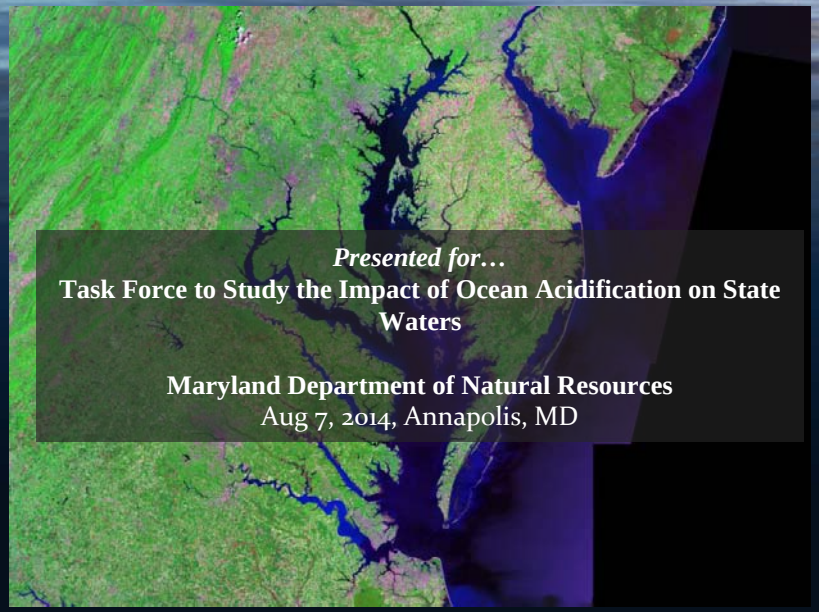
The Impact of Ocean Acidification on Maryland State Waters

National Oceanic & Atmospheric Association
Ocean Acidification Program Office
Libby Jewett (Director)
Dwight Gledhill (Deputy)
Jennifer Bennett
Erica Hudson Ombres
Shallin Busch
Paula Keener-Chavis

>55 projects and activities engaged by NOAA, Regional Partners, Academic Researchers

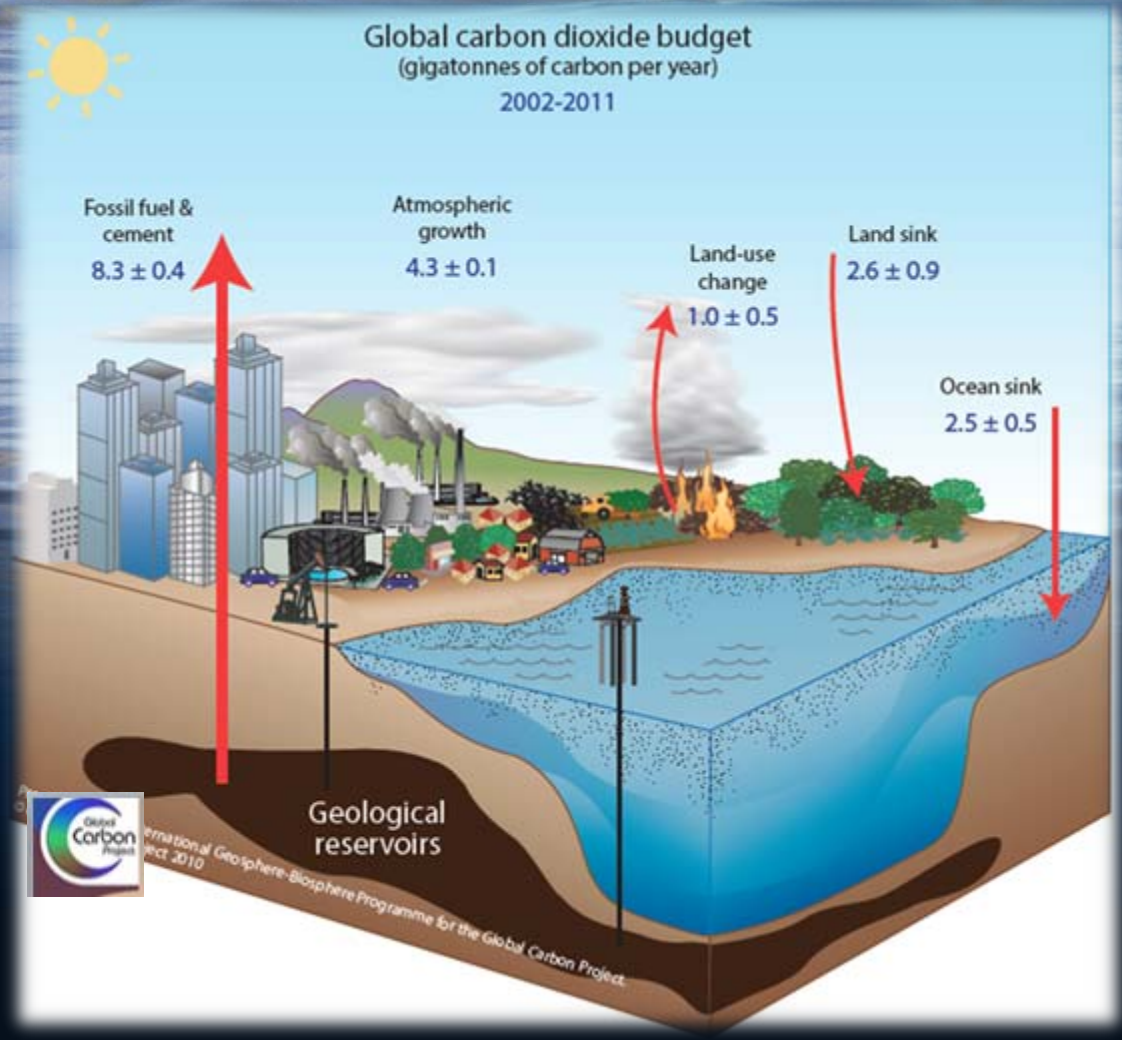


NOAA OCEAN ACIDIFICATION PROGRAM

http://www.oceanacidification.noaa.gov/

OA 101 (V.10)

Ocean Acidification v1.0



A railroad train carrying 2.6 GT of carbon would stretch around the Earth 15 times! – Chris Sabine (NOAA PMEL)

120 GT !
≈ 1/2 of anthropogenic CO_2 taken up by the ocean

1 Gigatones = 10^{15}grams = 1 billion metric tonnes

OAP
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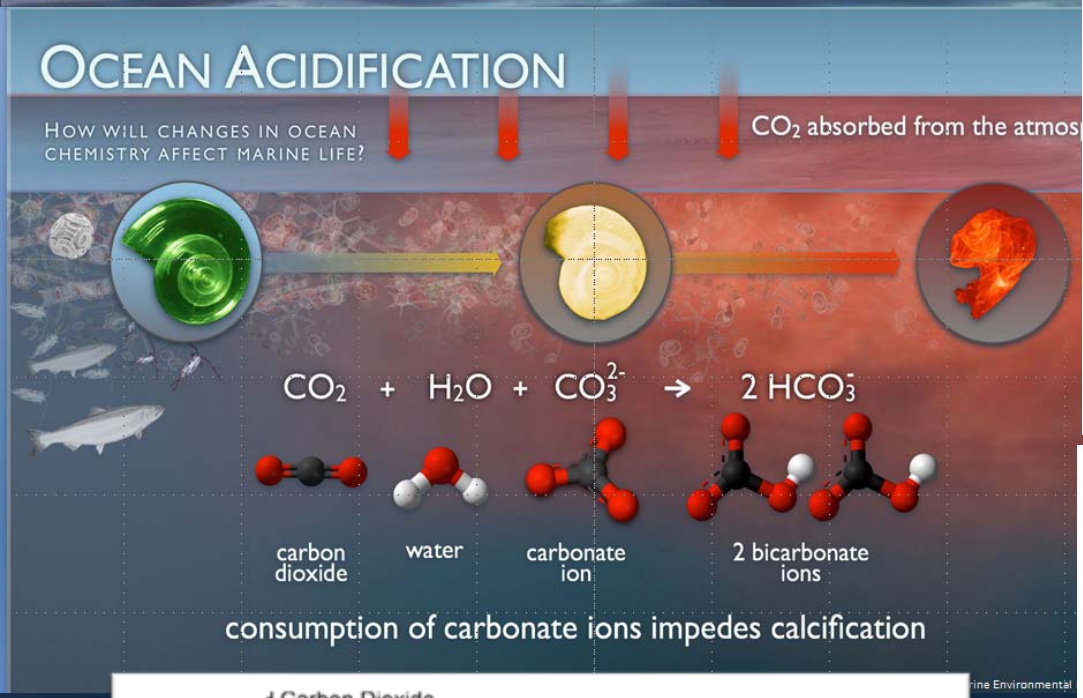
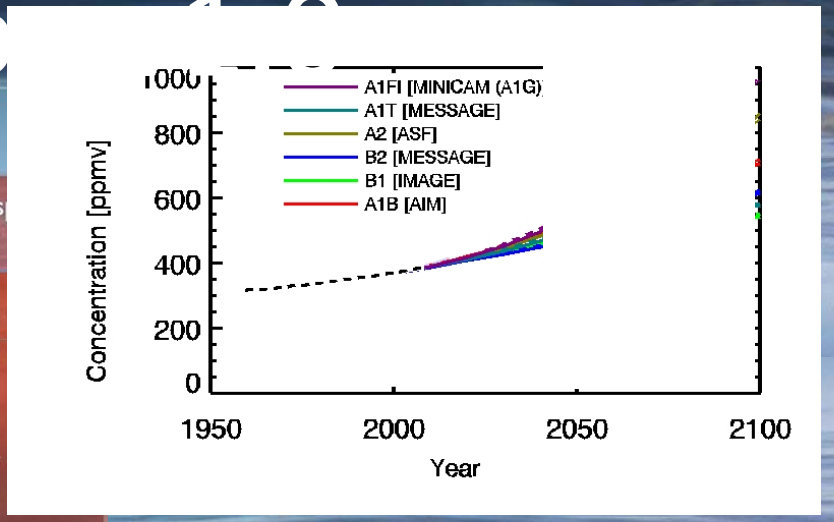
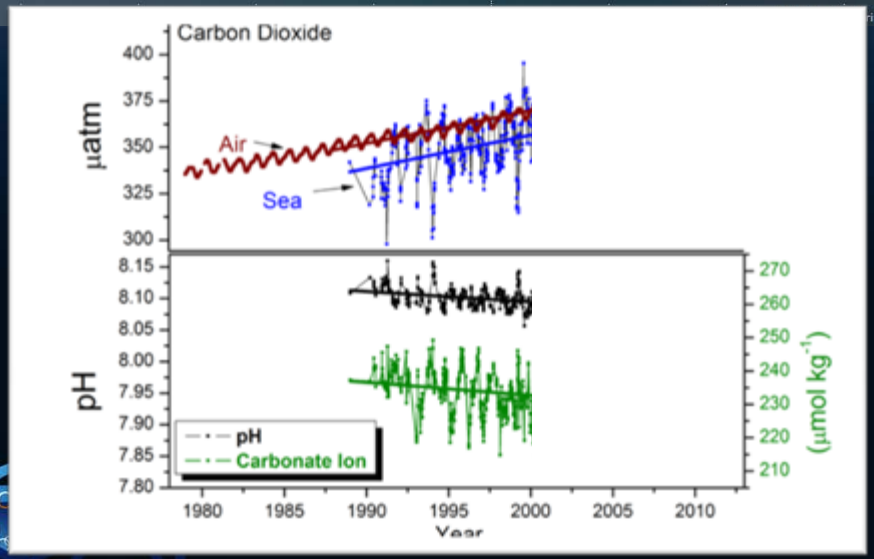
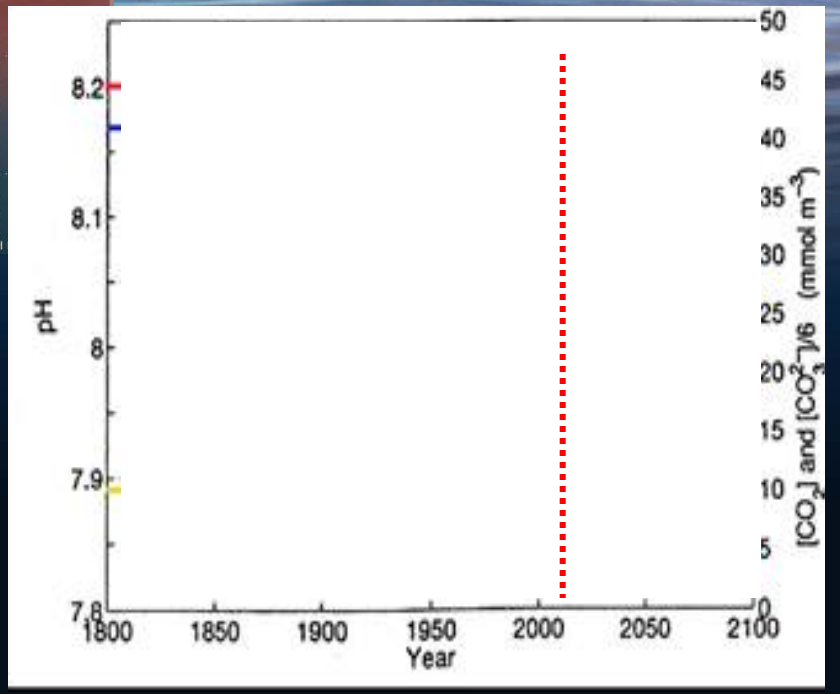
NOAA

