# Informing Ocean Energy Planning: Megadata for Detecting Nearshore Impacts

## Understanding Baseline Conditions in the Santa Barbara Channel Ecosystem

As part of their marine resource planning, the **Bureau of Ocean Energy Management (BOEM)** is interested in understanding the long-term trends of the Santa Barbara Channel. But much of these data has been recorded differently across many institutions, hampering the ability of scientists to model the ecosystem effects of oil spill scenarios or proposed wave energy development.

With collaborators at the **National Park Service (NPS)**, **Long Term Ecological Research Network (LTER)**, BOEM, and the **Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)**, USGS researchers are seeking to merge these disparate data sets into **megadata** that can be used for complex, system-scale analyses—providing new directions in environmental impact assessments for this important marine ecosystem.

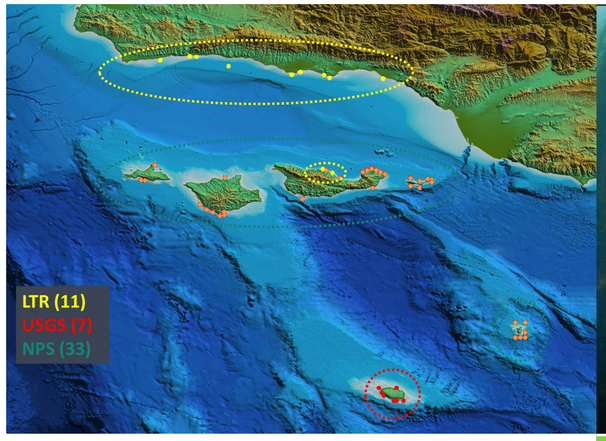
## What Are Megadata?

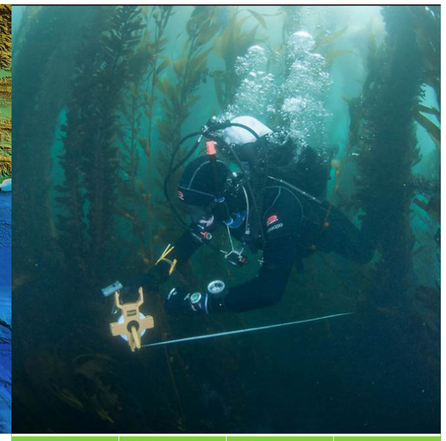
Megadata are sets of data sets. We like megadata for a simple reason: **more is better**. Having data on multiple variables from multiple places at multiple time periods gives us a better picture of baseline variation in dynamic systems like the Santa Barbara Channel. **Megadata improve our ability to detect environmental changes that might result from human activity.**

The challenge with megadata is getting different data sets to talk nicely to one another.

Fortunately for marine resource planners, the Santa Barbara Channel is well-studied. Several institutions—USGS, NPS, LTER, PISCO—have been conducting annual diving surveys at more than 60 sites, some going back to the early 1980's. Divers take counts of living things like fish, invertebrates, and kelp using transects and quadrats.

Unfortunately, each institution counts things and organizes data a bit differently. But if we can transform and merge these data sets together into megadata, we will have much more powerful means of understanding nearshore systems and detecting impacts.



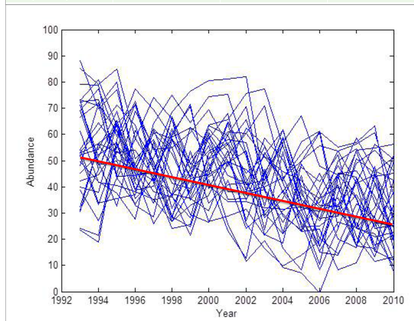



## Working with Megadata

So far, we have been working with USGS, NPS, and LTER data sets (map of study area and sites that we have worked with to date, **above**). More than 1,000 site x data samples have been incorporated (table, **right**). We are also proposing to add the extensive PISCO diver survey data to the megadata effort.

| | USGS | NPS | LTER |
|---|---|---|---|
| Point Contact | 200 points | 600 points | 80 points x 2-8 transects |
| Benthic counts | 100 $m^2$ | 480 $m^2$ | 2-8 80 $m^2$ transects |
| Fish Counts | 400 $m^2$ | 100 $m^2$ | 2-8 80 $m^2$ transects |
| Sampling frequency | twice per year | once per year | once per year |

Because diver surveys are hard work and very expensive, there is incredible added value to combining data sets for analysis. Long-term trends can emerge from messy data when you look at enough sites over enough time (**right**).

