A Primer on Ocean Acidification and NOAA's OA Program

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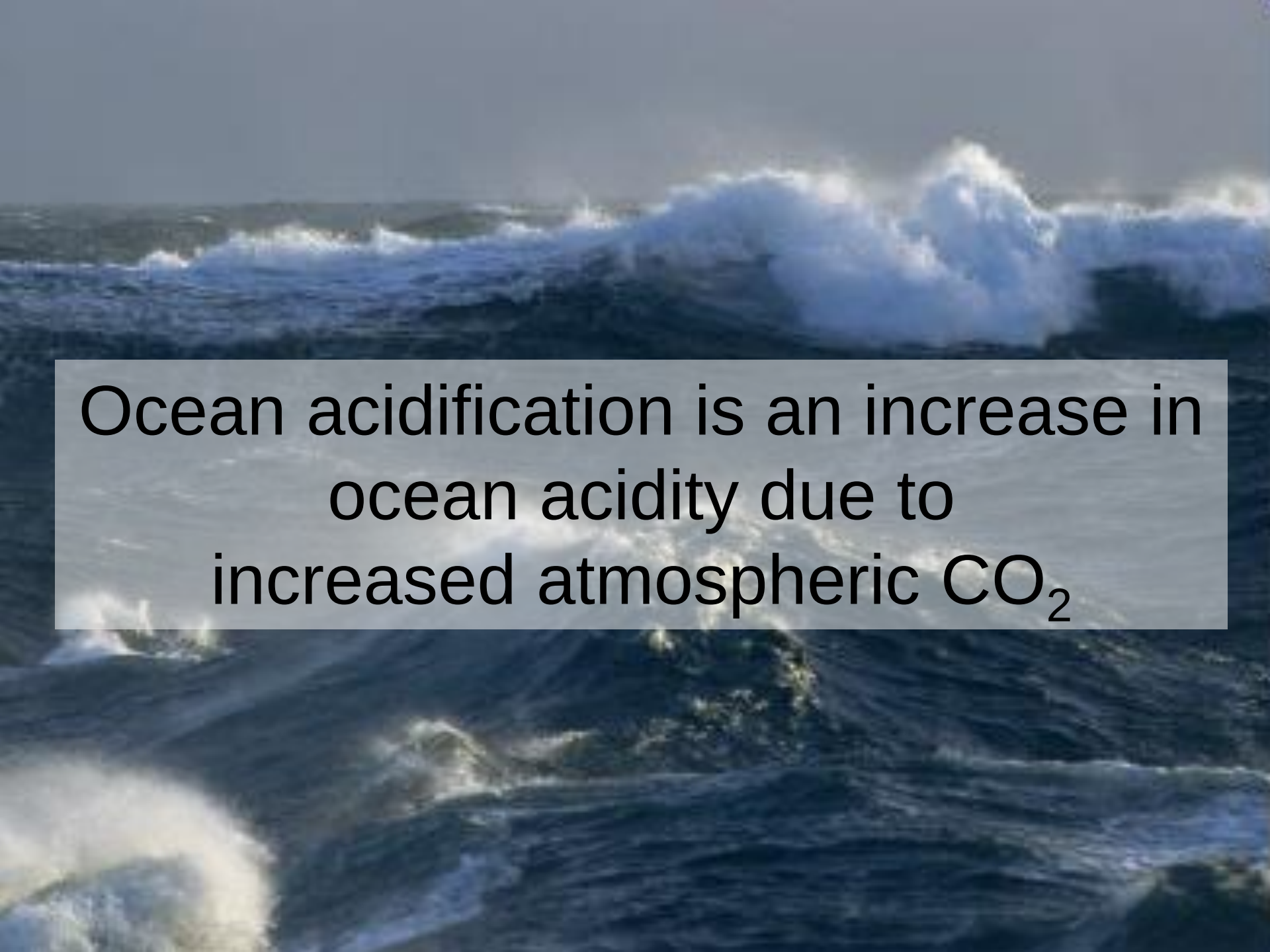
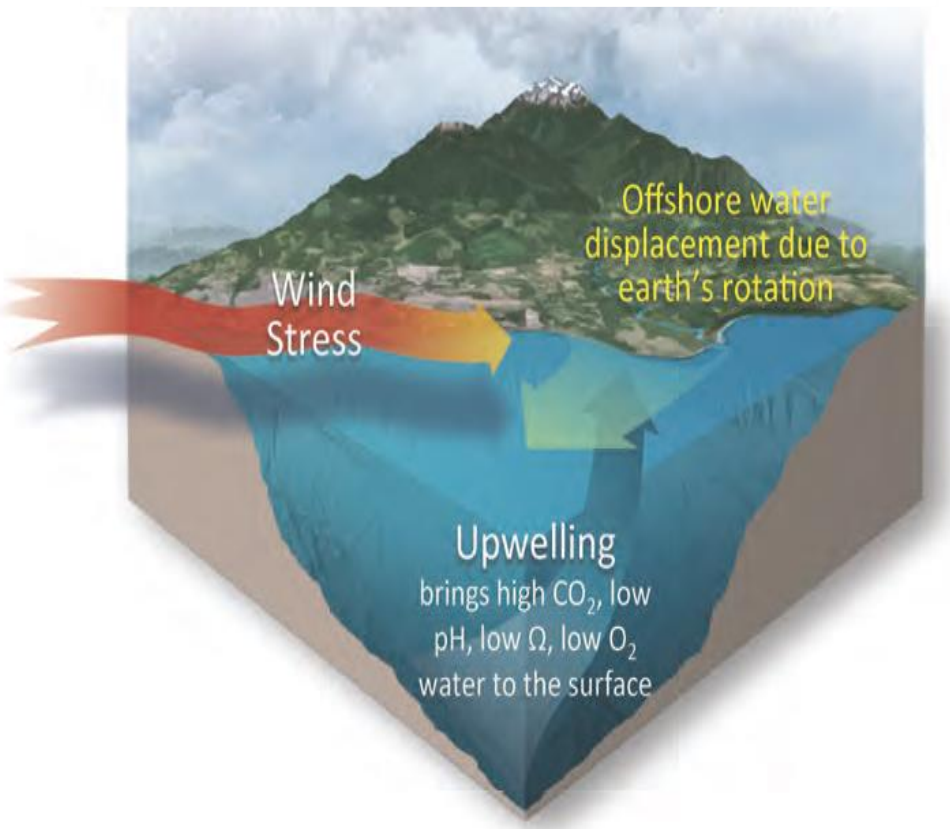


Ocean acidification is an increase in ocean acidity due to increased atmospheric CO_2