Ocean Acidificatio









Wolf-Gladrow *et al.*, 1999

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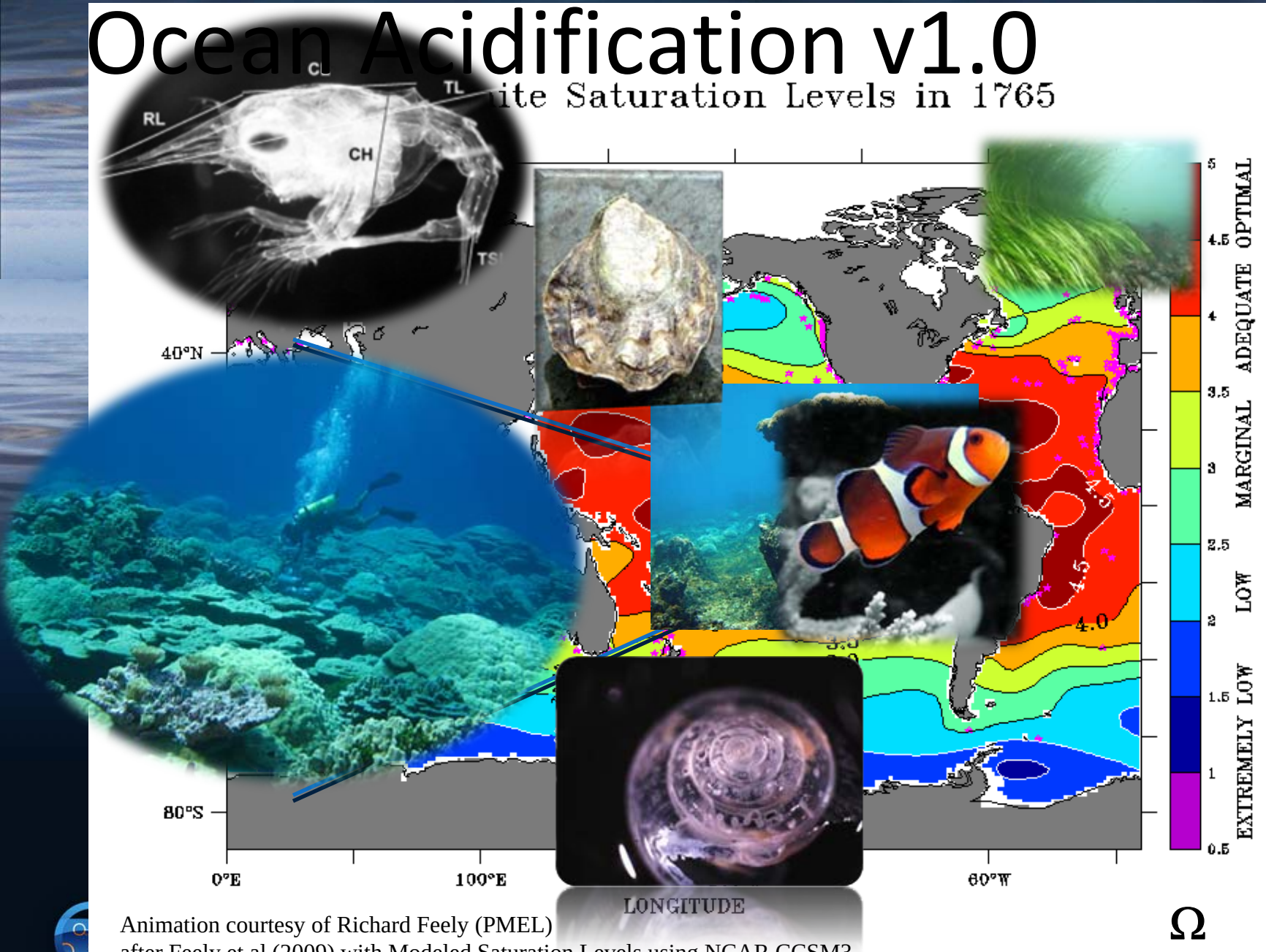
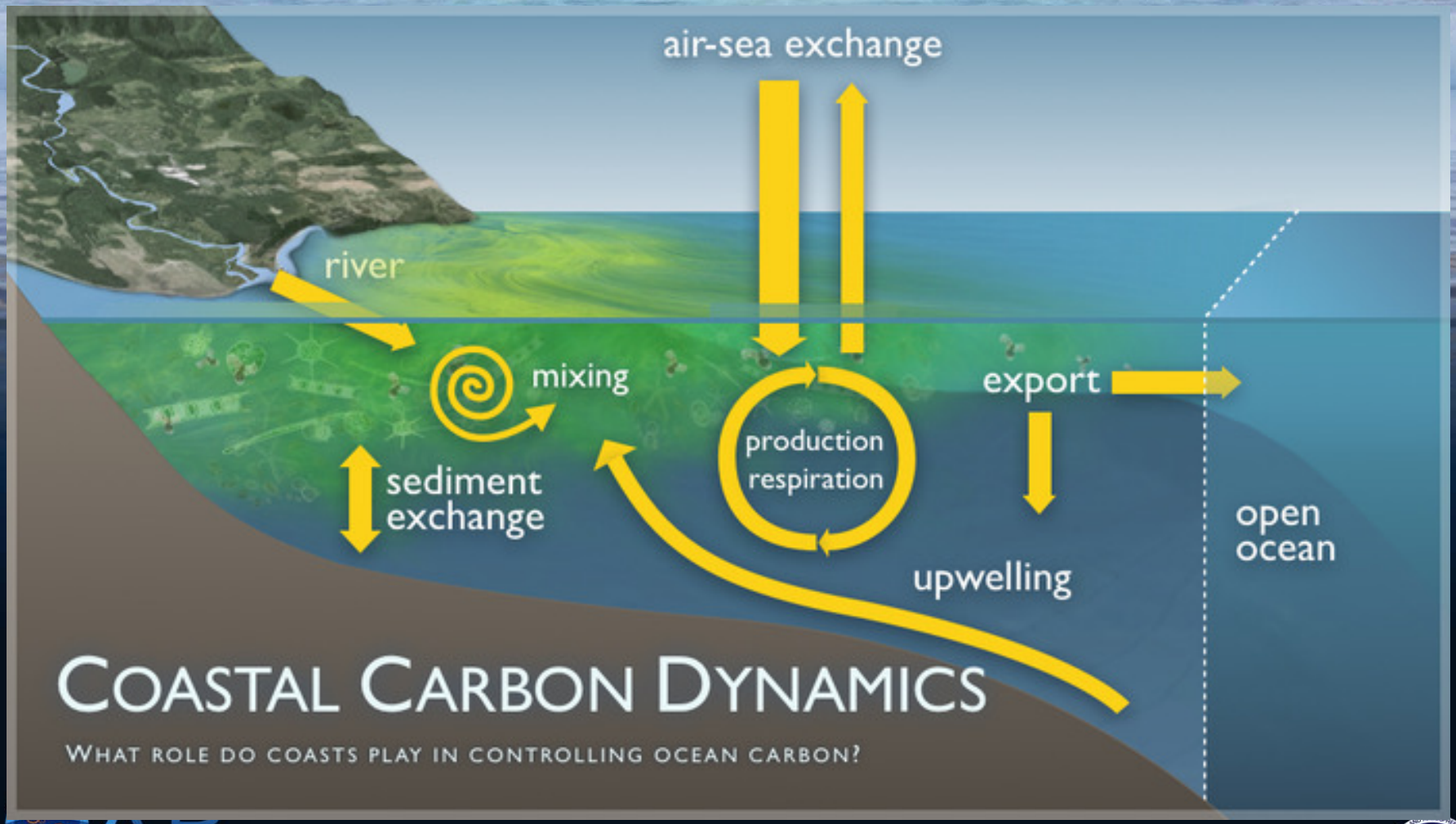
Ocean Acidification v1.0



