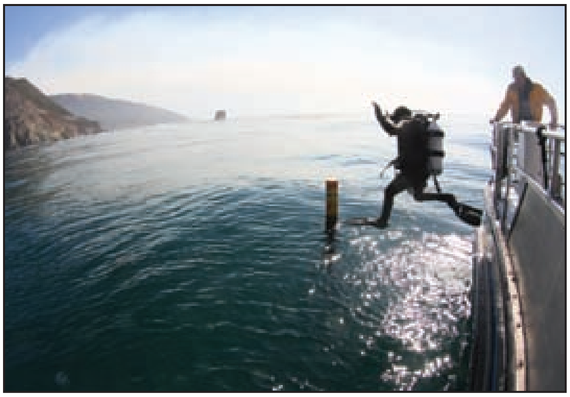
Introduction

California coastal oceans face many threats, including habitat loss, reduced water quality, invasive species, marine debris, overfishing, and the increasing threats posed by climate change and ocean acidification. These coastal threats reduce the health of marine ecosystems and the valuable services provided to coastal communities. To counteract these threats, marine resource managers are using multiple tools to manage marine ecosystems, including ecosystem-based fisheries management and networks of marine protected areas (MPAs). MPAs protect representative marine habitats by restricting some human activities to varying degrees, depending on the type of MPA. Rather than using a single species approach, MPAs function to protect all organisms and ecological linkages within an ecosystem.

In 1999 the California Legislature passed the Marine Life Protection Act (MLPA), which was established to "*redesign California's system of marine protected areas (MPAs) to function as a network in order to: increase coherence and effectiveness in protecting the state's marine life and habitats, marine ecosystems, and marine natural heritage, as well as to improve recreational, educational and study opportunities provided by marine ecosystems subject to minimal human disturbance.*"

In September 2007, upon implementation of the first MLPA MPA network on the central California coast (Pigeon Point to Point Conception), and with funding from the California Ocean Protection Council administered by California Sea Grant, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) initiated baseline surveys to monitor these MPAs. Of the 29 MPAs established in the Central Coast Study Region (CCSR), 17 MPAs contain kelp and 14 can be safely sampled using SCUBA. The baseline surveys focused on both subtidal and intertidal systems for the central coast, characterizing ecosystem attributes such as biodiversity, community structure, and population abundance and size structure. Baseline surveys were conducted in both 2007 and 2008. By monitoring these ecosystem attributes, scientists can make comparisons inside vs. outside MPAs, track changes in ecosystem attributes over time, and evaluate if MPAs are having the desired results.



SCUBA Survey in Big Sur Scott Gabara

This booklet describes patterns in MLPA state marine reserves (SMR) generated from the first 2 years of baseline data collected; SMRs are one type of MPA that provides protection from all forms of fishing and resource extraction. This project represents the most extensive ecological surveys to date of kelp forests along the central coast of California.

Tube-dwelling anemone Steve Lonhart

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Front cover photo: *Steve Lonhart*
Back cover photo: *Scott Gabara*
Algae and substrate drawings: *Claire Saarman*
MPAs and Dive Sites map: *Images provided by the California Department of Fish and Game*

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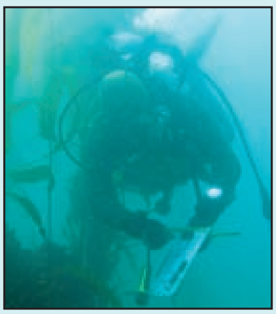
Methods

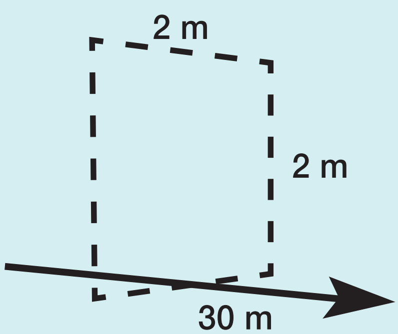
Scott Gabara

Fish Surveys

In each of the 14 coastal MPAs within the CCSR sampled using SCUBA, 4 sites inside and 4 sites outside of the MPA were selected using a random stratified approach. At each of these sites divers collected data on the size and abundance of all conspicuous fish species found at 4 depth zones (5, 10, 15, and 20 m deep). At each depth zone, pairs of divers surveyed 3 transects (30 m long by 2 m wide by 2 m tall) at three levels within the water column (benthic, mid-water and canopy), totaling 36 transects per site.

