Channel Islands National Marine Sanctuary

2006 Research Summary

Overview

Research and Monitoring at Channel Islands National Marine Sanctuary (CINMS, or sanctuary) is a cooperative effort, accomplished through partnerships with state and federal agencies, universities, private institutions, and non-profit organizations. CINMS contributes the use of the Research Vessel (R/V) *Shearwater*, Lake Seawolf aircraft, boat crew, staff and field assistance, and funding to the projects included in this report. We currently partner on programs that support marine reserves monitoring (both biological and socioeconomic), site characterization, and protected resource research and monitoring. There are many other valuable research projects not included here which are conducted independently of CINMS but within the boundary of the sanctuary.

R/V Shearwater
Photo credit: Dani Lipski

The researchers from many of our partnerships have provided the following updates on their 2006 field research. We look forward to continuing to work with our partners on these projects and to developing research programs to meet our management needs.

Marine Reserves[1] Monitoring

PISCO: Oceanographic Studies, Marine Reserves Monitoring, and Recruitment Studies *By Jenn Caselle, PISCO Science Coordinator, UCSB*

In 2006 PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) continued research in the sanctuary, begun in 1999. PISCO is an interdisciplinary collaboration of scientists from four universities, with many local scientists at the University of California Santa Barbara (UCSB). Within the sanctuary, PISCO's interdisciplinary research focuses on understanding these three issues: 1) how currents, upwelling, and other physical and ecological processes affect the plants and animals of coastal

[1] Marine reserves- Channel Islands state marine reserves prohibit all take of living, geological, or cultural resources. Scientific take may be permitted. These areas are also commonly referred to as marine protected areas (MPAs), no-fishing zones, and no-take zones.

marine ecosystems, 2) how ocean circulation affects the dispersal of marine organisms in their earliest larval stages, and 3) how coastal ocean ecosystems respond to shifts in water temperature, currents, and other factors that may vary with global climate change.

In our studies of physical processes, we use several advanced oceanographic tools, including Acoustic Doppler Current Profilers (ADCPs), coastal radar (CODAR), satellite imagery, surface chlorophyll estimation, and physical sensors mounted on moorings. In 2006 we maintained the existing array of thirteen moorings which consist of three temperature loggers at three depths, and a current meter. We have used these data to interpret patterns of recruitment of fishes as well as patterns in community structure (see below). In 2006, we made significant progress in getting the oceanographic data quality checked and made available to the public. Data up to 2005 are available at: http://data.piscoweb.org/catalog/style/skins/nmsp_harvest_list/

Secondly, we conduct a long-term, sanctuary-wide monitoring study to examine temporal and spatial patterns in recruitment of young fishes and invertebrates and the factors responsible for these patterns. In this research we employ artificial collectors called SMURFs (Standardized Monitoring Units for Recruitment of Fishes) which are plastic mesh cylinders suspended in the water column. In 2006 we maintained the existing array of eleven sites. To date, this research has shown very strong yearly patterns in reef fish recruitment. Previous results showed that years of very strong recruitment for the rockfishes (*Sebastes* species) tend to be relatively poor years for kelp bass (*Paralabrax clathratus*). 2006 was a phenomenal year for recruitment of kelp bass. We recorded the highest numbers of kelp bass settlers since the program began. True to the patterns we have seen in the past, 2006 was a very low year for rockfish recruitment.

Finally, we conduct a large-scale, long-term study of the patterns of community structure on shallow subtidal, rocky reefs. Ultimately, the goal is to understand and predict how environmental change (including human impacts and management strategies such as marine reserves) influences these physical and ecological processes and how biological communities respond to such changes. This program started in 1999 with two sites and has increased to the current sampling level of 35 sites within the sanctuary boundaries. These sites are located both inside and outside of the marine reserves and span the range in water temperature across the sanctuary.

This research is supported in part by CINMS through use of the R/V *Shearwater* and crew. In 2006, PISCO scientists took three summer cruises on the R/V *Shearwater*. In addition, this year we completed our interactive web tools for accessing data from PISCO. New interactive maps on the PISCO web site enable public users to explore several years of data on fishes, invertebrates, and algae and view graphs of query results. In addition, the web site includes photographs, video, and descriptions of the research methods. Integrated with an enhanced version of Google Maps, the site is linked directly to the PISCO database for the most up to date information. Access the website at www.piscoweb.org/data.

This project is continuing in 2007, with several trips on the R/V *Shearwater* scheduled throughout the year.

Channel Islands National Park: Kelp Forest Monitoring Program *By David Kushner, Marine Biologist, Channel Islands National Park*

Channel Islands National Park (CINP or park) in collaboration with the sanctuary, California Department of Fish and Game (CDFG), National Marine Fisheries Service, and others, has monitored important components of the kelp forest ecosystem on an annual basis since 1982. Park Biologist David

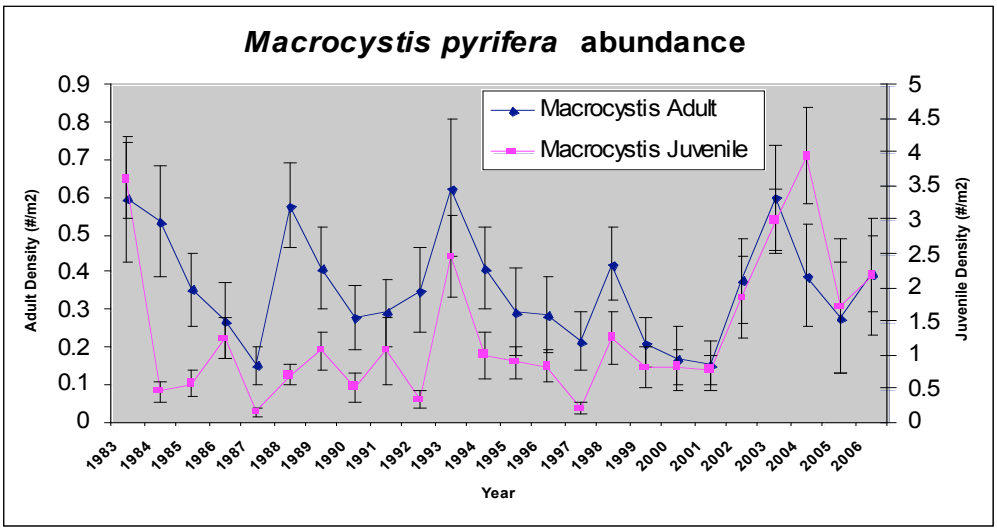
Kushner led a multi-agency team of scientists in monitoring over 70 indicator species at the five islands within the park and sanctuary. The park's Kelp Forest Monitoring Program continues to document the dramatic changes that have occurred in the kelp forests around the islands over the past 25 years.

In addition to the continued monitoring at the 16 original kelp forest monitoring sites, 2006 was the second year of monitoring at 16 new sites established in 2005. These new sites were paired up with existing sites to collect baseline data inside and adjacent to four of the recently established marine reserves. In future evaluations, this baseline information will be a crucial reference point to document ecological changes and help us determine the effectiveness of the marine reserves on local populations and habitats.

Kelp Forest Monitoring Diver
Photo credit: Greg Sanders

In 2006, divers using SCUBA and surface-supplied air conducted an array of standardized techniques, such as visual transects and quadrats, to gather abundance information on indicator species that include algae, invertebrates, and fish. The 2006 monitoring effort was completed by 32 divers conducting 1,077 dives with over 1,005 hours of bottom time.