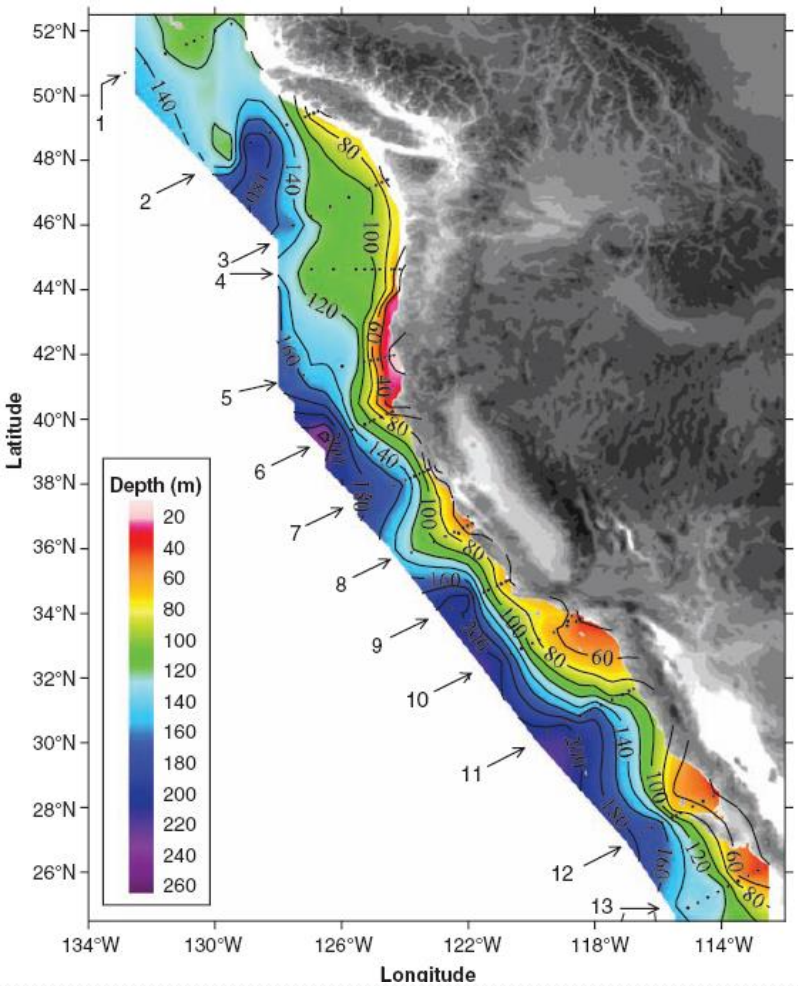
Ocean acidity could increase 100-150% by the year 2100.

The rate of acidification is 10-100 times faster than any time in the last 50 **MILLION** years.

