Building a Geographic Context: Comparing the Rocky Shores of Monterey Bay to Other Sites Along the West Coast of the United States

PISCO

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INTRODUCTION

Scientists at Oregon State University are taking the lead on a very large-scale survey of the marine communities on the rocky shores of Washington, Oregon, and California. Some of our primary research questions include:

* What are the geographic patterns of abundance and distribution of species over space and time?

* What are the relationships between intertidal communities of organisms and nearshore oceanographic patterns?

* How are these biological communities structured along our shores?

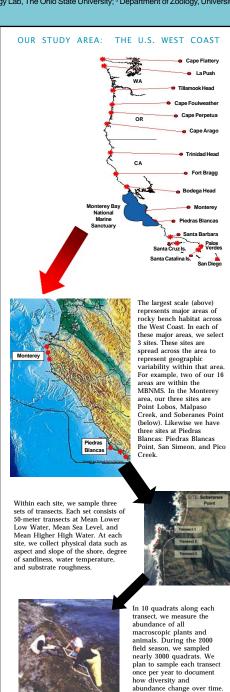### The West Coast Hosts an Incredible Diversity of Organisms

Annual surveys of sites located in the Monterey Bay area allow us to compare sites within the National Marine Sanctuary to the rest of the coastline and to detect shifts in the composition of the intertidal communities in both space and time. In 2000 and 2001, we observed over 125 species or groups of species within the Sanctuary. Several species were found only in the Monterey surveys, and many others peaked in abundance here. These surveys help us to both document the unique qualities of the ecological communities in the MBNMS region and begin to understand the interconnectedness of this area with the rest of the coast.
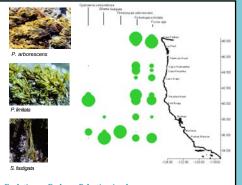
We found the following intertidal organisms in the Monterey Bay NMS:
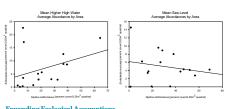

OVERVIEW OF OUR METHODS

To document the patterns of diversity and abundance, we employ a "nested" sampling scheme. First, at the largest scale, we pick stretches of rocky habitat that are spaced across the U.S. West Coast to represent the major areas that are relatively similar in physical factors. Nested within each of these major areas we selected three 'sites,' and nested within each of these sites are three sets of sampled areas. In each sampled area, we place a transect tape at three specific elevations and measure the abundance of all macroscopic plants and animals in 10 quadrats on each transect. Sampling in this nested fashion allows us to examine correlations between the diversity and abundance of rocky shore organisms and local-scale versus very large-scale factors.
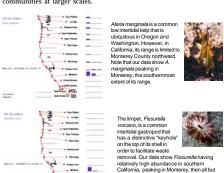
OUR STUDY AREA: THE U.S. WEST COAST

The largest scale (above) represents major areas of rocky bench habitat across the West Coast. In each of these major areas, we select 3 sites. These sites are spread across the area to represent geographic variability within that area. For example, two of our 16 areas are within the MBNMS. In the Monterey area, our three sites are Point Lobos, Malpaso Creek, and Soberanes Point (below). Likewise we have three sites at Piedras Blancas: Piedras Blancas Point, San Simeon, and Pico Creek.

Within each site, we sample three sets of transects. Each set consists of 50-meter transects at Mean Lower Low Water, Mean Sea Level, and Mean Higher High Water. At each site, we collect physical data such as aspect and slope of the shore, degree of sandiness, water temperature, and substrate roughness.

In 10 quadrats along each transect, we measure the abundance of all macroscopic plants and animals. During the 2000 field season, we sampled nearly 3000 quadrats. We plan to sample each transect once per year to document how diversity and abundance change over time.

Evolutionary Ecology: *Pelvetiopsis arborescens*

Often, taxonomists and evolutionary ecologists will use information about species ranges and abundances to shed light on their phylogeny (evolutionary history). Shown above is a table showing the distribution and abundance of the fucoid algae within our study area. Note the occurrence of *P. arborescens* only in the Monterey Area. Its nearest relative, *P. limitata* peaks further north in central Oregon and is virtually absent in Monterey. When distribution and phylogeny are coupled with morphology, life-history variation, and genetic analysis, this enables scientists to better understand why new species occur, why some fare better than others, why species go extinct, and the potential effects of introduced species.

Expanding Ecological Assumptions

The presence of one species may influence the presence or abundance of another species. In Washington and Oregon, ecologists have noticed positive correlations between the abundance of the mussel, *Mytilus californianus*, and the red alga, *Endocladia muricata*. How does the strength of this species interaction vary over larger geographical areas? Scaling out from a single area to the entire Pacific coast shows that these correlations weaken or even reverse, indicating that other factors, such as wave force or oceanographic patterns, may shape communities at larger scales.

Alaria marginata is a common low intertidal kelp that is ubiquitous in Oregon and Washington. However, in California, its range is limited to Monterey County northward. Note that our data show *A. marginata* peaking in Monterey, the southernmost extent of its range.

The limpet, *Fissurella volcano*, is a common intertidal gastropod that has a distinctive "keyhole" on the top of its shell in order to facilitate waste removal. Our data show *Fissurella* having relatively high abundance in southern California, peaking in Monterey, then all but disappearing further north.

SCALE

* Not all species or species groups "behave" in the same manner at different scales. Many other factors (species interactions, physiological stresses, oceanographic or physical factors, human impacts) can contribute to how well a species fares within its range.

* Some transects may be "hotspots" for abundance. However, they may not correspond to the Area where maximum mean abundance may occur.

* The nested design and the large geographical scope of our study allow us to scale up or down depending on specific management goals or scope of basic scientific study to answer ecological questions in the context of their functional scale.
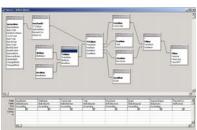
TAXONOMIC RESOURCE

As a training and organizational tool, we have compiled an algal and invertebrate database that includes the species we observe in the field. This web-based resource contains pictures and descriptions of approximately 600 different species. We use this resource to help identify species we see in the field, to teach identification skills to interns, and to resolve differences between scientists in species identification. This resource is available to the public at http://www.piscoweb.org/research/community/products/taxonfront.html.

HOW DO WE KEEP TRACK OF ALL THESE DATA?

Because this project generates such large amounts of data, it is critical that we pay close attention to long-term data storage and accessibility. Our strategy has been to store the data in a relational database. This format allows us to query the raw data in a format that is appropriate for the scale of the question. It also allows us to link our physical data with the biological data in a meaningful manner.

FUTURE DIRECTIONS

We will continue to sample these sites on an annual basis to monitor for changes in the biological communities. As we collect more data on the physical characteristics, such as water temperature, nutrient availability, and climatic extremes at the various sites, we will be able to evaluate the likely importance of such factors in structuring biological communities. Because our data set provides a rich picture of diversity at numerous sites, we hope to use the data to inform decisions concerning a variety of issues of interest to the public. Examples include long-term changes due to climatic shifts, the influence of exotic species, and the placement of marine reserves.