



Establishing a Southern California Rocky Intertidal Monitoring Network

Dunaway, Ambrose, Campbell, Engle, Hill, Hymanson, and Richards¹

Abstract

Continuous monitoring of both the nature of rocky intertidal habitats and the temporal dynamics of key species along the southern California coastline is critical to our ability to detect and predict change in the marine environment and to develop measures to anticipate and reduce harmful effects. Although a large part of the Southern California coastline is being actively monitored and informally coordinated by interested agencies, no coordinated program has been established over the region. We believe establishing a long-term monitoring network for rocky intertidal resources in the Southern California Bight will greatly improve our understanding of the changes to rocky intertidal communities by providing a regional context and by increasing communication among researchers. The network could serve as a model for future monitoring of other resources or in other areas.

Long-term monitoring is not a new idea in the region. The National Park Service's Channel Islands long-term monitoring program was established in the early 1980's and contains both intertidal and subtidal programs. The Shoreline Inventory of Resources of Santa Barbara County program co-sponsored by Santa Barbara County and the Minerals Management Service was patterned after the Park Service's program with the intention of maintaining a long-term monitoring program along the adjacent mainland. This mainland inventory, now in its 5th year, has been linked to several other monitoring programs along the coastline extending from San Luis

¹Dunaway, Mary Elaine. U.S. Minerals Mgmt Ser, 770 Paseo Camarillo, Camarillo, CA 93010-6064
Ambrose, Richard. Environmental Science and Engineering Program, UCLA, CA 90095-1772
Campbell, Jackie. Santa Barbara County Energy Division, Santa Barbara, CA 93101
Engle, John. Marinc Science Institute, University of California, Santa Barbara, CA 93106
Hill, Maurice. U.S. Minerals Management Service, 770 Paseo Camarillo, Camarillo, CA 93010-6064
Hymanson, Zachary. California Coastal Commission, Energy Div. San Francisco, CA 94105-2219
Richards, Dan. Channel Islands National Park, Ventura, CA 93001-4354

Obispo to San Diego. These additional programs are currently sponsored by several agencies/institutions including the California Coastal Commission, National Park Service, University of California, and Minerals Management Service.

The success of these programs and the desire to examine marine resources from a regional perspective is leading agencies concerned with these resources to develop a coordinated, regional, long-term monitoring network. The network is presently focused on rocky intertidal resources and will provide for continued annual/semiannual monitoring of intertidal resources over the area, a joint data management system, an integrated research program and shared long-term monetary support.

The benefits of a regional monitoring program are numerous and somewhat obvious, yet obtaining consistent funding for such an effort is difficult and requires the dedication and teamwork of many agencies and researchers. Accordingly, this paper is co-authored by several agencies and researchers who have had key roles in developing the network and who are working toward its continued future. This paper will discuss the goals of this network, several of the ongoing monitoring programs in southern California, and the future plans of the network.

Introduction

The efforts of many scientists are required to set up a large multi-agency monitoring network. To obtain the input from scientists from academic, governmental and private interests, a workshop was held at the Cliff House on the University of California, Santa Barbara (UCSB) campus February 26th and 27th, 1997. Fifty-one invited scientists attended the workshop and provided their recommendations for the establishment of the Multi-Agency Rocky Intertidal Monitoring Network (MARINE). The workshop has led to renewed commitments from sponsoring agencies and new participation by a variety of groups. The specific results will be summarized at the end of this paper.

Monitoring has not always been valued by researchers, but this attitude is changing. In the mid- to-late 1970's, intensive monitoring of 22 sites in the Southern California Bight were funded by the Bureau of Land Management (BLM) (now the Minerals Management Service (MMS)) (Littler, 1978a, 1978b, 1979). This intensive three year study was part of a larger baseline study of the Southern California Bight which included the simultaneous monitoring of subtidal, benthic, and marine mammal and seabird resources, geochemical and physical oceanographic parameters. It was intended that the initial effort would provide the information needed to establish a long-term monitoring program. However, funding for the entire program was cut after the National Academy of Science reviewed the program and directed BLM/MMS to contract for more focused research. Prevailing thought among scientists was that conducting "monitoring" or collecting "baseline" data was too general to be a useful expenditure of resources. It is only fairly recently that scientists and managers have identified monitoring as a critical part of the resource

management program, a philosophy which is changing the way National Parks are managed (Halvorson and Davis, 1996).

Fortunately, in the 1990's there has been a renewed appreciation for monitoring as a regulatory tool for detecting impacts to the environment. This is demonstrated by the large sections of the Southern California coastline currently being monitored by state, Federal and local agencies, private groups and institutions. We can now also realize the synergistic benefits of a network as technology advancements make communication among organizations and data synthesis comparatively easy. A network of coordinated groups conducting research and comparing data provides a wealth of information about the coastline, allowing scientists to understand changes in the marine environment in a regional context. This paper will describe the existing monitoring programs sponsored by the key agencies from a historical perspective and discuss significant findings from the monitoring to date. The paper will also discuss the issues presented at the workshop and summarize the recommendations made by the scientists present.