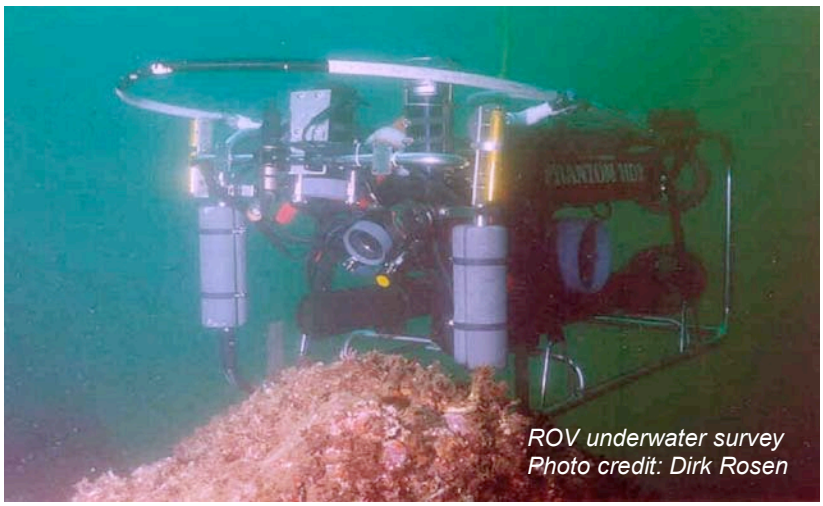
In recent years, the Channel Islands kelp forests have been healthier overall than they were during most of the 1980's and 1990's, with relatively higher densities of both adults and juveniles. However, certain areas that historically had an abundance of kelp remain mostly devoid of kelp and are dominated by echinoderms. Though fish abundance has increased in recent years, many of the fished species are small in size, an indication of fishing pressure. In 2006 we observed significant warm water fish recruitment that was most likely a result of a short but anomalous warm water event that occurred from approximately mid July to mid August. For example, we observed some of the highest counts of the warm water blue banded goby (*Lythrypnus dalli)* than we have observed since the 1982-83 El Niño. In addition we observed higher numbers of juvenile garibaldi (*Hypsypops rubicundus)* and juvenile sheephead (*Semicossyphus pulcher)* both warm water species. The warm water had a negative effect on other species. For example, we estimated at least a 25% mortality of several sea star species at some sites due to warm-water induced wasting disease. As a result we expect a decline in sea star densities in the 2007 monitoring season.



Adult and juvenile Giant Kelp density from 1983 through 2006

In the marine environment there is often high spatial and temporal variation in local populations and habitats making it difficult to quickly document significant differences inside and adjacent to the marine reserves. However, we have made some general observations that indicate the marine reserves are helping species to recover from fishing. Most notable over the past several years is an increase in both abundance and size of the spiny lobster (*Panulirus interruptus)* inside the marine reserves compared to outside. This project is continuing, with several trips on R/V *Shearwater* scheduled in 2007.

ROV: Marine Reserve Finfish Monitoring *By Andy Lauermann, Marine Biologist, Marine Applied Research and Exploration*


ROV underwater survey
Photo credit: Dirk Rosen

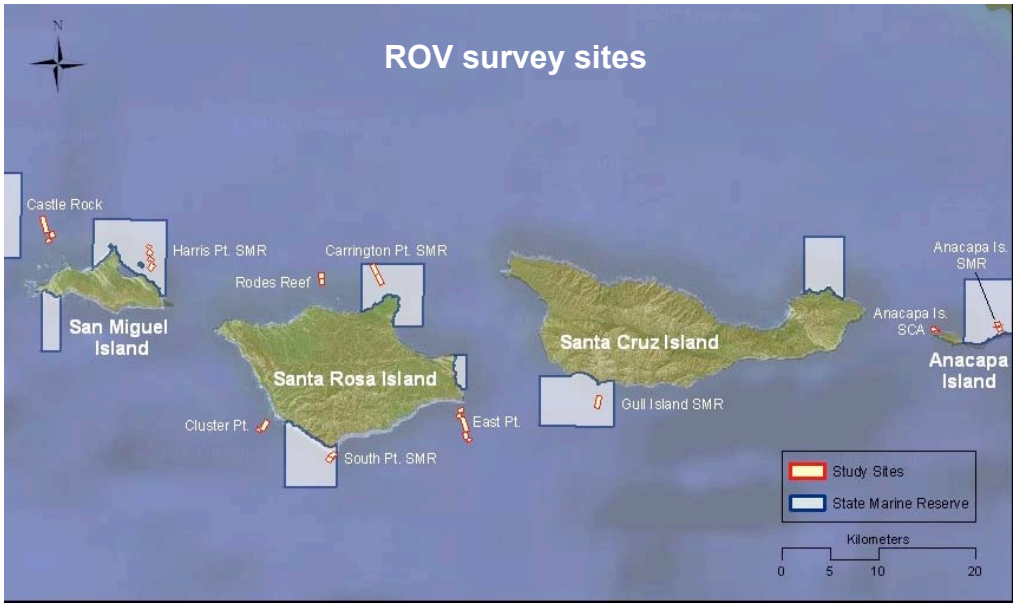
For the fourth consecutive year the California Department of Fish and Game (CDFG) and Marine Applied Research and Exploration (MARE), in partnership with the sanctuary, The Nature Conservancy, and Kingfisher Foundation, used a remotely operated vehicle (ROV) to survey fish populations in the sanctuary. The objective of our ongoing research is to monitor changes in finfish density within areas of predominantly rocky habitat that are beyond the depth limit of SCUBA-based sampling. By targeting paired sites that are inside and outside marine reserves, our work will provide data for the evaluation of the marine reserve network. In addition, our archived video, taken by the ROV along each survey transect, will be a valuable reference for future research and monitoring.

During the 2006 survey, we quantitatively measured substrate and finfish abundance within our 10 priority sampling sites. Five of the sites are located within marine reserves near San Miguel, Santa Rosa, Santa Cruz, and Anacapa Islands, and the other five reference sites are outside and adjacent to our marine reserve sites. We selected the five reference sites for comparable habitat in nearby areas open to fishing. In general, our permanent sampling sites are rectangles 500 meters wide spanning a depth range from 20 to 70 meters. Each year we survey randomly selected 500 meter of track lines within the permanent sites to create finfish density transects over predominantly rocky habitat at each of the ten sites.

In August and September of 2006 we worked aboard the CDFG patrol vessel *Swordfish* to quantitatively sample seven sites, completing 65% of the total planned survey. In September and October of 2006, our work continued aboard the sanctuary's R/V *Shearwater*, completing the season's remaining quantitative survey and two additional experiments to develop a method for calculating habitat relief and fish size from video.

Refinements to our field protocols over the last four years have increased data collection efficiency and allowed for real-time determination of the amount of target habitat sampled. We are currently able to capture over six kilometers of track line per day. During the 2006 season, we collected over 65 hours of video covering 100 kilometers of seafloor. This video is still be analyzed, however, previous years' data suggest that differences in fish abundance among sites may be greater than differences between years. For example, abundance indices for species such as blacksmith *(Chromis*

punctipinnis), lingcod *(Ophiodon elongates)*, copper rockfish *(Sebastes caurinus)*, and sebastomus species differed more between sites than between years.



