LiMPETS
Long-Term Monitoring Program and Experiential Training for Students
limpets.noaa.gov

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ABSTRACT

We have developed a program for middle school, high schools and other volunteer groups to monitor rocky intertidal, sandy beach and offshore areas of the five west coast National Marine Sanctuaries – Olympic Coast, Cordell Bank, Gulf of the Farallones, Monterey Bay and Channel Islands. LiMPETS, Long-term Monitoring Program and Experiential Training for Students, is a collaborative monitoring effort with staff from the five west coast marine Sanctuaries partnering with the California Sea Grant Program, the Farallones Marine Sanctuary Association, and University of California, Santa Cruz researchers.

The intertidal and offshore habitats of the west coast Sanctuaries are among the most diverse and productive of any region in the world. Despite their ecological significance and protected status, these habitats, along with sandy beaches, are being increasingly impacted by human activities (directly by harvesting and trampling, indirectly through pollution and litter). In addition, there are dramatic geological and climatic disruptions along Sanctuary shores (earthquakes, severe storms, El Niño events, global warming) that could generate change in the biota. Awareness by the local communities of these phenomena and how they influence these habitats and their inhabitants is vital if these ecosystems are to continue receiving the protection they deserve. The Sanctuaries and partners are establishing a rigorous program to monitor the abundance and distribution of major intertidal biota, sand crabs, and selected offshore species to increase awareness and stewardship of these ecosystems.

Protocols to monitor rocky intertidal, sandy beach and offshore areas have been established and used by numerous school groups to date. There are various procedures used to collect data, including but not limited to transects, random quadrat counts, total organism counts, sex determination and size measurements. Several sites are selected within each Sanctuary for the rocky intertidal and sandy shore monitoring. Species were chosen to be monitored if they had certain characteristics, namely:

1. Ecological importance
2. Easily recognized, studied and identified in the field
3. Sensitivity to disturbance, pollution or environmental changes.

Data are collected so that long-term changes can be followed by interested groups working with the Sanctuaries' education staff. Protocols, species, site descriptions, directions and more are currently posted on the web. All of the information in the LiMPETS website limpets.noaa.gov is public and free to be used. However, please credit the National Marine Sanctuary Program when information or photographs are used by other websites or in publications.

INTRODUCTION

The rocky intertidal on the west coast of North America supports one of the richest and most diverse biotas in the world (Stephenson and Stephenson, 1972; Ricketts *et al*., 1985). Moderate climate, energetic waves, and productive nearshore waters all contribute to this wealth. This biota is subject to constant change, today largely from anthropogenic causes. At some sites, harvesting and trampling have lead to dramatic decreases in the abundance and diversity of the biota (Ghazanshahi *et al.,* 1983; Brosnan and Crumrine, 1994; Addessi, 1995; Murray *et al.*, 1999). The very accessibility of the intertidal has lead to more and more people visiting it. By its very nature, the intertidal zone is exposed to many of the pollutants produced by human society. Contaminants released into the air fall on the surface of the sea and are carried into the intertidal, as are chemical contaminants such as oil spills. Waste materials dumped on the land are washed into the sea across the intertidal, some of it remaining there. Indeed, the animals and plants of the intertidal may be affected more severely by human activities than those in most other parts of the sea. Fortunately, because of their accessibility, they also may be the easiest to monitor, and so can serve as our marine canaries.

Sandy beach monitoring in the west coast Marine Sanctuaries focuses on the Pacific mole crab (*Emerita analoga*), or sand crab, a common inhabitant. Sand crabs are important organisms in the sandy beach ecosystem, filter feeding plankton from the water. They are eaten by coastal birds and sea otters. Sand crabs are used by humans as bait for fishing and have been confirmed to be good indicators of the pesticide DDT and the neurotoxin domoic acid (Ferdin *et al.,* 2002). The sand crab is also an intermediate host for a number of parasites, including acanthocephalans (thorny-headed worms) that affect threatened sea otters and surf scoters. Predators on sand crabs may become ill or die from the parasites after consuming numerous crabs.

