjoy recreational fishing at Anacapa Island. Photo: David Ono/DFG



A young angler displays her catch. Photo: Michelle Horeczko/DFG



Commercial passenger fishing vessel at the Channel Islands. Photo: David Ono/CDFG

Fishing Effort Shifted to Areas Outside MPAs

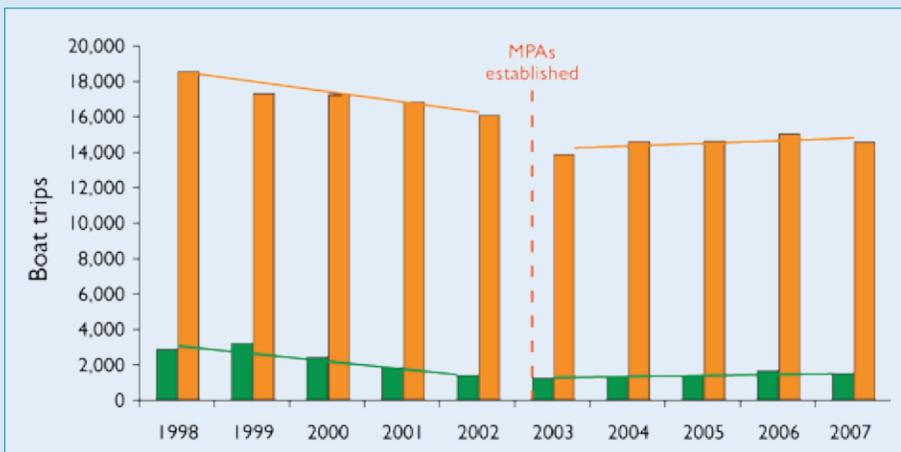
The northern Channel Islands are a popular fishing location for commercial passenger fishing vessels (CPFVs), also known as charter boats or party boats. Since MPAs were established in 2003, CPFVs made an average of 1,400 trips per year to the northern Channel Islands, carrying fewer than 10 to more than 100 anglers per trip. Using fishing logs and onboard observers, the California Department of Fish and Game collects data on the number of CPFV fishing trips, number of fish caught, and trip locations.

Logbook data show that CPFV trips per year to the northern Channel Islands and to other areas of southern California decreased between 1998 and 2003. Changes in fishing regulations and environmental conditions likely played roles in this decrease. Since MPAs were established in 2003, the annual number of CPFV trips to the Channel Islands and other places in southern California remained fairly constant. Onboard observer data from the islands showed that CPFVs shifted their fishing locations after MPA establishment. Previously, approximately 30% of their stops were inside areas that became MPAs. After 2003, only about 2% of the stops were inside MPAs that allow some recreational fishing. Although recreational fishing effort continued to be concentrated near Anacapa Island and Santa Cruz Island, it decreased on Anacapa's north side and Santa Cruz's northeast side, where MPAs were established. Meanwhile, recreational fishing effort increased south of those 2 islands and in the waters between them.

Data: California Department of Fish and Game. Analysis: C. Ryan, L. McGarvie, S. Owen, W. Dunlap, and A. Sadrozinski.

Key Findings

- The annual number of commercial passenger fishing vessel (CPFV) trips decreased throughout southern California between 1998 and 2003, before MPAs were established around the northern Channel Islands.
- Since 2003, the annual number of recreational CPFV fishing trips to the northern Channel Islands has remained fairly constant.
- After MPAs were established, recreational CPFV fishing effort did not decline but did shift from the areas that became MPAs to other areas still open to fishing.



- Annual number of commercial passenger fishing vessel (CPFV) trips in the northern Channel Islands
- Annual number of CPFV trips in the rest of southern California

Data from CPFV logbooks

How Do Recreational Boaters Use the Islands?



Fisherman enjoys “skurfing” on the wake of his vessel. Photo: Carla Guenther



Sailboat anchored at the Channel Islands. Photo: NOAA



A young sailor. Photo: C. LaFranchi

Favorite Activities: Relaxing, Exploring, Fishing

The public debate over MPAs often focuses on short-term impacts for consumptive users, such as recreational and commercial fisherman. This is, however, only part of the picture; effects on non-consumptive users are also important. Decision-makers need information on everyone affected by MPAs in order to make decisions that result in greater net economic value and social satisfaction.

To help provide this information, a team of social scientists conducted a study of private boaters in the Channel Islands National Marine Sanctuary and their activities, such as diving, kayaking, wildlife viewing, and exploring by dinghy. The researchers distributed postcard surveys by mail and at docks and launch ramps in Santa Barbara, Ventura, and Channel Islands harbors. They also conducted interviews with boaters at the islands.

