CHANNEL ISLANDS

NATIONAL PARK

BIENNIAL NATURAL RESOURCES STUDY REPORT

1986

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CHANNEL ISLANDS NATIONAL PARK
Biennial Natural Resources Study Report
1986

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The Secretary of Interior
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to

The Committee on Interior and Insular Affairs
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I. Introduction

In 1980, when Channel Islands National Monument was re-designated as Channel Islands National Park, National Park Service responsibilities were expanded from two small islands (<600 ha) to five islands (50,200 ha) and 50,700 ha of submerged lands and waters surrounding the islands. The park's enabling legislation (Public Law 96-199) contained some unusual mandates for monitoring natural resources. It required that:

a. Inventories including population dynamics be conducted for all species in the park;

b. Present conditions and probable future trends of populations be reported to Congress biennially for ten years; and that

c. The biennial reports contain recommendations for actions to be taken to better protect natural resources in the park.

The park contains a number of outstanding natural resources. Prominent among them are large and diverse pinniped rookeries and sea bird colonies, extensive kelp forests, pristine tide pools, high numbers of rare and endemic species, and unusual eolian land forms and caliche deposits. Several human activities in and adjacent to the park continue to threaten its resources. The metropolitan populations of southern California stress the region's air and water resources and have the potential of overcrowding the park. Existing regulations control fisheries, but the harvest of marine resources in the park continues to be heavy; and activities associated with extraction of some of the largest known offshore petroleum deposits loom on the park's horizon.

Establishment of the park with such threatened, diverse, and sensitive resources and such specific legislative mandates was recognized as an opportunity to develop a model system for monitoring natural resources in national parks. This report outlines the natural science research program that is developing a comprehensive natural resources monitoring system at Channel Islands National Park, discusses a number of monitoring activities, and describes our current understanding of the status of park resources.

II. RESOURCE DESCRIPTION

Channel Islands National Park consists of five islands and the surrounding marine ecosystems off the southern California coast. The park boundary includes five of the eight California Channel Islands and two kilometers of water around each island. The islands range in size from 265 ha Santa Barbara to 24,545 ha Santa Cruz. The total area of the park is 101,000 ha which is divided nearly equally between submerged lands and islands.

Park natural resources are of national and international significance in many respects. The islands are some of the last examples of natural Mediterranean ecosystems in North America. Pine forests of rare and endemic species characterize the larger islands. Park islands contain much of the remaining natural southern California coastal ecosystems, including coastal sage communities and exceptionally pristine tide pools which occupy marine terraces surrounding the islands. Prime examples of the only giant kelp forests in the northern hemisphere are found in park waters. The richness of marine ecosytems is reflected by some of the largest and most diverse sea bird and pinniped populations in the world. An archeological record spanning more than 11,000 years of continuous human habitation further attests to the unique assemblage of natural resources in Channel Islands National Park.

The park lies on the boundary of two major biogeographical provinces. This boundary is particularly noticeable in the marine environment. In the northwest, San Miguel and Santa Rosa Islands are bathed by cold northern waters carried south by the California current and reflect the biological communities of a boreal Oregonian province. Waters around the southeastern islands of Anacapa and Santa Barbara come from the south along the mainland coast and support a temperate biota known as the Californian province. Santa Cruz Island, at the boundary of these two provinces, is characterized by a broad transition zone where plants and animals from both provinces mingle and create a unique assemblage of species that are capable of adapting to the unique and variable conditions of the transition zone. Park waters harbor biota representative of 2,800 kilometers of the North American coast from Punta Eugenia, Mexico to Vancouver, Canada.

Prevailing winds and the bathymetry of adjacent basins also greatly influence biological communities in the park. Winter winds bring rain and buffet the north sides of the islands, while the biota of the southern coasts reflect a dryer, more sheltered environment. The confluence of major oceanic currents and the shape of the continental shelf create a rare phenomenon of persistent upwelling near the park. Nutrient-rich water from the deep sea wells up off Point Conception and produces exceptionally productive food webs in the waters around San Miguel and Santa Rosa Islands. The bond between land and sea is strong and the interaction between them is a major feature of the park.

Many of the park's exceptional values are a result of isolation from mainland populations. A million years of physical isolation from mainland ecosystems allowed life forms on the islands to evolve independently. The

park's reputation as the "American Galapagos" is well deserved. Physical difficulty of travel to and from the islands even now protects the park somewhat from urban developments in mainland southern California. Benefits of this isolation are particularly apparent with respect to marine birds and mammals. Those which once bred in areas widely scattered along the mainland coast now find sufficient freedom from civilization and human disturbance only on the islands. Exploitation of marine resources in the park has occurred for many years, but the park's logistic isolation slowed the rate in comparison to mainland locations. Modern technology and demands for human food are changing the effects of that isolation as well.

The geological background of this region is complex and many basic questions remain open to conjecture. The eight California Channel Islands can be divided evenly into two groups. The four northern islands are all within the park boundaries; of the southern group only Santa Barbara Island is within the park. The northern islands are thought to be a westward extension of the Santa Monica Mountains, one of the Transverse Ranges. They were developed at the end of the Miocene epoch by faulting and uplift. The most commonly-held hypothesis is that these islands were never linked to the mainland by a land bridge, but rather were joined with each other as one large island called "Santarosae" some 17,000 years ago during the Pleistocene epoch, when sea level was at its lowest. It is unlikely that the southern islands were ever linked to each other or to the mainland.

The islands also represent examples of some of the most extensive marine terraces in the world and contain many sea caves, rugged shorelines, sandy beaches, mountain peaks, and valleys. Eolian land forms with active dunes and sand castings of rocks from ancient forest plants, known as caliche, are also present. These unusual deposits are a few of many interesting geologic features found on the islands. Petroleum geologists seek answers to questions of regional tectonics on and around park islands.

Evolution of unique life forms on these islands, often coupled with recent human-mediated habitat destruction elsewhere, resulted in designations of rare, threatened, or endangered status for many species in the park. The island fox, a State of California rare species, is found on three of the five park islands. The island night lizard, a species Federally listed as threatened, is found on only Santa Barbara Island in the park, and on two of the other Channel Islands. Also on Santa Barbara Island, an endemic subspecies of song sparrow, once listed as endangered is now thought to be extinct. Over ten percent of the more than 400 types of vascular plants in the park are found nowhere else. Over 60 types of plants in the park are considered rare, endangered or threatened on State and Federal lists or by the California Native Plant Society.

The park's marine systems are equally significant. One third of the kelp forests in southern California are found in the park. These submarine forests provide food and shelter for over 125 fish species, as well as habitat for scores of other animal and algal species, nearly 1,000 in all. As many as 26 species of whales and porpoises and six species of pinnipeds are found in park

waters. Many of these animals are on the endangered species list. San Miguel Island is the only place in the world where five species of pinnipeds breed in one place. Eleven species of sea birds nest in the park. In the United States, the California brown pelican breeds successfully only on park islands.

The islands are also significant for their vertebrate fossils and cultural resources. Fossil remnants of an endemic dwarf mammoth, a giant mouse, and an extinct flightless goose were discovered on Santa Rosa and San Miguel Islands. Nearly 11,000 years ago at least, man appeared on the islands. Archeological sites abound on the islands; nearly 600 have been recorded on San Miguel alone. Intact and mostly untouched, these sites are unrivaled in their ability to yield information about cultural development on the islands. This development culminated in the Chumash, a group whose descendants remain in southern California and retain a vital interest in the islands. Anacapa, Santa Barbara, and San Miguel Islands are on the National Register of Historic Places as Archeological Districts. Santa Rosa, with archeological resources unrivaled by the other park islands, is unquestionably eligible. San Miguel is the traditional, albeit disputed, burial place of Juan Rodriquez Cabrillo, European discoverer of California in 1542. More recent structures remain from European settlement on the islands, including the Nidever Adobe on San Miguel, ranch buildings on Santa Rosa and Santa Cruz and the remnants of a United States Coast Guard lighthouse station on Anacapa. The cultural resources of the park tell of very different exploitation of the natural environment by two dissimilar cultural traditions.

Geology, topography, and geographic location give each island its own unique character. Those characteristics also extend offshore to the marine ecosystems, and are reflected in the vegetation, wildlife, and fisheries of each island.

A. San Miguel Island

San Miguel Island is the lonely western outpost of the Park. It is 13 km long, 6 km wide, and covers some 3,775 ha. Topographically and geographically it is a gently sloping plateau of sedimentary facies rising 253 m above sea level. Wide sandy beaches dominate the coastline. Strong, near-constant winds from the northwest mold the land and dictate vegetative patterns. Few trees survive, but stark caliche outcrops of former pine trees and shrubs remain. Plant communities on the island are still recovering from widespread grazing by recently removed sheep and burros. Extensive sandy substrate supports beach and coastal dune communities far inland. Grassland is the most prevalent plant community on the island, with coastal scrub and bluff communities covering much of the remaining area. Vast sandy beaches support spectacular pinniped rookeries. Elephant seals, northern fur seals, harbor seals, northern sea lions, and California sea lions have all bred on San Miguel. Isolated from predatory island foxes and alien black rats, seabirds nest on bluffs and offshore rocks. The park's largest rookeries of Leach's storm-petrels; ashy storm-petrels; double-crested, Brandt's and pelagic cormorants; and Cassin's auklets are found at San Miguel. Exceptionally rich

kelp forests are attached to broad slabs of sedimentary rock offshore which resemble central and northern California kelp communities. Several species of rockfish, lingcod, and red abalone support productive fisheries.

San Miguel is in Federal ownership, and its future is secure.

B. Santa Rosa Island

Just over 3 km east of San Miguel, 21,365 ha Santa Rosa is a mountainous east-west trending ridge 24 km long and nearly 16 km wide which rises over 460 m above sea level creating an impressive array of canyons, which cut deeply into extensive marine terraces along the northern side of the island and fall directly into the sea to the south. The topographic relief afforded by these features is reflected in the vegetation. Stands of pine, oak, ironwood, and toyon trees occupy the sheltered upper canyons and southeastern exposures. Extensive grasslands and coastal scrub communities dominate the gently rolling terraces and lower canyons. Riparian habitats, coastal sand dune systems, and coastal marshes are unique among the islands. Introduced pigs, sheep, cattle, elk, and deer take their toll on native plant communities and soils. Inaccessible sea cliffs along the north coast and offshore rocks harbor large numbers of breeding and roosting cormorants and other sea birds. Harbor seals haul out on sandy beaches. An endemic subspecies of island fox, spotted skunk, and several large raptor species are the most conspicuous native forms of wildlife. Numerous shore birds and passerines are also common and prominent elements of the island's fauna. Offshore, broad rocky shelves support the largest kelp forests in the park. Wide rocky terraces on the western end of the island also produce extensive intertidal zones that are nearly inaccessible from the sea and shelter incredibly high concentrations of black abalone.