Animation courtesy of Richard Feely (PMEL)
after Feely et al (2009) with Modeled Saturation Levels using NCAR CCSM3 model

Ocean Acidification v2.0

v2.0 v1.0



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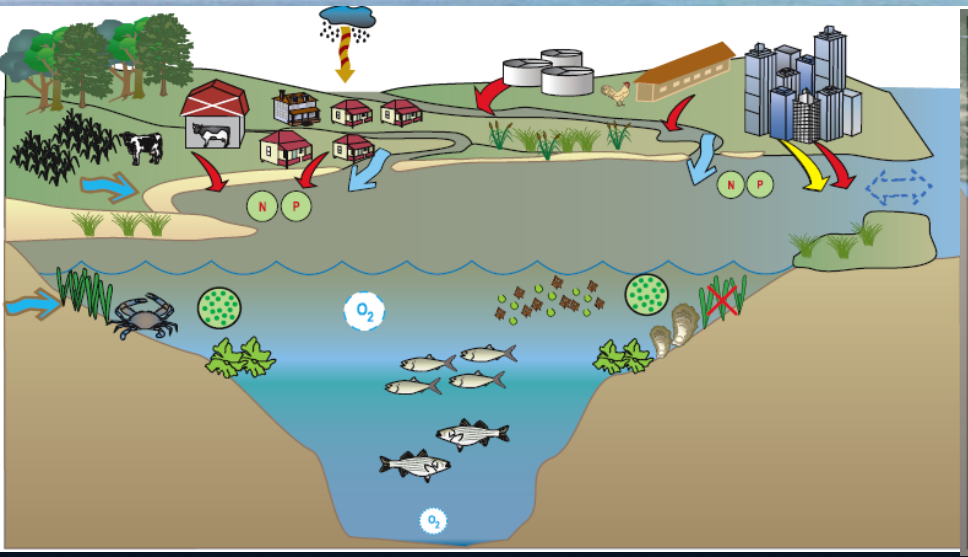
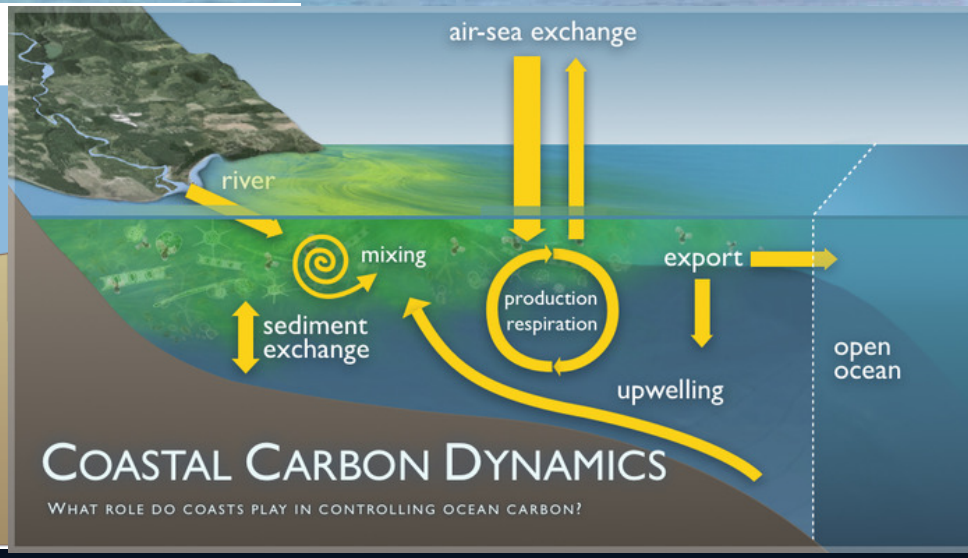
Ocean Acidification v3.0

v3.0



v2.0



v1.0

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Photo Credit: NOAA National Marine Fisheries Service

Photo Credit: NOAA National Marine Fisheries Service

What's at Stake?

Photo Credit: NOAA National Marine Fisheries Service

NATIONAL, REGIONAL INITIATIVES

Federal Ocean Acidification Research and Monitoring (FOARAM) Act of 2009

FOARAM ACT

NOAA

NOAA Ocean Acidification Program (SEC. 12406)

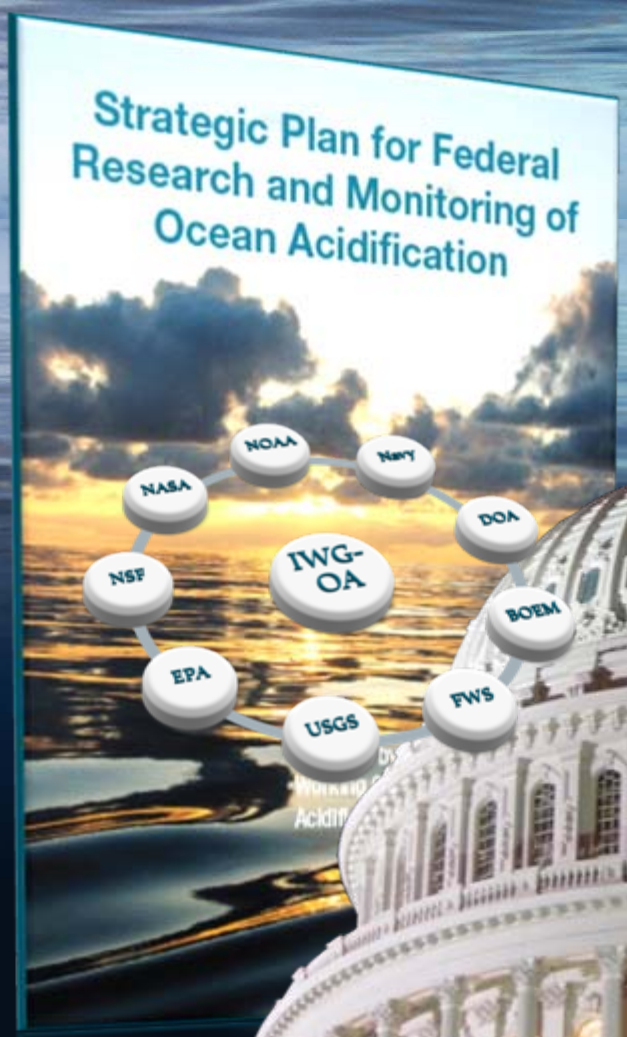
The NOAA Ocean Acidification Program (OAP) was established under SEC. 12406. of the Federal Ocean Acidification and Monitoring Act (FOARAM) to oversee and coordinate research, monitoring, and other activities consistent with the **strategic research and implementation plan developed by the interagency working group** on ocean acidification.

Foster, direct, coordinate:
(A)interdisciplinary research to improve understanding of ocean acidification;
(B)establish a long-term monitoring program for ocean acidification
(C)research to identify and develop adaptation strategies for conservation of marine ecosystems;
(D)educational opportunities exploring the impacts of ocean acidification;
(E)national public outreach
(F)coordination of ocean acidification monitoring and impacts research with other appropriate international ocean science bodies

OAP
NOAA OCEAN ACIDIFICATION PROGRAM

NOAA

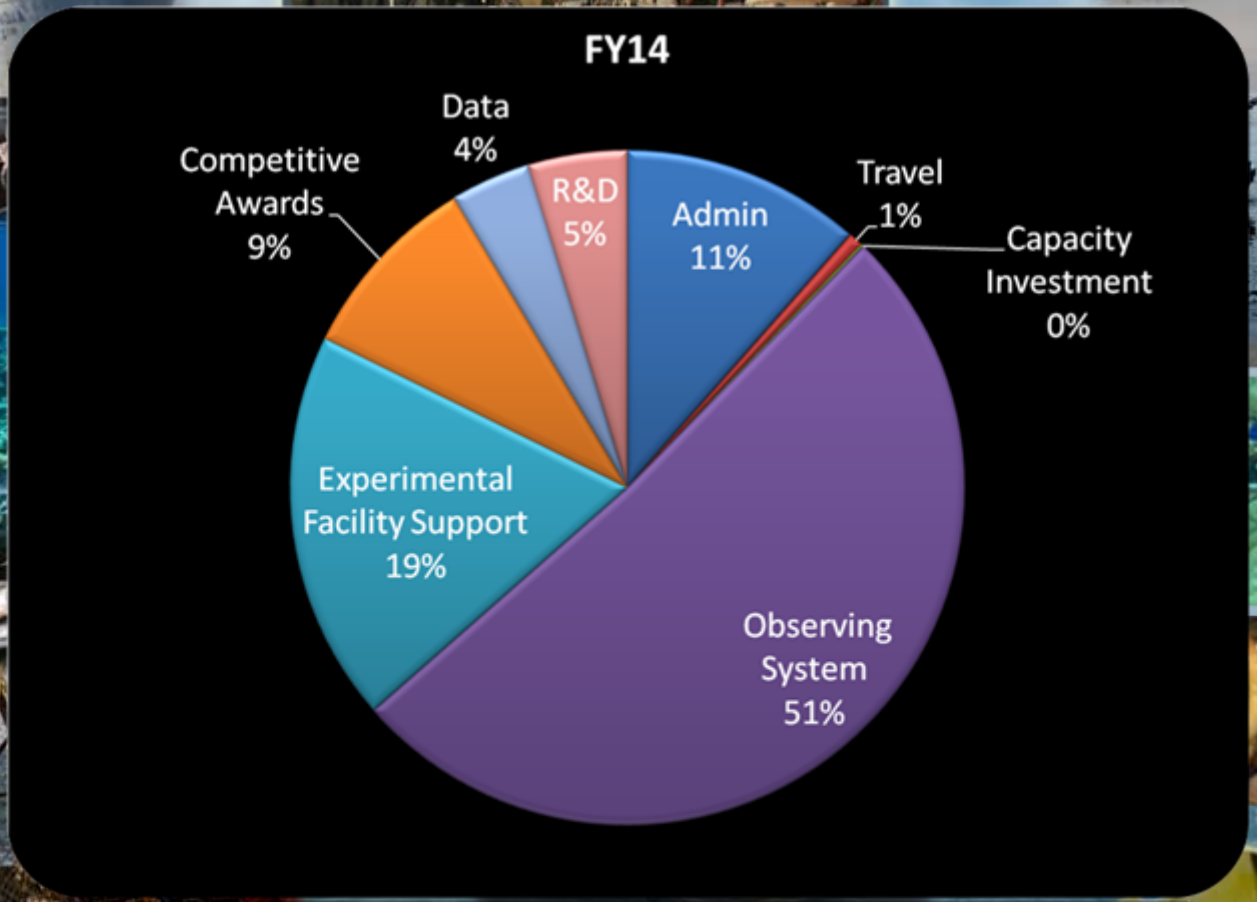
Federal Ocean Acidification Research and Monitoring (FOARAM) Act of 2009



March 26, 2014

NOAA OCEAN ACIDIFICATION PROGRAM

NOAA Ocean Acidification Program



NOAA OCEAN ACIDIFICATION PROGRAM

http://www.oceanacidification.noaa.gov/

NOAA Ocean Acidification Program
- Experimental Studies -

Ecosystem Function

Wild Catch

Aquaculture

Protected Species

Research to understand the implications.