Approximately 750 people responded to the postcard survey, and 85% said they visit the islands at least once per year. Santa Cruz Island is the most popular destination and is visited each year by 74% of the survey respondents. Boaters said they go to the Channel Islands because they offer solitude, nature, wildlife, and scenery, and they are close to home. Their favorite activities at the islands are relaxing, exploring using a dinghy, hook-and-line fishing, kayaking, and diving. They also enjoy socializing, snorkeling, hiking, beachcombing, and photography. Most boaters surveyed at overnight anchorages said they support the existing MPAs.

Data: Channel Islands National Marine Sanctuary, Coastal Ocean Values Center, and The Ocean Foundation. Analysis: C. LaFranchi, L. Pendleton, and A. Chan.

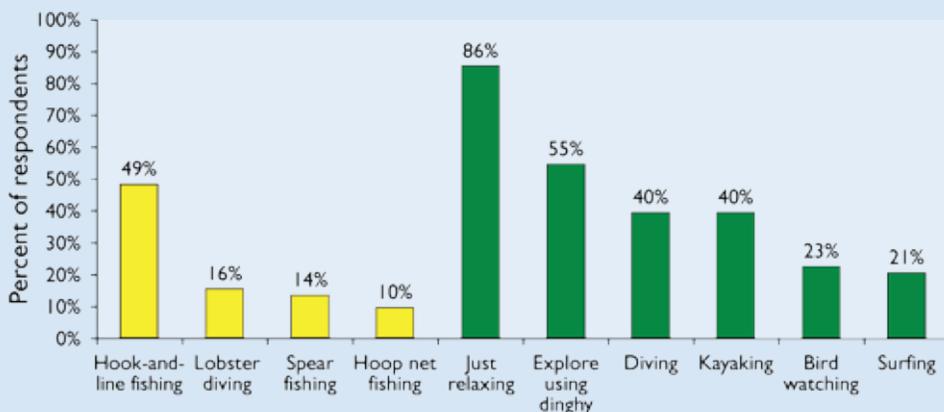


A couple enjoying the view. Photo: Claire Fackler/NOAA

Key Findings

- Boaters enjoy the Channel Islands because of the solitude, nature, wildlife, scenery, and proximity to home.
- The most common activities of boaters at the Channel Islands include relaxing, exploring using a dinghy, hook-and-line fishing, kayaking, and diving.
- Most boaters surveyed support MPAs at the Channel Islands.

Participation by Boaters in Recreational Activities (741 boaters)



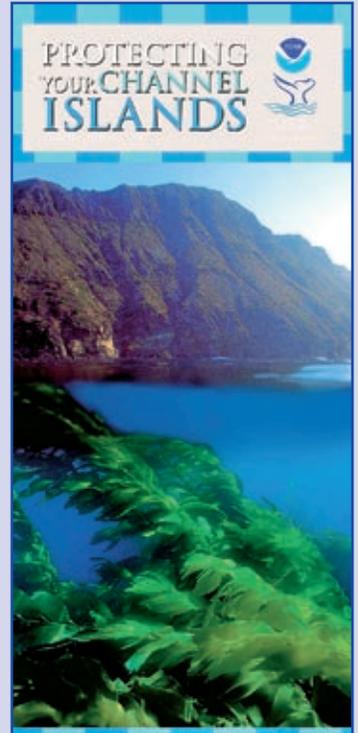
- Consumptive activities
- Non-consumptive activities

outreach

Federal and state agencies, educational institutions, and non-governmental organizations provide information about the Channel Islands MPAs to the public and learn about how people are interacting with the MPAs. Outreach goals are to increase public awareness of the MPAs, enhance compliance with MPA regulations, and cultivate a sense of ownership and responsibility.

Initially, outreach efforts focused on boaters and users directly affected by MPAs. State and federal agencies, working with input from users, developed and distributed a brochure (right) with maps, regulations, and other information about the MPAs. Interpretive signs about the MPAs are posted around the Channel Islands National Park Visitors Center and will be posted at coastal boat launches, popular coves at the islands, and park concessionaires. Channel Islands National Marine Sanctuary and National Park host a public lecture series and train volunteers to share information about the islands with local people, tourists, school children, and businesses. Websites and public computer kiosks offer activities for teachers and students, and they link to research about MPAs. To download educational materials, go to <http://channelislands.noaa.gov> and www.nps.gov/chis.