EXISTING MONITORING PROGRAMS

National Park Service - Channel Islands National Park and Cabrillo National Monument

The need to monitor the environment was recognized early in the establishment of the Channel Islands National Park and monitoring of the rocky intertidal and subtidal resources has been pursued continuously since the early 1980's. This ongoing program covers four of the Park's islands and is soon to be expanded to include Santa Cruz Island. They have been able to continue this monitoring by incorporating data collection as part of the ranger's normal activities in order to ensure the health of the resources under their purview.

The National Park Service's program was initially established at Anacapa Island to monitor visitor impacts. Low visitation control sites were established with visitor impact sites, and experimental plots tested the effects of trampling and clearing of organisms. Other concerns of the National Park Service include impacts from fishery harvest, oil spills, marine pollution, and global warming. Monitoring was expanded to Santa Barbara, San Miguel, and Santa Rosa islands in 1985 with a broader goal of collecting ecological baseline information. Sites were chosen to provide the full range of exposures and substrate types. Additional sites were added on Santa Rosa Island in 1986 and 1988 as access improved. Currently there are 14 sites monitored on four islands (Richards and Davis, 1988).

Three intertidal monitoring sites were established in high, medium, and low use areas of rocky reef at Cabrillo National Monument (NM) in 1990. Tidepools at Cabrillo NM are among the most accessible in San Diego County resulting in thousands of visitors exploring the reef every year.

Shoreline Inventory-Santa Barbara County/Minerals Management Service

The Shoreline Inventory Program was established by the Santa Barbara County Board of Supervisors in 1990 to create an inventory of subtidal, intertidal and wetland resources of Santa Barbara County's mainland coast to improve oil spill response and overall planning for habitat restoration efforts in the event of an oil spill. The program was co-sponsored by Santa Barbara County and MMS and has since been linked to other shoreline monitoring segments both to the north and south along the mainland.

The goal of the Shoreline Inventory Project is two-fold. First, the inventory is intended to provide a database to be used to establish a record of pre-existing conditions in the event of a marine oil spill and resulting damage to the coastline. This portion was funded by the offshore operators (Chevron, Exxon, Texaco, Unocal, and Clean Seas) and managed by Santa Barbara County. The database includes a Literature Search, species list, bibliographic and natural history databases, a set of maps for the County and an educational booklet entitled *Seashore Life of Santa Barbara County*. Agencies and the public alike are able to access and rely on these data for a variety of needs including biologic study, community planning and education. This information is provided to interested parties free of charge and has proven helpful in analyzing and monitoring potential impacts of development on coastal resources through the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) environmental review processes.

Second, the inventory provides responsible agencies and the public with increased information and a database of intertidal and subtidal habitats along the coastline, including ten wetland habitat locations in Santa Barbara County. As part of this effort, a three-year field monitoring study of the rocky intertidal shoreline in Santa Barbara County was funded by MMS and carried out by UCSB scientists in the early 1990's; MMS has committed to continued long-term monitoring of these nine rocky intertidal sites. Data reports and the database can be obtained by contacting the County Energy Division or MMS.

California Coastal Commission Shoreline Monitoring

The shoreline monitoring programs initiated in Ventura and Los Angeles Counties and the Northern Channel Islands were required through a regulatory action. In January 1993, the California Coastal Commission approved a coastal development permit to allow the Point Arguello Producers to transport up to 50 thousand barrels of crude oil per day from the Gaviota Marine Terminal in Santa Barbara County to Los Angeles for up to three years. A special condition of this permit required the Point Arguello Producers to pay \$600,000 for the purpose of funding shoreline inventories of coastal ecological resources at the Northern Channel Islands and the mainland of Ventura and Los Angeles Counties. Thus, the available funds served to

extend the geographic coverage of the existing Santa Barbara County mainland shoreline inventory.

The Coastal Commission required funding for a shoreline inventory as one of several advanced preparedness measures in the event of a tanker oil spill. The goal of the Northern Channel Islands and Ventura/Los Angeles Counties shoreline monitoring programs is to establish a baseline record of select biological resources at representative nearshore habitats potentially affected by an oil spill. In such an event, the resulting information will be used to provide strategies for the protection of resident biota and sensitive habitats, as well as for the clean-up and rehabilitation of oiled areas. Other objectives of the monitoring program, include: 1) establishment of monitoring sites and methods suitable for use in a long-term monitoring program; 2) expansion of the information base for the study regions through collection of baseline information in locations or habitats not previously sampled; and 3) provision of baseline information useful in completing natural resource damage assessments resulting from other catastrophes.