Local oceanography

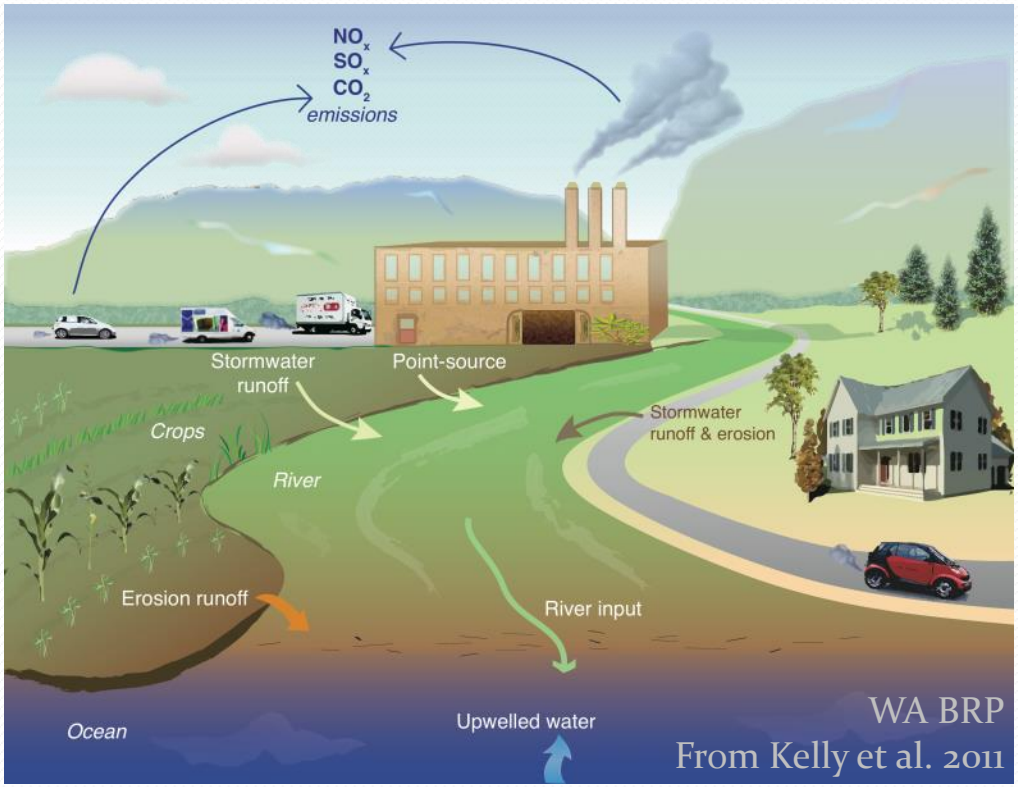


NOAA PMEL

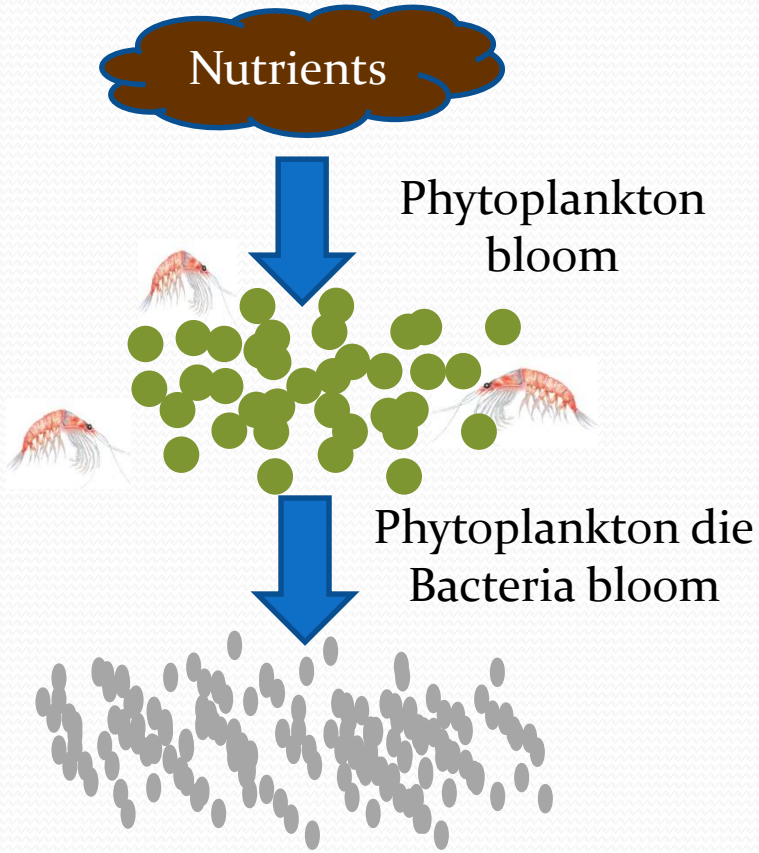


Feely et al. 2008

Nutrients and acidification



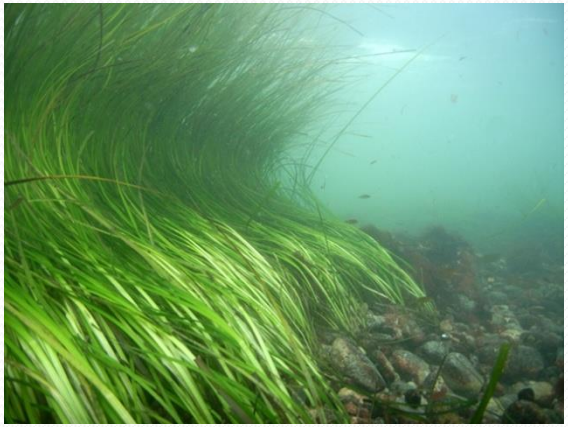
WA BRP
From Kelly et al. 2011



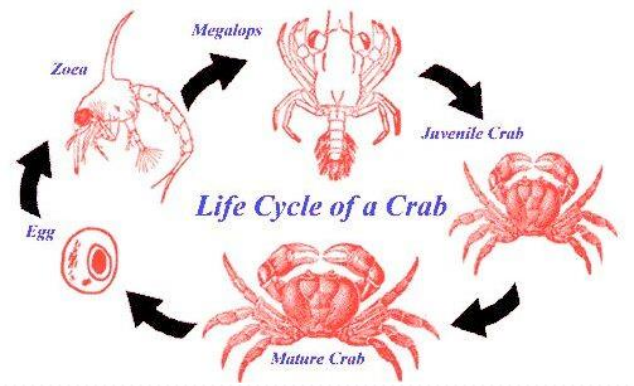
Bacteria consume oxygen, respire carbon dioxide

