FAR FROM BASIC: Locating Ocean Acidification Monitoring Gaps and Hotspots within the California Current

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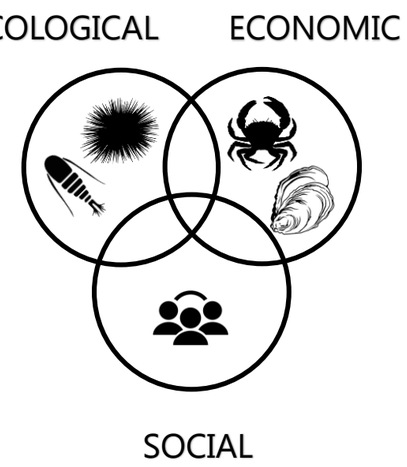
Spring 2018 | Project Brief

BACKGROUND

Ocean acidification (OA) is a global problem with particular regional concern in the California Current System. Ocean acidification results from the ocean absorbing carbon dioxide from the atmosphere, causing seawater to become acidic. This changes ocean chemistry, making it difficult for marine organisms to build and maintain hard shells. Many of these marine organisms have high economic, ecological, and social value on the West Coast.

Certain areas acidify at faster rates than others, creating hotspots. Acidification hotspots threaten the ecosystems along the West Coast that states have been working to protect. Over 400 marine protected areas (MPAs) have been established Washington, Oregon, and California with the overarching goal of marine conservation; however, OA may challenge the effectiveness of these protections.



PROBLEM

Scientists and managers of the West Coast Regional Planning Body identified ocean acidification as a priority issue for the West Coast. Large data gaps make changing ocean conditions difficult to understand on a regional scale. We identified two key problems in managing for OA in the California Current System:

Monitoring
Ocean acidification monitoring is inconsistent along the West Coast

Evaluation
MPA managers have no framework to evaluate risk to ocean acidification

OBJECTIVES

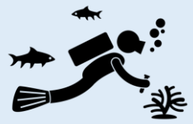
1. Develop a method to identify gaps in West Coast ocean acidification monitoring network

2. Locate and map acidification hotspots to determine which MPAs are most impacted

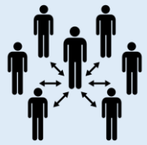
NEXT STEPS

CLOSING THE GAPS

Upgrade existing monitoring assets to maximize coverage of aragonite measurements

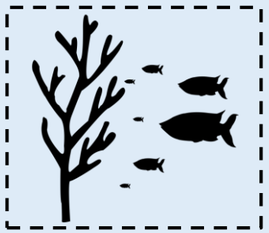


Pair biological and physical monitoring to increase knowledge of biological impacts

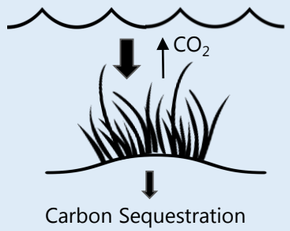


Ensure public access to data so that managers can make informed decisions

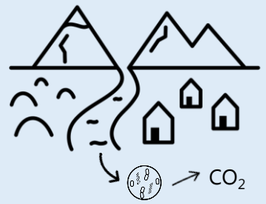
MANAGEMENT MOVING FORWARD



Strengthen ability of marine organisms to adapt to OA through MPAs



Remove CO_2 in seawater through seagrass and kelp restoration



Reduce local water pollutants that intensify ocean acidification

CONCLUSIONS

- Closing data gaps will increase our regional understanding of ocean acidification
- Consistent data will strengthen analysis of hotspot trends
- Improved monitoring and evaluation will facilitate strategic management of ocean acidification

ACKNOWLEDGMENTS

We would like to thank our advisors who assisted us with our project: Dr. Bruce Kendall, Alexa Fredston-Hermann, Dr. Ben Best and Dr. Ben Halpern, as well as our clients Andy Lanier, Dr. Steve Steinberg, and John Hansen. This project also received valuable assistance from Jennifer Phillips, Sara Briley, Daniel Sund, Caren Braby and Dr. Richard Feely. This research is funded [in part] by the Gordon and Betty Moore Foundation and the James S. Bower Foundation.