Minerals Management Service Mainland Shoreline Monitoring

The MMS is responsible for the regulation of offshore oil production in federal waters beyond three miles from the Southern California coastline. Pursuant to the Outer Continental Shelf Lands Act, the MMS is required to monitor the effects of offshore oil operations under their regulatory jurisdiction. Specifically, the Act states that MMS "shall conduct such additional studies to establish environmental information as [it] deems necessary and shall monitor the human, marine, and coastal environments of such area or region in a manner designed to provide time-series and data trend information which can be used for comparison with any previously collected data for the purpose of identifying any significant changes in the quality and productivity of such environments, for establishing trends in the areas studied and monitored, and for designing experiments to identify the causes of such changes." Furthermore, the National Environmental Policy Act also requires federal agencies to monitor the effects of the operations that they regulate. Of particular concern to the MMS is the effect of an oil spill from an offshore oil platform or subsea pipeline; or from other sources outside the regulatory authority of MMS, such as tankers, barges, or offshore oil platforms and pipelines that are located within state waters.

As a result of MMS's regulatory responsibilities and an increased public concern for oil spills following the EXXON VALDEZ spill in Alaska, the MMS funded a three-year study of rocky intertidal resources in Santa Barbara County (previously in the discussion of the Shoreline Inventory) which consists of sampling selected sites along the Santa Barbara County coastline to fill in gaps in our knowledge about these areas, and provide current data on the shoreline resources. A total of 8 rocky intertidal sampling sites were established in Santa Barbara County in 1992. The

selection of these monitoring sites was based on a review of existing information at the time (Ambrose et al. 1992), a qualitative reconnaissance of many rocky intertidal sites in the County, and quantitative sampling of 11 potential sites (Ambrose et al. 1995). The monitoring sites are located from just south of Point Sal in north County to Carpinteria in the south County. A site located at Purisima Point was established in Fall 1993 to monitor the black abalone population for a total of nine sites in Santa Barbara County (Figure 1).

Through the UCSB Coastal Marine Institute funding, four new rocky intertidal monitoring sites were established in San Luis Obispo County in fall 1995 and four sites were established in Orange County in fall 1996 to provide monitoring data for areas adjacent to offshore oil production and transportation that were not being monitored (Figure 1).

Sampling Design

The monitoring program for long-term programs described in this paper consists of repeated sampling during spring and fall of each year at a series of permanent sites along the coast. These sites range from southern San Diego County in the south to northern San Luis Obispo County in the north, and include most of the Channel Islands. Currently, there are 59 sites being monitored, with 49 sites using similar monitoring methods. This similarity in the sampling design makes forming a network easier and logical.

With the exception of San Diego County, the sites were chosen to provide good geographic coverage of the area so that at least one site affected by a large oil spill would have baseline data. Along the mainland, four sites in San Luis Obispo County and four sites in Santa Barbara County north of Pt. Conception ensure that this section of the central coast, which is predominantly rocky, has good coverage (Figure 1). South of Pt. Conception there are four sites in Santa Barbara County, two in Ventura County, two in Los Angeles County, and four in Orange County. Although the density of sites is lower along this section of coast, this is appropriate because rocky areas are less common. Finally, there are five sites clustered in the southern area of San Diego County. Because these sites were established for a different purpose, the sites in San Diego County were not spaced throughout the entire County.

Seven of the eight Channel Islands are also included in the monitoring (Figure 2). There are two sites on Santa Catalina and Santa Barbara Island, four sites on Anacapa and San Miguel, five sites on Santa Rosa, and six sites on Santa Cruz Island. Five sites on San Nicolas Island are sampled by the U.S. Geological Survey, Biological Resources Division. The islands have a relatively high density of sites compared to the mainland, and coverage is fairly equal except for relatively few sites

on Santa Catalina, the north side of Santa Rosa, and of course San Clemence Island, which currently has no sites.

All sites discussed here are rocky intertidal habitats, and most are rocky benches with a fairly consistent gradient from upper to lower intertidal. Where possible, we chose sites where historic data was available, particularly those sampled during the earlier baseline study funded by BLM (Littler 1978a, 1978b, 1979). At each site, a series of permanent plots have been established by epoxying stainless steel bolts into the rock substrate. The plots target key intertidal species. A number of criteria were used to select the target species (Ambrose et al. 1992), including ecological importance, abundance, susceptibility to human impacts (especially oil spills), and practicality. Examples of target species include barnacles (*Chthamalus* spp., *Balanus glandula*), mussels (*Mytilus californianus*), rockweed (*Pelvetia fastigiata*), turfweed (*Endocladia muricata*), owl limpets (*Lottia gigantea*), black abalone (*Haliotis cracherodii*), and surfgrass (*Phyllospadix* spp.).