OA can have many effects

Respiration/Photosynthesis

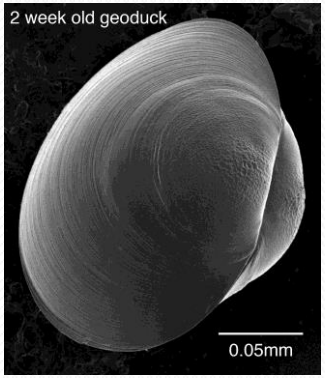


Development

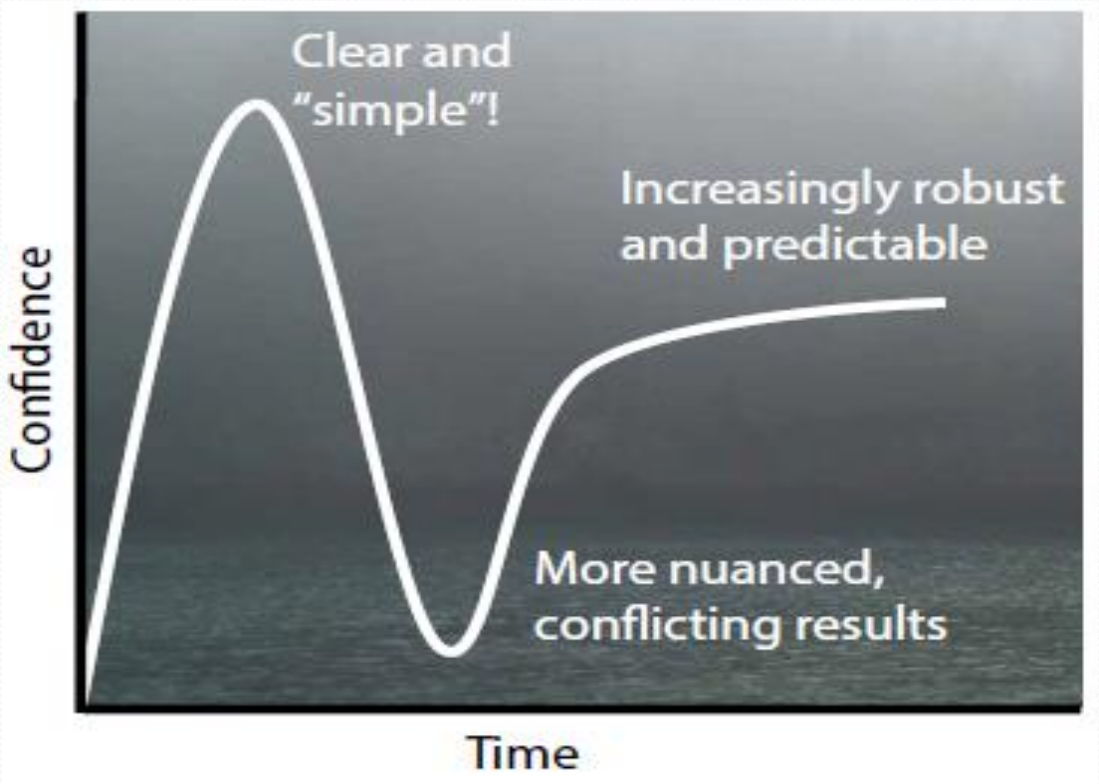


Behavior/Nervous system

Growth

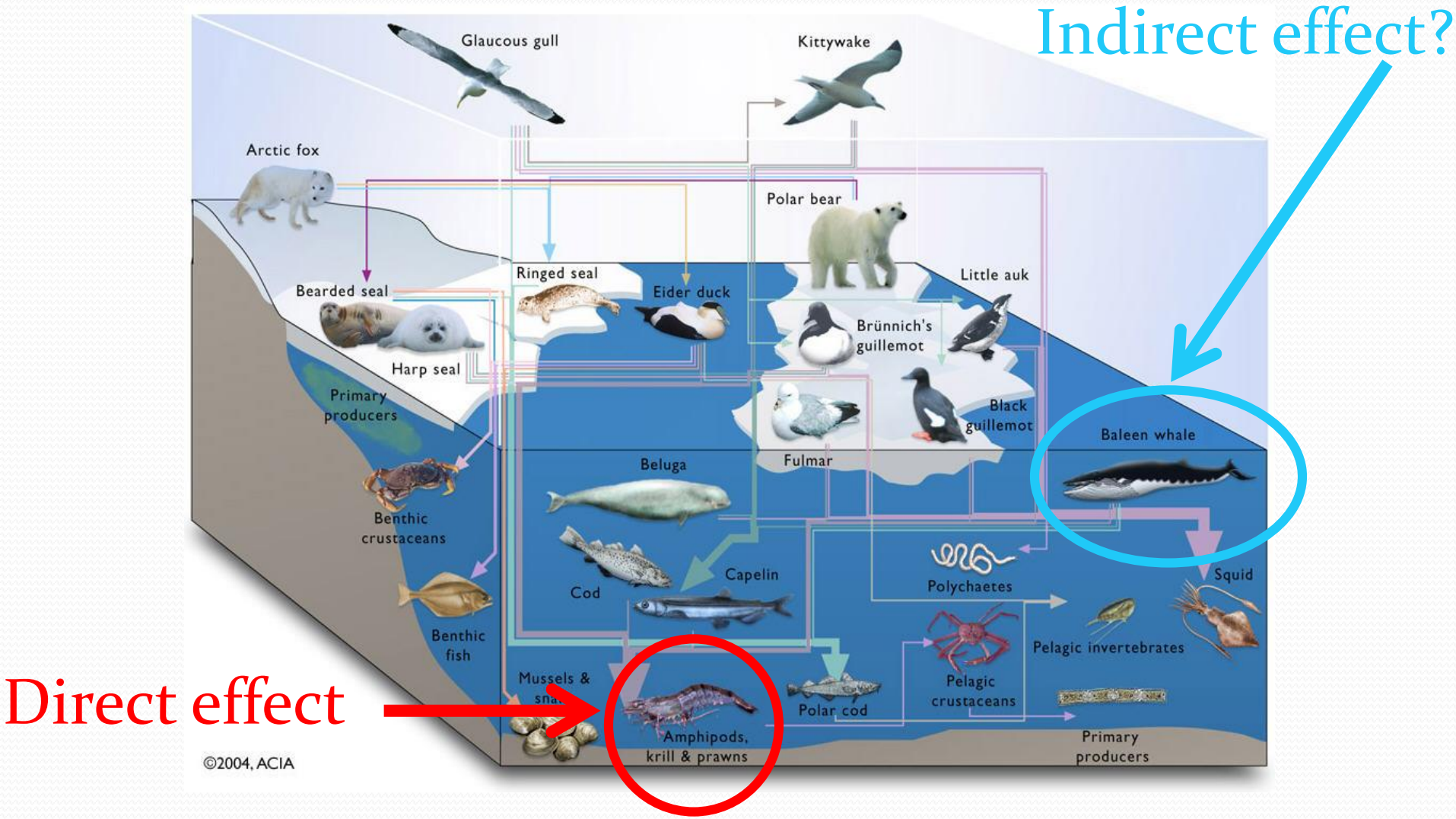


Development of OA science



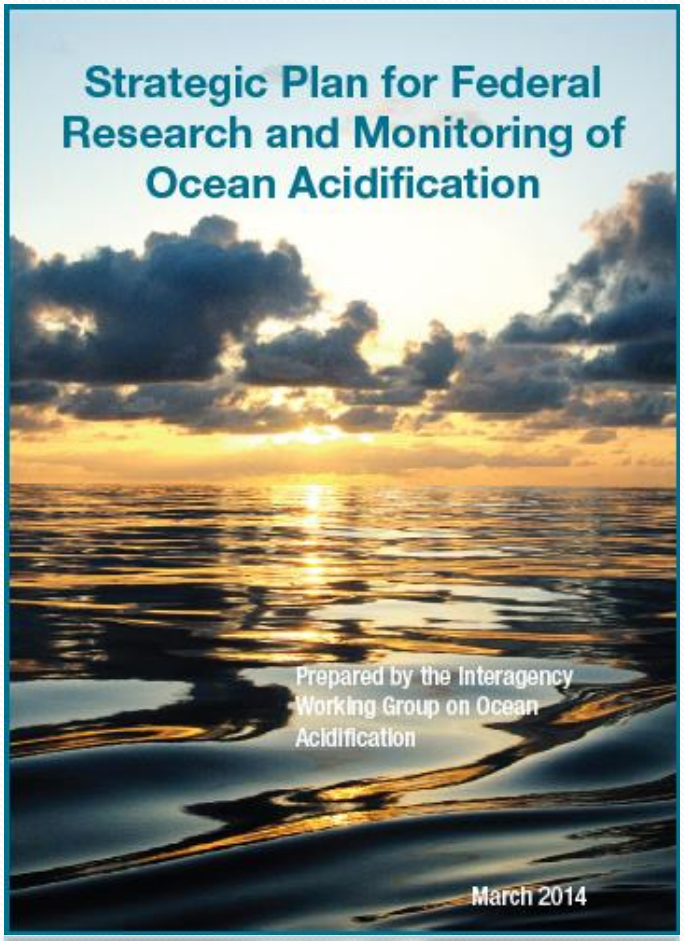
Busch et al 2015

Complex systems have complex responses



http://marinebio.org/Oceans/Biotic-Structure.asp

Interagency Working Group on OA



Vision

"A nation, globally engaged and guided by science, sustaining healthy marine and coastal ecosystems, communities, and economies through informed response to ocean acidification"