Banner Photo Credit: Jonathan Irish, National Geographic

References: Assis, J. et al. "Bio-ORACLE v2.0: Extending marine data layers for bioclimatic modelling." *Global Ecology and Biogeography* 27.3 (2017): 277-284.; Chan, F., et al. "Emergence of anoxia in the California Current large marine ecosystem." *Science* 319.5865 (2008): 920-920.; Feely, Richard A., et al. (2015). *Chemical and hydrographic profile measurements during the 2013 West Coast Ocean Acidification Cruise (WCOA2013, August 3-29, 2013)*.

MONITORING

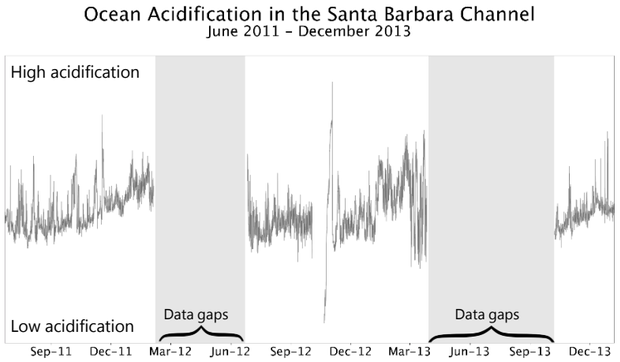
Objective 1: Develop a method to analyze gaps in West Coast ocean acidification monitoring network.

METHODS

Using the West Coast Ocean Acidification and Hypoxia Monitoring Inventory, we analyzed gaps in the overall monitoring network of the West Coast. We defined large data gaps as areas that are 1) spatially distant from other monitoring sites, and 2) areas that differ in ocean condition (or high variability) from nearby monitoring sites. We used global models of sea surface temperature and dissolved oxygen to represent oceanographic variability.

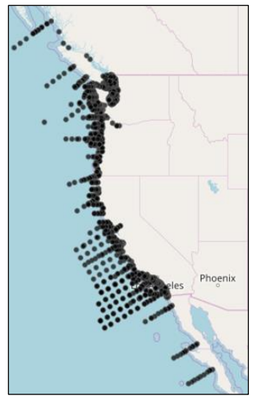
RESULTS

How are we currently monitoring our oceans?
Buoys, cruises, surveys, sensors, and satellites all collect information we use to understand the ocean.



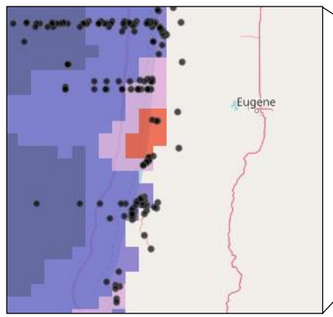
Ocean acidification data collected at Alegria Reef. Data source: Santa Barbara Channel Long Term Ecological Research Group

What is an ideal monitoring network?
An ideal monitoring network will have adequate spatial and temporal coverage. It will take biologically relevant measurements, and it will have a higher density of monitoring stations where there is more variability.

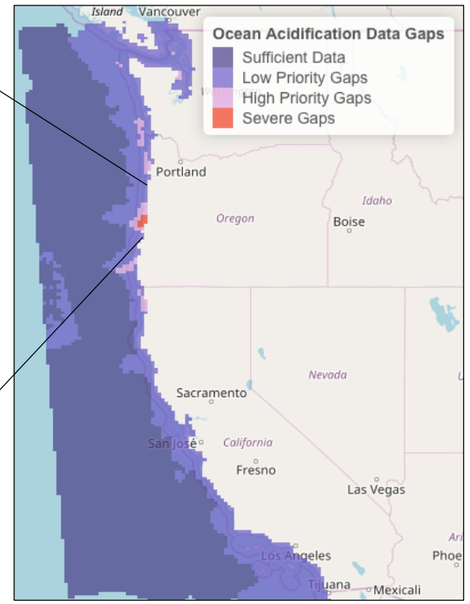


How can we improve the current monitoring network?