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NOAA Ocean Acidification Program
- NOAA Ocean Acidification Network (NOAN) -

Geochemical

HYDROGRAPHI
DOCUMENTING CARBON DIST
IN THE OCEAN INTERIOR

VOLUNTEER OBSE
DOCUMENTING CARBON DIST
IN THE SURFACE OCEAN

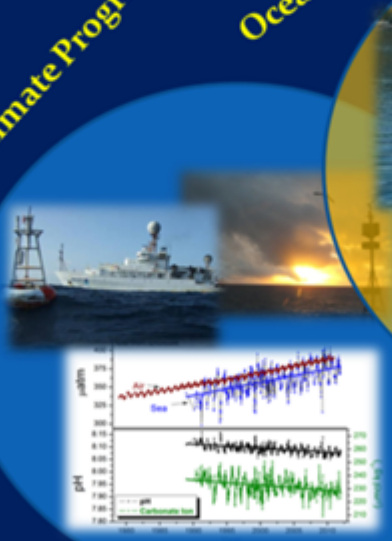
BUOYS AND OTHER
AUTONOMOUS
DOCUMENTING TEMPORAL
CHANGES IN OCEAN CARBON

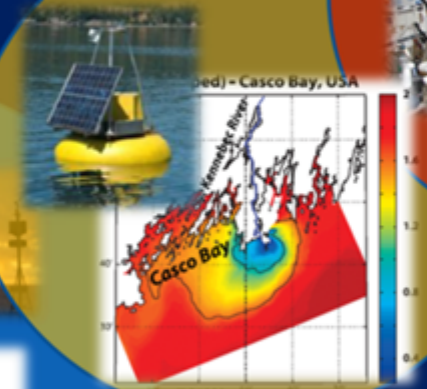
Ecosystem

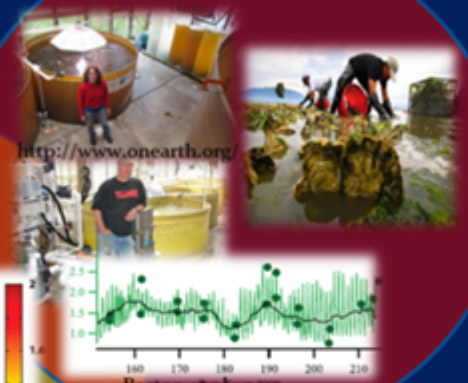
Spatial Variability

Climate Program Office (CPO)

Ocean Acidification Program







Sea Grant
State DEP
Citizen Science
Ect.