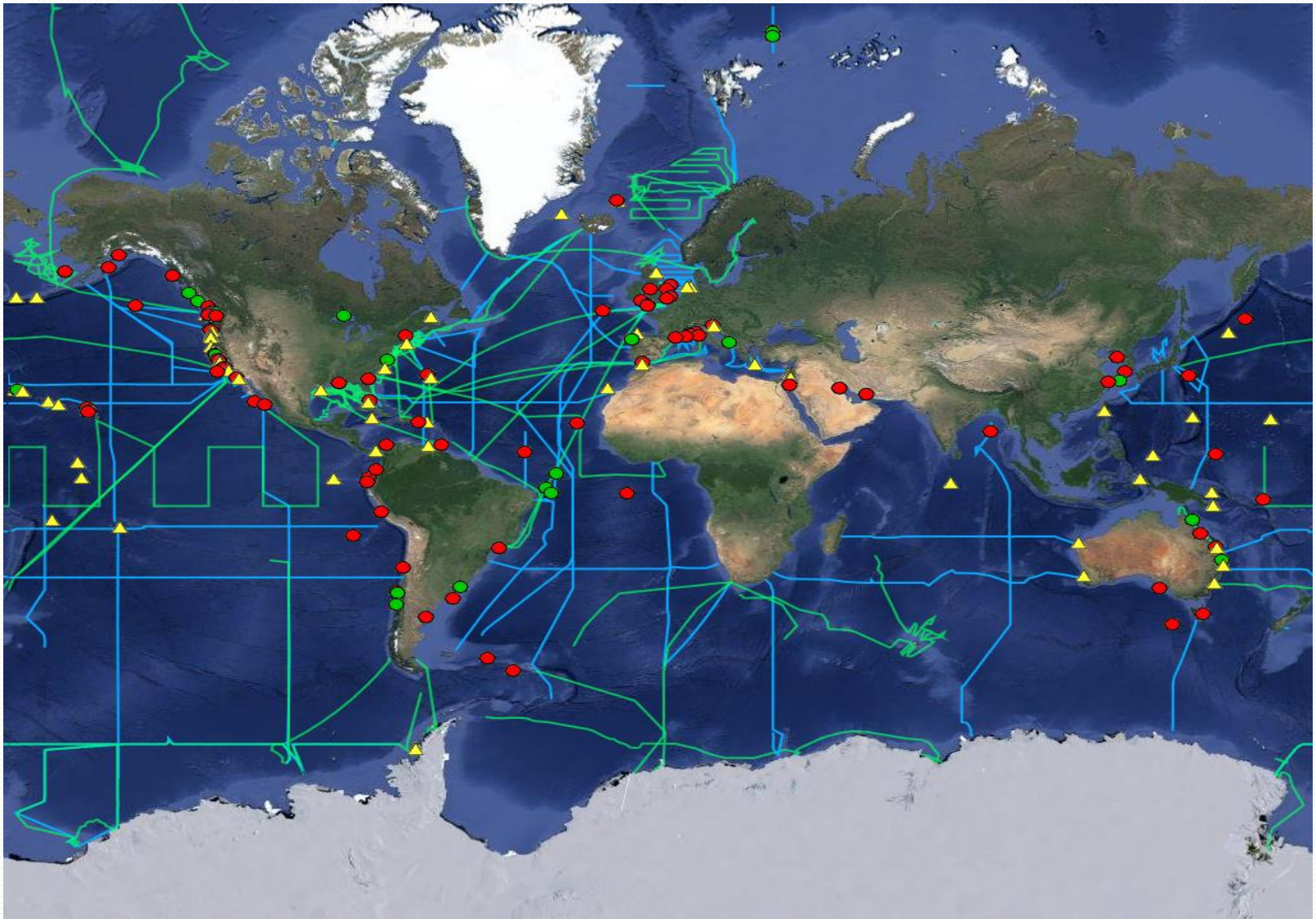
March 26, 2014

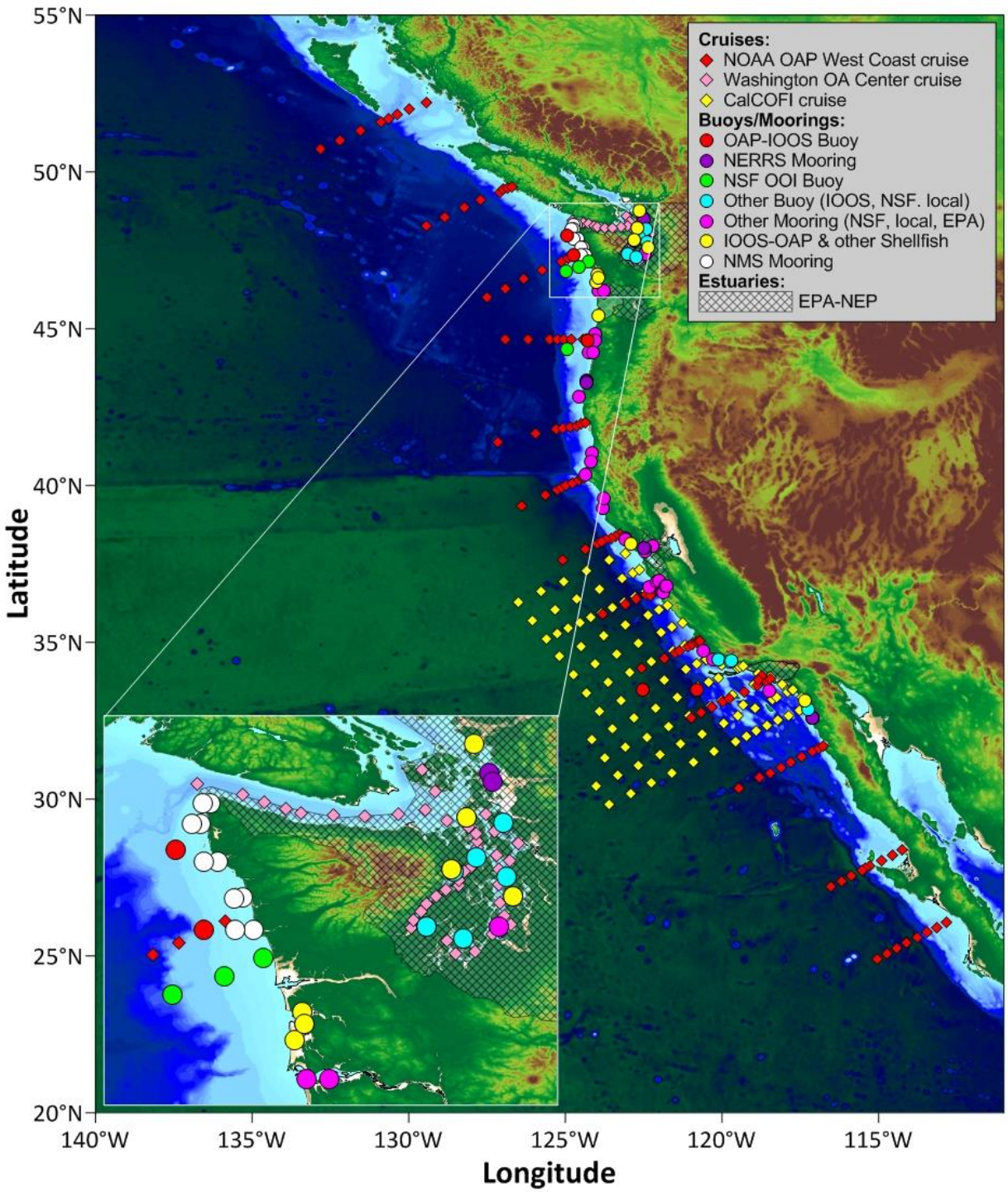
Monitoring
Biological & Ecosystem Response
Data Management
Modeling
Adaptation Strategies
Education & Outreach
OAP
NOAA OCEAN ACIDIFICATION PROGRAM

OAP Observing Portfolio

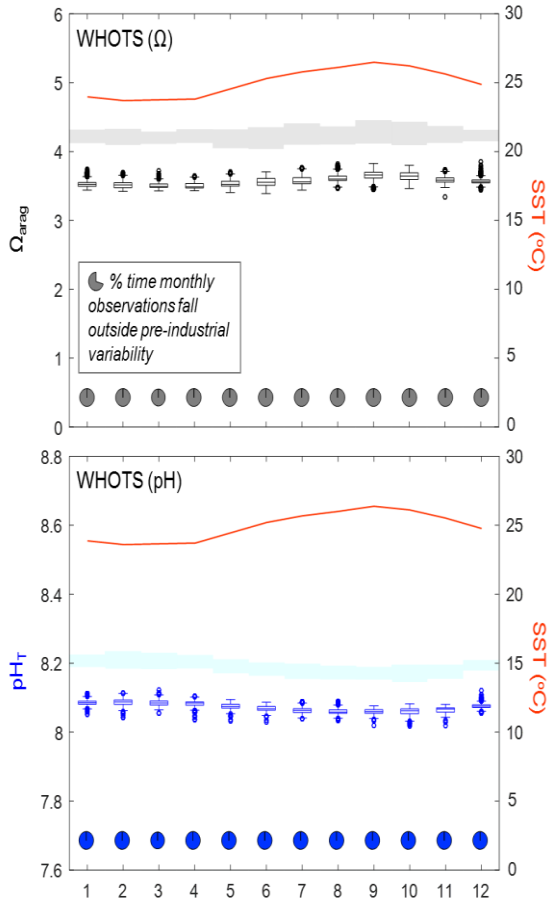
- Assess the current state and development of OA
- Understanding of spatial and temporal variability in carbonate chemistry and the processes that drive this variability
- Produce validated maps, meta data and underlying data
- Continue long-term record of dynamics and processes controlling OA on the coastal shelves