Most target species are sampled using 50 cm x 75 cm (0.375 m²) photoplots. Cover is estimated for these species by scoring the photographs taken in the field using a point-contact method (Table 1). For each species at a site, five photoplots were

Table 1. Summary of sampling techniques used for representative targeted taxa and methods of data collection. Refer to text for common names. NA = not applicable

| Sampling Technique | Field | Laboratory |
|--|-------------------------------------|---------------------------------|
| Quadrats: barnacles <i>Endocladia</i> <i>Pelvetia</i> <i>Mytilus</i> | Photographs | % cover by point-contact method |
| Transect line: <i>Phyllospadix</i> | % cover by point-intercept method | NA |
| Circular plots: <i>Lottia gigantea</i> | Counts/size measurements | NA |
| Irregular plots or band transects: sea stars black abalone | Counts/ size measurements (abalone) | NA |

Figure 1.
Location of rocky intertidal monitoring sites along the central and southern California Coast.

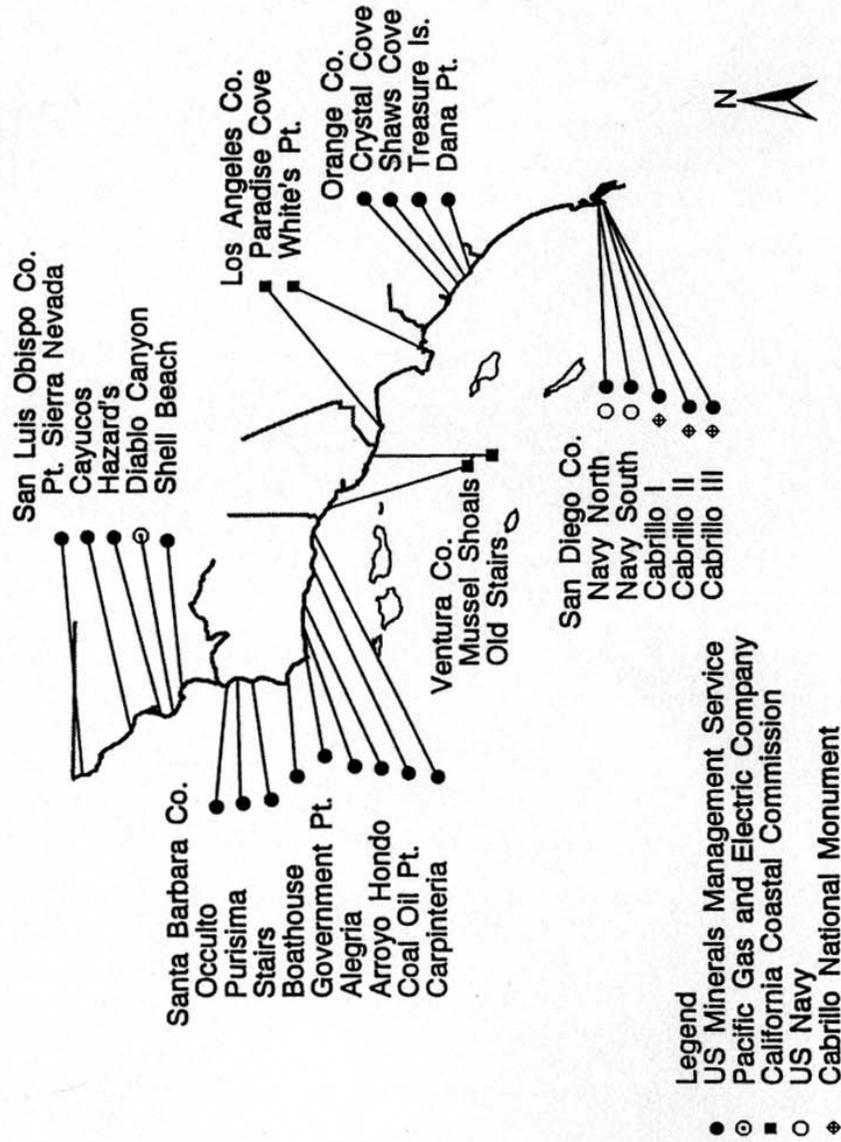
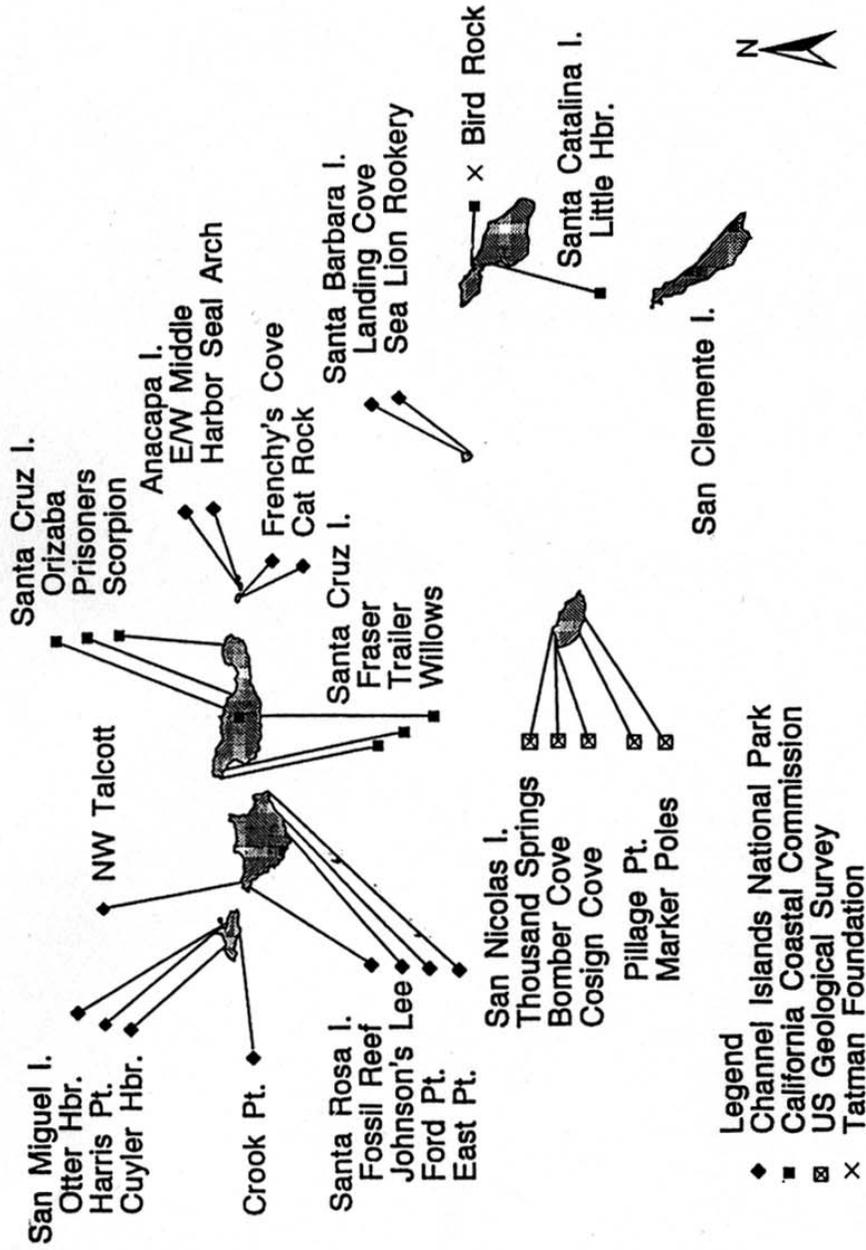