Santa Rosa Island is owned by Vail and Vickers, which maintains a cattle ranch and sport hunting operation on the island. Acquiring Santa Rosa Island was the top recommendation of the 1984 Biennial Natural Resources Study Report. This is now nearly accomplished as Congress appropriated funds in 1985 and the Federal government is in the process of acquiring the island.

C. Santa Cruz Island

The largest of the islands, Santa Cruz lies 8 km east of Santa Rosa. Long and narrow (3-11 km wide), the island consists of 2 parallel volcanic ridges 34 km long which tower 730 m above an impressive coastline of cliffs riddled with sea caves and numerous small, protected anchorages. Rugged slopes with steep canyons and freshwater streams give the appearance of an undisturbed California mainland, especially in the island's deep central valley. Sheltered from incessant winds by the island's mountains, pine forests and groves of oak and ironwood flourish. Annual grasses form the major plant community, broken only by small isolated areas of coastal sage, scrub, and chaparral that survive heavy browsing and grazing by virtue of

occupying land unsuitable for livestock. Introduced sheep, pigs, and cattle heavily impact plant communities and soils on Santa Cruz Island. Island bird populations are diverse and have been the object of important biogeographical studies. Endemic subspecies of island fox and scrub jay testify to the uniqueness of the island ecosystem. California sea lions are found in the many small caves with cobble and coarse sand beaches that dot the coast and on nearby Gull Island. The steep coastal cliffs continue into the sea, providing only a narrow, rocky ledge for kelp, in contrast to the broad reaches of kelp forest off Santa Rosa. The marine communities around Santa Cruz exhibit affinities to both boreal and temperate provinces. It is here that the remarkable diversity of the transition zone peaks. The offshore rocks at Gull Island to the south and Scorpion Rock on the north coast provide predator-free havens for western gulls, California brown pelicans, cormorants and other sea birds.

The island is owned by the Santa Cruz Island Company, The Nature Conservancy, and the Gherini family. Current ranching activities and feral animals on Santa Cruz Island threaten the integrity of island ecosystems. The Federal government plans to acquire the Gherini property as soon as Congress appropriates the funds.

D. Anacapa Island

Anacapa Island is a series of 3 narrow islets connected by shallow reefs lying less than 6 km east of Santa Cruz Island. Anacapa's 283 ha are strung out over 8 km, but the island is generally no more than 3/4 km wide. Sheer cliffs soar 75 m over rocky beaches, and steep slopes on West Anacapa Island reach 283 m at the highest point. Its rugged volcanic coastline is pockmarked with extensive sea caves. Stark rock ridges offer little shelter from wind or sea for island inhabitants. The only native trees on the island are two small groves of island oaks huddled in a small canyon on West Island. Free from browsing and grazing, giant coreopsis flourish on Anacapa as an important element of the coastal bluff and grassland communities. A few small patches of chaparral occur in the deeper canyons, and coastal sage scrub communities cover the island's dry southern slopes. Anacapa is the site of the largest breeding colony of California brown pelicans in the United States and supports the park's largest western gull colony. Rocky promontories and beaches are frequented by basking California sea lions and harbor seals. The narrow fringing kelp forest clearly represents southern California, with an abundance of spiny lobsters, pink abalone, kelp bass, and sheephead.

Anacapa Island is in Federal ownership, and its future is secure.

E. Santa Barbara Island

Santa Barbara Island is a small volcanic island 58 km southeast of Anacapa Island and 56 km west of the mainland at Palos Verdes. Encompassing 264 ha, it rises only 193 m above the sea, but the towering

cliffs that surround the island are nevertheless spectacular. A few tiny cobble beaches offer the only access to the island from the sea. No trees survive the wind and exposure, but giant coreopsis reach heights of more than two m in protected canyons. Island vegetation is still recovering from farming activities, a catastrophic fire, and introduced rabbits (which were recently eliminated from the island). Grassland covers most of the island, but small patches of coastal bluff, sage scrub, and maritime cactus scrub communities harbor many plants, including several endemic and otherwise rare species such as the Santa Barbara island live-forever, Dudleya traskiae. The largest black storm-petrel and Xantus' murrelet rookeries in the park are found on Santa Barbara Island, as well as active colonies of California brown pelicans, western gulls, ashy storm petrels, double-crested and Brandt's cormorants, pigeon guillemots, and Cassin's auklets. Elephant seals and California sea lions also reproduce on the island. A wide variety of migratory land birds seek haven on the island every spring and fall. The surrounding sea contains extensive kelp forests characteristic of southern California. Notably large populations of green abalone, spiny lobsters, and sea urchins support important fisheries.

Santa Barbara Island is in Federal ownership, and its future is secure.

III. NATURAL RESOURCES MONITORING PROGRAM

Monitoring natural resources in Channel Islands National Park requires a long-term commitment of funds and personnel. Many dominant organisms in park ecosystems have generation times well in excess of 10 years. Thirty-year life spans are not uncommon, and some exceed 100 years. Major climatic and oceanographic processes such as El Niño, which drive park ecosystems, also show cyclical variations with periodicities on the order of 25 to 35 years. To assess the health of these ecosystems, natural long-term trends and cycles must be discovered and defined. Regular, periodic monitoring of population dynamics is also needed to detect abnormalities in park ecosystems, and to determine if abnormalities are man-caused and amenable to management action. In addition, long-term information on population dynamics in the park will greatly facilitate additional research and understanding of ecosystem structure and function. Natural resource monitoring needs to be incorporated into the park's ongoing resource management program and conducted by professionally trained scientists engaged as resource management specialists.

A step-down plan was developed to show all tasks required to develop a natural resources monitoring system in the park and to submit the Natural Resources Study Reports to Congress (Davis 1983). A total of 16 research projects was identified in the plan. Natural resources in the park were divided into 15 large taxonomic categories which are generally studied as discrete units, such as sea birds, island vegetation, or subtidal marine invertebrates. The remaining research project developed an automated information management system specifically for the resources monitoring program. The priority of each research project was established by the Superintendent of Channel Islands National Park and the Natural Science Division, Western Region. Each design study addressed the same five basic elements:

1. Review and summarize historical data on population dynamics for the resources to be monitored.
2. Develop specific standardized sampling techniques.
3. Select appropriate techniques to analyze population dynamics data and identify trends.
4. Design standardized report formats.
5. Field test and demonstrate the efficacy of sampling techniques, analytical approach, and reporting sytems.

Through 1985, all 16 of the research projects identified in the step-down plan had been funded. Of these, seven design studies have been completed and monitoring has already been started (Boat Visitation; Pinnipeds; Tide Pools; Seabirds; Weather; Oceanic Environmental; and Information Management System). Five studies are scheduled to be completed in late 1986 and monitoring should start in 1987 (Marine Invertebrates; Marine Plants; Marine Fish; Island Birds; and Island Vegetation). The remaining four studies should be completed in 1988 (Island Invertebrates; Island Herpetofauna; Island Mammals; and Fisheries Harvest).

The following outline briefly describes the status of each design study, indicating principal investigators and their affiliations, sources of funding, stage of completion, and status of monitoring activity:

1. Pinniped Monitoring Design Study (seals and sea lions)
   a. National Marine Fisheries Service (D.P. DeMaster).
   b. National Marine Sanctuary Program funded 1981-86.
   c. Design study completed, final report in preparation.
   d. Monitoring implemented with NOAA funding in 1984.

2. Information Management System Design Study
   a. MARIS, Inc./National Park Service (G.E. Davis).
   b. National Park Service, Western Region Science Program and National Marine Sanctuary Program funded in 1981.
   c. Design study completed, Apple II+ microcomputer and a variety of applications software packages are in place.
   d. Formats for data files on pinnipeds, sea birds, tide pools, marine plants, marine invertebrates, and fishes were created and tested. An annotated species list for the park and limited climatic data are maintained with data management programs. As other design studies are completed data files are added to the system.

3. Tide Pool Monitoring Design and Visitor Impact Study
   a. VTN Oregon, Inc. (R.L. Cimberg and J.M. Engle).
   b. National Park Service, Special Initiative Project funded in 1982.
   c. Design study completed, final report accepted in 1984, professional journal manuscript prepared on visitor impacts from trampling.
   d. Limited monitoring initiated in 1984, full scale monitoring implemented in 1985 and 1986. Draft of first annual monitoring report completed in July, 1986; contains summary and analysis of data and recommendations to management.

4. Seabird Monitoring Design Study
   a. University of California (G.L. Hunt and D.W. Anderson).
   b. National Marine Sanctuary Program funded in 1981.
   c. Design study completed, final report accepted in 1983.
   d. Monitoring implemented in 1985 and 1986. Draft of first annual monitoring report completed in June, 1986; contains summary and analysis of data and recommendations to management.

5. Marine Invertebrate Monitoring Design Study
   a. National Park Service and California Department of Fish & Game (G.E. Davis, H. Frey, et al.).
   b. National Park Service, Western Region Science Program & Special Initiative Project, and National Marine Sanctuary Program funded 1981-86.

c. Design study underway, projected completion in 1986. Report on population dynamics data compiled by design study team for 1982-85 period published in 1986.
d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1987.

6. Island Bird Monitoring Design Study
   a. National Park Service (C. van Riper, III).
   b. National Park Service, Western Region Science Program (CPSU-UCD) funded 1983-86.
   c. Design study underway, projected completion in 1986.
   d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1987.

7. Island Vegetation Monitoring Design Study
   a. National Park Service (W.L. Halvorson and S.D. Viers Jr.).
   b. National Park Service, Western Region Science Program & Special Initiative Project funded 1983-86.
   c. Design study underway, projected completion in December, 1986.
   d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1987.