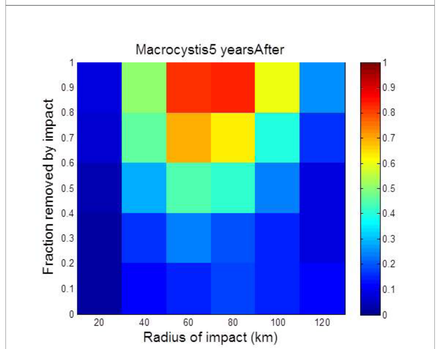



Challenges in merging data sets include reconciling different taxonomic resolutions, frequency of sampling, fish counting methods, and number of replicates sampled. This approach could be used for other data sets, such as **Pacific nesting seabird data** and **coral reef transects**—no doubt of high interest to BOEM planning.

## Analytical Power

Despite the challenges, megadata affords us the ability to do models like **mock BACI analyses** of impacts (Rassweiler *et al.* in prep.) on the scale of a platform or tanker spill. We would gain the ability to detect impacts of various sizes and intensities on kelp (colored figure, **right**).

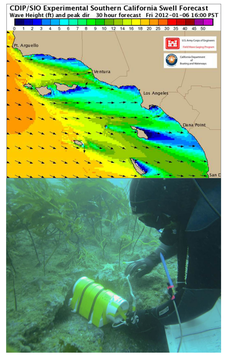
This example show that even with many sites, detecting impacts to kelp will be difficult due to high interannual variation. Adding sites and using covariates to help explain interannual variation could solve this problem. Or, focusing on less variable taxa could provide more power to detect change.



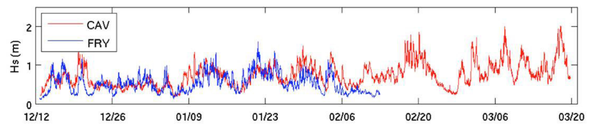

## Potential Applications: Wave Energy Effects

One data type not captured in diver data is **waves**. Wave energy actively affects nearshore ecosystems; understanding the **wave climate** for each site for each year would be very valuable.

Fine-scale differences in structure and depth from site to site means that we cannot just take wave energy data from existing data sets like CDIP (**right**). We need to ground-truth the amount of wave energy that organisms experience at each site. To assist this, BOEM has funded the construction and deployment of pressure sensors (**right**) designed by UCSB oceanographer Libe Washburn, which collect wave height data otherwise not quantified (time series of wave heights at two sites, **below**).




We propose to use these new data to build statistical models for the effect of wave energy on nearshore ecosystems. **Such models would enable BOEM to assess potential environmental effects of wave-energy projects.** For example, what changes would we see if a project reduced mean wave height by 10 percent?




## Project Snapshot

MEGADATA FOR DETECTING NEARSHORE IMPACTS TO THE SANTA BARBARA CHANNEL, CALIFORNIA

Kevin D. Lafferty

PROJECT DESCRIPTION
As part of their marine resource planning, BOEM is interested in understanding the long-term trends of the Santa Barbara Channel. But much of these data has been recorded differently across many institutions, hampering the ability of scientists to model the ecosystem effects of oil spill scenarios or proposed wave energy development. Now, USGS researchers are seeking to merge these disparate data sets into megadata that can be used for complex, system-scale analyses.

The resulting megadata offers the ability to do models like mock BACI analyses of impacts on the scale of a platform or tanker spill—gaining the ability to detect impacts of various sizes and intensities on kelp. And if coupled with fine-scale sensor data of wave climates, statistical models could be built allowing BOEM to assess the potential environmental effects of wave-energy projects on nearshore ecosystems, under scenarios such as wave-height reduction.

KEY COLLABORATORS
Mike Kenner, Tim Tinker (USGS WERC) • David Kushner (NPS) • Andrew Rassweiler, Dan Reed (LTER) • Donna Schroeder (BOEM) • Jenn Caselle (PISCO)

RECENT PUBLICATIONS
DJ Kushner, A Rassweiler, JP McLaughlin, KD Lafferty. 2013. A multi-decade time series of kelp forest community structure at the California Channel Islands. Ecology 94:2655 doi: 10.1890/13-0562R.1

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