Sand crabs would be affected by an oil spill or potential increases in pollution along the coast. Data collected will provide baseline information about the distribution and density of sand crabs on beaches so if there are environmental changes, we can determine how the population shifts or how long it takes for the population to recover. In this long-term monitoring program, we will be able to examine fluctuations in the population over a long time period which will greatly help us understand sand crab biology and the health of the sandy beaches. We hope to add more species to our sandy beach monitoring in the future, including arrival time and abundance of the cnidarian *Velella velella*, or by-the-wind-sailor, on the beaches.

Offshore monitoring focuses on Cordell Bank, a unique Sanctuary. It is an offshore, underwater island that sits on a peninsula surrounded by deep water on three sides. Cordell Bank is a granite peak that rises from the soft bottom of the continental shelf to within 37 m of the oceans' surface. The topography and oceanic conditions create a very productive marine environment. Because of the productive environment, Cordell Bank is also a feeding area for many migrant and seasonal pelagic birds from far away, including Sooty Shearwaters and Black-footed Albatrosses. These albatrosses are able to fly long distances to Cordell Bank during food gathering trips between their nest sites on the northwest Hawaiian Islands. Offshore monitoring consists of examining video taken from a research submersible in

different habitats of Cordell Bank. The abundance of a sea cucumber, sponge, purple hydrocoral and rockfish is measured on the rocky reef video. In the soft bottom habitat, the abundance of box crabs, rockfish and ratfish is measured. In addition, we analyze a one-time-shot migratory path of a Black-footed Albatross during the breeding season, using telemetry tag data. We hope to add more species to our offshore monitoring in the future as well, and possibly even work with scientists who attach real-time data transmitters on birds to track their movements across the Pacific during breeding season.

Until relatively recently, long-term monitoring programs were few (*e.g.,* by the Channel Islands National Park (Davis *et al*., 1994), Diablo Canyon Nuclear Power Station (PG&E, 1984), and the Minerals Management Services (Kinnetics, 1992; Raimondi *et al*., 1999). In addition, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), supported by the David and Lucille Packard Foundation, is an ambitious effort to expand long-term monitoring along this coast www.piscoweb.org/. These programs offer great promise in providing long-term data that can be used to detect changes in the future. However, they are large, expensive, and employ highly trained technicians to collect and analyze the data.

Another approach to monitoring environmental change is to utilize members of the public. The Audubon Society has taken this approach with their annual Christmas Bird Count www.audubon.org/bird/cbc/index.html for over a century. In the past decade the Great Annual Fish Count www.fishcount.org/ has taken that example into the sea. A variety of groups have made special efforts to involve school groups in monitoring programs, *e.g.*, the Federal interagency GLOBE program www.globe.gov/fsl/welcome.html

Not only will the Long-term Monitoring Program and Experiential Training for Students (LiMPETS) provide another set of long-term data that can be used to follow changes, but it will also introduce people of all ages to the rich biota of the five west coast National Marine Sanctuaries' ecosystems (Figure 1), and build up a group of well-informed, concerned citizens who will watch over these habitats in the future. In addition, it is our hope that by being involved in this program, people will gain a better idea about how science is carried out, both in the field and when interpreting data.