In addition, we continue to locate derelict fishing gear that CDFG, the sanctuary, and marine debris removal groups have been working to remove. One such piece of gear located last year was a 4,000 pound purse seine net off the eastern end of Santa Rosa Island that Dr. Kirsten Gilardi and the SeaDoc Society of the University of California Davis later removed from a depth of 23 to 30 meters.

For more information on ROV sampling protocols and research cruises, see the CDFG web site (www.dfg.ca.gov/mrd) and MARE web site (www.maregroup.org). The ROV project will continue in 2007 with two trips scheduled during August and September on R/V *Shearwater*.

PIER: Acoustic Tracking of Fish Movement *By Dr. James Lindholm, Assistant Professor, California State University Monterey Bay*

In 2006 Pfleger Institute of Environmental Research (PIER) completed its final year tracking behavior, movement, and habitat use of fishes using acoustic transmitters in the sanctuary. Begun in 2000 at Anacapa Island tracking giant sea bass (*Stereolopsis gigas*), we expanded the program in recent years to also include Santa Cruz, Santa Rosa, and Santa Barbara islands, and also track white sea bass *(Atractoscion nobilis)*, kelp bass *(Paralabrax clathratus)*, and sheephead *(Semicossyphus pulcher)*. This research, led by James Lindholm and Michael Domeier, aimed to determine spatial distribution and movement of fishes in the sanctuary to understand how fish use areas of the sanctuary.

We captured fish and surgically implanted small tags that emit a unique pulse every 60-180 seconds that is recorded by acoustic receivers when a tagged fish swims into range. We tagged over 200 individuals: 24 giant sea bass, 50 kelp bass, 97 white sea bass, and 54 sheephead. There were 96 receivers stationed around the islands each with a range of about 500 meters. At Anacapa and Santa Barbara islands, there were two rings of receivers surrounding the islands, providing contiguous coverage. The receivers recorded the pulse from the tags and the receivers were retrieved every four to five months. SCUBA divers retrieved the receivers that were stationed at 30 meters in depth or less and we retrieved deeper receivers by an automated release or by a remotely operated vehicle

Tagged Sheephead
Photo credit: Michael Domeier

We surgically tagged all fishes with coded acoustic transmitters, with the transmitter model and placement dependent on the size of each fish. We inserted giant sea bass tags in muscle tissue, and kelp bass, white sea bass and California sheephead tags in the abdominal cavity.

While data analysis is ongoing, results to date have been very interesting. All of the sheephead and 93 percent of the kelp bass released inside the state reserve at Anacapa Island have remained in the reserve. Further, up to 70 percent of male sheephead and 33 percent of kelp bass released outside the reserve have been recorded inside the reserve on a regular basis.

The acoustic tracking data reveal other little-known aspects of fish behavior. For example, an adult male sheephead tracked at Anacapa Island from July 2004-January 2005 was found to spend most of his time near where he was caught and released, in the inner ring of receivers. However, he made periodic movements to the outer ring of receivers in deeper water. While it had been assumed that large male sheephead only occupy specific territories during spawning season, this fish ventured into deeper water for days at a time.

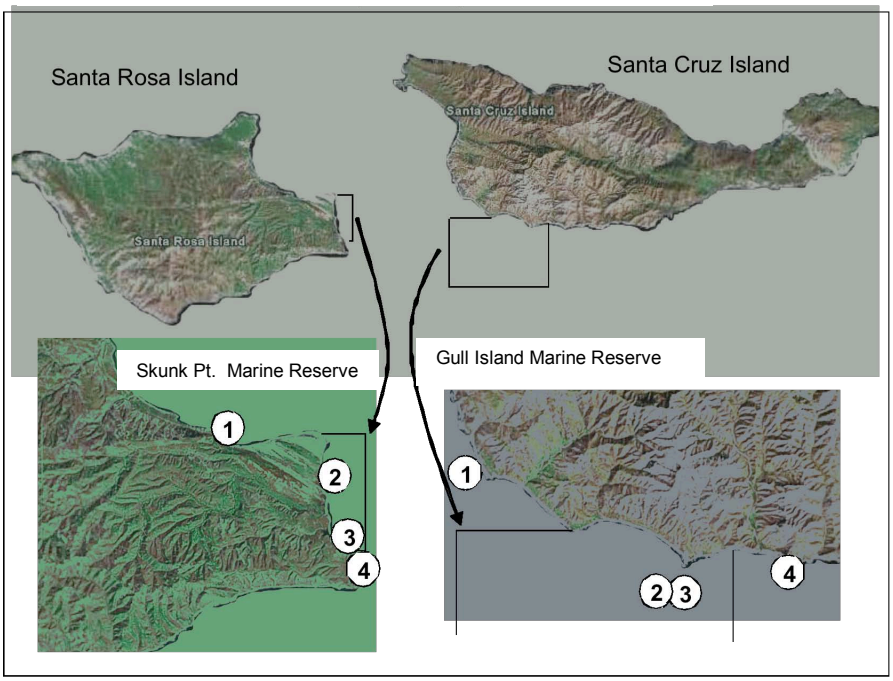
In 2006 we did not tag any new fish. The project was terminated after funding was not renewed, all receivers were recovered in October 2006, and a final report is expected in 2007.

Collaborative Marine Research Project: Variation in Larval Supply Inside and Outside of Marine Reserves *By Dr. Mark Page, Associate Research Biologist, Marine Science Institute, UCSB*

Researchers Mark Page, Jenifer Dugan, Steve Schroeter, and Carrie Culver of the Marine Science Institute at UCSB collaborated with commercial fishing partners Bruce Steele and Rick Gutierrez to develop a new project in the spring through fall of 2006 that examined the variation of invertebrate larval supply inside and outside marine reserves within the sanctuary. Populations of invertebrates on shallow rocky reefs located inside and outside of marine reserves are potentially linked through the passive transport of planktonic larvae by ocean currents. With funding from the Channel Islands National Marine Sanctuary Foundation, we developed a project to gain information on spatial variation in larval supply needed to better understand the factors responsible for regulating the distribution and abundance of benthic invertebrates inside and outside of marine reserves.

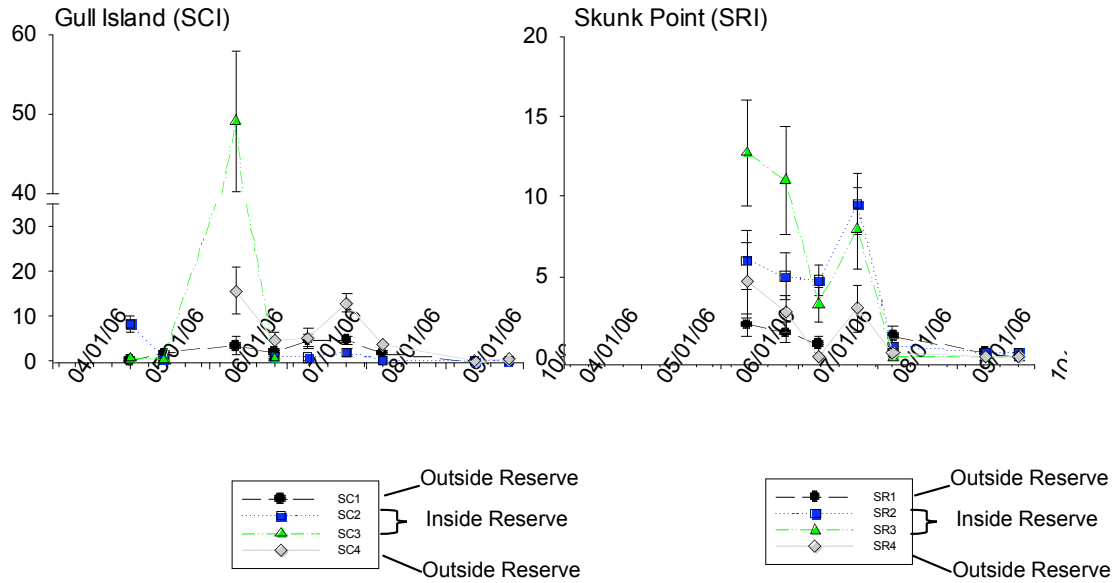
We studied settlement of invertebrate species important commercially (e.g., red sea urchins, rock crabs), recreationally (rock scallops), and ecologically (e.g., purple sea urchins) inside and outside of marine reserves adjacent to Santa Cruz and Santa Rosa islands. The objectives of our preliminary study were to 1) explore patterns in the settlement of important invertebrate species inside and outside of marine reserves, 2) examine how settlement rates vary among species, 3) develop methods to facilitate the measurement of settlement rates, 4) involve stakeholders in research within the CINMS, and 5) collect preliminary data for generating a more comprehensive proposal to improve understanding of factors regulating benthic populations within the CINMS and other areas.