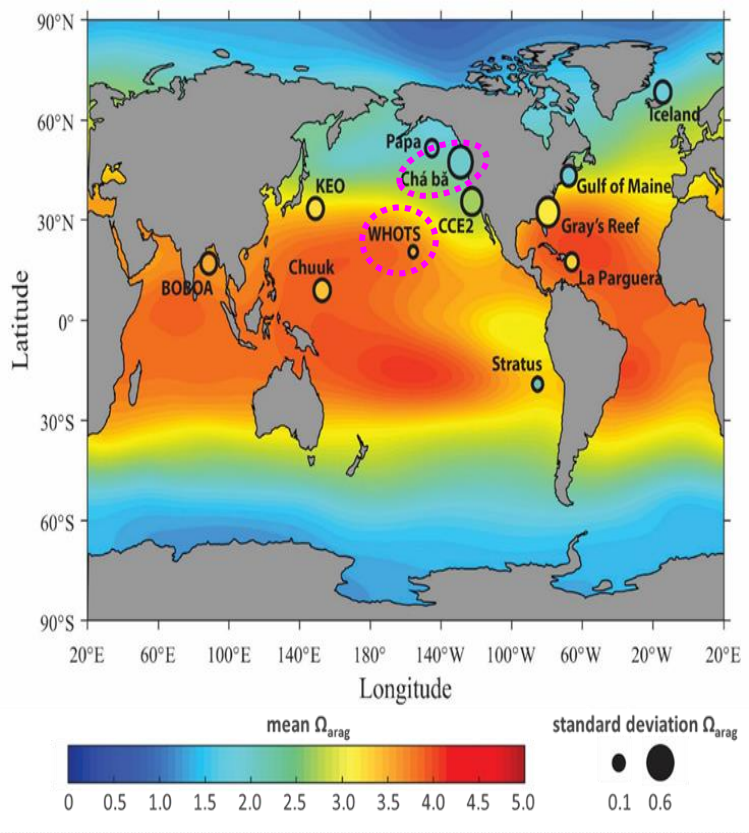
Global OA Observing Network



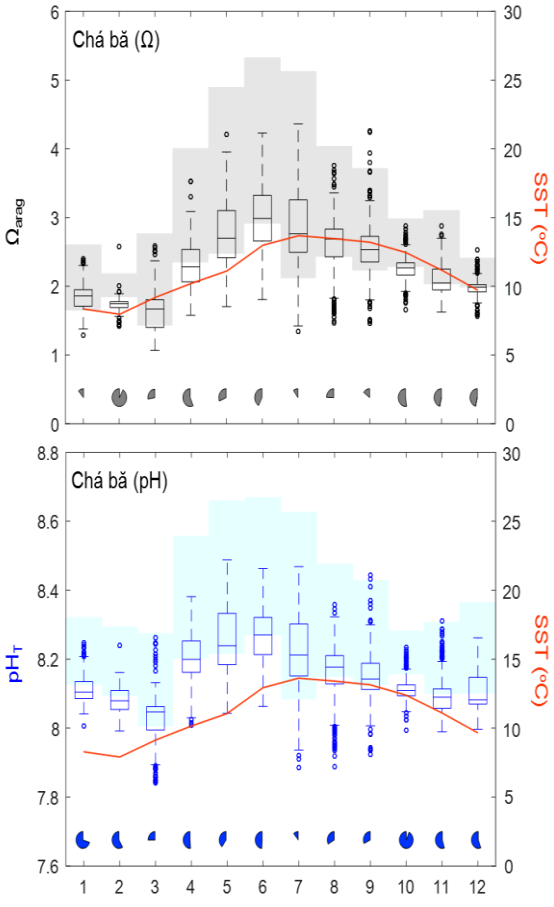

Cruises:
NOAA OAP West Coast cruise
Washington OA Center cruise
CalCOFI cruise
Buoys/Moorings:
OAP-IOOS Buoy
NERRS Mooring
NSF OOI Buoy
Other Buoy (IOOS, NSF. local)
Other Mooring (NSF, local, EPA)
IOOS-OAP & other Shellfish
NMS Mooring
Estuaries:
EPA-NEP
55°N
50°N
45°N
40°N
35°N
30°N
25°N
20°N
Latitude
140°W
135°W
130°W
125°W
120°W
115°W
Longitude

Open Ocean vs. Coast



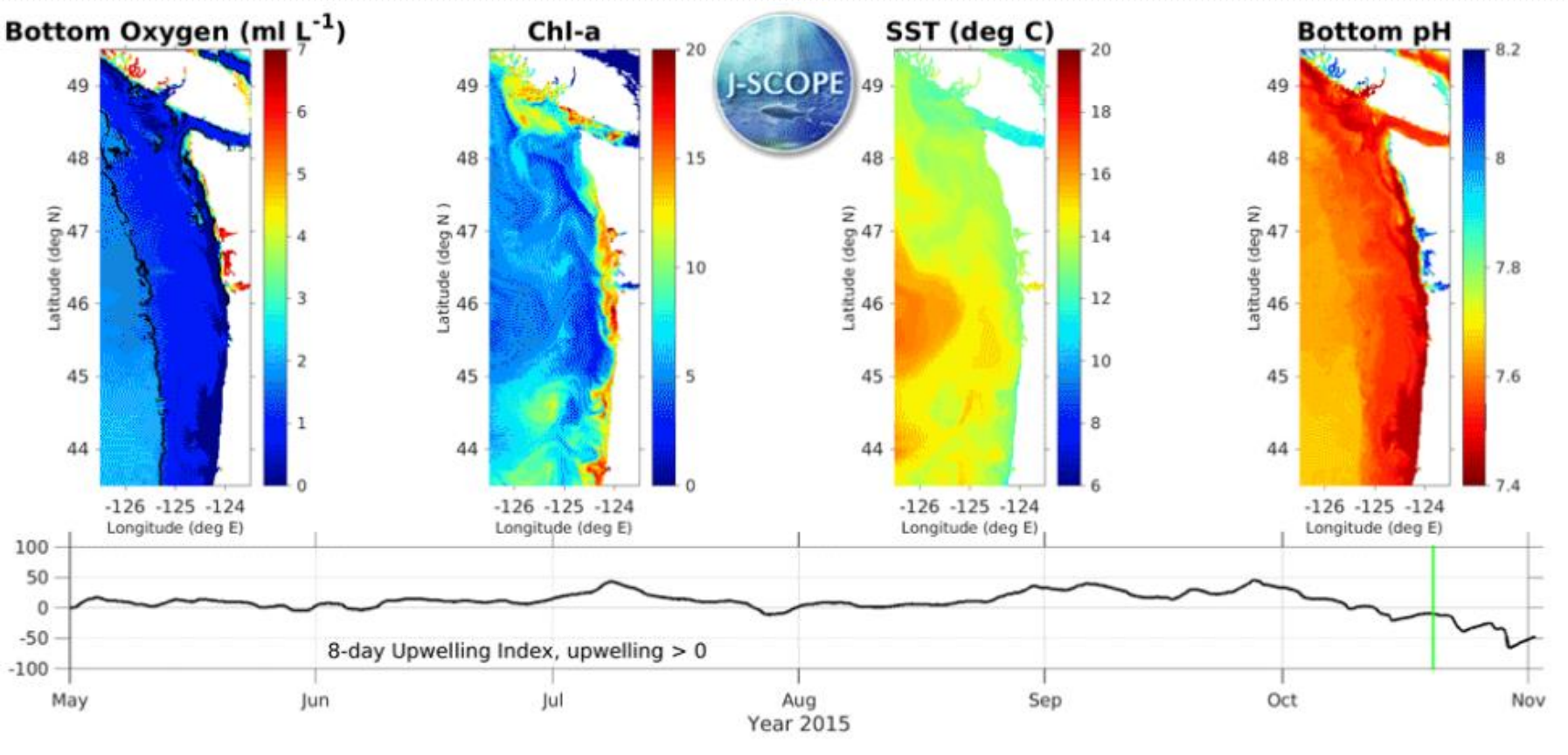


base map from Jiang et al. 2015



After Sutton et al (in prep)