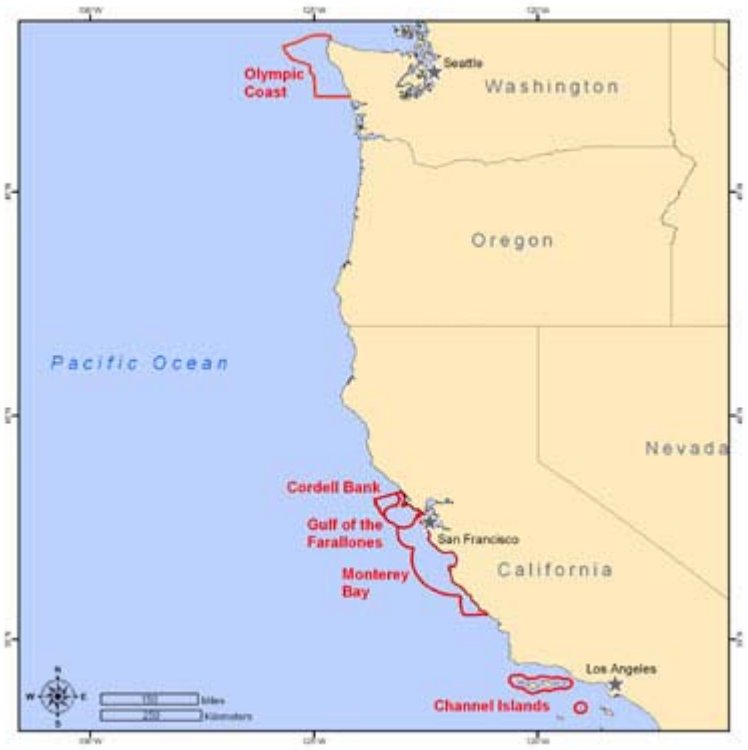


Figure 1. Map showing the boundaries of the five west coast National Marine Sanctuaries participating in LiMPETS – Olympic Coast, Cordell Bank, Gulf of the Farallones, Monterey Bay and Channel Islands.

GOALS

Our overall program goals are to:

1. Establish a long-term, quantitative rocky intertidal, sandy beach and offshore monitoring program that can be used by the Sanctuaries, other concerned organizations, and the public in general to assess the health of these habitats,

2. Increase the understanding and appreciation of the intertidal, sandy beach and offshore habitats by the general public through the direct involvement of high school and middle school teachers, their students, and adult volunteer groups.

Our specific goal is for this monitoring program to be continued in perpetuity by high school students, middle school students and volunteers both to increase public awareness and to provide critical data that can be used to evaluate the health of Sanctuary habitats and promote wise stewardship.

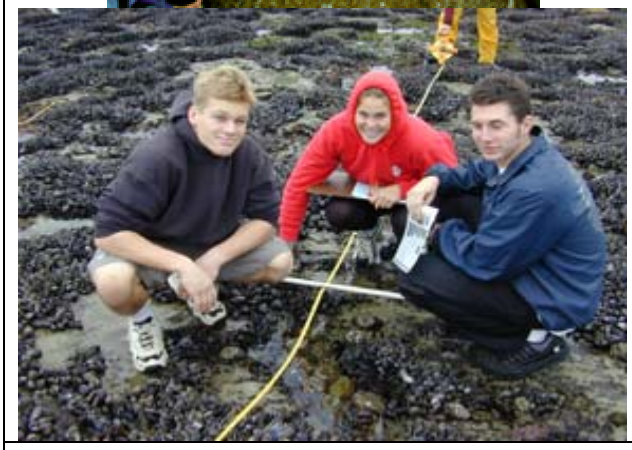
For the rocky intertidal monitoring, we want to track changes in the abundance and distribution of selected organisms over time and allow students to analyze data looking for trends. Our hope is that is students will alert Sanctuary staff to significant distribution and abundance shifts that could indicate stress to the intertidal habitat and species there. We developed protocols for three approaches to sample the rocky intertidal, depending on the

sites and species involved: 1) Fixed quadrats along a permanent vertical transect that crosses the intertidal from the top of the high zone through a mussel bed and into the low zone; 2) Random quadrats placed within large fixed plots covering more-or-less uniform areas, usually of mussel beds; 3) Total counts and measurements of selected larger animals within defined areas. Species had to be easily identifiable in the field to be included on our monitoring list. We tested numerous species in the field with students and excluded or combined those that were difficult for them to distinguish. Currently, we have 34 taxa of algae and invertebrates listed for monitoring (Osborn *et al.,* 2003).