Invertebrate recruitment sampling sites



We established moorings to monitor settlement at eight stations, two inside and two outside of the Skunk Pt. marine reserve at Santa Rosa Island and two inside and two outside of the Gull Island marine reserve at Santa Cruz Island. We investigated whether settlement differed among stations for red and purple sea urchins (*Strongylocentrotus franciscanus*, *S. purpuratus*), and rock crabs (*Cancer antennarius*). We measured settlement using two types of collectors: wood-handled scrub brushes and "tuffy" scrub pads. At each station, we attached four brushes and two tuffies to a buoyed mooring line one to two meters off the bottom. We retrieved and replaced samples (brushes and tuffies) generally every two weeks from May through September 2006 using methods we developed that allowed surface-based retrieval (not underwater retrieval). We kept retrieved samples on ice until UCSB undergraduate interns processed them.

Data analysis is on-going, but preliminary results suggest that larval settlement can vary dramatically on a scale of meters to kilometers within and across marine reserve boundaries. For example, settlement of purple sea urchins was consistently higher at one of the sites (SC4) outside of the Gull Island marine reserve as compared with the two sites (SC2, SC3) inside the reserve. Settlement of purple urchins was higher at two sites (SR2 and SR3) inside the Skunk Pt. marine reserve as compared with 2 sites (SR1 and SR4) outside that reserve. Although more data are needed, our results, which suggest that some areas may consistently experience low larval settlement not related to reserve status, but rather to physical conditions, could have important implications for marine reserves. Such areas may take longer to recover depleted populations or be less suitable for restoration efforts based



Average number of purple urchins per sampling device (brushes) at Santa Cruz and Santa Rosa Islands (note difference in x axis).

on natural replenishment than areas with greater settlement. Continuation of this project in 2007 will depend on availability of funds.

Collaborative Marine Research Project: Marine Reserve Benefits for Recreational Fishers of Kelp Bass *By Dr. Patricia Halpin, Marine Biologist, Marine Science Institute, UCSB*

In 2006 Dr. Patricia Halpin of UCSB's Marine Science Institute, Dr. Carrie Culver, California Sea Grant Extension Marine Advisor, and Captain David Bacon, sportfishing charter boat owner and operator, collaborated to examine movement and population structure of kelp bass *(Paralabrax clathratus,* also called calico bass*)*. The implementation of a marine reserve network in 2003 in the sanctuary resulted in the closure of several areas formerly used as kelp bass fishing areas, a highly valued recreational species in southern California. As a result, the recreational fishing community is very interested in the potential benefits that may stem from marine reserves either through increased larval production by fish within the reserve or through net movement of large fish from within to outside of reserves. Scientists are interesting in understanding fish movement and reserve effects, and this project joins the two interests together.

Existing information on kelp bass movements is not consistent, with some sources stating the fish move very little, and others indicating they can move tens to hundreds of miles. For benefits from marine reserves to occur, individuals must stay, grow, and reproduce within the reserve boundaries. We established this program to document movements of adults from within to outside of the marine reserves and to assess the size structure of the kelp bass population within reserves.

For the project, expert anglers from recreational fishing associations caught kelp bass within Scorpion marine reserve and a lesser number at Anacapa Island marine conservation area[2]. Scientists measured and tagged the fish with visible tags, noting the geographic location of capture and release. We offered a reward for the reporting of tagged fish to the project website (www.calicobasstag.org) or reporting phone line (805-448-0845). From May to September 2006, we tagged 172 kelp bass at Scorpion marine reserve, and 22 fish

[2] Marine conservation areas – Channel Islands state marine conservation areas prohibit specific commercial and/or recreational take of living, geological, or cultural resources on a case-by-case basis. Scientific take may be permitted.

at Anacapa Island marine conservation area and marine reserve during 10 trips. Three fish were recaptured within Scorpion marine reserve at the location of original tagging (100% of recaptures within the reserve). The collaboration between the scientists and anglers benefited the project in many ways. The fishers' knowledge of and experience with kelp bass fishing allowed the project to maximize catch of the target species, with only 11.8% catch of other species. In turn, anglers were able to participate first hand in a scientific project.

This project functions as a step toward evaluating the potential influence of the Channel Islands marine reserves on the kelp bass population. Due to limited funding, this is a pilot project designed to develop collaborative research partnerships, while gathering limited scientific data. Continuation of this project will depend on funding availability in 2007.

Channel Islands National Park: Rocky Intertidal Monitoring *By Susie Tharratt, Biological Technician, Channel Islands National Park*

In 2006, the National Park Service (NPS), in collaboration with researchers from other agencies, academic institutions, and numerous partners, continued our biannual monitoring of twenty-one rocky intertidal monitoring sites located at all five islands in CINMS (Santa Barbara, Anacapa, Santa Cruz, Santa Rosa, and San Miguel). Since 1982, the park's Rocky Intertidal Monitoring Program has collected ecological data to establish baseline conditions of marine natural resources along the Park's rocky shorelines and to follow longer term shifts in abundance and distribution of population assemblages of invertebrates and algal species.

Each spring and fall, we photograph nearly 500 50 x 75 cm fixed plots and score them for percent coverage of approximately 32 target species (sessile invertebrate and algal taxa). Further, once yearly (usually in spring) we sample these plots for motile invertebrates, with counts and size measurements collected for highly mobile species, including certain species of snails, chitons, and limpets. We follow sea star (*Pisaster* species), black abalone (*Haliotis cracherodii*) and keyhole limpet (*Lottia gigantea*) abundance and size distribution across sites during each monitoring visit, as well as surfgrass (*Phyllospadix* species) cover in fixed transects at selected sites.

The sanctuary's R/V *Shearwater* and crew provided five consecutive days of vessel support in late March, ferrying multi-agency researchers around Anacapa Island and east Santa Cruz Island. Intertidal researchers lead by Dan Richards (NPS) completed the annual spring monitoring of four of five sites visited: Middle Anacapa, South Frenchy's Cove, Orizaba Cove, and Scorpion Rock. A crest in the number of hauled-out Pacific harbor seals (*Phoca vitulina richardsi*) prevented a landing at Cat Rock during that trip and nesting of endangered California Brown pelicans *(Pelicanus occidentalis)* (on Santa Barbara Island), weather, and other logistical constraints prevented monitoring in spring 2006 at most of the park's other rocky intertidal sites.