Temporal Variability

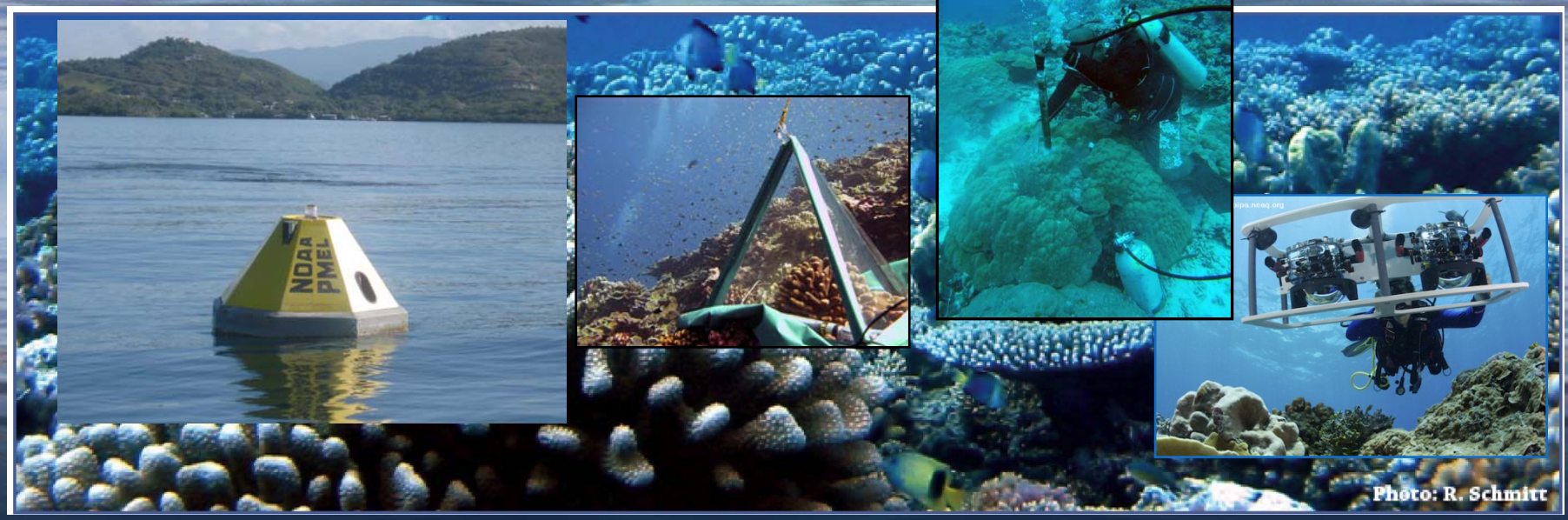
Map
Traffic

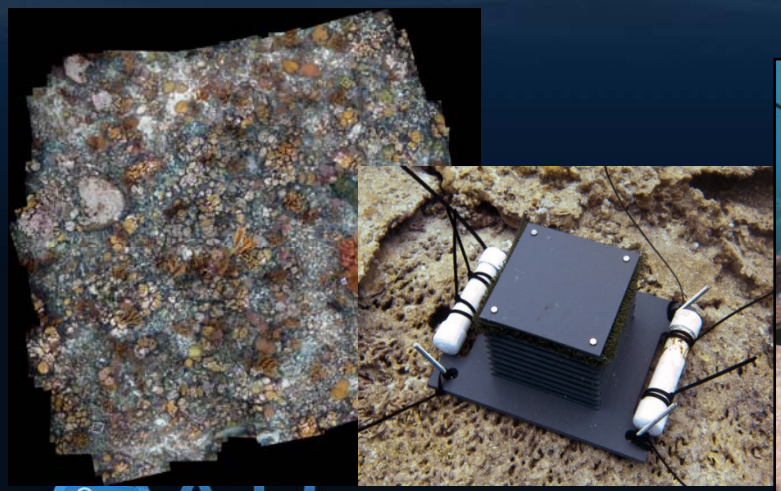
500 km

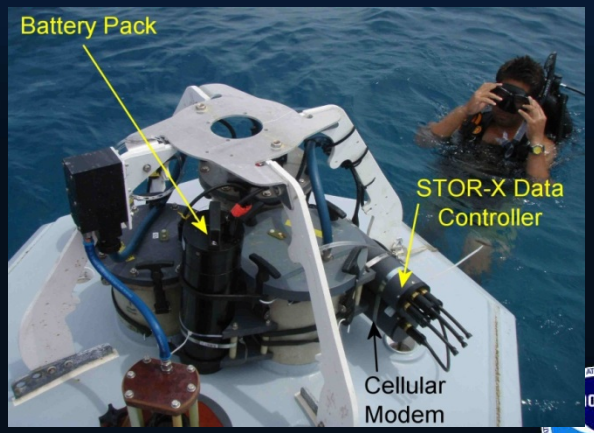
Imagery ©2013 TerraMetrics

NOAA OCEAN ACIDIFICATION PROGRAM

NOAA Ocean Acidification Program
- National Coral Reef Monitoring -

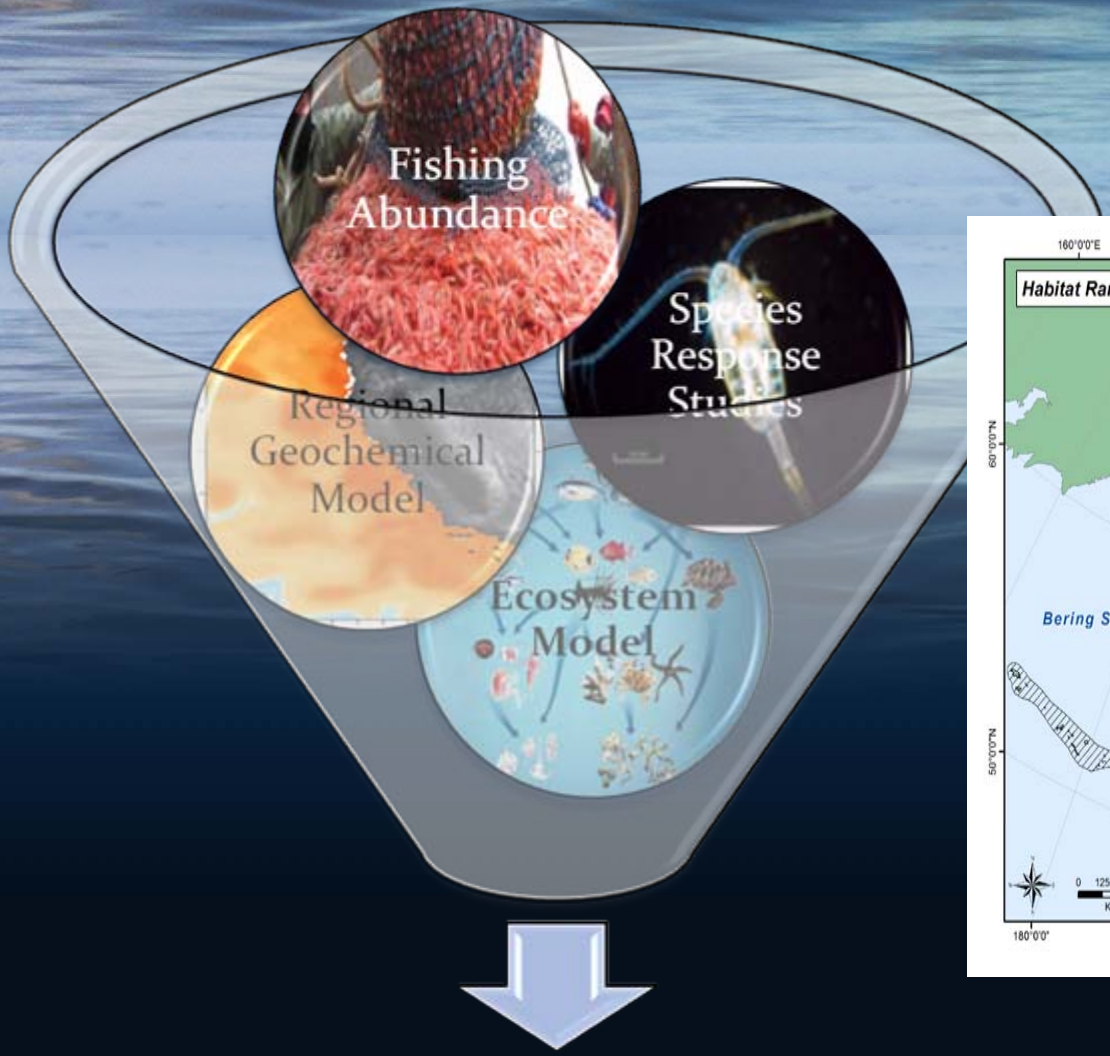


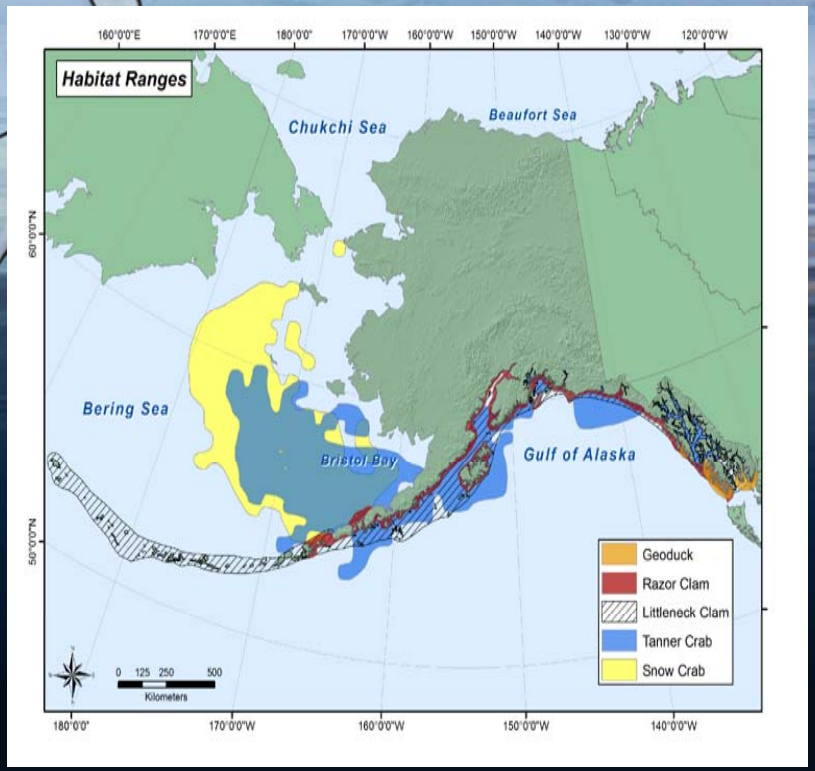




NOAA OCEAN ACIDIFICATION PROGRAM

NOAA Ocean Acidification Program
- Modeling & Assessment -





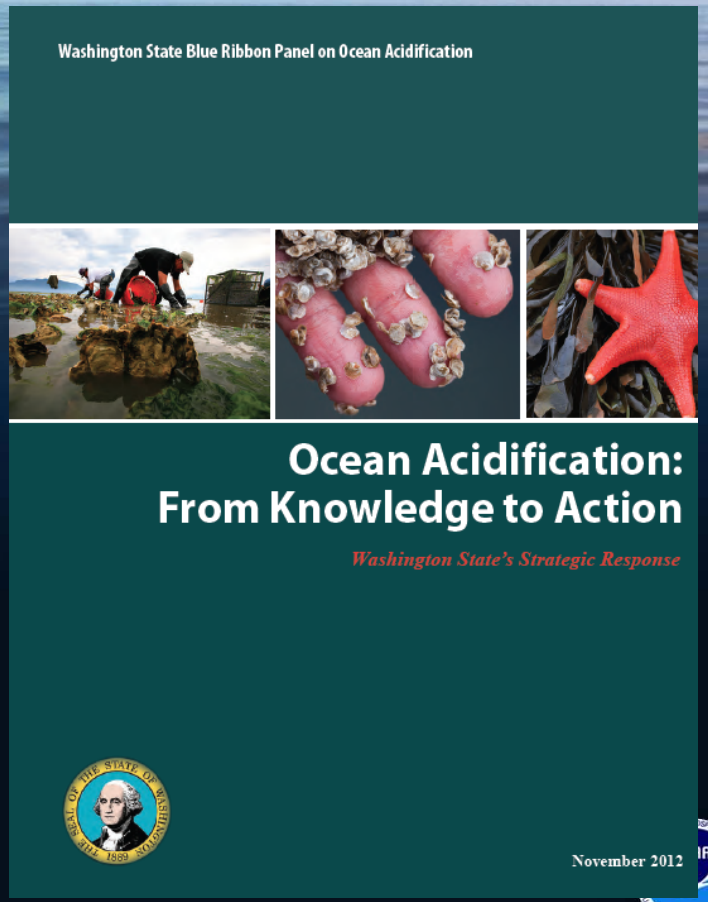
Ecosystem Assessment, Living Marine Resource Management, Socioeconomic Impacts, etc...

NOAA OCEAN ACIDIFICATION PROGRAM

REGIONAL INITIATIVES (OA V2.0)

The C-CAN Mission is to:

1. Coordinate and encourage development of an ocean acidification monitoring network for the west coast that serves publicly available data;
2. Improve understanding of linkages between oceanographic conditions and biological responses;
3. Facilitate and encourage the development of causal, predictive and economic models that characterize these linkages and forecast effects; and
4. Facilitate communication and resource / data sharing among the many groups, organizations and entities that participate in C-CAN or utilize C-CAN as an informational resource.



NOAA OCEAN ACIDIFICATION PROGRAM

Blue Ribbon Panel: WA State

- Convened by Governor Gregoire in February 2012.
- A first-of-a-kind comprehensive state-level effort to address ocean acidification.
- Charged with reviewing the best available science, and producing a set of recommendations to guide Washington's response.
- Scientists, decision makers, industry stakeholders, tribal representatives, and conservation community representatives worked together to produce a comprehensive set of recommendations

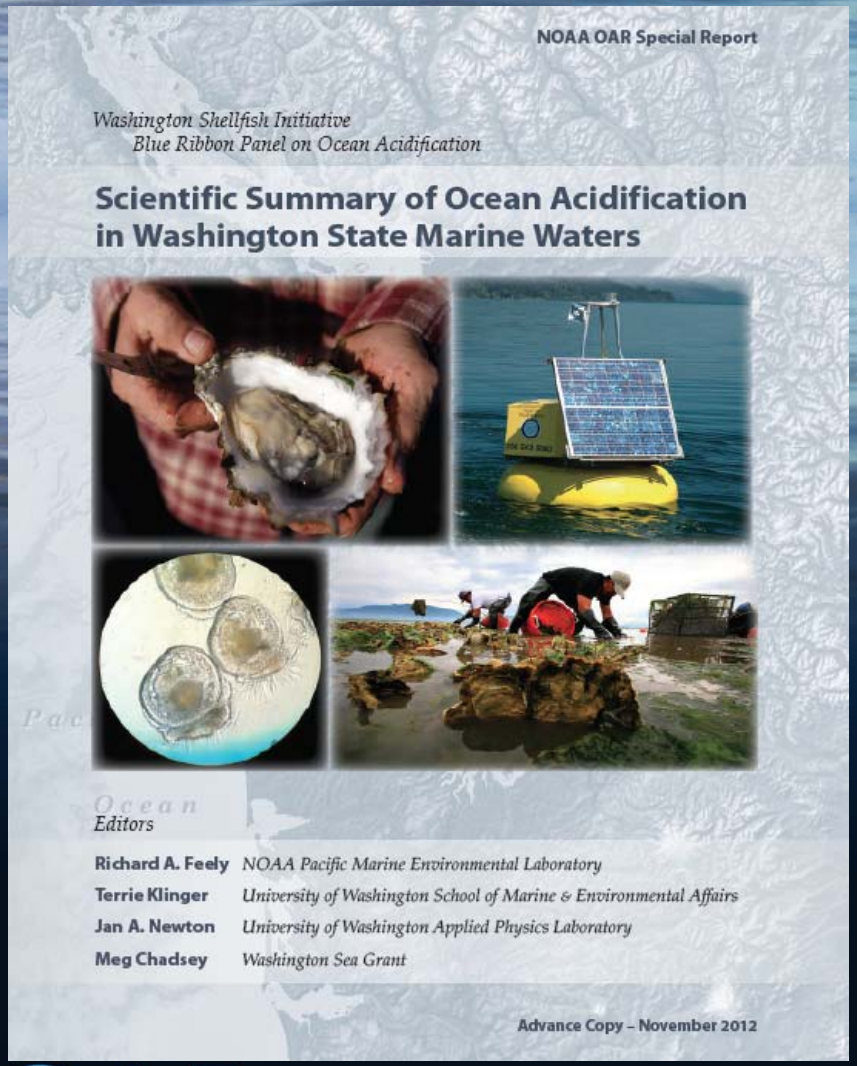
Gov. Gregoire and Bill Dewey of Taylor Shellfish Company discuss growing and harvesting techniques for oysters in the tide flats in Samish Bay.