8. Marine Plant Monitoring Design Study
   a. National Park Service and California Department of Fish & Game (G.E. Davis, H. Frey, et al.).
   b. National Park Service, Western Region Science Program & Special Initiative Project, and National Marine Sanctuary Program funded 1981-86.
   c. Design study underway, projected completion in 1986. Report on population dynamics data compiled by design study team for 1982-85 period published in 1986.
   d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1987.

9. Marine Fish Monitoring Design Study
   a. National Park Service and California Department of Fish & Game (G.E. Davis, H. Frey, et al.).
   b. National Park Service, Western Region Science Program & Special Initiative Project, and National Marine Sanctuary Program funded 1981-86.
   c. Design study underway, projected completion in 1986. Report on population dynamics data compiled by design study team for 1982-85 period published in 1986.
   d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1987.

10. Island Invertebrate Monitoring Design Study
    a. National Park Service (G. Fellers).
    b. National Park Service, Significant Resource Problem funded in 1984.

c. Design study initiated in 1985. Field work projected completion in 1987; final report projected completion in 1988.
d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1988.

11. Island Herpetofauna Monitoring Design Study
a. National Park Service (G. Fellers).
b. National Park Service, Significant Resource Problem funded in 1984.
c. Design study initiated in 1985. Field work projected completion in 1987; final report projected completion in 1988.
d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1988.

12. Island Mammal Monitoring Design Study
a. National Park Service (G. Fellers).
b. National Park Service, Significant Resource Problem funded in 1984.
c. Design study initiated in 1985. Field work projected completion in 1987; final report projected completion in 1988.
d. Funds to implement monitoring requested from the National Park Service (ONPS) beginning in 1988.

13. Visitation (boat) Monitoring Design Study
a. National Park Service (G.E. Davis).
b. National Park Service, Western Region Science Program and National Marine Sanctuary Program funded 1981-82.
c. Design study underway, projected completion in 1983.
d. Monitoring initiated by Channel Islands National Park staff in 1982.

14. Fisheries Harvest Monitoring Design Study
a. National Park Service and California Department of Fish & Game (G.E. Davis, H. Frey, et al.).
b. National Park Service, Significant Resource Problem funded in 1985.
c. Field work delayed by California Department of Fish and Game.
d. No NPS funds requested yet to implement monitoring, California Department of Fish and Game portion funded.

15. Weather Monitoring Design Study
a. National Park Service (W.L. Halvorson).
b. National Park Service, Significant Resource Problem funded in 1985.
c. Field work initiated in 1985, and four automated weather stations installed on four islands in 1986.
d. Funds requested beginning in 1987 to implement monitoring.

16. Oceanic Environmental Monitoring Design Study
a. National Park Service (G.E. Davis).

b. National Park Service, Significant Resource Problem funded in 1984.
c. Project initiated in 1984, and six automated recorders installed in 1985.
d. Monitoring implemented in 1986.

The monitoring systems developed by these design studies need to be integrated and implemented to produce a functional, comprehensive, natural resource monitoring program at Channel Islands National Park. Long-term funding and professional staffing must be secured; training and quality control measures must be instituted; and data management techniques need to be developed.

Wherever possible, the design studies were coordinated to minimize impacts on resources, both natural and fiscal. Attempts were also made to integrate data collection sites and times among resources in the same ecosystems. Nevertheless, fiscal and personnel constraints dictated a phased approach to development of the program, which now requires careful integration to provide an effective and efficient monitoring program. The key to this phase will be an integrated data management system. A research proposal for funding in 1987-88 will be prepared to integrate the design studies. Additional funds were requested to extend terrestrial monitoring design studies to Santa Rosa Islands now that it is accessible.

When the design studies are integrated and implemented, provisions must be made for training generations of observers and assuring high quality data collection, analysis, and reporting. Interpretation of the information generated by the monitoring program will require extensive knowledge and experience with ecosystem dynamics. Abnormalities in natural resources that are identified by the monitoring program will require research, often involving resource manipulation, to establish cause-and-effect relationships and to develop appropriate management alternatives. A mechanism for regular communication among resource management specialists, research scientists, and managers needs to be instituted to assure timely and appropriate utilization of information.

Integration of the design studies began on an ad hoc basis but needs to be broadened and intensified. Nearly a third of the long-term funds and personnel required for implementation of the monitoring program have been allocated, and the remainder has been requested. Research scientists and resource managers work closely in the park transferring responsibilities from research design studies to ongoing resource management monitoring projects. Remarkable progress has been made toward implementation of a comprehensive natural resource monitoring program in the park, but the return on this investment has yet to be realized. The commitment to develop the program must be sustained to reap the full value of the design studies and provide the information needed to manage and protect park resources.

IV. STATUS OF PARK RESOURCES

Pinnipeds

The U.S. Department of Commerce provided this information on pinniped populations in the park from monitoring and research activities conducted by the National Marine Fisheries Service (NMFS) that were funded primarily by NMFS, the Sanctuaries Program Office (SPO) and the California Department of Fish and Game (CDFG) (Seagars, 1986). The following information summarizes the results of some of these studies on recent trends in pinniped population dynamics in the park.

Pup production of California sea lions and northern fur seals appears to be increasing once again after declines during the 1983 and 1984 seasons that were related to the 1982-83 El Niño event.[1] Northern elephant seal pup production continues to increase although the rate of increase on some islands appears to be slowing, perhaps due to competition for space. Elephant seal pupping expanded to Santa Rosa Island for the first time in 1985, although no pups were observed here in the 1986 season. Table 1 summarizes 1985 pinniped pup production and total counts of harbor seals. Table 2 provides a summary of recent population trends.

Declines in the use of park islands were observed in this reporting period for three species: northern sea lions, Guadalupe fur seals, and harbor seals. No northern sea lions or Guadalupe fur seals were observed in the 1985 season at San Miguel Island. The northern sea lion population has been declining in recent years along the California coast. This decline appears to be part of a contraction in the southern portion of the species range due to unexplained factors. In December 1985, Guadalupe fur seals were designated "Threatened" under the Endangered Species Act, and while they have been observed regularly at San Miguel Island since 1969, no individuals were seen there in 1985 [a few individuals were observed nearby (120 km) on San Nicolas Island]. The breeding population centered on Guadalupe Island appears to be growing under protection of Mexico.

The apparent decline in harbor seal numbers throughout the Channel Islands is under investigation by NMFS and CDFG. Emigration, effects of El Niño, and incidental mortality in set net fisheries, including a new, rapidly expanding angel shark fishery, are factors under investigation.

Monitoring of populations needs to be continued and several new research projects need to be conducted in order to adequately protect and manage the pinnipeds found in the Park. Monitoring programs for most species are in place for 1986 and are proposed to continue into 1987. However, future monitoring is currently uncertain due to budgetary considerations and the

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[1]El Niño is a major cyclic oceanographic and meteorological event. It is a period of above average water temperatures in the eastern Pacific.

priorities of various agencies. Of particular concern is continued population dynamics monitoring of the San Miguel Island northern fur seals and sea lions for 1987 and beyond. Plans to monitor sea lion pupping on Santa Cruz, Santa Rosa and Anacapa are uncertain beyond 1986. The need for studies assessing the effects of human disturbance to pinnipeds was also identified previously but they have yet to be conducted. These studies may be included in work to be funded by the NOAA Sanctuaries Program Office in 1987 and 1988; however, funding priorities have yet to be established.

A Memorandum of Agreement (MOA) concerning pinniped management in Channel Islands National Park between the National Park Service and the National Marine Fisheries Service expired in May, 1986. Under this agreement, the National Park Service requested that a proposal to remove northern fur seals from San Miguel Island be relocated, and the NMFS made recommendations on park projects to reduce disturbance to pinniped colonies. Both agencies agreed to abide by the other's recommendations and the MOA will be renewed.

The NMFS plans to conduct assessments of northern elephant seals, California sea lions, and harbor seals in 1987-1988. These assessments will be used to determine if authorized levels of incidental take in commercial fisheries is disadvantageous to any of the pinniped populations.

In 1984, the NMFS accepted a petition from the Sportfishing Association of California (SAC) to consider changing federal regulations to provide for the non-lethal harassment of marine mammals by commercial passenger sportfishing vessel operators. The NMFS proposed this rule change in January 1985 and implemented it in December 1985. Subsequently, the NMFS received an application from the SAC for authorization to use "non-lethal harassment devices" (seal bombs, cracker shells. and acoustic harassment devices) to frighten California sea lions away from their fishing operations. The NMFS issued this permit on June 17, 1986; the permit was conditioned to notify the SAC that the use of the devices may be prohibited by other federal or State regulations in certain areas-- such as within Channel Islands National Park (CHIS).

Intertidal Communities

The National Park Service provided information on intertidal communities in the park from NPS monitoring activity initiated in 1982 (Richards, in prep.).

Rocky intertidal monitoring sites have been established at 12 locations on 4 islands in Channel Islands National Park. Eight of these sites were newly established in 1985. The sites were chosen to represent the range of rocky intertidal communities in the park.

Permanently marked photoquadrats are used to monitor 4 dominant zones in each of the 12 intertidal monitoring sites. Black abalone plots were added in 1985 to monitor populations of these ecologically and economically

important species. Each of the 12 sites was sampled in the spring and fall each year.

Photoquadrat data show seasonal trends in the red-turf alga Endocladia muricata which declined during summer months, and rockweed which declined during winter months. Data since 1982 from Anacapa Island showed a major decline in Endocladia cover after the 1983 El Niño event. Recovery was just becoming apparent in 1985. Mussel and barnacle populations appeared healthy and stable at all sites.

Incidental damage from a large grounding on Santa Barbara Island provided an opportunity to document natural response to unnatural disturbance in two intertidal zones. Experimental disturbance of intertidal communities at Anacapa Island showed that damage was still apparent after more than three years in mussel and rockweed zones.

Observations at South Frenchy's Cove on Anacapa Island, the most heavily visited intertidal area in the park, showed damage to the lower algal zones. Animals such as abalone and anemones were also rare or absent at the site. Methods to reduce the impact of visitation, while still providing public access, need to be developed and evaluated through continual monitoring.

It is clear that rocky intertidal communities are part of a dynamic ecosystem with much variability both seasonally and annually. Storms, water temperature, and juvenile recruitment are just a few of the many factors affecting this seasonal variability. Events such as El Niño, large-scale storm damage, and chronic disturbance from visitation or pollution influence the system for many years following their occurrence. Only through long-term monitoring will the effects of these events be understood.