Figure 2. Location of rocky intertidal monitoring sites at the Channel Islands.



established; the photoplots were not randomly located, but rather placed in areas with high abundance of the species at that site. Surfgrass cannot be sampled adequately using photoplots, so three line transects, each 100 m long, are used. Other target species are counted, either in 2-m diameter circular plots (*Lottia*) or larger irregular plots or band transects (sea stars and abalone). The size and shape of the irregular plots or band transects depend on the abundance of the species and the configuration of the habitat at a particular site. At some sites, timed searches are used for species that are too rare for establishing permanent plots for estimating density.

The California Coastal Commission's shoreline monitoring program is collecting and analyzing information on intertidal, subtidal, and wetland resources during the study period (March 1994 through October 1998). Study emphasis is on those resources and habitats most vulnerable to oil spill impacts. One-time reconnaissance surveys to characterize biotic assemblages and habitat types over the study areas are included, as well as periodic surveys. The periodic surveys provide data on species dynamics to assess seasonal and long-term changes in community structure.

Surveys at the Northern Channel Islands, including Anacapa, Santa Cruz, Santa Rosa, and San Miguel Islands, emphasize rocky intertidal communities. Sandy intertidal communities are also surveyed at a reduced intensity. Subtidal surveys concentrate on reconnaissance surveys of shallow soft-bottom habitats, particularly eelgrass and clam beds. Surveys of subtidal rocky habitats are already ongoing by the Channel Islands National Park and other organizations.

Surveys of Ventura and Los Angeles Counties cover the mainland coast and Santa Catalina Island, and like the Northern Channel Islands program, include rocky intertidal and sandy intertidal communities. Coastal wetlands are also a primary focus of the Ventura and Los Angeles Counties program. This is because coastal wetlands are a habitat of concern in California, and are disproportionately susceptible to damage from oil spills. The utility of the wetland data collected is further increased by the sampling of comparable sites in Santa Barbara County.