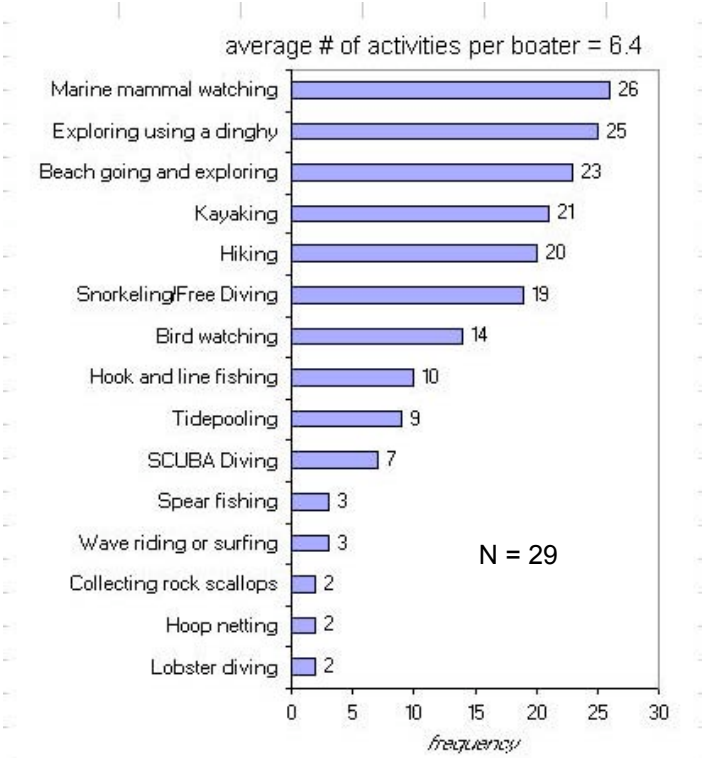
We conducted three days of fall sampling

in November on R/V *Shearwater*. In the fall of 2006, visits to all five islands, including 20 of the 21 monitoring sites, showed a healthy and lush intertidal assemblage, despite coming on the heels of a summer of unseasonable warm temperature spikes and purported El Niño conditions. Observations made among sites showed a significant recruitment of acorn barnacles (*Cthamalus* and *Balanus* species), a robust (albeit not notably dense) distribution of rockweeds, seasonal algae showing very little evidence of bleaching, and a high numbers of motile invertebrates, including sea urchins and sea stars. This project continues in 2007 with several spring trips scheduled, including a March trip on R/V *Shearwater*.

CINMS Social Science Program: Socioeconomic Monitoring of Marine Reserves *By Chris LaFranchi, Social Science Coordinator, CINMS*

Since 2005, under the leadership of Chris LaFranchi, CINMS Social Science Coordinator, the sanctuary has developed a social science program (SSP) to better understand human-sanctuary interactions and to contribute social science information for adaptive management. An important aspect of socioeconomic research and monitoring is understanding the long-term effects of marine reserves on people: do marine reserves help maintain productive, sustainable ecosystems that provide what humans want and need. Socioeconomic analyses predict that the short-term impacts to consumptive users (for example, recreational and commercial fisherman) of marine reserves should be relatively small, the long-term net benefits to non-consumptive (for example, private boaters and divers) and possibly to consumptive users could be potentially large. One of our goals is to test these predictions.

In 2006, the SSP continued work in three areas: 1) Development of a three-year socioeconomic research and monitoring plan, 2) Study of non-consumptive uses (for example, private boaters and related activities such as diving, kayaking, and wildlife viewing), and 3) coordination with related socioeconomic and ecological research based outside the Sanctuary program.

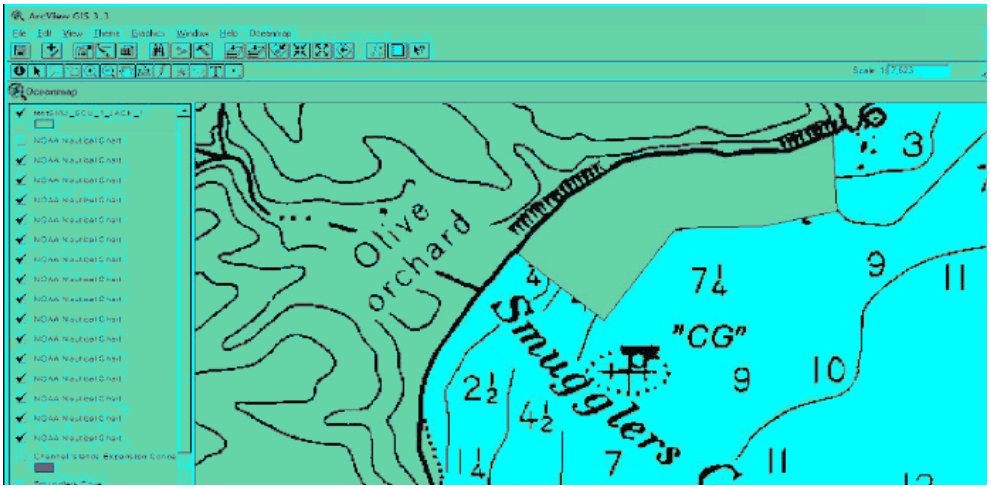


Survey results of activities of private boaters, conducted at island anchorages from the R/V Shearwater

We developed the socioeconomic research and monitoring plan with sanctuary users through a series of two workshops and it was reviewed by the Sanctuary Advisory Council and CDFG. The final plan is focused on research and monitoring needs, priorities, and costs. For each user group (either consumptive or non-consumptive), the plan identifies: research questions to be addressed, the information and data required to address research questions, activities required to collect these data, and discussion on how research questions, data, and, activities should be used together to contribute to an ecosystem-based management approach.

For the second consecutive year, we continued a study of non-consumptive uses in collaboration with Linwood Pendleton, UCLA associate professor, and Bob Leeworthy, NOAA economist. Two surveys were launched. First, we

conducted an on-the-water survey from the R/V *Shearwater* in May and June 2006. We approached private boaters at anchorages in the sanctuary, asked them about the locations of their activities, and recorded this information in a GIS-based, interactive computer program. Secondly, we launched the first phase of a postcard and internet survey of boaters in Ventura and Santa Barbara counties. These surveys collect spatial information on boater activities, the frequency and distribution of boater trips, local expenditures associated with boater trips, and the knowledge, attitudes, and perceptions of boaters. The survey of boating activities will provide the first spatial data capable of supporting the management of human-sanctuary interactions at a relatively fine spatial scale, a result that is important to management of areas that are heavily used, valued, and potentially impacted ecologically, both inside and outside of marine reserves. Perhaps of equal value is the process of collecting fine-scale data and respectfully interacting with private boaters in the sanctuary. We will continue this project in 2007, with five weekend trips on the R/V *Shearwater* scheduled from May to September 2007. The second phase of the postcard and internet survey will be launched in August 2007.



Screen capture of the interactive GIS program, showing Smugglers Cove (green shaded polygon denotes area used by a private boater for an activity).