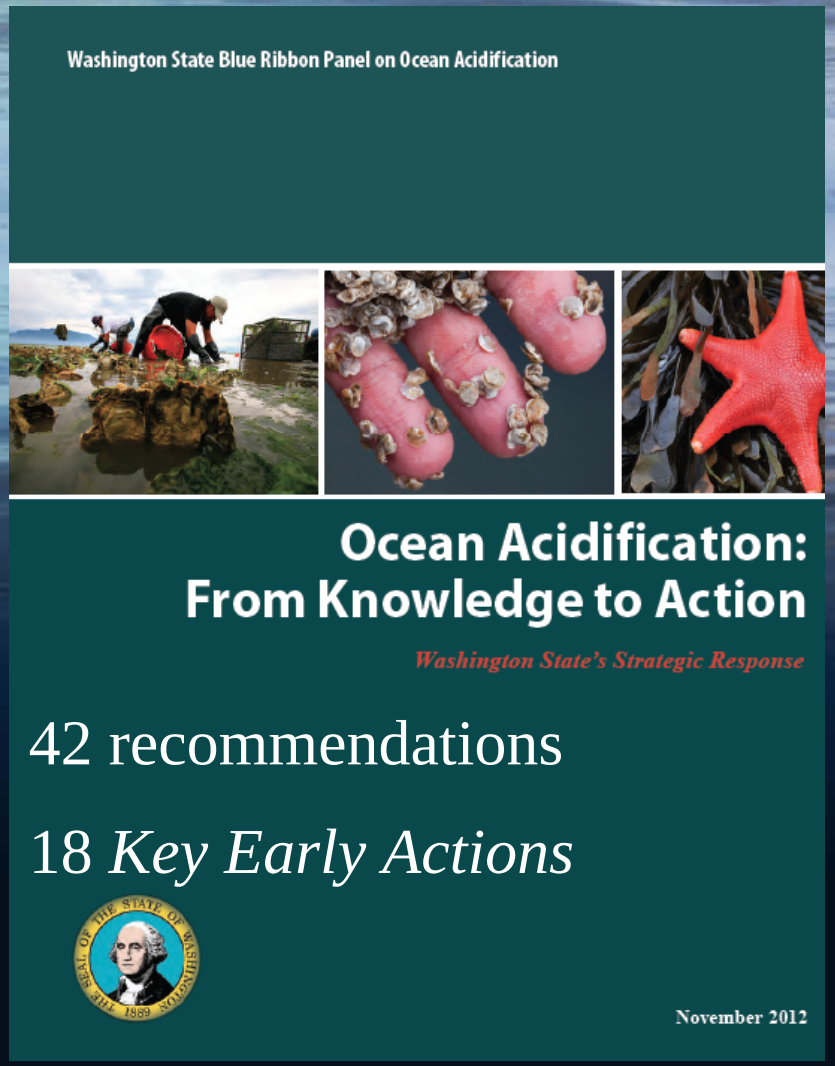
Photo: Puget Sound Partnership

NOAA OCEAN ACIDIFICATION PROGRAM

Slides Prepared by Lara Whitely Binder (UW)

Washington State Panel Reports





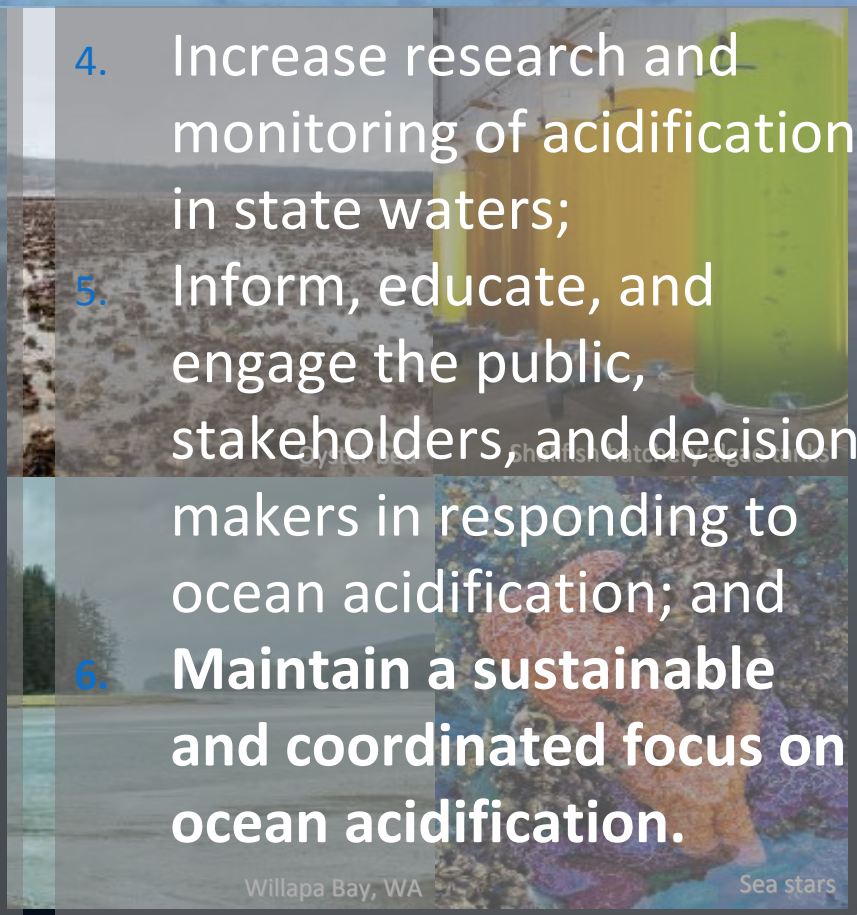
http://www.ecy.wa.gov/water/marine/oceanacidification.html

Slides Prepared by Lara Whitely Binder (UW)

Panel Recommendations

42 recommendations, including 18 *Key Early Actions*, that will:

1. Address the root cause of acidification by reducing CO_2 emissions;
2. Reduce local land-based pollutants that worsen acidification;
3. **Foster adaptation and remediation to protect the shellfish industry and marine ecosystems;**
4. Increase research and monitoring of acidification in state waters;
5. Inform, educate, and engage the public, stakeholders, and decision makers in responding to ocean acidification; and
6. **Maintain a sustainable and coordinated focus on ocean acidification.**



NOAA OCEAN ACIDIFICATION PROGRAM

Photos: Benjamin Drummond (top); Bern Harrison (lower right); Jim Culp (lower left)

The West Coast Ocean Acidification and Hypoxia Science Panel

- West Coast governments recognized the value of a coast-wide effort and the opportunity to build on the work of the WA Blue Ribbon Panel
- Convened in 2013 by the Ocean Science Trust at the request of the California Ocean Protection Council, a cabinet-level state body

  - Multi-state effort links governments of California, Oregon, Washington, and British Columbia
  - Panel mandated to address the science needs of decision-makers

POC: Moose O'Donnell, m.odonnell@calost.org

NOAA OCEAN ACIDIFICATION PROGRAM

www.westcoastOAH.org

CALIFORNIA OST Ocean Science Trust

CALIFORNIA OCEAN PROTECTION COUNCIL

The West Coast Ocean Acidification and Hypoxia Science Panel

Panel working groups are identifying:

- Research and monitoring trajectories for meaningful progress 5 – 20 years out
- How to slot scientific information into existing management frameworks
- Ecosystem and food web impacts
- Interplay of open-ocean chemical dynamics vs. near-shore processes
- Impacts to physiology of key West Coast species

NOAA OCEAN ACIDIFICATION PROGRAM

www.westcoastOAH.org

HB 118: Task Force to Study the Impacts of OA on MD State Waters (kicks of August 7)

(f) The Task Force shall:

(1) analyze the best available science regarding ocean acidification and the potential effects of acidification on the ecology of State waters and on State fisheries; and

(2) make recommendations regarding potential strategies to mitigate the effects of acidification on State waters and on State fisheries.

- Chair: Eric Schwaab, Director of Baltimore National Aquarium. ESchwaab@aqua.org
- POC: Bruce Michael, MD DNR: Bruce.Michael@Maryland.Gov

NOAA Ocean Acidification Program

IAEA International Atomic Energy Agency

ICC-OA

GOA-ON Global Ocean Acidification Observing Network

Interagency Working Group on Ocean Acidification

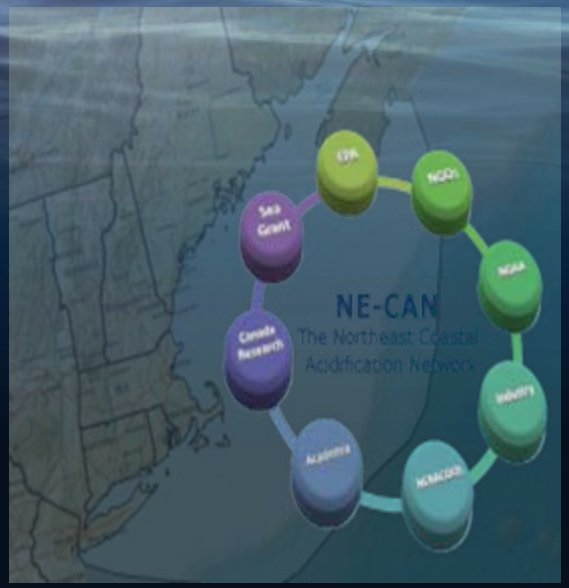
OAP
NOAA OCEAN ACIDIFICATION PROGRAM

NOAA

The Northeast Coastal Acidification Network (NE-CAN)


SOS Meeting, NH

Webinar Series → State of the Science Synthesis → Translation → Stakeholder Input → Implementation Plan