Special Studies

Permanent survey sites are ideal locations for research and special studies that complement the monitoring program. Time-series data are necessary for many ecological investigations and raise questions that can be addressed by research projects. Research increases basic understanding of ecological structure and processes, resulting in enhanced impact predictability, improved means to detect change, and other insights benefiting long-term monitoring. Special studies conducted at the monitoring sites include sampling method evaluations, community studies, manipulative experiments, and additional monitoring for particular species and life history parameters. Methods-testing studies have emphasized evaluation of biotic cover estimates by various techniques, including video. Community studies include comparison of boulder and bedrock habitats in Los Angeles County and

characterization of rockweed assemblages in Orange County. Few experimental studies have been done at the monitoring sites, in part because manipulations could affect "natural" monitoring. In a study at the northernmost site, mussels had not fully recovered eight years after plots were cleared (MMS 1996). At several other sites, habitat studies involve transplants of surfgrass, abalone, or mussels. The importance of lobster predation on mussels in determining intertidal community structure at Santa Catalina Island was determined using predator-exclusion cages and other field experiments (Robles et al. 1990; Dittman and Robles 1991; Robles and Robb 1993).

Many of the special studies focus on temporal and spatial dynamics of particular species or processes (e.g., recruitment, growth, mortality). This research requires additional monitoring efforts beyond the basic key species surveys. Rockweed, surfgrass, turban snails, abalone and mussels have been targeted for population and life history studies at various sites. Also, the type and extent of human recreational activities have been surveyed at some of the urban sites. Recruitment is a critical process about which surprisingly little is known. Colonization studies of barnacles, hermit crabs, abalone and mussels at representative island and mainland sites indicate unique local and regional patterns that likely are related to varying oceanographic regimes. For example, at 11 sites along 200 mi of coastline, barnacle settlement was consistently high at 2 sites, intermediate at 6, and low at the remaining 3. Settlement "hotspots" and "coldspots" were not in geographic clusters; hence, local chronic conditions prevailed.

Additional studies also help tie the biological data collected to physical measurements in order to better explain trends seen in the monitoring. Temperature loggers were recently placed in the intertidal zone on the northern Channel Islands. Coupled with the temperature loggers at subtidal sites, this will help in understanding local oceanographic conditions and possibly explain recruitment patterns.

Significant Findings

One of the more significant findings of the monitoring has been the marked decline of the black abalone, *Haliotis cracherodii*. Black abalone density declines at the Channel Islands were observed at some sites as early as 1986. The monitoring program identified that there was a serious problem early on and directed research towards identifying the cause (Haaker et al. 1992). Monitoring documented the mass mortality of the species (over 90% parkwide), and guided research about the mass mortality. Monitoring results, including size-frequency measurements and growth studies, documented the magnitude and regional pattern of mortality. Associated special studies confirmed the presence and spread of "withering foot syndrome" and searched for a causative agent. It is believed to be caused by a microorganism which causes the foot to shrink and leads to mortality. The microorganism appears to be linked to warm water conditions though there is no clear understanding of how it is spread.

Sharp declines of the black abalone were first noticed on the mainland at Government Point in 1992. Monitoring programs provided quantitative data to document the mass mortality of black abalone from the beginning, thus attention was drawn to this issue early on. The decline on the mainland has since continued north to other MMS sites on Vandenburg Air Force Base at Boathouse and Stairs (Altstatt et al. 1996.) As of spring 1997, the number of abalone at Boathouse is holding at a fairly constant level (at approximately one-fourth of the original number of abalone). At Stairs the numbers continue to drop; currently the mean value is around a third of the original mean value (pers.comm., M.Wilson, UCSB). Fortunately, the Purisima Point site further north (established after the first decline was noted to document black abalone abundance) is still showing undiminished numbers of abalone and withered foot animals have not been specifically identified at that site.

Monitoring data from the islands and mainland provided the non-fishery data used to support closure of the black abalone fishery in 1993 to protect the species (Richards and Davis 1993). Other research is underway to evaluate community changes associated with black abalone loss, and determine if future black abalone recruitment will be affected by these community alterations.

Observations from the monitoring of Cabrillo National Monument have led to a management program of education and limited access to one portion of the reef to allow recovery. Dramatic declines in mussel density have occurred since at least 1990. While the cause is unknown, it is evident that the mussels have suffered from a lack of recruitment. The monitoring program was able to detect changes from the 1992 sewage spill off Point Loma. Though some species were temporarily impacted from the spill, they recovered and others actually benefited from closing the area to visitation for two months (Engle and Davis 1996b).