In addition, the SSP is coordinating with a University of California Santa Barbara study on the effect to the regional commercial lobster fishery from the network of marine reserves. The study will combine lobster logbook data and DFG landings receipts for five seasons before the reserves implementation and three seasons after the reserves implementation in a relational database for a before-and-after comparison of catch, effort, and ex-vessel value per trapper and trap location.

Site Characterization

Sanctuary Aerial Monitoring Spatial Analysis Program (SAMSAP) *By Ben Waltenberger, Physical Scientist, and Natalie Senyk, Science Advisor, CINMS*

The Sanctuary Aerial Monitoring Spatial Analysis Program monitors the location and activities of boats and marine mammals in the sanctuary. Julie Helmers, NOAA pilot, and Ben Waltenberger, CINMS physical scientist, regularly fly a NOAA aircraft over the sanctuary to monitor changes in human uses and marine mammals over time and potential ecological impacts to resources from human uses. Research-specific vessel monitoring includes recording consumptive vessel use and non-consumptive visitor use impacts. Additionally, SAMSAP is used in emergency response to monitor both immediate resource impacts of incidents such as oil spills and vessel groundings, and to monitor affected resources and gather data for post incident resource protection

and monitoring. SAMSAP is also used for enforcement surveillance related to sanctuary and CDFG regulations.

SAMSAP monitoring takes place throughout the year, ideally with weekly flights as weather and aircraft maintenance schedules allow. The current research platform for SAMSAP is a NOAA Lake Seawolf amphibian aircraft, tail number N64RF (or NOAA-64). SAMSAP surveys take place around all five islands within the sanctuary. We fly survey transects at 1000 feet in elevation and in two parts: an inner loop flown one half nautical mile from island shorelines, and an outer loop flown four nautical miles from the island shorelines. We record data on a laptop computer running custom survey software. The computer is interfaced to the aircraft's Global Positioning System (GPS). Information we record includes location, species (for cetaceans) or type (for vessels), and number present. Each survey flight is saved as an individual file which is then added to a master database that is Geographic Information System (GIS) compatible. These data are freely available to researchers by request.

NOAA's aircraft conducting SAMSAP Survey
Photo credit: US Gov/NOAA

In 2006 we conducted a total of 49 flights totaling over 120 hours of flight time. During these flights, a total of 554 vessels were recorded. The pattern of distribution of vessels was similar as in previous years: 93% of vessels were observed in state waters (0-3 nautical miles from islands), non-consumptive recreational vessels were the most commonly observed, and these were located mainly in the eastern portion of the sanctuary, closest to the mainland. Major accomplishments for the year included responding to a capsized vessel, tracking the vessel's trajectory, and accurately predicting the time and place of its landfall to prepare responders to protect sanctuary resources. Additionally, we improved the SAMSAP database to allow more

2006 Vessel use statistics in sanctuary waters. State waters include mean high water out to 3 nautical miles. Federal waters include 3 nautical miles out to the sanctuary's 6 nautical mile boundary.

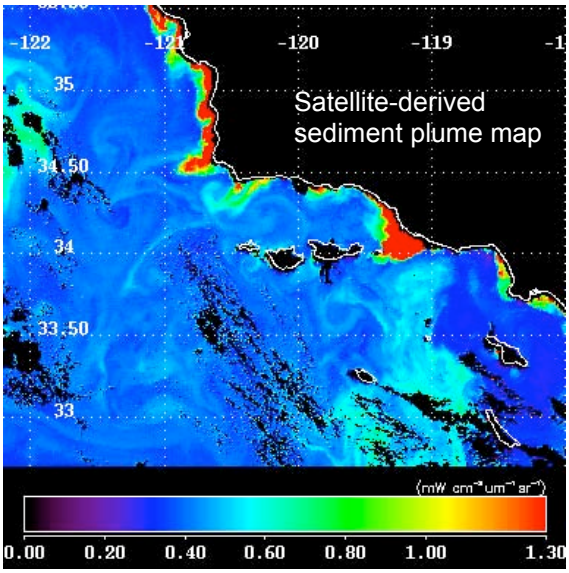
Vessels			Vessel Type			
Sanctuary Waters	**# of Vessels**	**Percent of Observed Vessels**	**Consumptive Commercial**	**Consumptive Recreational**	**Non-consumptive Commercial**	**Non-consumptive Recreational**
State Waters	516	93.1%	209	63	19	225
Federal Waters	38	6.9%	7	1	12	18
Total	**554**	**100.0%**	**216**	**64**	**31**	**243**

intuitive data queries, and we have begun performing more in-depth analysis of the eight-year dataset to assist with decision-making in areas such as marine zoning. SAMSAP data are also being used by other researchers to study socioeconomic impacts of marine reserves and how recreational visitors perceive and use the sanctuary.

We expect SAMSAP to continue into 2007. However, limited funded may result in the loss of the current aircraft. If this occurs, we will explore use of alternate aircraft through agreements with other agencies or contractors.

Plumes and Blooms: Santa Barbara Channel Water Quality Characterization *By Nathalie Guillocheau, Assistant Specialist, Institute for Computational Earth System Science, UCSB*

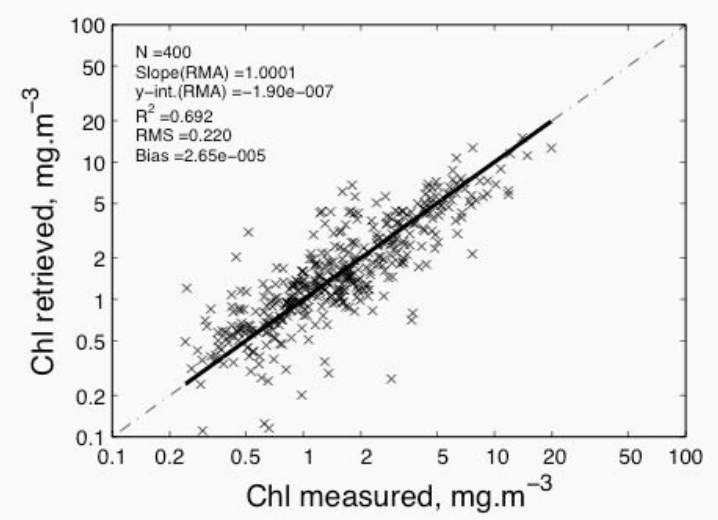
Researchers at the Institute for Computational Earth System Science (ICESS) at UCSB completed our tenth year of the on-going Plumes and Blooms (PnB) project. In the Santa Barbara Channel, the ocean is influenced by runoff from land which after storms may appear as sediment "plumes" from river mouths, and by "blooms" of microscopic algae (phytoplankton) when ocean conditions are favorable, such as during upwelling in spring and summer months. The color of the ocean is determined by the interaction of light with these particles (sediment or phytoplankton) and chemicals present in the water. Therefore, by studying ocean color, we can understand the varying concentrations of light absorbing components such as phytoplankton and non-living particles and dissolved matter present. The different shades of blue, green, or brown reflected by the ocean can be measured and analyzed from space through satellite sensors (a method called "remote sensing") to estimate the amount of phytoplankton, sediment, and dissolved compounds present in the water. Quantifying these characteristics helps scientists and coastal managers understand changing oceanographic conditions.