Seabirds

The National Park Service provided information on seabird populations from monitoring activity initiated in 1982 as part of a monitoring design study.

Routine monitoring of four seabird and one shorebird species nesting in Channel Islands National Park commenced during 1985 (Lewis and Gress, in prep.). Reproductive data on double-crested cormorants (Phalacrocorax auritus), California brown pelicans (Pelecanus occidentalis californicus), western gulls (Larus occidentalis), Xantus' murrelets (Synthliboramphus [Endomychura] hypoleuca), and snowy plovers (Charadrius alexandrinus) were collected on Anacapa, San Miguel, and Santa Barbara Islands (Lewis and Gress, in prep.). Double-crested cormorants nested in normal numbers on both Anacapa and Santa Barbara Islands during 1985; productivity was similar to or above previous years. California brown pelicans nested in record numbers on both West Anacapa (5148 pairs) and Santa Barbara Islands (1046 pairs). All measures of production (nesting pairs, chick production, and fledging rates)

were much above mean values previously recorded for brown pelicans in the Channel Islands (see table 3).

Western gulls nested in near-record numbers on Santa Barbara Island, and also were abundant on Anacapa Island. A mid-season heat wave caused significant chick mortality in the gull colonies on both islands; birds nesting within different habitat types were differentially affected. Chick growth rates and indices of reproductive success were greater for western gulls nesting on Santa Barbara Island that on Anacapa. Xantus' murrelets on Santa Barbara Island nested in average numbers and produced at average to above-average rates based on mean values from previous studies. Data collected on snowy plovers nesting on San Miguel Island were inconclusive because the 1985 data are not directly comparable to the 1982 data due to changes in the area surveyed and the monitoring methods used.

Kelp Forests

The National Park Service provided information on kelp forest dynamics from research on design and testing of monitoring techniques initiated in 1981 (Davis, 1986).

The 54 species listed in Table 4 and several composite taxa such as crustose coraline algae and encrusting animals were monitored to provide general information on the health of kelp forests in the park. Abundance data for these index species from 1982-85 are summarized in Table 5. Major winter storms in 1982-83 and an extreme El Niño event in 1983-84 dominated California kelp forest environmental conditions during this period. Variability in kelp forest populations during this period consequently represented extreme conditions. Examples of this variability are briefly discussed below.

Major winter storms in 1982-83 greatly reduced surface canopies of giant kelp, *Macrocystis pyrifera* at study sites. The subsequent El Niño event increased mean summer sea temperatures measured in park kelp forests 1.1 degrees Celsius in 1983, further reduced kelp canopy, and slowed its recovery from storm impacts, especially at Santa Barbara Island, Anacapa Island, and the northern shores of Santa Cruz and Santa Rosa Islands. On the bottom, giant kelp densities increased dramatically from 1.4 to 4.5 m^{-2} between 1982 and 1983, with juvenile recruitment accounting for nearly all of the increase. Giant kelp densities then fell to 1.0 m^{-2} in 1984 and 0.8 m^{-2} in 1985. Other algae showed similar patterns of change, especially at exposed sites on the southern sides of the northern islands. The erect algae, which constitute the understory canopy, covered 53% of the bottom (mean for all sites) in 1982. After the surface canopy-opening storms of 1982-83, understory canopy increased to 79% cover (109% at southern exposed sites), but the flush of recruitment faded quickly to 39% cover in 1984, and dropped to only 19% in 1985. Mean densities of urchins, *Strongylocentrotus* sp., fluctuated from 10-14 m^{-2} in 1982-84 and then doubled to more than 20 m^{-2} in 1985.

California sheephead, Semicossyphus pulcher, a southern temperate species, was represented by very few, large individuals in the boreal zone at San Miguel and Santa Rosa Islands in 1982. In 1983 and 1984 it successfully recruited in the boreal zone, more than doubling its abundance during the El Niño years. In the transition and temperate zones, sheephead populations experienced high recruitment in 1983, but by 1984, their abundance had returned to levels only 30% above 1982, while their abundance in the boreal zone remained high. Sheephead populations in the boreal zone may be expected to slowly decline for the next few decades as members of the 1983 and 1984 year-classes die, or until recruitment conditions permit another cycle to begin.

Sea star populations in the park declined markedly during the study period. A temperate species, the giant-spined sea star, Pisaster giganteus, dropped continually from a high of 1400 per ha at all sites in 1982 to just 860 ha^{-1} in 1983, 770 ha^{-1} in 1984, and finally to 500 ha^{-1} in 1985. There was notable mortality occurring for more than a year before monitoring began, and it is likely the major part of the population decline was not documented by this study. More dramatically, numbers of a boreal species, the bat star, Patiria miniata, dropped an order of magnitude in three years from over 14 000 per ha in 1982 to 8 600 ha^{-1} in 1983, 1 400 ha^{-1} in 1984, and 2 000 ha^{-1} in 1985. Other species of asteroids were also affected, primarily at southern islands outside the park (J.M. Engle personal communication).

It is clear from these few examples that kelp forest ecosystems in the park are extremely variable from year to year. Major fluctuations in primary producers, herbivores, and carnivores were observed in just four consecutive years. There are many factors and processes involved with each of the observed changes. Interactions of light penetration, nutrient levels, kelp recruitment, urchin and sea star densities, and California sheephead abundance are only a few of the factors known to influence kelp forest ecosystem dynamics. Understanding even these few interactions and their ecological consequences presents an impossible task given traditional limitations on time (study duration) and the lack of control over marine ecosystems. In lieu of huge laboratory-like controlled environmental chambers, time series of ecological data spanning many generations and environmental conditions drawn from large ecologically-discrete management zones may be the only way to acquire the knowledge necessary to develop management approaches that will sustain coastal fisheries and the kelp forest ecosystems that support them.

Any concept of "baseline conditions" for kelp forests that establishes normal limits or identifies human impacts must also be dynamic and based on many years of information. There is high year-to-year variability in abundance, distribution, recruitment, and phenology of many kelp forest species. When this variability is combined with generation times of kelp forest organisms, many of which exceed 30 years, and the infrequent occurrences of major driving forces such as El Niño and extraordinary winter storms, the need for long-term research and monitoring is clear. The long-term population dynamics monitoring program at Channel Islands National Park is a beginning, not a complete answer. It can provide a framework and support

for more exhaustive and detailed ecological research that is needed to understand these valuable and vital coastal ecosystems.

Island Vegetation

The National Park Service-supported vegetation monitoring design study is not yet complete, but initial field work was done on San Miguel, Anacapa, and Santa Barbara Islands. Plant assemblages that will be monitored as map units were defined and mapped. Comparisons with previous vegetation maps may not be possible because historical maps neither defined nor mapped units precisely, but that analysis is continuing. Population surveys of the rare and endemic Santa Barbara Island live-forever, Dudleya traskiae, in 1986 revealed still further individuals than were previously known (Clark and Halvorson, 1986a, 1986b). During this survey, a large but uncounted number of individuals was found on an inaccessible sheer cliff face. This finding further improves the prognosis for the species' survival. A floristics study was conducted (Table 6) which detailed the number of alien and native plant species on the three islands currently managed by the park. This plant list contains 334 species and of those, 23.4% are considered to be alien to the southern California flora. If, however, one considers vegetation aspects of the islands rather than floristics, preliminary data indicate that the alien species take on much more importance because the vegetation units currently dominating the islands are themselves dominated by alien species (Halvorson, 1986).

Alien animal species continue to seriously threaten native plants in the park. Endemic island oaks, Quercus tomentella, on Santa Rosa Island have not successfully reproduced for over 75 years because alien pigs eat the acorns. Distributions and reproduction of many other island endemics are restricted by alien sheep, cattle, deer, and elk on Santa Cruz and Santa Rosa Islands. Notably affected are Torrey pine, Pinus torreyana; Santa Cruz Island pine, P. remorata; fern-leafed Catalina ironwood, Lyanothamnus floribundus; toyon, Heteromeles arbutifolia; and Catalina cherry, Prunus lyonii. Serious attention still needs to be given to eradication of noxious alien species, rehabilitation of native plant communities, and development of long-term policies defining natural (acceptable) species immigration and extirpation for park ecosystems.

Air pollution remains a major concern for the long-term health of island ecosystems. Air quality in the coastal counties in which the park is located frequently falls below national standards. Huge urban and and industrial sources of air pollution exist on the adjacent mainland coast which impact the park especially during seasonal easterly winds. Prevailing northwest winds place extensive off-shore petroleum exploration and extraction activities upwind of the park. Specific effects of pollutants on native plants in the park are largely unknown, but pine species on the mainland are notably sensitive to air pollutants. Specific research projects are needed to evaluate the risks to native plant communities in the park and determine acceptable levels of pollution for the park airshed.

Fisheries

The California Department of Fish and Game (CDFG) provided information on fisheries harvest in the park (Frey, 1986).

The resources that support both the recreational and commercial fisheries that occur in the nearshore and adjacent waters around Channel Islands National Park remained in good condition throughout the 1980-85 period, in spite of a 46% decline in recreational landings and a 67% decline in commercial landings compared to 27% and 13% respective declines in these fisheries elsewhere in California at this time.

During the six-year period, an El Niño occurred for the first time since the late 1950's. One biological result of El Niño along the California coast is the shifting northward of the center of abundance of some fish and invertebrate species.

Water temperature is an important factor in successful reproduction of living marine resources. This is particularly true in a localized situation such as the water surrounding Channel Islands National Park. Populations of non-migratory species that are near the northern edge of their distribution may be enhanced by successful recruitment; whereas, those near the southern edge of their distribution may experience poor recruitment.

Weather during an El Niño period tends to be more inclement. This directly affects fisheries by permitting fewer days at sea. This results in a slight decrease in total fishing effort.

Southern California fisheries responded to a number of biological, economic, and sociological factors during the 1980-85 period. As a result, both recreational and commercial fishery landings from waters surrounding Channel Islands National Park decreased during this period.

Data used in this report were extracted from CDFG landing reports for both commercial passenger fishing vessels (party boats) and commercial vessels. These landings are reported on the basis of catch block areas along the California Coast that are 10 minutes latitude by 10 minutes longitude. As a result, they not only represent catches from nearshore waters within Channel Islands National Park but from adjacent waters as well.