THE MULTI-AGENCY ROCKY INTERTIDAL NETWORK

The authors of this paper strongly believe that formation of a monitoring network is advantageous for all parties concerned. Some of these key advantages include:

- ✓Increasing the reliability, efficiency and cost-effectiveness of programs
- ✓Enhances long-term support to ensure continuity of sampling
- ✓Permits the evaluation of large scale patterns
- ✓Provides for better analysis synthesis and reporting of the data

Cliff House Workshop Findings

A workshop was held at the University of California, Santa Barbara to discuss formation of a network and develop recommendations for improving the monitoring

of the rocky intertidal communities in the Southern California Bight. The concept of the network has been extremely well received and the number of participants continues to grow.

There was general consensus that establishing a network met the needs of both resource management agencies and public use agencies. Though the goals of agencies managing a specific resource differed from agencies that need to assess the impact of their program on or public use of these resources, the need for consistently funded long term monitoring programs were the same. Long-term monitoring is valued because it provides the information to gather information on ecosystem health, establish limits of variation diagnose abnormal conditions, and identify potential agents of change (Davis et al. 1994). The formation of the network greatly enhances individual monitoring programs by providing for better communication among researchers, by permitting evaluation of large-scale spatial and temporal patterns, by providing more timely access to the data by all users, and by integrating information for efficient analysis, synthesis, and reporting. The network also provides a more certain funding mechanism through a formalized joint sharing of the process; a value which cannot be underestimated.

A synopsis of the findings from the workshop has been released and is available upon request from the MMS or UCSB (Engle et al. 1997). The four key recommendations drafted by the scientists attending the workshop were:

1. Continue monitoring, create a network, and secure stable funding.

It was recognized by all the workshop participants that the most critical part of the program was to continue the monitoring so that data gaps are not created. While aspects of the network will be aimed at improving sampling and developing a database, the highest priority for the network is to maintain sampling at the existing sites. Once basic monitoring needs for the Bight are met, the participants can focus on setting up the structure needed for the network and addressing network goals.

One of the highlighted benefits of the network is the opportunity to pool resources so that a stable funding base is established. Obtaining long-term funding is difficult for most agencies and organizations as most programs are funded on a year-to-year basis. Shared long-term funding or in-kind services are critical to ensure the stability of the network and to maximize its effectiveness.

2. Form a Steering Committee, Scientific Review Panel, and Data Review Panel.

Some structure was recommended to assure continuity and good communication among participants. A Steering Committee, made up of groups committing resources and involved in joint assessment of the data, would ensure long-term support of the monitoring and provide oversight of a Scientific Review Panel and Data Review Panel.

3. Develop a management system for network data.

The scientists believe there is an immediate need to develop a system capable of managing the data from all programs in the network. Initially, this system should provide an efficient means to access standardized data from each monitoring program. Eventually, all monitoring data should be placed in a central repository maintained by a data specialist. Members appointed to a Data Review Panel would oversee the design and development of the system, and report their findings to the Steering Committee.

4. Review existing data from network programs.

High priority should be placed on reviewing pooled data from all network programs. This review is needed before any recommendations for improving the monitoring can be made. This review would be conducted by the Scientific Review Panel and would serve as the basis for any decisions for future modifications.

A number of detailed recommendations were also made by the invited scientists. This input will be used to further delineate areas of improvement once the initial tasks are completed. Many of these recommendations relate to possible technical improvements in sampling protocol, species selection, and increasing the efficiency of the tasks. One of the recommendations which was discussed at length was identifying practical ways to improve the ability to extrapolate information within and among sites.

Participation and Support

Thirteen agencies and organizations have committed money, or in-kind support (staff field time, boat transport to the islands, computer support, etc.) for the network. Six of these organizations/agencies have committed support for long-term monitoring of specific sites along the mainland or islands; nine have indicated interest in participating on a Steering Committee. We anticipate that at least a dozen more groups will participate in the network for the purpose of data exchange.

The scientists at the workshop discussed the existing programs and anticipated funding needs. Several organizations including Federal agencies, local entities, and volunteer organizations came forward to fill identified funding gaps. By the end of the workshop, funding was identified to support almost all of the 62 sites being monitored in the Southern California Bight. The remaining gaps in LA County and San Clemente Island which will occur when the CCC funding expires spring of 1998, are of interest to several groups and are likely be funded.

Conclusion

Long-term monitoring of shoreline resources provides the data needed for knowledge-based decisionmaking and strong resource management programs. As has been seen in the monitoring conducted to date, consistent sampling provides resource managers with early warnings of abnormal conditions and allows for

reduction of environmental effects. The network concept evolved from the natural process of working together, combining resources, and sharing a common goal. We believe that establishment of this network furthers the common needs of many organizations while advancing our understanding of the dynamics of the rocky intertidal communities in the Southern California Bight. We are excited about this opportunity and look forward to the progress we will make in the coming year.