In collaboration with the sanctuary, we study time-series of ocean color, oceanographic observations, and satellite ocean color imagery. Interpreting remotely sensed data requires the use of mathematical models to interpret the concentrations of seawater components from the light reflected off the water. The objective of the PnB field program is to sample water at different times of the year in different conditions to assess the variation in the amounts of light reflecting particles, such as sediment and phytoplankton, in the coastal waters of the Santa Barbara Channel and then compare these results to the satellite data. The field work occurs during one-day cruises approximately every month on board the R/V *Shearwater*. We collect data along a seven-station transect from Santa Rosa Island to Goleta Point. In 2006 we completed a total of nine cruises during which we sampled 59 stations. At each station, we measure data from the underwater light field and collect water samples to determine the concentration of phytoplankton pigments, and the absorption characteristics of dissolved and particulate matter .

The amount of cholorphyll *a* is used as an index of phytoplankton biomass and a reliable estimation of it can help us understand phytoplankton's important contributions to the ecosystem. In this context, using the PnB dataset we adapted a bio-optical model originally designed for open-ocean systems to the Santa Barbara Channel coastal waters. This model has been refined to predict the chlorophyll *a* concentration, the light absorbed by dissolved matter, and the light scattered by particles in the Channel.

The plot below shows the points clustered around the line, indicating a very good agreement between the amount of chlorophyll *a* the model predicted and what was actually measured in the field, indicating the high efficiency of this model in terms of chlorophyll *a* estimation.



Model-derived vs. measured chlorophyll *a*

We also used the satellite remote sensing data to monitor ocean color parameters and produce images of the distribution of chlorophyll *a* and highly reflective coastal suspended sediment river plumes. For more information about this project visit the Plumes and Blooms web site: http://www.icess.ucsb.edu.ed/PnB/PnB.html. Ten cruises are planned on the R/V *Shearwater* to continue this project in 2007.

Protected Resource Monitoring

Ashy Storm-Petrel Monitoring at Santa Cruz Island *By Bill McIver, Biologist, Fish and Wildlife Service*

The ashy storm-petrel (*Oceanodroma homochroa*) is a rare seabird (approximately 10,000 worldwide) and breeds on islands and offshore rocks off central California (South Farallon Islands), southern California (Channel Islands), and northwestern Baja California. Much concern has been expressed about population declines at the Farallon Islands and Channel Islands, due to predation, pollutants, and human disturbance. Approximately half of the global population of this rare storm-petrel breeds at the Channel Islands. Since 1995, researchers Harry Carter (Carter Biological Consulting, Victoria, British Columbia, Canada) and Bill McIver (U.S. Fish and Wildlife Service, Ventura, California) have been conducting baseline population monitoring for ashy storm-petrels at Santa Cruz Island.

In 2006, with funding from the Montrose Trustee Council (U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and California Department of Fish and Game), CINMS R/V *Shearwater* vessel support, and excellent volunteer assistance, we used standardized methods to search for and monitor all nests of ashy storm-petrels in accessible habitats in four sea caves and one offshore rock at Santa Cruz Island. The breeding season lasts from about May through December and monitoring trips occurred on 14-16 June, 28-29 July, 19-20 September, and 20-21 October. We found similar population size and breeding success at Cavern Point Cove Caves, Cave of the Birds Eggs, and Dry Sandy Beach Cave in 2006 as in 2005. At Orizaba Rock, we found higher numbers of nests in 2006.

Ashy storm-petrels do not excavate burrows, usually nesting in semi-exposed crevices of rock debris, rock walls, sea caves, cliffs, and driftwood, leaving them vulnerable to predation. In 2005, island spotted skunks (*Spilogole gracilis amphiala*) killed many adults and ate most eggs laid at Bat Cave. This was an unusual predation event which has not previously occurred since monitoring began in 1995.

Skunk trapping was conducted by park staff in late March 2006, involving additional R/V *Shearwater* trips in March and no skunks were found. In 2006, although we had hoped to see the colony recover at this site, only about 25% of this colony remained.

A report describing 2006 monitoring of ashy storm-petrels at Santa Cruz Island is in preparation. The park and Montrose Trustee Council will use information from 2006 monitoring to: 1) refine and implement habitat restoration plans for ashy storm-petrels at Orizaba Rock, and possibly other areas at Santa Cruz Island in 2008 and beyond; and 2) develop and implement a long-term monitoring program at Santa Cruz Island for measuring population changes in response to restoration actions and other natural and anthropogenic factors. In cooperation with several other sanctuary seabird projects, monitoring of ashy storm-petrels will continue in 2007.

Xantus's Murrelet Nest Monitoring at Anacapa Island *By Darrell Whitworth, Seabird Biologist, California Institute of Environmental Studies*

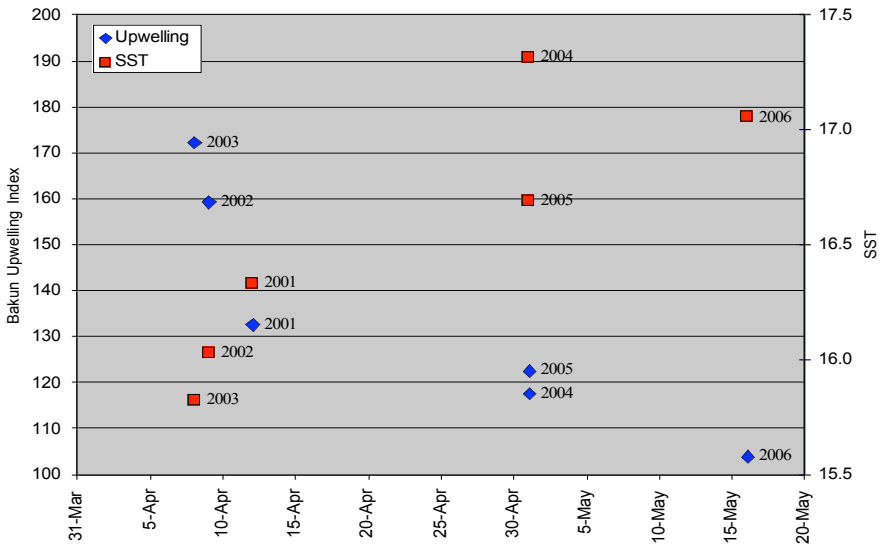
In 2006, seabird biologists Darrell Whitworth, Josh Koepke and Harry Carter of the California Institute of Environmental Studies, in collaboration with the sanctuary and park, completed the seventh year of Xantus's murrelet (*Synthliboramphus hypoleucus*) nest monitoring on Anacapa Island to measure nesting effort and breeding success. Anacapa is one of only 12 islands where Xantus's murrelets are known to breed, but the survival of this important colony had been threatened by predatory non-native black rats (*Rattus rattus*). The eradication of rats (completed in 2002) was a key element of the Anacapa Island Restoration Program, a project sponsored by the *American Trader* Trustee Council with support from the sanctuary and park. We have been monitoring this population prior to (2000-02) and after (2003-06) the eradication of rats.

Adult Xantus's Murrelet on nest
Photo credit: Darrell Whitworth

With the enthusiastic assistance of the Channel Islands Naturalist Corps volunteers, we conducted bi-weekly monitoring throughout the breeding season (March-July) aboard the R/V *Shearwater*. Murrelets usually nest in small rocky crevices hidden among the steep cliffs or sea caves, difficult to reach habitats which make nesting studies quite a challenge. However, our efforts have amply demonstrated the benefits of removing rats from Anacapa. The mean number of nests found each year has increased from 10.3 to 20.0 nests since the completion of the eradication program, while the proportion of hatched nests has nearly doubled from 42% in 2000-02 to 82% in 2003-06.