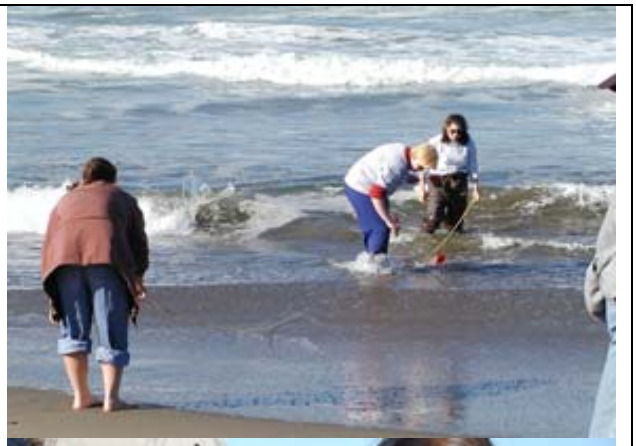
For sandy beach monitoring, the overall goal of the project is to assess changes in the sandy beach environment that might affect coastal birds and other species that depend on the environment. The following questions will be answered through monitoring:
-What is the community of sand crabs? Described in terms of the crabs' size, gender, and reproductive status.
-What is the abundance of sand crabs? Described in terms of density.
-What is the distribution of crabs along a transect?
-How does the community of sand crabs change throughout the year?
-What is the *Acanthocephalan spp*. parasite load in the sand crabs?

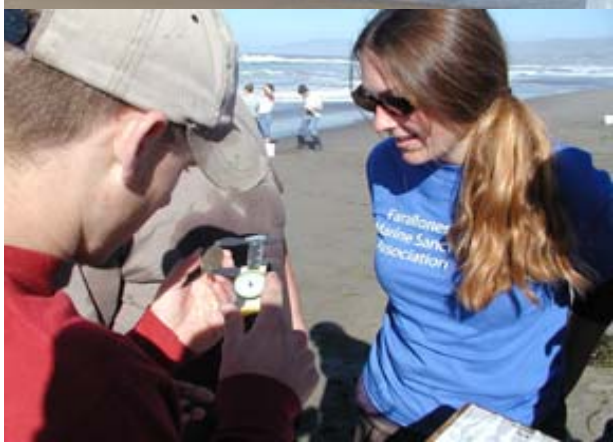
Students set up five transect lines perpendicular to the shore and collect ten samples one meter apart along each transect. The gender of the sand crabs is determined, and the carapace length measured to the nearest millimeter. Back in the classroom, the data are entered into the online database, at www.sandcrabs.org. Students can graph and analyze their results on the website, looking at spatial and seasonal variation, and comparing their beach with other beaches being monitored. So far, sixteen schools are involved in the project, monitoring ten different beaches. Students have started collecting crabs to dissect in the lab to investigate the parasite load of sand crabs from their beach.

The offshore activities are done in a classroom setting. The purpose is to demonstrate other types of monitoring methods, such as investigating migratory movements of pelagic birds and subtidal monitoring with submersible video. The goals are to introduce students to a less familiar habitat offshore that is very different than those nearshore they are used to and show them organisms that exist in offshore systems.



Intertidal monitoring





Sand crab monitoring

VALIDATION

Although getting high school students and volunteers into these habitats may be a great educational experience, there is always the question of whether students are able to collect reliable data, even with the taxa selected for ease in identification. To test the reliability of student counts with rocky intertidal data, we had teams of students and professionals do replicate counts both of large species within delineated areas and of species in the same quarter-meter-square quadrats on the vertical transects (Osborn *et al.,* 2003). On two different days, student and professional teams counted nearly the same number of selected species. The variation among the teams of professionals was as great as those for the students. These differences among teams, whether by students or professionals, need to be taken into consideration when comparing counts (Pearse *et al.,* 2002). It is probably best to always have several replicate counts that can be averaged to get a reasonable estimate of actual abundance. These results, however, provide reassurance that our monitoring program can provide reliable data suitable for use by resource managers and other interested people interested in tracking long-term changes along our shores.