REFERENCES

- Altstatt, J.M., R.F. Ambrose, J.M. Engle, P.L. Haaker, K.D. Lafferty and P.T. Raimondi. 1996. *Recent declines of black abalone *Haliotis cracherodii* on the mainland coast of central California*. Mar. Ecol. Prog. Ser. 142: 185-192.
- Ambrose, R.F., P.T. Raimondi and J.M. Engle. 1992. *Final study plan for Inventory of Intertidal Resources in Santa Barbara County*. U.S. Department of the Interior, Minerals Management Service.
- Ambrose, R.F., J.M. Engle, P.T. Raimondi, M. Wilson, J. Altstatt. 1995. *Rocky Intertidal and Subtidal Resources: Santa Barbara County Mainland*. Final Report. U.S. Department of the Interior, Minerals Management Service. OCS Study MMS 95-0067. pp. 171.
- Dittman, D.E. & C. Robles. 1991. *Effect of algal epiphytes on the mussel *Mytilus californianus**. Ecology 72: 286-296.
- Davis, G.E., K.R. Faulkner, and W.L. Halvorson. 1994. *Ecological Monitoring in Channel Islands National Park, California*. In: the Fourth California Islands Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History, Santa Barbara, California.
- Engle, J.M. and G.E. Davis. 1996a. *Rocky Intertidal Resources Monitoring Handbook, Cabrillo National Monument, San Diego, California*. U.S. Department of the Interior, California Science Center, Davis, CA 38pp.
- Engle, J.M. and G.E. Davis. 1996b. *Ecological condition and public use of the Cabrillo National Monument Intertidal Zone 1990-1995*. Technical Report. U.S. Department of the Interior, California Science Center, Davis, CA 183pp.
- Engle, J.M., R.F. Ambrose, and P.T. Raimondi. 1997. *Synopsis of the Interagency Rocky Intertidal Monitoring Network Workshop. Final Report*. U.S. Department of the Interior, Minerals Management Service. OCS Study MMS 97-0012.
- Halvorson, W.L. and G.E. Davis. 1996. *Science and Ecosystem Management in the National Parks*. University of Arizona Press.
- Haaker, P.L., D.V. Richards, C.S. Friedman, G.E. Davis, D.O. Parker, and H. Togstad., 1992. *Mass Mortality and withering Syndrome in Black Abalone, *Haliotis cracherodii* in California*, In: Abalone of the World: Biology, Fisheries, and Culture. Proceedings of the first International Symposium on Abalone pp. 214-224. Blackwell Scientific Publications, Inc. Cambridge.

- Haaker, P.L., D.O. Parker & C.Y. Chun. 1995. *Growth of black abalone, Haliotis cracherodii Leach, at San Miguel Island and Point Arguello, California*. J. Shellfish Res. 14: 519-525.
- Littler, M.M., ed. 1978a. *Spatial and temporal variations in the distribution and abundance of rocky intertidal and tide pool biotas in the Southern California Bight., Year I - Southern California OCS*.
- Littler, M.M., ed. 1978b. *The annual and seasonal ecology of Southern California rocky intertidal, subtidal and tide pool biotas. Year II - Southern California Outer Continental Shelf Program*. Bureau of Land Management, Technical Report III-1.1. U.S. Government Printing Office, Washington, D.C..
- Littler, M.M., ed. 1979. *The distribution, abundance and community structure of rocky intertidal and tide pool biotas in the Southern California Bight*, ed. M. M. Littler. Year III - Southern California Outer Continental Shelf Program. Bureau of Land Management, Technical Report III-1.0. U.S. Government Printing Office, Washington, D.C..
- Minerals Management Service & Kinnetic Laboratories, Inc. 1996. *Mussel recovery and species dynamics at four California rocky intertidal sites: 1992 Data Report*. U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region. OCS Study MMS 96-0009. 151 pp.
- Richards, D.V. 1994. *Effects of disturbance on population dynamics of selected taxa in the rocky intertidal zone of Channel Islands National Park, California*. In the Fourth California Islands Symposium; update on the status of resources. Halvorson, W.L. and G.J. Maender, Eds. pp. 45-58. Santa Barbara Museum of Natural History, Santa Barbara, CA.
- Richards, D.V. and G.E. Davis. 1988. *Rocky Intertidal Communities Monitoring Handbook*. Channel Islands National Park.
- Richards, D.V. & G.E. Davis. 1993. *Early warnings of modern population collapse in black abalone Haliotis cracherodii, Leach, 1814 at the California Channel Islands*. J. Shellfish Res. 12: 189-194.
- Robles, C., D.A. Sweetnam & J. Eminike. 1990. *Lobster predation on mussels: shore-level differences in prey vulnerability and predator preference*. Ecology 71: 1564-1577.
- Robles, C. and J. Robb, 1993. *Varied carnivore effects and the prevalence of Intertidal turfs*. J. Exp. Mar. Biol. Ecol. 166: 65-91.