Perhaps the most encouraging signs of recovery have been the elimination of rat predation as a cause of murrelet nest failure and the spread of the murrelet colony into areas previously occupied by rats. From 2000-02, over half (52%) of all murrelet nests failed due to rat depredation, but no rat-depredated nests have been recorded since 2002. We have found a total of eight murrelet nests sites established in the Landing Cove since 2002, where none were found prior to rat eradication.

Although we noted slightly fewer murrelet nests in 2006 compared to the previous year (we found 23 nests compared to 27 in 2005) murrelets were still quite successful with 82% of the nests



Timing of breeding (mean annual nest initiation date) in relation to indices of coastal upwelling (Bakun Upwelling Index; $m^3\ s^{-1}$ 100 m $coastline^{-2}$) and sea surface temperature (SST; Cº) during the breeding season (April-June) for Xantus's Murrelets at Anacapa Island, California, 2001-2006.

hatched, the highest success of any year except 2005. As in the previous two years (2004-05), murrelets nested very late in 2006. A preliminary analysis has shown that the timing of murrelet nesting is related to oceanographic variables such as local sea surface temperatures and indices of upwelling which are directly related to murrelet prey (small fish and krill) abundance. Generally, murrelets have nested later in years when sea temperatures are high and upwelling is low.

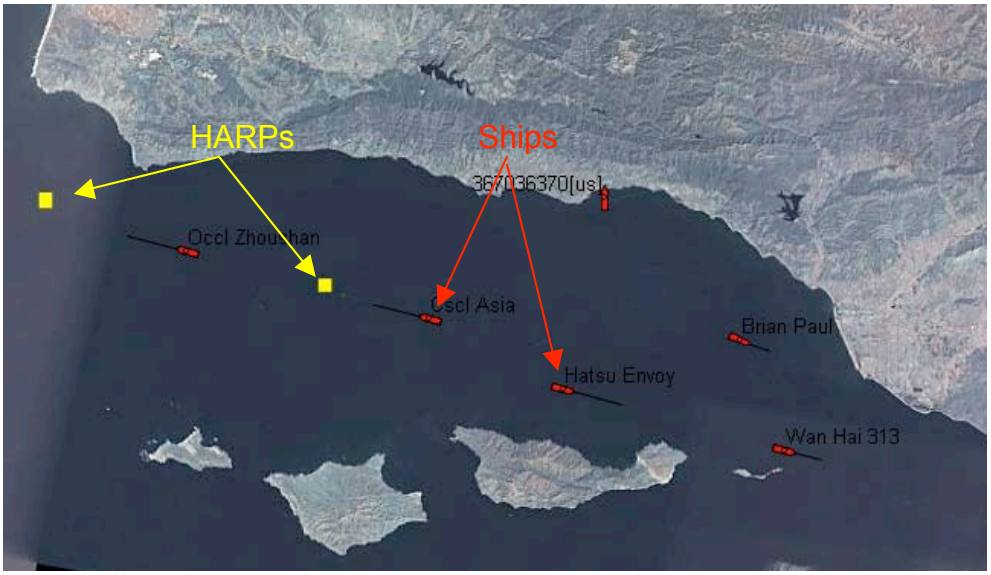
We will continue Xantus's murrelet nest monitoring at Anacapa in 2007, and hope to expand our efforts in the future to survey other parts of the island where murrelet studies have not been conducted since 1997.

Acoustic Research: Effects of Shipping Noise on Marine Mammals *By Megan McKenna, PhD Candidate, Scripps Institute of Oceanography*

There is growing concern that sound introduced into the sea by human activities has detrimental effects on the marine environment. Primary sources of anthropogenic noise in the sanctuary are generated by commercial ship traffic and recreational boating activity. Dr. John Hildebrand of Scripps University and graduate students Megan McKenna, Elizabeth Henderson, and Ethan Roth are conducting research to understand the impact of noise from commercial ships on the marine environment and marine mammal populations. Our main objectives include: 1) creating a noise budget for the region, 2) identifying the most intense and pervasive sources of noise, 3) understanding how marine mammals utilize the local habitat, which would lead to 4) an assessment of the impacts of noise on the local fauna.

The commercial shipping lanes which run near and within the CINMS are some of the busiest in the US; the combined ports of Los Angeles and Long Beach, located just to the south of the CINMS, carry 37 percent of the total US waterborne foreign trade. Evidence suggests that noise pollution is an important factor in the health of marine mammals. High levels of noise may interfere with marine mammals' ability to detect sounds such as calls from other individuals, echos from prey, and natural sounds that aid in navigation or foraging. Noise may affect reproductive or immune functions and cause more generalized stress. The effects of other pollutants (e.g., chemicals) may compound the detrimental effects of noise.

This project is in its beginning stages. In 2006, we had two high frequency recording packages (HARPs) continuously recording: one in the Santa Barbara Channel and one at Point Conception. On November 16th, 2006 we were onboard the R/V *Shearwater* to service the instrument in the Santa Barbara Channel. This operation involved recovering the instrument that was on the seafloor, and replacing it with a new instrument. We are currently processing the data contained in these instruments and analyzing them for characteristics such as seasonal and time-of-day patterns, as well as other characteristics of marine mammal sounds.



Large commercial ships are required to carry an Automatic Information System (AIS) which transmits a signal containing information such as name of the ship, its GPS location, speed and direction of travel, and destination. CINMS assisted in installing an AIS receiver in Santa Barbara Harbor to track commercial ship traffic in the Santa Barbara Channel. Information from the receiver is sent to a computer and can be downloaded by researchers. The information on the ships is combined with data collected from instruments recording noise in the Santa Barbara Channel, allowing us to learn about what kind of noises ships make, how noisy the ships are, and what areas of the CINMS have the most amount of noise from ships. We also can start to understand how the noise from the ship might influence dolphin and whale behavior and/or distribution. In addition, we are working with CINMS education staff to make the information on the shipping activity in CINMS and marine mammals in the area available to the public on a website.

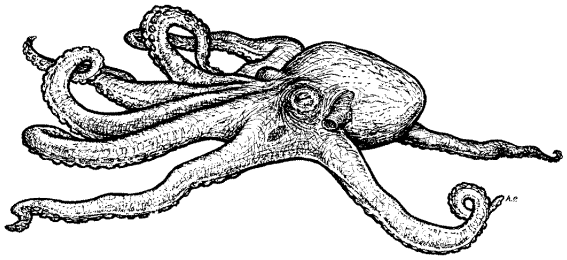
Additional Projects

We partner on two other projects for which reports were not available. The first is Rockfish Recruitment and Fish Community Assemblage Monitoring, conducted by Dr. Donna Schroeder and Dr. Milton Love's lab at UCSB. This project uses SCUBA surveys to monitor fish communities at Anacapa and Santa Rosa Island. In addition, we work with Reef Environmental Education Foundation, a marine conservation non-profit organization that recruits volunteer divers to conduct fish and invertebrate surveys. Read more about REEF at: http://www.reef.org/

Closing Remarks and Acknowledgments

These fifteen projects demonstrate the sanctuary's and our partners commitments to engaging in research to understand the effects of marine reserves and sanctuary resources. The results of this research will be used to inform adaptive management of the sanctuary. We look forward to continuing this important work and to growing our research program in 2007. Many thanks to report contributors, our research partners, and CINMS staff reviewers.

View this report and learn more about your sanctuary at www.channelislands.noaa.gov



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