A brochure called *Protecting Your Channel Islands* provides close-up views and geographic coordinates of MPA boundaries. Since 2003, 40,000 brochures have been distributed to boaters and tackle shops, divers and dive shops, and at public events and teacher workshops. In 2004, thousands of boaters in Santa Barbara and Ventura counties also received fliers with tips about boating safety and MPA rules and regulations.
Photo: John D. Brooks



Detailed maps are at www.dfg.ca.gov/marine.

Volunteers at the Heart of Outreach



The Channel Islands Naturalist Corps are trained volunteers dedicated to educating passengers on vessels and island hikes. They reach nearly half a million people annually at outreach events in southern California and interact with local residents, tourists, and school children to provide information about the Channel Islands.



Through its "Adopt-a-Business" Program, Channel Islands Naturalist Corps volunteers distribute information about the MPA network to over 80 marine-related businesses every month.

Photos: CINMS/NOAA, Tina Reed/NOAA, © Carl Gwinn



Each year, volunteer divers from REEF (Reef Environmental Education Foundation) join sanctuary staff to count fish and invertebrates inside and outside MPAs. Since 1996, divers have logged more than 1,700 surveys. For results, see page 5 and visit www.reef.org.

enforcing MPAs cooperatively

Compliance with regulations is essential for protecting biodiversity and habitats in the Channel Islands MPAs and providing long-term social and economic benefits. Community support is built through education, sharing monitoring results, and effective enforcement, which in turn enhances compliance with MPA regulations. One aim of MPA education is to increase public awareness of the MPA boundaries and rules. Since 2003, enforcement officers report a relatively high level of compliance, although some people break the rules because they are unaware of the MPAs or their boundaries and regulations. A small percentage of the users knowingly violated MPA regulations.

Number of Patrol Days, Contacts, Warnings, and Citations at the Channel Islands MPAs

	Agency	2003	2004	2005	2006	2007
Enforcement presence	NPS Vessel	99 days	108 days	151 days	170 days	150 days
	NPS Island-based		817 days	1,129 days	996 days	820 days
	NPS Aerial		37 days	38 days	66 days	62 days
	Coast Guard Aerial		10 hours	150 hours	125 hours	110 hours
	DFG Vessel	113 days*	38 days	48 days	37 days	0 days**
	DFG Aerial	8 days	12 days	7 days	2 days	8 days
	CINMS Aerial	81 hours	59 hours	123 hours	67 hours	14 hours
No. of citations (individuals)	NPS	3	9	23	14	28
	DFG	5*	22	46	14	0**
No. of written warnings (individuals)	NPS		46	65	22	27
	DFG		24	52	21	0**
No. of verbal warnings (individuals)	NPS	~400	100	100	50	50
No. of contacts (boats)	NPS	550	4,100	~2,000	~2,400	~2,000
	DFG		238	386	162	0**
No. of contacts (individuals)	NPS	1,645	8,900	~7,000	~7,100	~7,000
	DFG	3,775*	623	1,177	588	0**

NPS is National Park Service; DFG is Department of Fish and Game; CINMS is Channel Islands National Marine Sanctuary

*Additional DFG vessels and staff on patrol.

**Primary DFG vessel inoperable.



California Department of Fish and Game wardens conduct joint training with U.S. Coast Guard. Photo: John Ugoretz/DFG

By Sea and Air

In 2003, the State of California invested heavily in boats and personnel to patrol waters around the Channel Islands. State wardens primarily focus on regulating commercial fishermen and charter boat activities. In the last 3 years, the number of state patrols has decreased due to a reduction in staff and increased costs of vessel maintenance.

At the same time, National Park Service rangers have patrolled the MPAs by land, air, and sea. Park rangers are responsible for a majority of the contacts with recreational users to disseminate information and have issued dozens of warnings and violations each year.

In recent years, the U.S. Coast Guard has conducted patrols of the Channel Islands MPAs using helicopters and their 87-foot cutter vessels. U.S. Coast Guard personnel work closely with National Park Service rangers to combine patrol efforts in the air and by sea.

summary: first 5 years of monitoring

Monitoring of marine protected areas (MPAs) is essential for resource managers, scientists, and the public to understand the effects of MPAs on the ocean ecosystem and human society. The California Fish and Game Commission intends to review monitoring data from the Channel Islands MPAs every 5 years and may adjust management based on the findings. The information also will be used for scientific research, education, and public outreach.

Results Show Positive Ecological Effects of Reserves

Many species of fish and invertebrates targeted by fishing outside reserves are bigger and more abundant inside no-take reserves, while non-targeted species' abundances are essentially equal. Marine reserves have greater biodiversity and greater fish biomass than fished areas nearby. Studies of fish movement suggest that even wide-ranging species can benefit from the Channel Islands reserves and that some individuals move from reserves to fished areas. These results show that the Channel Islands reserves and other protected areas may contribute to the goals of protecting and promoting healthy ecosystems.