Landings by recreational fishers participating in the commercial passenger fishing vessel (CPFV) fishery varied considerably from island to island, but did exhibit the downward trend mentioned above (Table 7). Because of the effects of El Niño on the distribution of abundance of desirable species, recreational fishers tended to shift part of their effort to other waters in the Southern California Bight.

Commercial fishery landings from the nearshore and adjacent waters surrounding the park also exhibited a sizable decline (Table 8). While part

of this decline can be attributed to El Niño effects, economics and social factors also were involved. During the six-year period, the anchovy reduction fishery ceased because of economics and several tuna canneries in southern California ceased operations. As a result, demand changed and commercial fishing effort shifted to other areas.

V. RECOMMENDATIONS FOR ACTION

1. Finalize the Acquisition of Santa Rosa Island and Acquire Eastern Santa Cruz Island

In 1985, the United States Congress appropriated funds to acquire Santa Rosa Island. The National Park Service is now continuing negotiations with the landowners to acquire the island. It is possible that there will be appropriated funds remaining after the acquisition of Santa Rosa Island to begin negotiations with the owners for eastern Santa Cruz Island. However, more appropriated funds will be required to complete the acquisition. Acquisition of these private lands is of the highest priority to better protect the natural resources and to allow access to begin basic surveys and population monitoring.

2. Implement Long-term Monitoring of Remaining Natural Resource Types

Acquisition of long-term ecological information is essential to protect the natural resources of Channel Islands National Park. This information on population dynamics of selected species is needed to discover and define natural population trends and cycles, establish normal limits to population fluctuations, detect abnormalities in park ecosystems, and to determine if the abnormalities are man-caused and amenable to management action. In FY 86, funds were provided to monitor the following types of natural resources; a) Pinnipeds; b) Tidepools; c) Seabirds; and d) Oceanic Environment. Additional funds and personnel are needed to implement the monitoring of the remaining types of natural resources. These include: a) Marine Invertebrates, Plants, and Fish; b) Island Birds; c) Island Vegetation; d) Island Invertebrates, Herpetofauna, and Mammals; e) Fisheries Harvest; and f) Weather. Design studies on how to monitor these natural resource types have either been completed or are ongoing and scheduled for completion by the end of FY 87.

3. Monitor and Manage Pinniped Populations

a. NMFS will continue to manage pinniped populations consistent with the mutual objectives of the NMFS, NPS, and the SPO. NMFS will also continue to monitor trends in distribution and abundance for all pinniped species within CHIS, collect life history data, and synthesize this information into an assessment of population status relative to optimum sustainable population for California sea lions in 1987, and for elephant seals and harbor seals in 1988.

b. NMFS will expand or initiate the following projects (in order of priority):

(1) Work with the CDFG and NPS to monitor the incidental take of pinnipeds within Channel Islands National Park and National Marine Sanctuary due to commercial fishing operations; (2) Initiate radio tracking studies of the pelagic distribution and abundance of harbor seals within Channel Islands National Park and National Marine Sanctuary. This information will provide

correction factors for population estimates made from counts on the hauling/breeding grounds, provide data useful for defining stocks within a population; and will assist managers to assess the contribution of these waters to pinniped foraging activities; (3) Assess the impact of human disturbance to pinnipeds within Channel Islands National Park; (4) Continue systematic surveys of selected island beaches to document the amount and type of net debris that washes on shore; and (5) Periodically monitor reproductive status, seasonal use, and human disturbance of California sea lions at Santa Rosa, Santa Cruz, and Anacapa Islands.

4. Eradication and Control of Alien Animals

Alien animals are causing significant impacts to park ecosystems. Black rats probably eliminated endemic deer mice from East Anacapa, and pose serious threats to that species as well as to birds, land snails, and other native species through predation and/or habitat alteration on Middle and West Anacapa and San Miguel Islands. Feral pigs and sheep and alien deer and elk have periodically inhabited Santa Rosa and Santa Cruz Islands since the start of ranching operations over 125 years ago. These animals, have caused and continue to cause serious erosion problems and severe damage to habitats of several rare and endangered species. NPS needs to eradicate these alien animals.

5. Develop Methods of Controlling Alien Plants and Re-establishing Native Plant Communities

Alien plants, particularly annual grasses and crystalline iceplant, are widespread on the park islands and aggressively compete with native species for habitat. NPS needs to determine the true extent of alien plant influences on native biota; and to determine which alien plants can be eradicated or controlled. NPS also needs to determine the best methods of eradicating or controlling the target alien species and re-establishing native plant communities.

6. Upgrade Park's Air Quality Classification

The park's air quality classification under the Clean Air Act, as amended in 1977, should be upgraded from Class II to Class I. This action was initiated in 1979, but there has been no response from the State of California. In recognition of the threats and recent increase in status from monument to national park, this matter should be expedited.

7. Study of Soil Erosion Monitoring and Mitigation

A combination of domestic animal overgrazing, road building, farming cultivation, and fire has resulted in severe erosion and tremendous net losses of valuable mineral earth and organic matter. NPS needs to determine which areas of severe erosion should receive mitigation/restoration measures because of their negative impact on visitor safety, hiking trails or

significant natural and cultural resources. NPS must also recommend the actual methods that should be used in the mitigation or restoration areas.

8. Continue Cooperative Management Programs

The management environment of Channel Islands National Park is exceedingly complex. Over thirty local, state, and federal agencies and private landowners are involved directly with the management of resources and public safety in the park. The National Park Service has entered into a variety of Memoranda of Agreement or Understanding with these agencies for the purpose of improving communication and thereby resource and visitor protection. These formal expressions of cooperation, and the many informal cooperative relationships that have been developed, should be sustained and continued. Park resources and the public benefit greatly from these programs through reduced costs for shared logistical support, improved communication among regulatory agencies, and elimination of redundant facilities.

9. Conduct Research on Fishery Resource Management Strategies

A cooperative research program needs to be initiated by the National Park Service and the California Department of Fish and Game. The program should investigate the efficacy of extant fishery management strategies and develop new or different management concepts by which fishery yields may be sustained or improved utilizing naturally functioning ecosystems. Hypotheses regarding sizes, numbers, and distributions of fishery production zones with adjacent harvest zones may be postulated with existing knowledge. These hypotheses need to be formulated and tested. Channel Islands National Park is an ideal place to test such hypotheses and develop new fishery management strategies based on ecological principals.

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Table 1. Pinniped population dynamics by island for Channel Islands National Park, 1985. Maximum count of live pups for sea lions, fur seals, and elephant seals. Total counts of harbor seals.

Species	Island					Park Total
	San Miguel	Santa Rosa	Santa Cruz	Anacapa	Santa Barbara	
California sea lion[1]	9516[a]	?	?	?	543[g]	10,059
Northern sea lion[1]	0[b]	0	NHP	NHP	NHP	0
Northern fur seal[1]	441[c]	NHP	NHP	NHP	NHP	441
Guadalupe fur seal[1]	0[b]	NHP	NHP	NHP	NHP	0
Northern elephant seal[1]	9490[d]	2[f]	NHP	NHP	93[g]	9585
Pacific harbor seal[2]	619[e]	585[e]	515[e]	207[e]	311[e]	2237

? = Numbers not available
NHP = No historic records of pupping

1 Number of pups produced

2 Number of seals estimated from beach and aerial surveys

Sources:

a DeLong, R.L., G.A. Antonellis, and E. Jameyson. In prep. NWAFC, NMML, manuscript.

b Delong, R.L. pers. comm. 6/27/86; NWAFC unpubl. observations.

c Kozloff, P. In prep. NWAFC Process. Rept.

d Perryman, W., pers. comm. 6/20/86.

e Hanan, D., pers. comm. 6/26/86.

f Stewart, B.S. and P.K. Yochem. 1986. Northern elephant seals breeding at Santa Rosa Island, California. J. Mammal. 67(2):402-403.

g Hawes, S. and L.J. Hansen. SWFC Internal memo.

Table 2. Estimated recent trends[1] in pup production for pinniped species in Channel Islands National Park[2], California, 1985.

Species	Island				
	San Miguel	Santa Rosa	Santa Cruz	Anacapa	Santa Barbara
California sea lion	Inc(+)	NHP	?(+)	?(+)	flct(+)
Northern sea lion	Np(+)	Np(+)	Np(+)	NHP	NHP
Northern fur seal	Inc(+)	NHP	NHP	NHP	NHP
Guadalupe fur seal	Np(+)	NHP	NHP	NHP	NHP
Northern elephant seal	Inc(+)	Inc(+)	Np(+)	NHP	Stb(+)
Pacific harbor seal	Dcl(-)	Dcl(-)	Stb(-)	Flct(-)	Flct(-)

NHP means islands not believed to have been used historically as a pupping site.

"?" means data not available at the current time.

1. Trends of "numbers" based on pup counts for sea lions, fur seals, and elephant seals; total counts of harbor seals.

2. Abbreviations as follows: Inc, increasing; Dcl, declining; Stb, stable; Np, no pupping in 1981; Flct, fluctuating; NHP, island not believed to have been used historically as pupping site. Reliability of estimates indicated as follows; (+) reliable, based on at least 5 years of data; (-) marginal, limited less that 5 years of recent data only.

Table 3. Yearly population data for California Brown Pelicans nesting in the Anacapa Island Area (West Anacapa Island and Scorpion Rock), and Santa Barbara Island, 1969-1985.

Year	No. of Pairs[a]	No. Yng. Fledged	Productivity[b]
1969	750	4	0.005
1970	552	1	0.002
1971	540	7	0.013
1972[c]	261	57	0.22
1973	247	34	0.14
1974[c]	416	305	0.73
1975[c]	292	256	0.88
1976	417	279	0.67
1977	76	39	0.51
1978	210	37	0.18
1979	1,258	980	0.78
1980[d]	2,244	1,515	0.68
1981	2,946	1,805	0.61
1982	1,862	1,175	0.63
1983[d]	1,877	1,159	0.62
1984	628	530	0.84
1985[d]	6,194	7,902	1.28

a Estimates based on maximum numbers present, numbers of nests constructed, reproductive behavior, and appearances of secondary sexual characteristics.

b Number of young fledged per pair

c Years that nesting occurred on Scorpion Rock

d Years that nesting occurred on Santa Barbara Island

Table 4. Summary of natural history and status of kelp forest indicator species selected for long-term monitoring in Channel Islands National Park, California.