PROCEDURES

In order to familiarize students and volunteer groups with the species and monitoring protocols, teachers and group leaders need to check the LiMPETS website and then contact program coordinators in the Sanctuaries to arrange classroom visits or, if appropriate, to pick up classroom kits to use themselves. There are classroom and field kits for the rocky intertidal, sandy beach and offshore habitats.

The rocky intertidal kit includes a slide show introducing the program: goals, what to wear into the field, the purpose of monitoring, photos of the sites, ecology of a few key species, and some data. We hope to have teacher training workshops each year as well to familiarize interested teachers with the sampling methods and species.

In most cases, there are activities for the monitored habitats that can be done in the classroom before sampling begins. For rocky intertidal classroom activities, there are life-sized photo-quadrats big enough to fit quarter-meter-square quadrats. Using data sheets identical to those used in the field, and aided by laminated photo-identification sheets, students can do practice counts in the classroom. Then several species can be selected and the counts obtained by the different student groups can be put on the chalk board for discussion. Slight differences in the counts among the different student teams can be noted and the students can explore reasons for such differences, such as misidentifications or slight movement of the quadrats.

There are shell collections in the classroom kits as well. These allow the photo-quadrats to become 3-dimensional; students can feel barnacle or mussel shells to better familiarize themselves with the species. An activity on two selected species – owl limpets and turban snails – asks students to read a few paragraphs on each and then answer questions together, such as “describe an owl limpet farm; why do you think we monitor owl limpets?; and why do you think we monitor turban snails?”

There are numerous ways to familiarize the students with the habitats and species. Please consult the LiMPETS website limpets.noaa.gov for these details. There are also detailed descriptions about preparing to visit each site. For example, for the first visit into the rocky intertidal, the students should have clipboards, pencils, laminated photo-identification sheets with all the species to be monitored, and a specific assignment. A list of all the species to be monitored is given to each student; the assignment is to write descriptions, in their own words, of the algae or animals after they find them; students can also draw the algae or animals to help them remember. In this way, students can create their personalized identification sheets to laminate and bring into the field with them the next time for a practice count, and every time thereafter.

After the classroom activities and preliminary field trips, the students should be ready to monitor. They need the previous background and exposure to the species and the field to become familiar with the whole experience, however. We have found that reliable data are collected after these initial steps are executed. This is a “check-out” process as well, so teachers and the Sanctuaries’ coordinating staff can interact and answer questions.

After the classroom activities and preliminary field trip are completed, the teacher/leader will be given a passcode from the Sanctuary coordinator for entering data into the program’s website. The data can then be entered into the program’s website for long-term storage and analysis, preferably by the students themselves. There are some checks in the data entry system on the website to make sure data are entered properly. After the data are entered, the students—and anyone else—will be able to download both their own and past data to create graphs for specified species, sites, or dates. These data also provide material for teaching about statistical analyses and critical reasoning.

PARTICIPANT RESPONSE

In order to gather comparable data over time among the different sites and habitats, there needs to be consistency in how the different schools work in the program. Education staff within each Sanctuary office will assist with teacher workshops, dispensing the kits for each monitoring section and teacher support when time permits. It is our hope that the program will continue to maintain flexibility in how people work in it, while at the same time the program coordinators refine the procedures to a manageable level. It would be best if data were collected at each site at least once every spring.

In addition to schools, volunteer groups could easily work in this program, adopting sites that their members could take over as their own, similar to “adopting a site.” With the increase in volunteer programs today involved with hands-on environmental issues, we hope many groups become involved with LiMPETS and hope to foster new partnerships.

PARTNERING ORGANIZATIONS

Staff from several organizations and West Coast Marine Sanctuaries have worked together since 2002 to create LiMPETS. Partnering organizations are the California Sea Grant Program, Farallones Marine Sanctuary Association, University of California, Santa Cruz, and NOAA’s National Marine Sanctuary Program, including Olympic Coast, Cordell Bank, Gulf of the Farallones, Monterey Bay and Channel Islands National Marine Sanctuaries staff. This publication is a joint effort with staff at all participating organizations.

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