- Establish more monitoring sites in areas of high oceanographic variability
- Increase temporal frequency of monitoring to better understand OA trends
- Ensure existing monitoring sites collect data that relates to biological impacts of OA



There is currently inadequate monitoring off the coast of central Oregon due to high oceanographic variability in that region.



EVALUATION

Objective 2: Locate and map acidification hotspots to determine which MPAs are most impacted.

METHODS

We used NOAA West Coast Ocean Acidification Cruise data to create a hotspot map of aragonite saturation state values throughout the California Current System. Aragonite is the mineral that many calcifying organisms use to build shells and it is reduced in acidified waters. We defined hotspots as areas with high levels of ocean acidification that negatively impact marine organisms. We identified MPAs with the lowest aragonite saturation state values and those that occur within ocean acidification hotspots.

RESULTS

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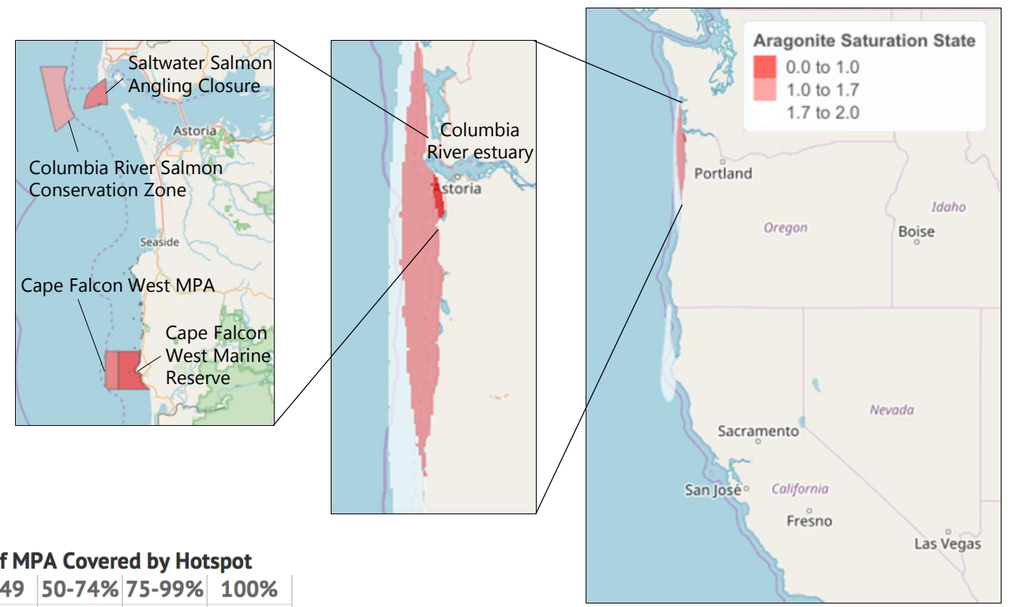
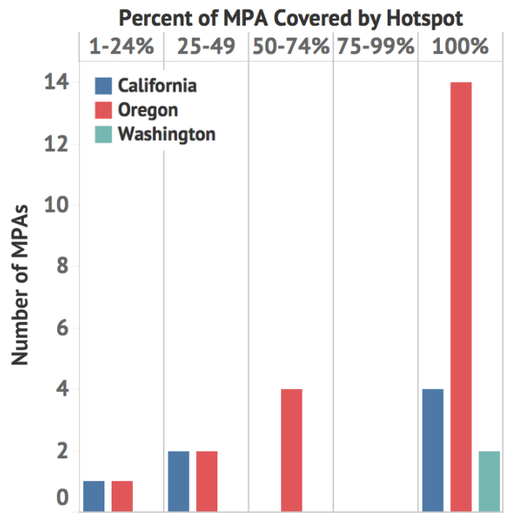
MPAs are within hotspot at the Columbia River estuary





What is a hotspot?

- A place in the ocean where acidification negatively impacts marine organisms

Aragonite Saturation State Values:

- 0-1 Dissolution of shells
- 1-1.7 Negative effects on aquaculture
- 1.7-2 Negative effects in lab

- Caused by oceanographic conditions (upwelling) and local factors (nutrient inputs)