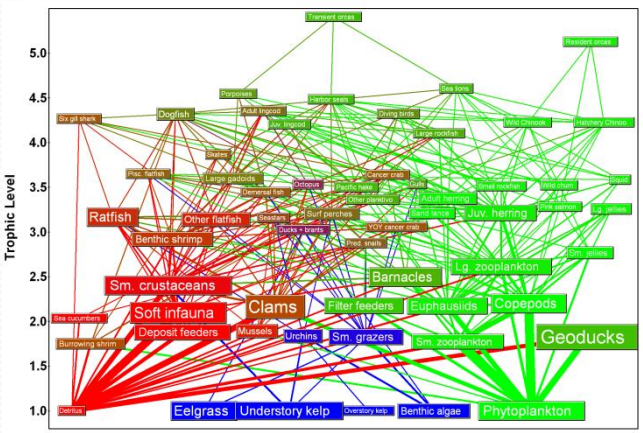
OA Model and Forecasts



Northwest Fisheries Science Center

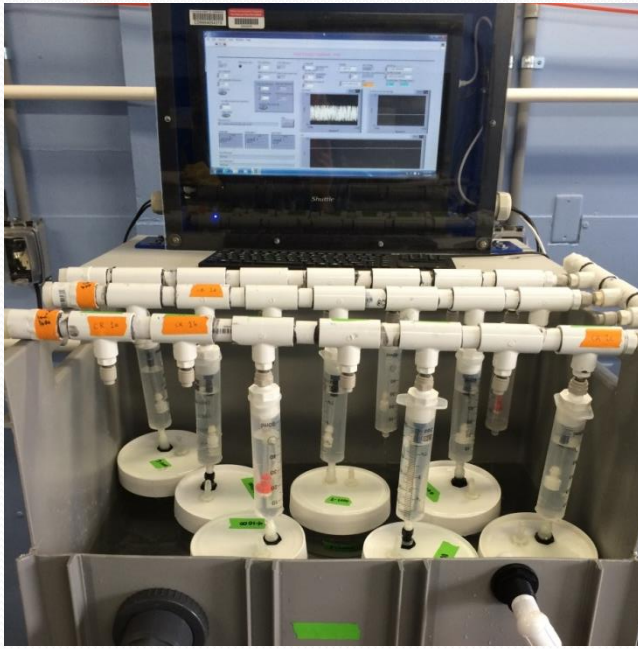
Understanding how physical, chemical, biological and ecological processes interact in the California Current System and Salish Sea, such that managers can make informed choices of how to account for OA effects in their decision-making

Experiments



Field work

Modeling



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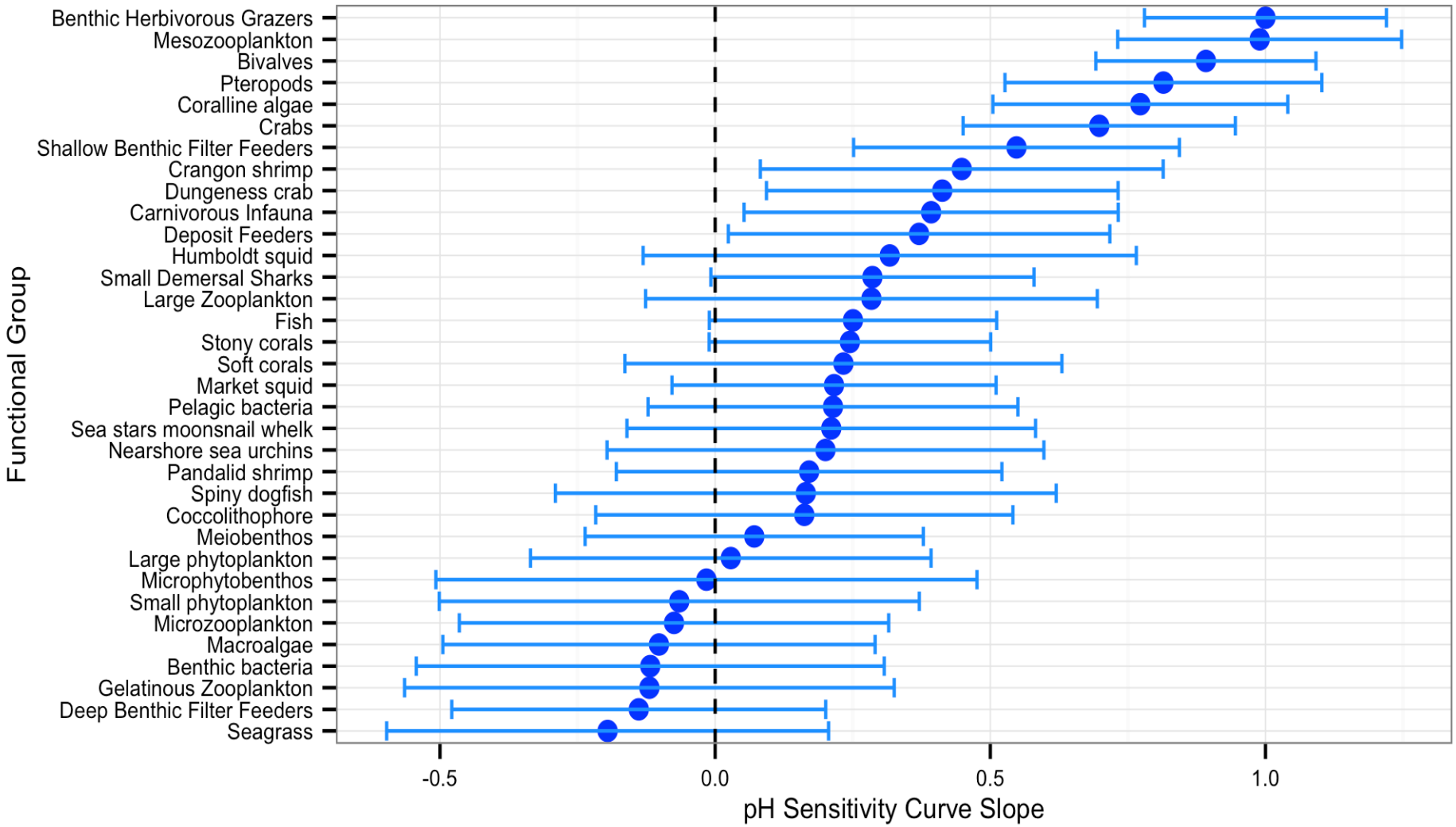
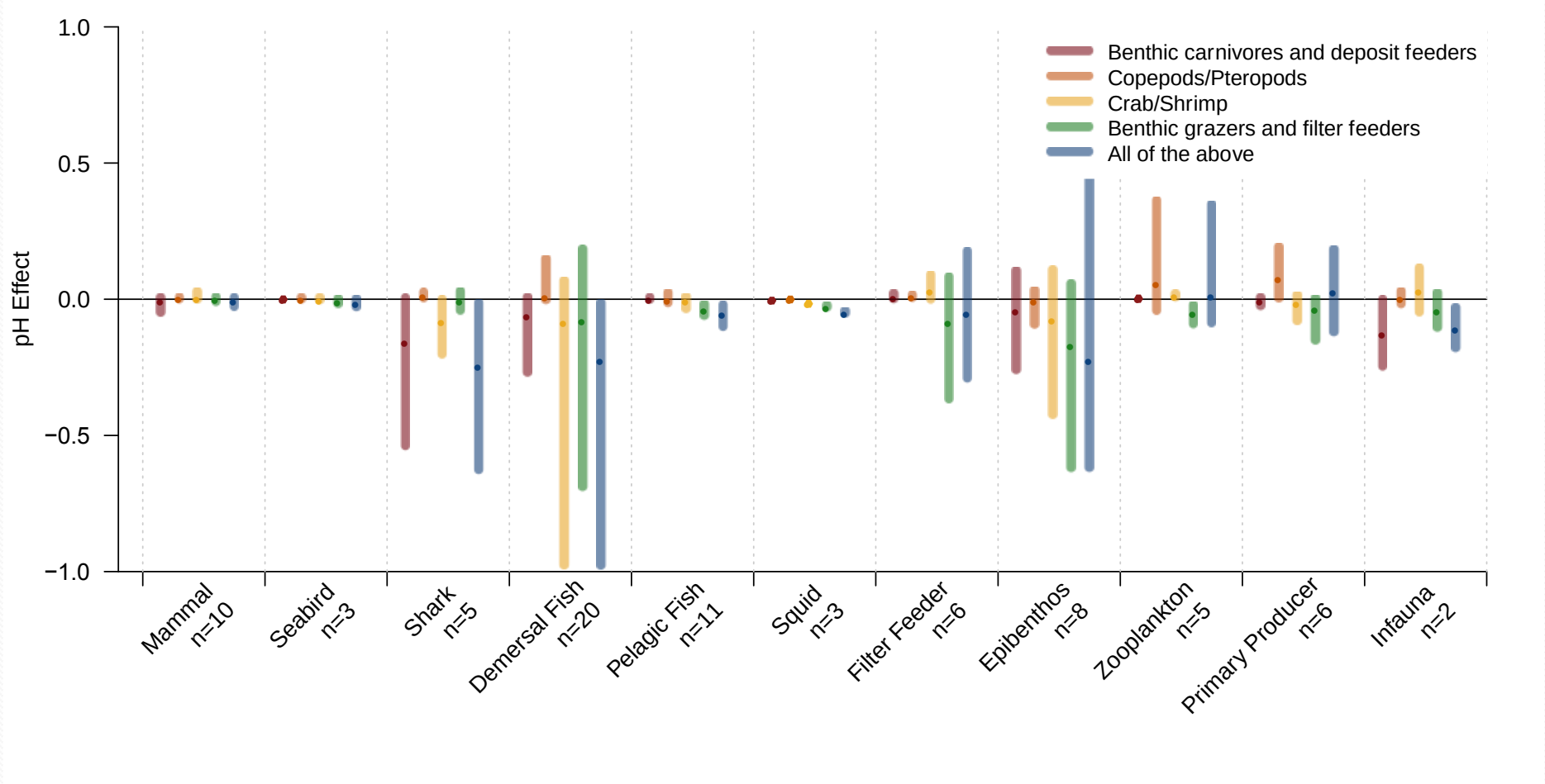