Scientific Name	Common Name	Natural History* G' F M T L S
PLANTS		
Cystoseira osmundacea	bladder chain kelp	w s a p m
Desmarestia ligulata	acid weed	n s a p s
Eisenia arborea	southern sea palm	s s a p m
Laminaria farlowii	oar weed	w s a p m
Macrocystis pyrifera	giant kelp	w s a p m h
Pterygophora californica	California sea palm	n s a p m
Sargassum muticum	sargassum weed	w s a p s a
Gigartina spp.	sea tongue	w s a p m
Gelidium robustum	agar weed	w s a p m h
INVERTEBRATES		
Tethya aurantia	orange puffball sponge	w c a f m
Polymastia pachymastia	aggregated vase sponge	n c a f m
Leucetta losangelensis	white calcareous sponge	s c a f m
Allopora californica	California hydrocoral	n c a f l h
Astrangia lajollensis	La Jolla cup coral	s a a f m
Balanophyllia elegans	orange cup coral	n s a f m
Lophogorgia chilensis	red gorgonian	s c a f l
Muricea fruticosa	brown gorgonian	s c a f l
Corynactis californica	strawberry anemone	w a s f m
Tealia lofotensis	white-spotted rose anemone	n s s c l
Diopatra ornata	ornate tube worm	w s a o m
Phragmatopoma californica	colonial sand-tube worm	w a a f m
Panulirus interruptus	California spiny lobster	s s m o l h
Megathura crenulata	giant keyhole limpet	w s m o l
Haliotis rufescens	red abalone	n s s h l h
Haliotis corrugata	pink abalone	s s s h l h
Haliotis fulgens	green abalone	s s s h l h
Astrea undosa	wavy turban snail	s s m h l
Cypraea spadicea	chestnut cowrie	s s m c m
Kelletia kelletii	Kellet's whelk	s s m c l
Serpulorbis squamigerus	scaled tube shell	s a a f m
Hinnites giganteus	rock scallop	w s a f l h
Aplysia californica	California brown sea hare	w s m h s
Diaperoecia californica	southern staghorn bryozoan	w c a f m
Strongylocentrotus franciscanus	giant red sea urchin	w s s h l h
Strongylocentrotus purpuratus	purple sea urchin	w s s h l
Lytechinus anamesus	white sea urchin	s s m o m
Pycnopodia helianthoides	sunflower star	n s m c l
Patiria miniata	sea bat	n s m o l
Pisaster giganteus	giant-spined sea star	w s m c l
Parastichopus parvimensis	warty sea cucumber	s s m o m h
Pachythyone rubra	aggregated red cucumber	n a s f s
Styela montereyensis	stalked tunicate	n s a f m

Table 4 continued.

Scientific Name	Common Name	Natural History* G' F M T L S
FISHES		
Sebastes mystinus	blue rockfish	n s m c l h
Sebastes atrovirens	kelp rockfish	w s m c m h
Embiotoca jacksoni	black perch	w s m c m h
Embiotoca lateralis	striped seaperch	n s m c m h
Girella nigricans	opaleye	s s m o m h
Semicossyphus pulcher	California sheephead	s s m c l h
Oxyjulis californica	senorita	w s m c m
Coryphopterus nicholsii	blackeye goby	w s m c m
Lythrypnus dalli	bluebanded goby	s s m c s
Hypsypops rubicundus	garibaldi	s s m o l p
Chromis punctipinnis	blacksmith	s s m c m
Paralabrax clathratus	kelp bass	s s m c l h

* Natural History Codes — Total Species

G' = Geographic range
- n = northern — 13
- s = southern — 20
- w = widespread — 21

F = Life form
- s = solitary — 42
- a = aggregated — 5
- c = colonial — 7

M = Mobility
- a = attached — 23
- s = sedentary — 8
- m = mobile — 23

T = Trophic level
- p = producer — 9
- h = herbivore — 7
- f = filter feeder — 15
- c = carnivore — 15
- o = omnivore — 8

L = Life span
- s = short < 2 years — 5
- m = medium 2 - 10 years — 28
- l = long > 10 years — 21

S = Status
- a = alien — 1
- h = harvested — 17
- p = protected — 1

Table 5. Variations in kelp forest index species abundance 1982 - 1985, Channel Islands National Park, California.

	YEAR '82*	'83	'84	'85	Sample**
PLANTS					
Cystoseira osmundacea	727	347	316	250	R
Desmarestia ligulata	ns	800	16	7	R
Eisenia arborea	176	205	152	116	Q
Laminaria farlowii	678	298	246	94	Q
Macrocystis pyrifera	908	2926	668	512	Q
Pterygophora californica	41	530	94	2	Q
Gigartina spp.	91	203	34	19	R
Gelidium robustum	475	224	218	111	R
INVERTEBRATES					
Tethya aurantia	ns	837	819	436	B
Allopora californica	ns	77	22	42	B
Astrangia lajollensis	393	697	588	448	R
Balanophyllia elegans	307	253	248	269	R
Lophogorgia chilensis	ns	238	243	622	B
Muricea fruticosa	ns	9	13	34	B
Corynactis californica	230	116	156	195	R
Tealia lofotensis	ns	342	288	361	B
Diopatra ornata	314	329	244	322	R
Phragmatopoma californica	32	32	90	511	R
Panulirus interruptus	ns	32	43	6	B
Megathura crenulata	ns	815	950	727	B
Haliotis rufescens	ns	301	162	103	B
Haliotis corrugata	ns	256	209	187	B
Haliotis fulgens	ns	0	0	2	B
Astrea undosa	246	184	525	719	Q
Cypraea spadicea	ns	68	89	124	Q
Kelletia kelletii	ns	162	209	269	B
Serpulorbis squamigerus	123	145	360	339	R
Hinnites giganteus	ns	1332	1098	742	B
Aplysia californica	ns	153	108	222	B
Diaperoecia californica	223	45	186	101	R
Strongylocentrotus franciscanus	2384	2320	2660	2860	Q
Strongylocentrotus purpuratus	5731	5548	4228	7530	Q
Lytechinus anamesus	ns	884	680	5791	B
Pycnopodia helianthoides	ns	38	7	13	B
Patiria miniata	985	550	84	104	Q
Pisaster giganteus	98	60	54	33	Q
Parastichopus parvimensis	355	368	474	400	Q
Styela montereyensis	155	35	575	155	Q

Table 5 continued.

	YEAR '82*	'83	'84	'85	Sample**
FISHES					
Sebastes mystinus	123	140	23	343	C/V
Sebastes atrovirens	44	38	17	53	C/V
Sebastes serranoides	ns	ns	ns	70	V
Embiotoca jacksoni	218	275	272	562	C/V
Embiotoca lateralis	42	157	43	99	C/V
Girella nigricans	2	8	18	56	C/V
Semicossyphus pulcher	142	260	229	365	C/V
Oxyjulis californica	ns	ns	1300	822	V
Coryphopterus nicholsi	ns	ns	ns	59	Q
Alloclinus holderi	ns	ns	ns	176	Q
Lythrypnus dalli	ns	ns	ns	808	Q
Hypsypops rubicundus	40	68	52	173	C/V
Chromis punctipinnis	ns	ns	1056	5476	V
Paralabrax clathratus	296	411	567	510	C/V

* In 1983, the Rodes Reef transect was re-located about 150 m north of its previous location, consequently 1982 data in this table exclude samples from Rodes Reef and represent only 13 sites.

** Abundances are expressed in different ways depending on the sampling method employed:

R = Abundance expressed as total number of contacts per 14,000 randomly selected points uniformly distributed among 14 permanently marked sites (RPC).

Q = Abundance expressed as total number of individuals observed per 350 2.0 m^2 quadrats uniformly distributed among 14 permanently marked sites (Quadrats).

B = Abundance expressed as total number of individuals observed per 168 3 X 20 m band transects uniformly distributed among 14 permanently marked sites (Band Transects).

C = Abundance expressed as total number of individuals observed during 112 10-minute counts at baited stations uniformly distributed among 14 permanently marked sites (Baited Fish Counts). All 1985 fish samples were visual transects, see below.

V = Abundance expressed as total number of individuals observed on 112 2 X 100 m transects uniformly distributed among 14 permanently marked sites (Visual Transects).

ns = No sample taken

Table 6. Status and distribution of plants of Channel Islands National Park. Status: I = Alien, E = Insular Endemic, N = Native, R = Extirpated. Islands: A = Anacapa, B = Santa Barbara, M = San Miguel

	Status	Island
AIZOACEAE		
Carpobrotus aequilaterus (Haw.) N.E.Br.	I	AM
Carpobrotus edulis (L.) Bolus.	I	A
Malephora crocea (Jacq.) Schwant.	I	A
Mesembryanthemum crystallinum L.	I	ABM
Mesembryanthemum nodiflorum L.	I	ABM
Tetragonia tetragonioides (Pall.) O. Kuntze.	I	AM
AMARYLLIDACEAE		
Allium praecox Bdg.	N	M
Brodiaea jolonensis Eastw.	N	M
Dichelostemma pulchellum (Salisb.) Heller	N	ABM
ANACARDIACEAE		
Toxicodendron diversilobum Greene	N	AM
Rhus integrifolia (Nutt.) Benth. & Hook.	N	AM
APIACEAE		
Apiastrum angustifolium Nutt. in T. & G.	N	ABM
Berula erecta (Huds.) Cov.	N	AM
Daucus pusillus Michx.	N	ABM
Lomatium caruifolium (H. & A.) Coult. & Rose.	N	M
Sanicula arguta Greene ex Coult. & Rose.	N	AM
Torilis nodosa (L.) Gaertn.	I	M
ARACEAE		
Zantedeschia aethiopica (L.) Spreng.	I	M
ARECACEAE		
Washingtonia sp.	I	M
ASPIDIACEAE		
Dryopteris arguta (Kaulf.) Watt.	N	A
ASTERACEAE		
Achillea millefolium L.	N	ABM
Agroseris grandiflora (Nutt.) Greene	N	M
Amblyopappus pusillus H. & A.	N	ABM
Ambrosia chamissonis bipinnatisecta (Less.) Wig. & St.	N	AM
Ambrosia chamissonis chamissonis (Less.) Greene	N	M
Artemisia californica californica Less.	N	AM

Table 6 continued.