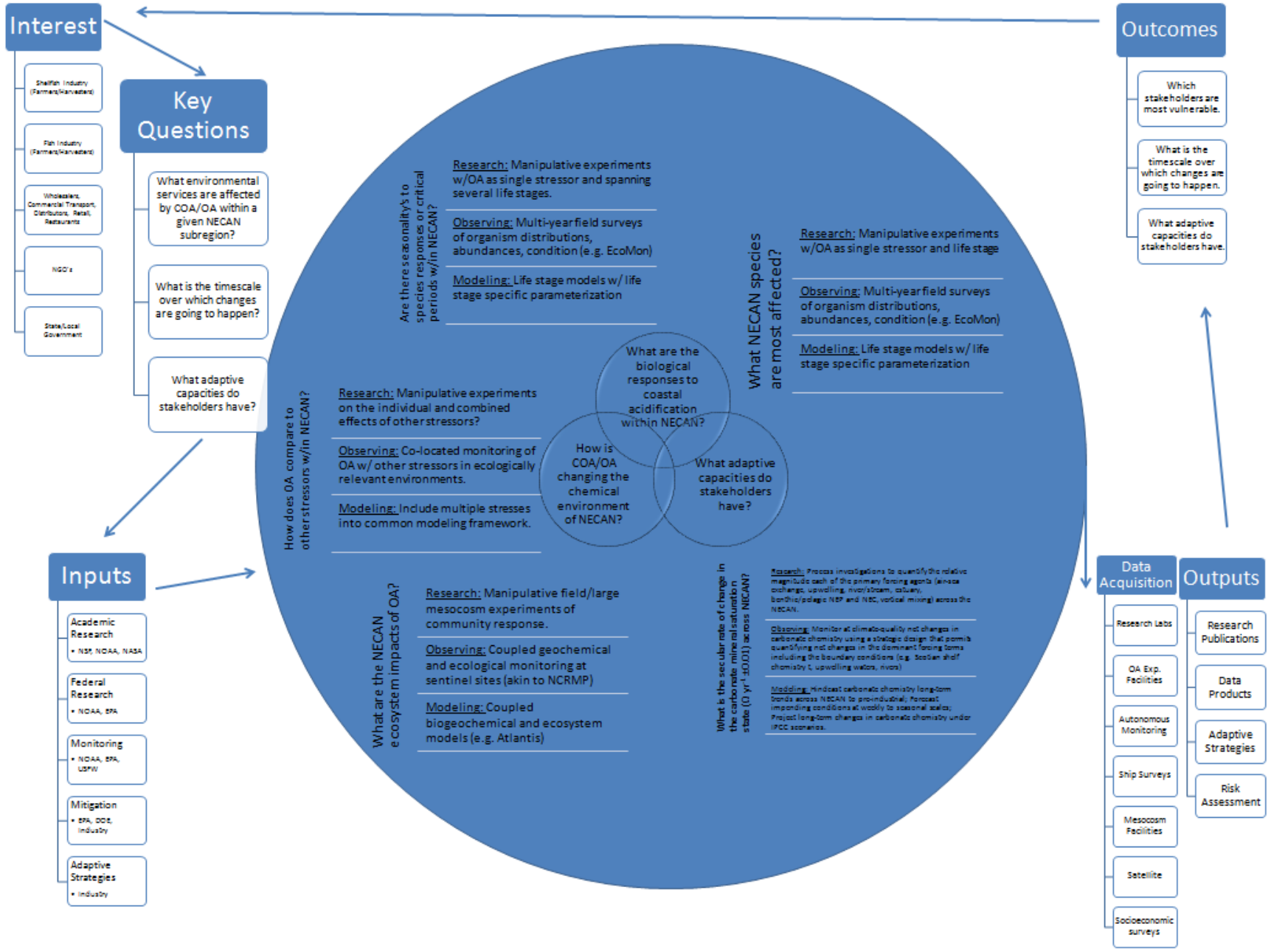



UNH, Coastal Marine Lab (CML)


Mook Seafarm, ME

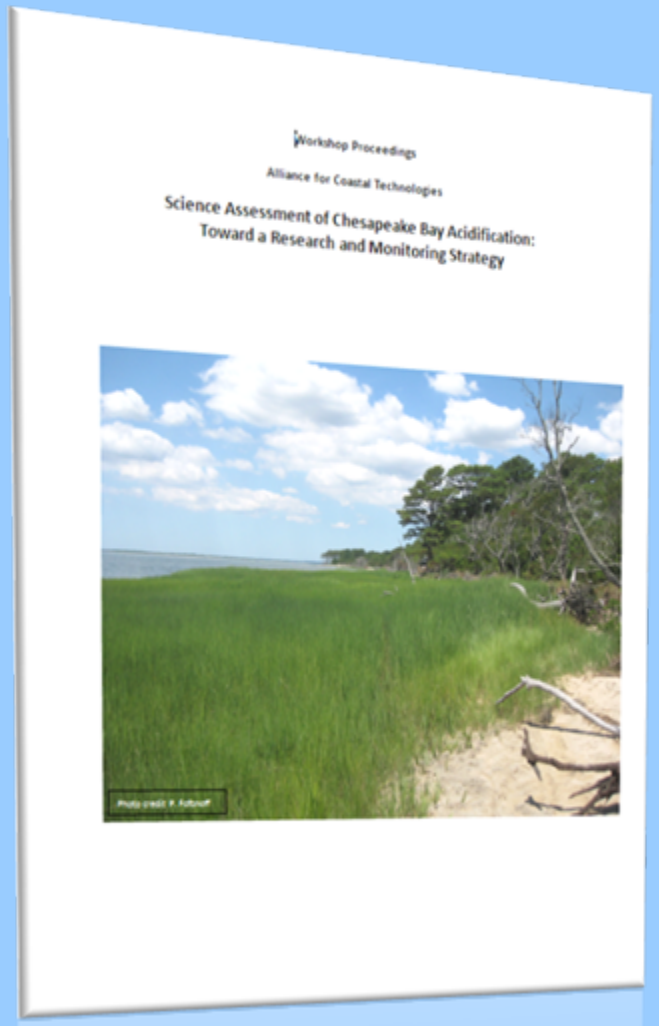
NOAA OCEAN ACIDIFICATION PROGRAM

What are the potential socioeconomic effect of coastal & ocean acidification within the NECAN region?



NERACOOS · OAP · Sustainable Fisheries Partnership · University of New Hampshire · NCCOS · Sea Grant · Sea Grant · Dalhousie University · The University of Maine

Chesapeake Bay Acidification Network (CBAN)

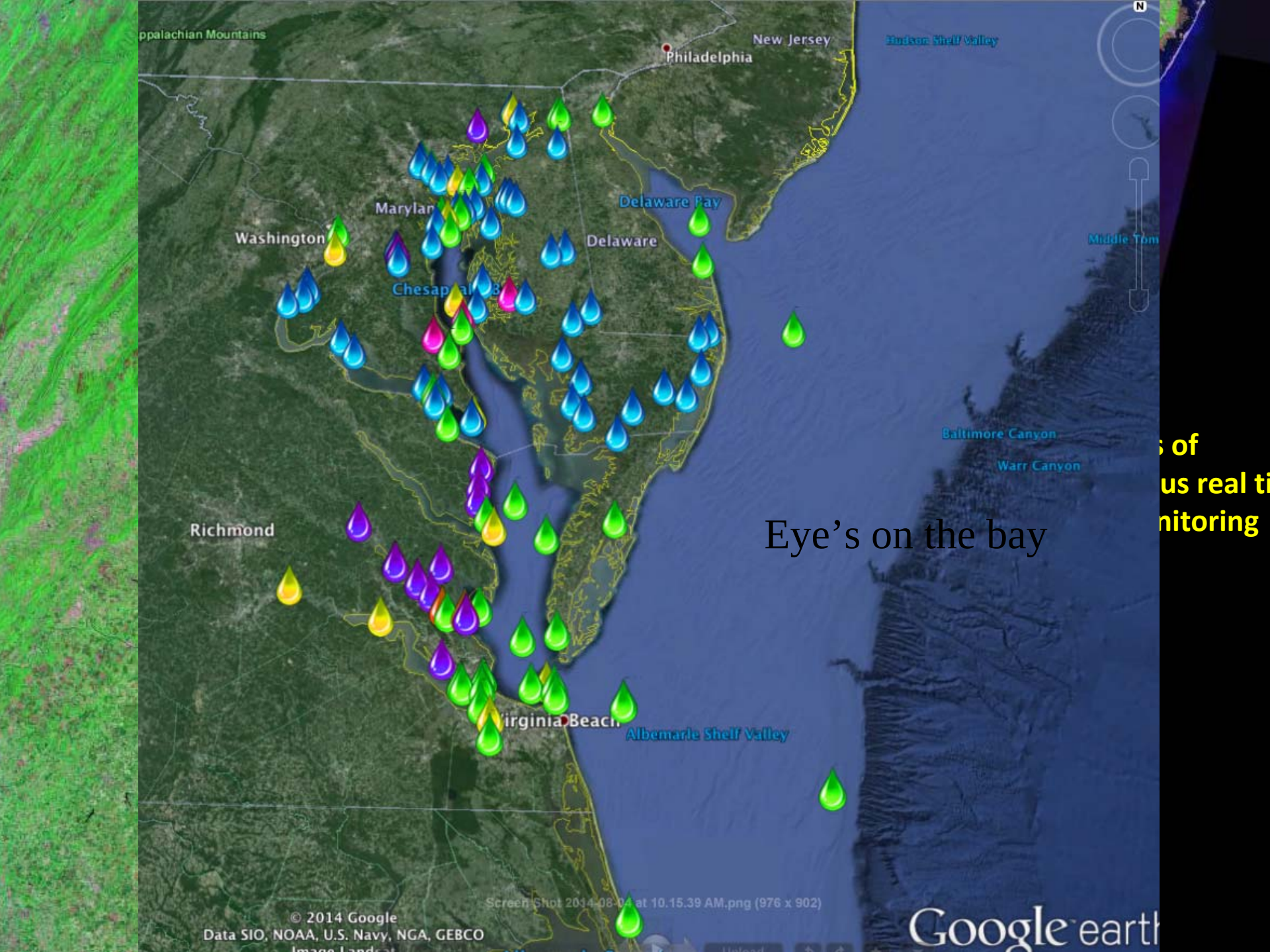


Whitman Miller

Smithsonian Environmental Research Center

Chesapeake Bay Features that can affect Acidification chemistry

- Extensive and diverse freshwater input affect chemistry of Bay on local and regional scales
- Salinity gradient(s) correlate with buffering capacity of water
- Highly productive systems with extensive year-round photosynthesis (draws down CO_2 and increases pH)
- Shallow system with extensive muddy bottom and associated seasonal benthic respiration (strong CO_2 inputs and decreases in pH)