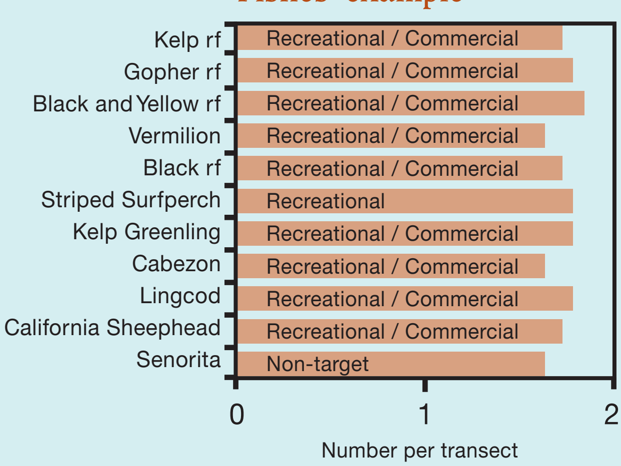


PISCO research diver conducts fish survey



Data from these fish surveys are summarized here to illustrate community patterns across the MPA network. Density estimates (number of individuals encountered on a standard transect) of 11 common fish species are graphed for each group of MPA and reference sites in the CCSR. These species are listed in the example graph below, along with their status as targets of commercial and recreational fishing, recreational fishing only, or non-targeted species.

Fishes–example

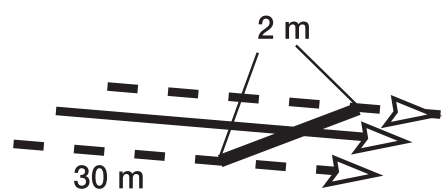


Benthic Surveys

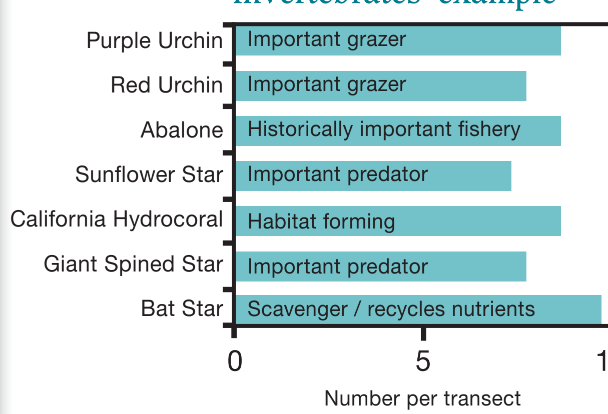
Divers collected data on the size and abundance of canopy forming kelp and the abundance of understory algae and invertebrates in separate surveys. Among the many invertebrate species encountered by divers, 7 key species were selected because of the important ecological roles they play in structuring kelp forest communities within the CCSR. Density estimates for these species are presented to portray similarities and differences among sites across the MPA network. These benthic community data were collected from 2 transects (30 m long by 2 m wide) at three depths (5, 12.5, and 20 m deep), totaling 6 transects per site.

Detailed descriptions of sampling protocols are at: http://www.piscoweb.org/research/science-by-discipline/ecosystem-monitoring/kelp-forest-monitoring