Artemisia californica insularis (Rydb.) Munz.	N,E	B
Baccharis douglasii DC.	N	AM
Baccharis glutinosa Pers.	N	A
Baccharis pilularis DC.consanguinea (DC.) C. B. Wolf.	N	ABM
Brickellia californica (T. & G.) Gray	N	A
Centaurea melitensis L.	I	BM
Cirsium occidentale (Nutt.) Jeps.	N	M
Conyza bonariensis (L.) Cronq.	I	AB
Conyza canadensis (L.) Cronq.	I	ABM
Coreopsis gigantea (Kell.) Hall.	N	ABM
Corethrogyne filaginifolia (H. & A.) Nutt.	N	AM
Cotula coronopifolia L.	I	AM
Erechtites glomerata (Poir.) DC.	I	M
Erigeron foliosus Nutt. foliosus Nutt.	N	M
Erigeron foliosus Nutt. stenophyllus (Nutt.) Gray.	N	AM
Erigeron glaucus Ker.	N	AM
Erigeron sanctarum Wats.	N	A
Eriophyllum confertiflorum (DC.) Gray.	N	AM
Eriophyllum nevinii Gray.	N,E	B
Eriophyllum staechadifolium Lag.	N	AM
Filago californica Nutt.	N	ABM
Gnaphalium beneolens A. Davids.	N	A
Gnaphalium bicolor Bioletti.	N	AB
Gnaphalium californicum DC.	N	AB
Gnaphalium chilense Spreng.	N	AM
Gnaphalium luteo-album L.	I	M
Gnaphalium microcephalum Nutt.	N	A
Gnaphalium purpureum L.	N	A
Grindelia latifolia Kell.	N	AM
Haplopappus canus (Gray) Blake.	N,E	A
Haplopappus detonsus (Greene) Raven	N,E	A
Haplopappus ericoides (Less.) H. & A.	N	M
Haplopappus squarrosus H. & A.	N	A
Haplopappus venetus (HBK) Blake sedoides (Greene) Munz	N	AM
Haplopappus venetus vernonioides (Nutt.) Hall.	N	AM
Hemizonia clementina Bdg.	N,E	AB
Hemizonia fasciculata (DC.) T. & G.	N	BM
Hypochoeris sp	I	A
Jaumea carnosa (Less.) Gray	N	M
Lactuca serriola L. integrata Gren. & Godr.	I	M
Lasthenia chrysostoma (F. & M.) Greene	N	ABM
Layia platyglossa (F. & M.) Gray	N	M
Malacothrix foliosa Gray	N,E	ABM
Malacothrix incana (Nutt.) T. & G.	N	M
Malacothrix indecora Greene	N,E	M
Malacothrix saxatilis implicata (Eastw.) Hall.	N,E	AM
Malacothrix saxatilis tenuifolia (Nutt.) Gray	N	A
Malacothrix squalida Greene	N	A

Table 6 continued.

Malacothrix succulenta Elmer	N	M
Microseris douglasii (DC)Sch-Bip tenella (Gray) Chamb.	N	M
Microseris elegans Greene ex Gray.	N	M
Microseris linearifolia (Nutt.) Sch.-Bip.	N	AB
Perityle emoryi Torr. in Emory.	N	AB
Rafinesquia californica Nutt.	N	AB
Senecia vulgaris L.	I	AM
Silybum marianum (L.) Gaertn.	I,R	B
Solidago sp.	N	A
Sonchus asper (L.) Hill	I	AM
Sonchus oleraceous L.	I	ABM
Sonchus tenerrimus L.	I	AB
Stephanomeria virgata Benth.	N	M
Xanthium spinosum L.	I	BM
BERBERIDACEAE		
Berberis pinnata Lag. insularis Munz.	N,E	A
BORAGINACEAE		
Amsinckia intermedia F. & M.	N	ABM
Amsinckia spectabilis F. & M.	N	ABM
Cryptantha clevelandii Greene	N	ABM
Cryptantha maritima (Greene) Greene	N	B
Cryptantha muricata jonesii (Gray) Jtn.	N	A
Heliotropium curassavicum L. oculatum (Heller) Thorne	I	AM
Plagiobothrys californicus californicus (Gray) Greene	N	AM
Plagiobothrys californicus (Gray)Greene gracilis Jtn.	N	A
BRASSICACEAE		
Brassica geniculata (Desf.) J. Ball	I	M
Brassica nigra (L.) Koch. in Rohling	I,R	B
Brassica rapa L. sylvestris (L.) Janchen	I	M
Cakile edentula californica (Heller) Hult.	N	M
Cakile maritima Scop.	I	AM
Capsella bursa-pastoris (L.) Medic.	I	M
Cardamine californica (Nutt.) Greene	N	AM
Descurania pinnata menziesii (DC.) Detl.	N	A
Dithyrea californica maritima (A. Dav.) A. Dav.ex Rob	N	
Erysimum insulare Greene	N	AM
Hutchinsia procumbens (L.) Desv.	N	ABM
Lepidium nitidum Nutt. nitidum	N	AB
Lepidium oblongum Small insulare	I	AM
Lepidium strictum (Wats.) Rattan.	I	A
Nasturtium officinale R. Br.	I	M
Thelypodium lasiophyllum (H. & A.) Greene	N	ABM
CACTACEAE		
Opuntia ficus-indica (L.) Mill.	I	A

Table 6 continued.

Opuntia littoralis (Engelm.) Ckll.	N	ABM
Opuntia oricola Philbrick.	N	ABM
Opuntia prolifera Engelm.	N	ABM
CARYOPHYLLACEAE		
Cardionema ramosissimum (Weinm.) Nels. & Macbr.	N	M
Cersatium glomeratum Thuill.	I	M
Sagina decumbens (Ell.) T&G occidentalis Wats.Crow	N	M
Silene antirrhina L.	N	M
Silene gallica L.	I	ABM
Silene laciniata Cav. major Hitchc. & Maguire.	N	AM
Silene multinervia Wats.	N	A
Spergularia macrotheca (Hornem.) Heynh.	N	ABM
Stellaria media (L.) Vill.	I	AM
CHENOPODIACEAE		
Aphanisma blitoides Nutt. ex Moq. in DC.	N	B
Atriplex californica Moq. in DC.	N	ABM
Atriplex coulteri (Moq.) D. Dietr.	N	AM
Atriplex lentiformis breweri (Wats.) Hall. & Clem.	N	A
Atriplex leucophylla (Moq. in DC.) D. Dietr.	N	M
Atriplex pacifica Nels.	N	AB
Atriplex patula L. hastata (L.) Hall. & Clem.	I	M
Atriplex semibaccata R. Br.	I	ABM
Beta vulgaris L.	I,R	M
Chenopodium californicum (Wats.) Wats.	N	ABM
Chenopodium murale L.	I	ABM
Monolepis nuttalliana (Schult.) Greene	N	BM
Salicornia subterminalis Parish.	N	M
Salicornia virginica L.	N	M
Suaeda californica Wats.	N	ABM
CISTACEAE		
Helianthemum greenei Rob.	N,E	AM
CONVOLVULACEAE		
Calystegia macrostegia amplissima Brummitt	N,E	B
Calystegia macrostegia macrostegia (Greene) Brummitt.	N,E	AM
Calystegia soldanella (L.) R. Br.	N	M
Cressa truxillensis HBK. vallicola (Heller) Munz.	N	AM
Dichondra occidentalis House.	N	M
CRASSULACEAE		
Crassula erecta (H. & A.) Berger.	N	ABM
Dudleya caespitosum (Haw.) Britt. & Rose	N	A
Dudleya greenei Rose	N,E	M
Dudleya traskiae (Rose) Moran	N,E	B

CUCURBITACEAE		
Marah macrocarpus (Greene) Greene	N	ABM
CUSCUTACEAE		
Cuscuta salina salina Engelm.	N	AM
CYPERACEAE		
Scirpus cernuus Vahl. californicus (Torr.) Thorne	N	M
ERICACEAE		
Comarostaphylos diversifolia Greene planifolia Jeps.	N	A
FABACEAE		
Astragalus curtipes Gray	N	M
Astragalus didymocarpus H. & A.	N	AM
Astragalus miguelensis Greene	N,E	ABM
Astragalus traskiae Eastw.	N,E	B
Astragalus trichopodus Gray leucopis (T&G) Thorne	N	A
Lathyrus laetiflorus Greene barbarae (White) C.L. Hitc.	N	A
Lotus argophyllus ornithopus (Greene) Raven	N,E	B
Lotus dendroideus (Greene) Greene dendroideus	N	A
Lotus dendroideus veatchii (Greene) Isley	N	M
Lotus salsuginosus Greene	N	AM
Lotus strigosus (Nutt. in T. & G.) Greene.	N	A
Lotus subpinnatus Lag.	N	A
Lupinus albifrons Benth.	N	AM
Lupinus arboreus Sims.	N	M
Lupinus bicolor Lindl.	N	AM
Lupinus bicolor Lindl. umbellatus (Greene) D. Dunn.	N	A
Lupinus chamissonis Eschs.	N	M
Lupinus succulentus Dougl. ex Koch.	N	AM
Lupinus truncatus Nutt. ex H. & A.	N	A
Medicago polymorpha L. brevispina (Benth.) Heyn.	I	M
Medicago polymorpha L. polymorpha L.	I	ABM
Medicago sativa L.	I	M
Melilotus indicus (L.) All.	I	ABM
Trifolium amplectens T. & G.	N	AM
Trifolium barbigerum Torr.	N	M
Trifolium fucatum Lindl.	N	M
Trifolium gracilentum T. & G.	N	AM
Trifolium microcephalum Pursh.	N	M
Trifolium palmeri Wats.	N,E	B
Trifolium tridentatum Lindl.	N	ABM
Vicia americana Muhl. ex Willd.	N	M
Vicia exigua Nutt. in T. & G.	N	AM
FAGACEAE		
Quercus tomentella Engelm.	N,E	A

Table 6 continued.