Monitoring Is Revealing Socioeconomic Changes

The number of boats seen at the Channel Islands has stayed approximately the same, but the boats go to different places. Fishing boats no longer go to the now-protected areas, while more sailboats are observed in those areas. Since MPAs were established, some commercial fisheries (rock crab, spiny lobster, market squid, and red urchin) have grown in value at the Channel Islands, while others (sea cucumber, California sheephead, and rockfish) have declined. Many of these changes also occurred throughout southern California, suggesting that the causes are due to factors other than MPAs. Detailed studies of the lobster fishery suggest some changes in number of fishermen and catch may be linked to the MPAs. The number of party boat trips for recreational fishing has remained fairly constant since MPAs were established.

Will Changes Due to MPAs Continue for Decades?

Initial findings from ecological monitoring at the Channel Islands are consistent with expected outcomes. Studies from MPAs elsewhere indicate that ecological changes still can occur even 30 years or more after an area is protected. Some benefits of protection may not be detected within the first 5 years because many species grow slowly and successful reproduction may be infrequent. Similarly, social and economic changes related to MPAs can take far longer than 5 years to achieve stable results. Long-term ecological and socioeconomic monitoring at the Channel Islands helps managers make informed decisions about how to sustain ocean life and socioeconomic values.



additional resources

California Department of Fish and Game, Partnership for Interdisciplinary Studies of Coastal Oceans, Channel Islands National Marine Sanctuary and Channel Islands National Park. 2008. Special Session: The First Five Years of Monitoring the Channel Islands Marine Protected Area Network. February 7-8, 2008. Oxnard, CA. www.dfg.ca.gov/marine

Biological Monitoring

California Department of Fish and Game. 2004. Channel Islands Marine Protected Areas Monitoring Plan. www.dfg.ca.gov/marine

Channel Islands National Park Kelp Forest, Tide Pool, Seabird and Pinniped Monitoring Programs. www.nps.gov/chis

Socioeconomic Monitoring

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U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). National Marine Sanctuary Program. 2007. Channel Islands National Marine Sanctuary Social Science Plan (2007–2010): Socioeconomic Research & Monitoring of Marine Reserves and Conservation Areas. Silver Spring, Maryland. 45 pages.

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General Information about Monitoring MPAs

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Pomeroy, R.S., J.E. Parks, and L.M. Watson. 2004. How Is Your MPA Doing? A Guidebook of Natural and Social Indicators for Evaluating Marine Protected Areas Management Effectiveness. IUCN, Gland, Switzerland and Cambridge, UK. xvi + 216 pages. <http://effectivempa.noaa.gov>

Partnership for Interdisciplinary Studies of Coastal Oceans. 2007. The Science of Marine Reserves (2nd Edition). www.piscoweb.org. 22 pages.

Web Tools

The **California Department of Fish and Game** hosts a comprehensive website with detailed maps, descriptions, regulations, and boundary coordinates for the Channel Islands MPAs and all other state MPAs. www.dfg.ca.gov/marine

NOAA's **National Marine Protected Areas Center** hosts a comprehensive website with information about MPAs in the United States, science and analysis of MPAs, a virtual library, and other educational materials about MPAs. www.mpa.gov

The **Channel Islands National Marine Sanctuary** provides information about MPAs on their website. <http://channelislands.noaa.gov>

The **PISCO Subtidal Community Survey Map** provides online access to data on fish, invertebrates, and seaweeds observed during scuba surveys. The data are searchable by location, time, and species. Summary data and charts are provided for sites in southern and central California. www.piscoweb.org/research



For more information:
www.dfg.ca.gov/marine



California Department of Fish and Game Marine Region

20 Lower Ragsdale Drive,
 Suite 100
 Monterey, CA 93940
 831-649-2870
www.dfg.ca.gov/marine



PISCO University of California, Santa Barbara Marine Science Institute

Santa Barbara, CA 93106-6150
 805-893-3387
www.piscoweb.org



Channel Islands National Marine Sanctuary

113 Harbor Way, Suite 150
 Santa Barbara, CA 93109
 805-966-7107

3600 S. Harbor Boulevard,
 Suite 111
 Oxnard, CA 93035
 805-382-6149

<http://channelislands.noaa.gov>



Channel Islands National Park

1901 Spinnaker Drive
 Ventura, CA 93001
 805-658-5730
www.nps.gov/chis

*Photos (left to right, top to bottom):
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