PISCO benthic community transect

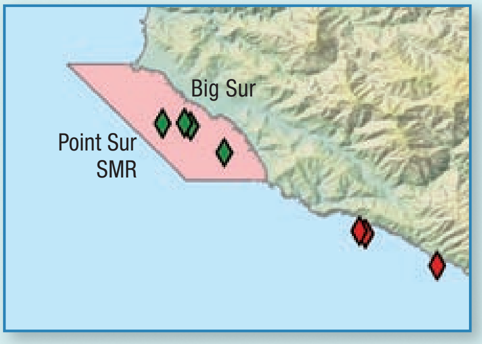


Invertebrates–example



Point Sur SMR

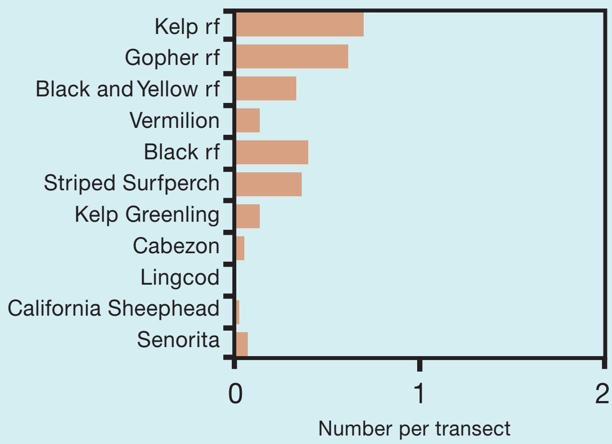
Red alga — Steve Lonhart



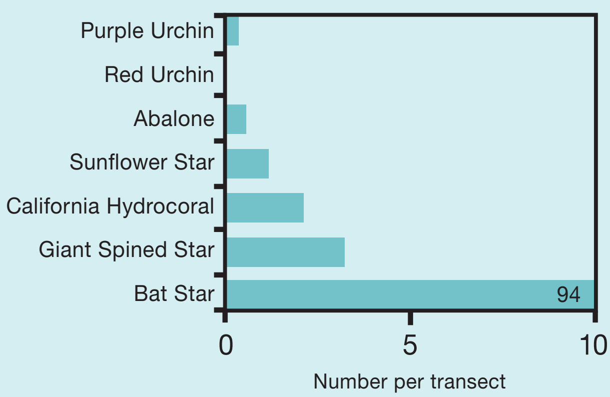
Substrate types in the Point Sur SMR are generally low-relief bedrock and large areas of boulders and cobble. The sub-canopy was dominated by dense stands of the stalked kelp *Pterygophora*, and the understory had the highest percent cover of fleshy red algae seen in any of the CCSR MPAs. Fish densities were generally low here, although kelp rockfish were seen in particularly high densities, and predatory sunflower stars were more abundant here than at other MPAs.

Sunflower star — Steve Lonhart

Fishes

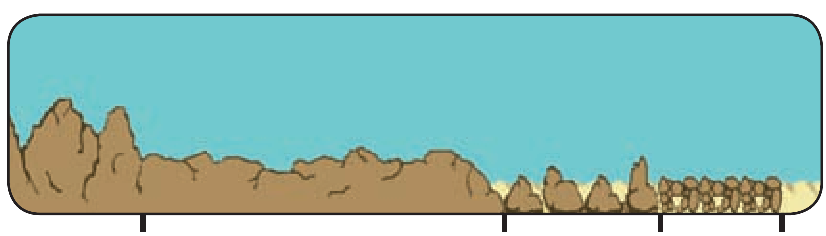


Invertebrates



Kelp rockfish — Scott Gabara

Substrate

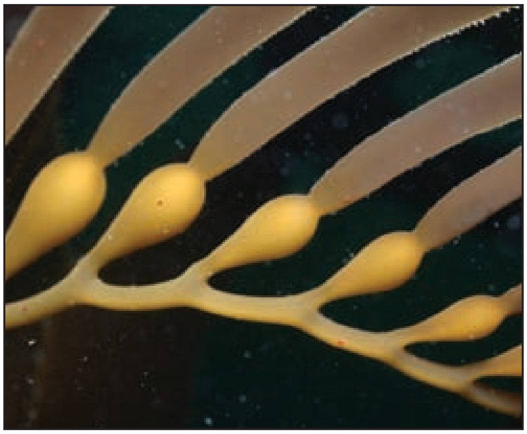


Algal Community

Scott Gabara

Future Steps

Baseline studies are only the initial step in evaluating the effectiveness of MPAs as conservation tools. Monitoring ecosystem attributes through time is critical to determining how individual MPAs and networks protect the integrity and resiliency of ecosystems. To fulfill the need for evaluation and adaptive management in the short term, the results of this baseline and subsequent monitoring are intended to be reviewed in detail approximately 5 years after implementation of the MPAs and every 5 years thereafter. Evaluations will provide managers with information such as relative success of these MPAs at meeting their conservation goals and providing insight into which design criteria (i.e., size, shape, allowed activities) are most useful to enhance their effectiveness, and if large-scale environmental processes affect the region as a whole. These evaluations will allow resource managers to adaptively manage MPA networks to ensure they are fulfilling the goals they were established to achieve.



Macrocystis Steve Lonhart

Monitoring studies are critical to the evaluation of MPAs as conservation tools. MPAs and monitoring programs also offer scientists and resource managers opportunities to learn about the influence of humans and changing natural phenomena on these ecosystems.

By using the MPA as an ecological baseline, we can compare how areas inside and outside the MPA change over time. This will allow us to:

- **Use observed differences in abundance and size structure of fished populations to assess the state of fished populations**
  To better assess the state of fished stocks, we can compare data from outside to inside the MPA or provide population data for stocks outside the MPAs that have not been formally assessed.
- **Determine potential ecosystem-wide effects of fishing in kelp forests**
  Observed local differences between ecosystems inside and outside of MPAs suggest ecosystem-wide effects of human uses such as fishing. Similarly, monitoring inside of MPAs allows scientists to separate ecosystem-wide effects of natural perturbations, such as climate change, from more localized and direct human-use impacts. Using this knowledge is critical to informing an ecosystem-based approach to management.

Conclusion

In conjunction with ocean observations, continued monitoring of ecosystems can reveal the drivers of ecosystem change, particularly as they influence ecosystem productivity, function, resiliency and services. When combined with socio-economic monitoring studies, ecological monitoring can identify how ecosystem effects from MPAs are both caused by and influence changes in human-use patterns. This knowledge will help managers consider and adjust how humans use and manage these ecosystems to protect them in the face of a changing climate.

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For more information on the Marine Life Protection Act, visit http://www.dfg.ca.gov/mlpa/
For more information on PISCO, visit http://www.piscoweb.org/

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