FRANKENIACEAE		
Frankenia grandifolia Cham. & Schlecht.	N	AM
GERANIACEAE		
Erodium cicutarium (L.) L'Her.	I	ABM
Erodium moschatum (L.) L'Her.	I	ABM
HYDROPHYLLACEAE		
Eucrypta chrysanthemifolia (Benth.) Greene	N	ABM
Nemophila pedunculata Dougl. ex Benth.	N	M
Phacelia cicutaria hispida (Gray) J.T.Howell	N	A
Phacelia distans Benth.	N	ABM
Phacelia insularis Munz insularis	N,E	M
Phacelia viscida (Benth.) Torr.	N	AM
Pholistoma auritum (Lindl.) Lilja. ex Lind.	N	B
Pholistoma racemosum (Nutt.) Const.	N	B
IRIDACEAE		
Chasmanthe aethiopica (L.) N.E.Br.	I	M
Sisyrinchium bellum Wats.	N	M
JUNCACEAE		
Juncus balticus Willd.	N	M
Juncus bufonius L.	N	AM
Juncus mexicanus Willd.	N	M
LAMIACEAE		
Marrubium vulgare L.	I	M
LILIACEAE		
Lilium humboldtii Roezl. & Leichtl.	N	A
Zigadenus fremontii Torr.	N	A
MALVACEAE		
Lavatera assurgentiflora Kell.	N,E	AM
Lavatera cretica L.	I	A
Malva parviflora L.	I	ABM
Sidalcea malvaeflora (DC.) Gray ex Benth.	N	M
MORACEAE		
Ficus carica L.	I,R	M
MYRTACEAEA		
Eucalyptus globulus Labill.	I	A
NYCTAGINACEAE		
Abronia latifolia Eschs.	N	M
Abronia maritima Nutt. ex Wats.	N	AM

Table 6 continued.

Abronia umbellata Lam.	N	M
Mirabilis californica Gray californica Gray	N	AB
ONAGRACEAE		
Camissonia cheiranthifolia cheiranthifolia Raven	N	BM
Camissonia micrantha (Hornem ex Spreng) Raven	N	M
Clarkia epilobioides (Nutt.) Nels. & Macbr.	N	A
Epilobium adenocaulon Hausskn.	N	M
Zauschneria californica Presl.	N	AM
Zauschneria cana Greene.	N	A
OROBANCHACEAE		
Orobanche fasciculata Nutt.	N	M
Orobanche parishii (Jeps.) Heckard brachyloba Heck.	N	M
PAPAVERACEAE		
Eschscholzia californica Cham.	N	M
Eschscholzia ramosa (Greene) Greene.	N,E	AB
Platystemon californicus Benth.	N	AM
Platystemon californicus Benth. ciliatus Dunkle.	N,E	B
Stylomecon heterophylla (Benth.) G. Tayl.	N	ABM
PLANTAGINACEAE		
Plantago bigelovii Gray.	N	M
Plantago erecta erecta Morris.	N	A
Plantago hirtella HBK.	N	M
Plantago insularis Eastw.	N	A
Plantago ovata Forrsk.	I	B
POACEAE		
Agropyron repens (L.) Beauv.	I	M
Agrostis semiverticillata (Forsk.) C. Chr.	I	A
Avena barbata Brot.	I	ABM
Avena fatua L.	I	ABM
Bromus arizonicus (Shear) Steb.	N	B
Bromus carinatus H. & A.	N	A
Bromus diandrus Roth.	I	ABM
Bromus madritensis L.	I	A
Bromus maritimus (Piper) Hitchc.	N	AM
Bromus mollis L.	I	ABM
Bromus pseudolaevipes Wagnon.	N	A
Bromus rubens L.	I	ABM
Bromus trinii E. Desv. in Gray	N	ABM
Cortaderia selloana (Schult.) Asch. & Graebn.	I	M
Cynodon dactylon (L.) Pers.	I	A
Distichlis spicata (L.) Greene stolonifera Beetle	N	AM
Elymus condensatus Presl.	N	AM
Elymus pacificus Gould.	N	M

Table 6 continued.

Hordeum californicum Covas & Steb.	N	AM
Hordeum glaucum Steud.	I	AB
Hordeum pusillum Nutt.	N	AB
Hordeum leporinum Link.	I	AM
Lamarckia aurea (L.) Moench.	I	ABM
Lolium perenne L.	I,R	B
Melica imperfecta Trin.	N	ABM
Muhlenbergia microsperma (DC.) Kunth.	N	AB
Parapholis incurva (L.) C.E.Hubb.	I	BM
Pennisetum clandestinum Hochst. ex Chior.	I	M
Phalaris minor Retz.	I	ABM
Poa annua L.	I	M
Poa douglasii Nees.	N	M
Poa scabrella (Thurb.) Benth. ex Vassey	N	A
Polypogon interruptus HBK.	I	M
Polypogon monspeliensis (L.) Desf.	I	BM
Stipa lepida Hitchc.	N	AM
Stipa pulchra Hitchc.	N	ABM
Vulpia dertonensis Volk.	I	AM
Vulpia megalura Rydb.	N	ABM
Vulpia octoflora (Walt.) Rydb.	N	ABM
Vulpia pacifica Rydb.	N	A
POLEMONIACEAE		
Gilia angelensis V. Grant	N	A
Gilia clivorum (Jeps.) V. Grant.	N	AM
Gilia nevinii Gray	N,E	A
Linanthus androcaceus micranthus (Steud.) Mason	N	M
POLYGONACEAE		
Eriogonum arborescens Greene.	N,E	A
Eriogonum giganteum Wats. compactum (Dunkle) Munz	N,E	B
Eriogonum grande Greene grande	N	A
Eriogonum grande Greene rubescens (Greene) Munz.	N,E	AM
Pterostegia drymarioides F. & M.	N	ABM
Rumex crispus L.	I	AM
Rumex fueginus Phil.	N	M
Rumex salicifolius Weinm.	N	M
POLYPODIACEAE		
Polypodium californicum Kaulf.	N	AB
PORTULACACEAE		
Calandrinia ciliata (R&P) DC. menziesii (Hook.) Macbr.	N	ABM
Calandrinia maritima Nutt.	N	AB
Claytonia perfoliata Donn.	N	ABM

Table 6 continued.

PRIMULACEAE		
Anagallis arvensis L.	I	AM
Dodecatheon clevelandii Greene *insulare* H.J.Thomps.	N	A
PTERIDACEAE		
Adiantum jordanii C. Muell.	N	A
Pellaea andromedaefolia (Kaulf.) Fee	N	A
Pellaea mucronata (D.C.Eat.) D.C.Eat.	N	A
Pityrogramma triangularis (Kaulf.) Maxon.	N	A
RANUNCULACEAE		
Delphinium parryi Gray	N	AM
Ranunculus californicus Benth.	N	M
RESEDACEAE		
Oligomeris linifolia (Vahl.) Macbr.	N	ABM
RHAMNACEAE		
Ceanothus megacarpus Nutt. *insularis* (Eastw.) Raven	N,E	A
Ceanothus megacarpus Nutt. *insularis* (Eastw.) Raven	N,E,R	M
Rhamnus pirifolia Greene	N,E	M
ROSACEAE		
Heteromeles arbutifolia (Ait.) M. Roem.	N	AM
Potentilla egedii Wormski *grandis* (Rydb.) J.T.Howell	N	M
Prunus lyonii (Eastw.) Sarg.	N	A
Rubus ursinus Cham. & Schlecht.	N	AM
RUBIACEAE		
Galium angustifolium Nutt. *foliosum* Hilend & Howell	N,E	A
Galium aparine L.	I	ABM
Galium buxifolium Greene	N,E	M
Galium californicum H. & A. *miguelense* (Greene) Jeps.	N,E	M
SALICACEAE		
Salix lasiolepis Benth.	N	M
SAXIFRAGACEAE		
Heuchera maxima Greene	N,E	A
Ribes malvaceum Sm.	N	A
SCROPHULARIACEAE		
Antirrhinum nuttallianum Benth. in DC.	N	AM
Castilleja affinis H. & A.	N	AM
Castilleja hololeuca Greene	N,E	AM
Linaria texana Scheele	N	AM
Mimulus flemingii Munz.	N	A
Orthocarpus densiflorus Benth.	N	M

Table 6 continued.

Orthocarpus purpurascens Benth.	N	M
Keckiella cordifolia (Benth.) Straw.	N	A
Scrophularia villosa Penn. in Millsp. & Nutt.	N	A
SELAGINELLACEAE		
Selaginella bigelovii Underw.	N	A
SOLANACEAE		
Lycium californicum Nutt.	N	ABM
Lycopersicum esculentum Mill.	I,R	BM
Solanum douglasii Dunal. in DC.	N	AM
TYPHACEAE		
Typha domingensis Pers.	N	M
URTICACEAE		
Hesperocnide tenella Torr.	N	B
Parietaria hespera Hinton	N	AB
Urtica dioica L. *holosericea* (Nutt.) Thorne	N	A
Urtica urens L.	I	M
VERBENACEAE		
Verbena lasiostachys Link.	N	M
ZOSTERACEAE		
Phyllospadix scouleri Hook.	N	AB
Phyllospadix torreyi Wats.	N	ABM
Zostera marina L.	N	A

Table 7. Commercial passenger fishing vessel 1980-85 landings from waters surrounding Channel Islands National Park (numbers of fish).

	Island					
Year	San Miguel	Santa Rosa	Santa Cruz	Anacapa	Santa Barbara	Total
1980	137,460	112,581	117,145	82,898	73,125	523,209
1981	156,984	77,226	106,884	104,374	96,080	541,548
1982	160,772	69,438	62,840	50,662	75,267	418,979
1983	77,074	79,429	44,844	18,570	37,411	257,328
1984	38,793	31,326	53,547	117,215	34,131	275,012
1985	53,273	45,854	76,582	68,888	22,122	266,719

Table 8. Commercial fisheries from waters surrounding Channel Islands National Park (pounds).

	Island						
Year	San Miguel	Santa Rosa	Santa Cruz	Anacapa	Santa Barbara	Northern CHIS area[a]	Total
80	6,972,354	4,283,555	36,272,958	6,259,885	2,353,424	1,428,480	57,570,656
81	8,590,395	4,809,353	61,490,914	9,864,532	1,361,854	1,237,018	87,273,066
82	6,917,039	8,294,525	30,926,122	3,403,880	769,388	851,863	51,162,817
83	7,164,483	3,678,240	12,804,846	968,885	457,704	158,035	25,232,193
84	5,227,747	2,352,625	6,962,194	255,883	129,256	7,136	14,934,841
85	4,304,012	4,778,557	4,540,957	673,530	82,959	1,691,851	16,071,866

a Fish caught around Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara but not assigned to a specific block.