Benthic Herbivorous Grazers
Mesozooplankton
Bivalves
Pteropods
Coralline algae
Crabs
Shallow Benthic Filter Feeders
Crangon shrimp
Dungeness crab
Carnivorous Infauna
Deposit Feeders
Humboldt squid
Small Demersal Sharks
Large Zooplankton
Fish
Stony corals
Soft corals
Market squid
Pelagic bacteria
Sea stars moonsnail whelk
Nearshore sea urchins
Pandalid shrimp
Spiny dogfish
Coccolithophore
Meiobenthos
Large phytoplankton
Microphytobenthos
Small phytoplankton
Microzooplankton
Macroalgae
Benthic bacteria
Gelatinous Zooplankton
Deep Benthic Filter Feeders
Seagrass
Functional Group
-0.5
0.0
0.5
1.0
pH Sensitivity Curve Slope

OA ecosystem modeling in Cali. Current



Understanding carbon chemistry where species live

Mar Biol (2013) 160:1807–1812
DOI 10.1007/s00227-012-2052-0

REVIEW, CONCEPT, AND SYNTHESIS

Appropriate pCO_2 treatments in ocean acidification experiments

Paul McElhany · D. Shallin Busch

OPEN ACCESS Freely available online PLOS | ONE

Seasonal Carbonate Chemistry Covariation with Temperature, Oxygen, and Salinity in a Fjord Estuary: Implications for the Design of Ocean Acidification Experiments

Jonathan C. P. Reum[1]*, Simone R. Alin[2], Richard A. Feely[2], Jan Newton[3], Mark Warner[4], Paul McElhany[1]

1 Conservation Biology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Washington, United States of America, 2 Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, Seattle, Washington, United States of America, 3 Applied Physics Laboratory, University of Washington, Seattle, Washington, United States of America, 4 School of Oceanography, University of Washington, Seattle, Washington, United States of America

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ICES Journal of Marine Science; doi:10.1093/icesjms/fsu231

Interpretation and design of ocean acidification experiments in upwelling systems in the context of carbonate chemistry co-variation with temperature and oxygen

Jonathan C. P. Reum[1*‡], Simone R. Alin[2], Chris J. Harvey[1], Nina Bednaršek[2], Wiley Evans[2,3], Richard A. Feely[2], Burke Hales[4], Noelle Lucey[5], Jeremy T. Mathis[2,3], Paul McElhany[1], Jan Newton[6], and Christopher L. Sabine[2]

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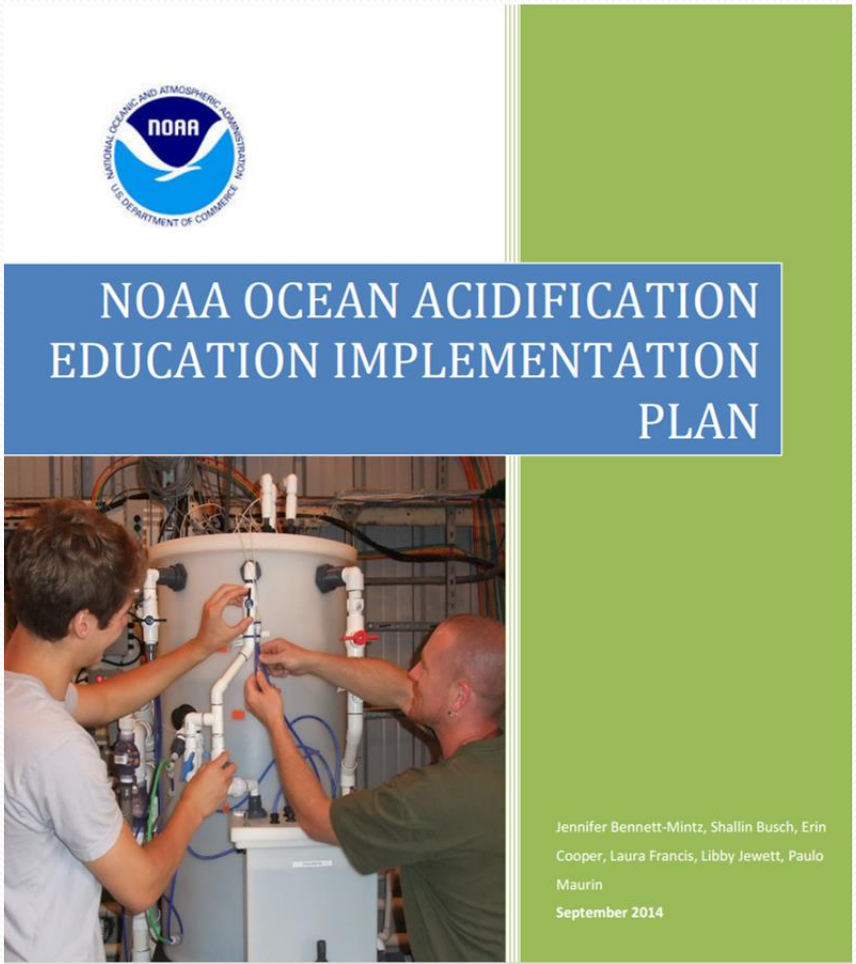
Educational Outreach

SOARCE Webinar Series

- 1100 participants to date
- 2200 listserv members

Education

Education Implementation Plan



Education Needs Assessment

EDUCATION PRODUCT INVENTORY

↓

NEEDS SURVEY

↓

GAPS IDENTIFIED

↓

NEEDS FILLED VIA MINI GRANTS