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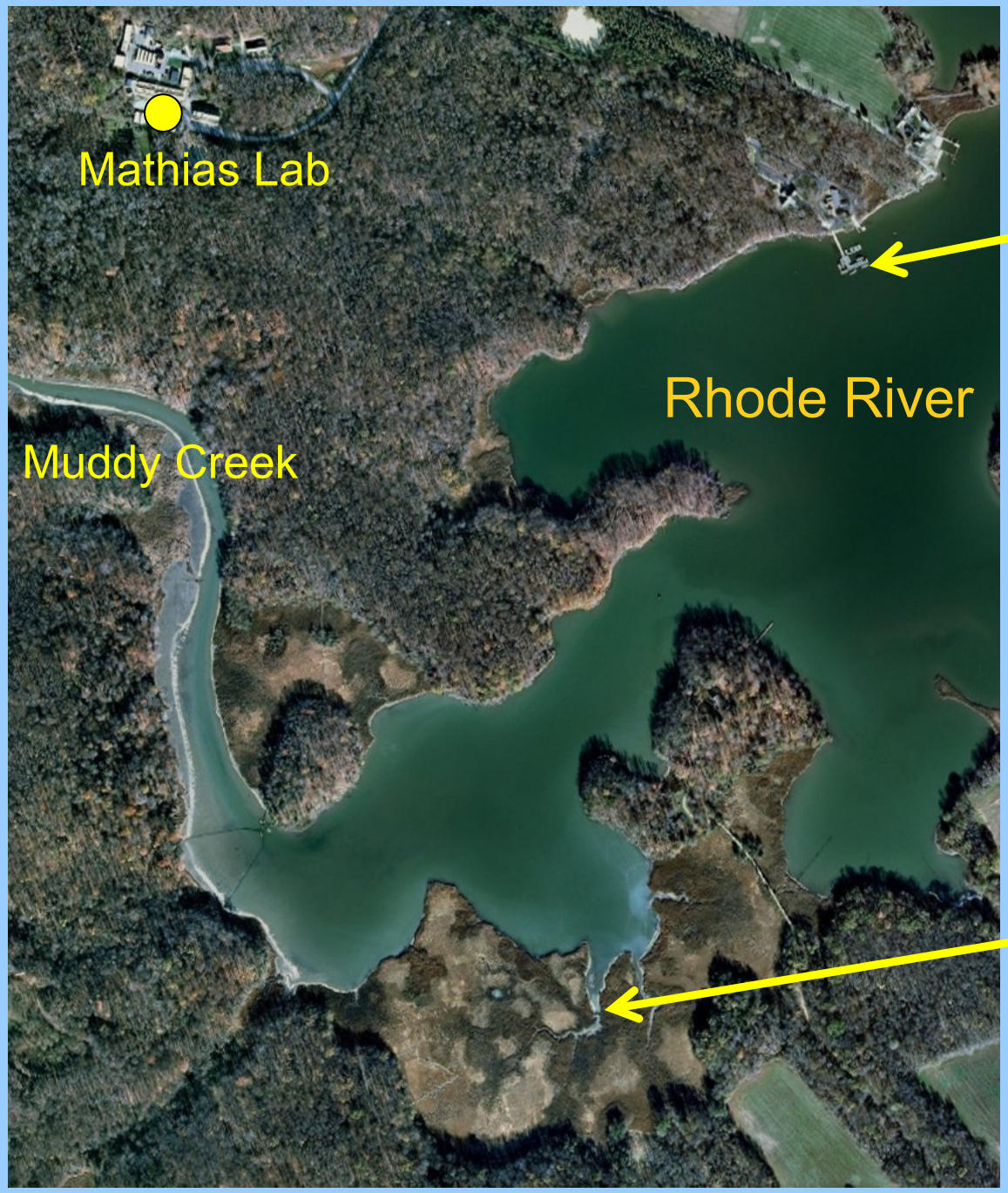
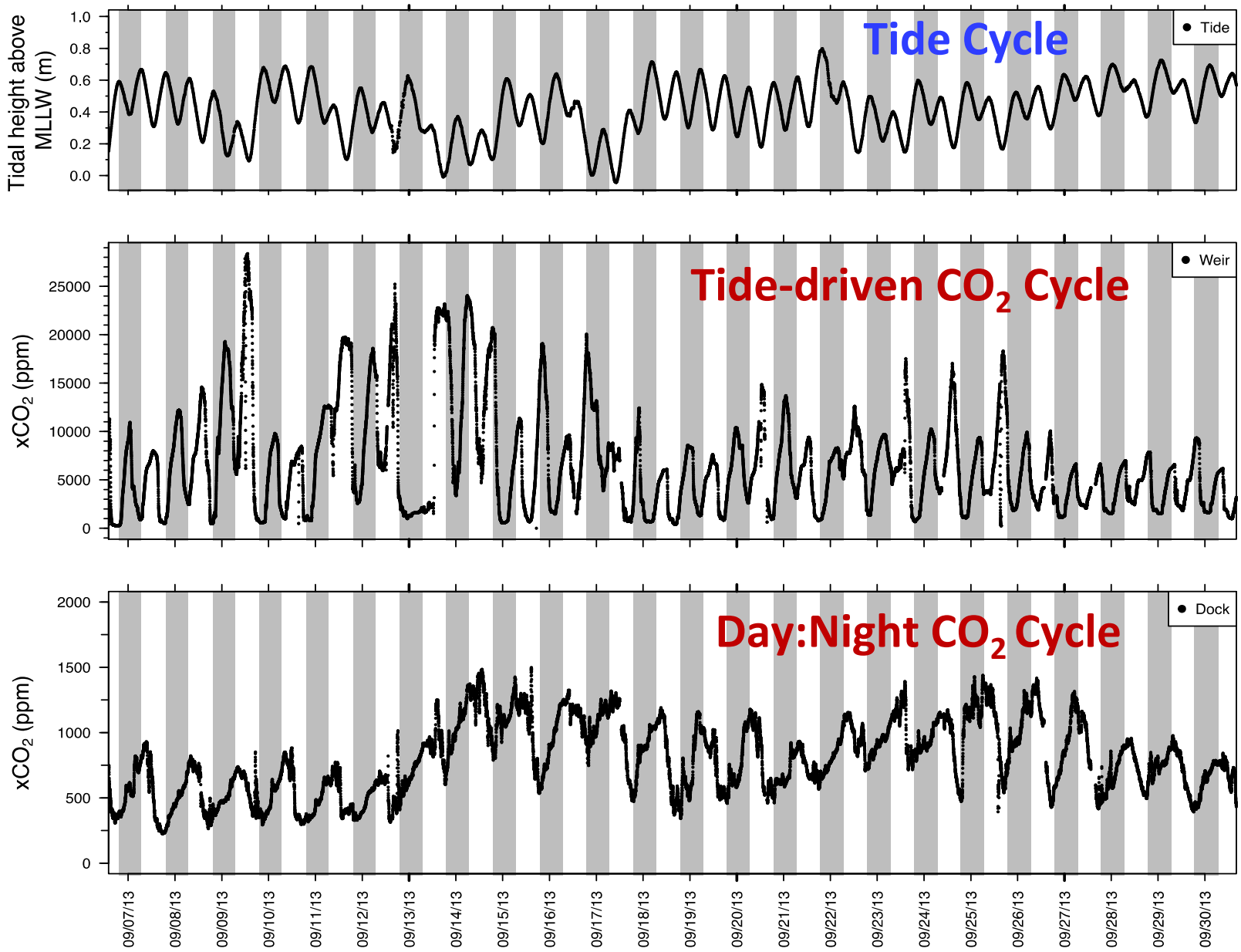


SERC Dock

Annual Salinity Range: 3 - 15 psu

Kirkpatrick Marsh Weir (GCReW)



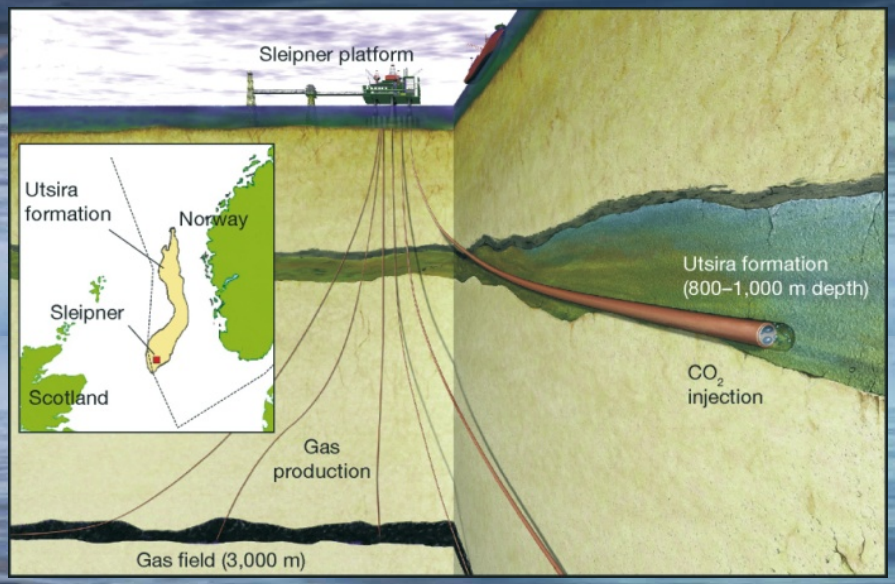
Sept 2013

Miller ,unpubl data

Why Chesapeake Bay?

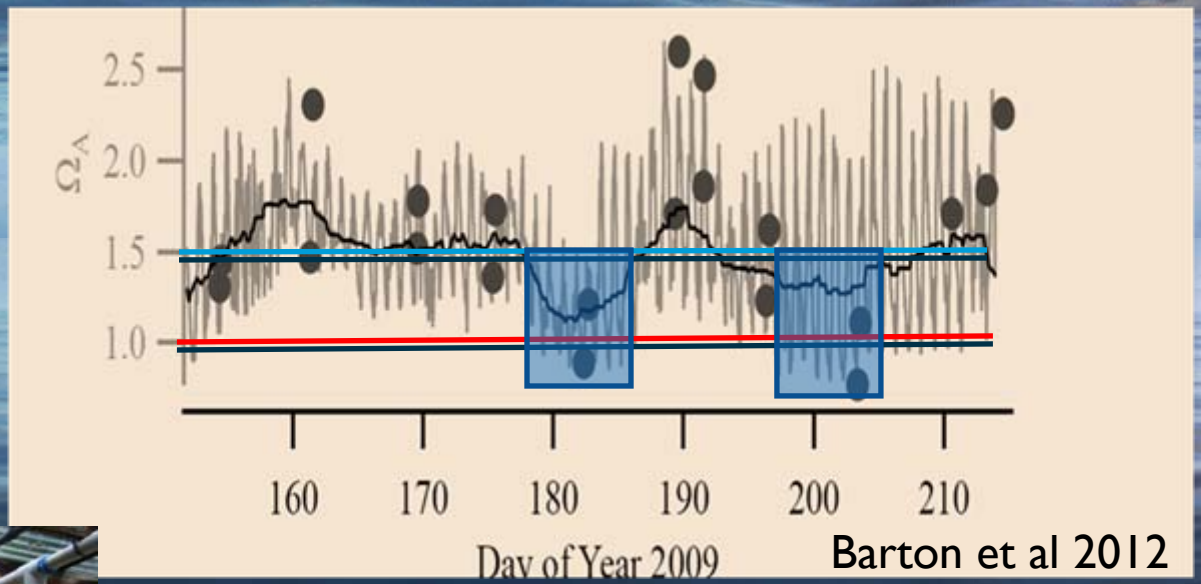
- Extensive natural resources and ecosystem services, including commercial fisheries.
- Scientific understanding of Chesapeake Bay is extensive; perhaps most studied estuary in the world, but very little is known about carbonate chemistry and acidification here.
- Given extensive research and monitoring activities and assets, it is a prime region to come up to speed fast by piggy-backing other measurements on existing observing networks (e.g., pCO_2, alkalinity, total inorganic carbon).

RESPONSE & ADAPTATION



Balance The Budget

An Oysters Tale.....



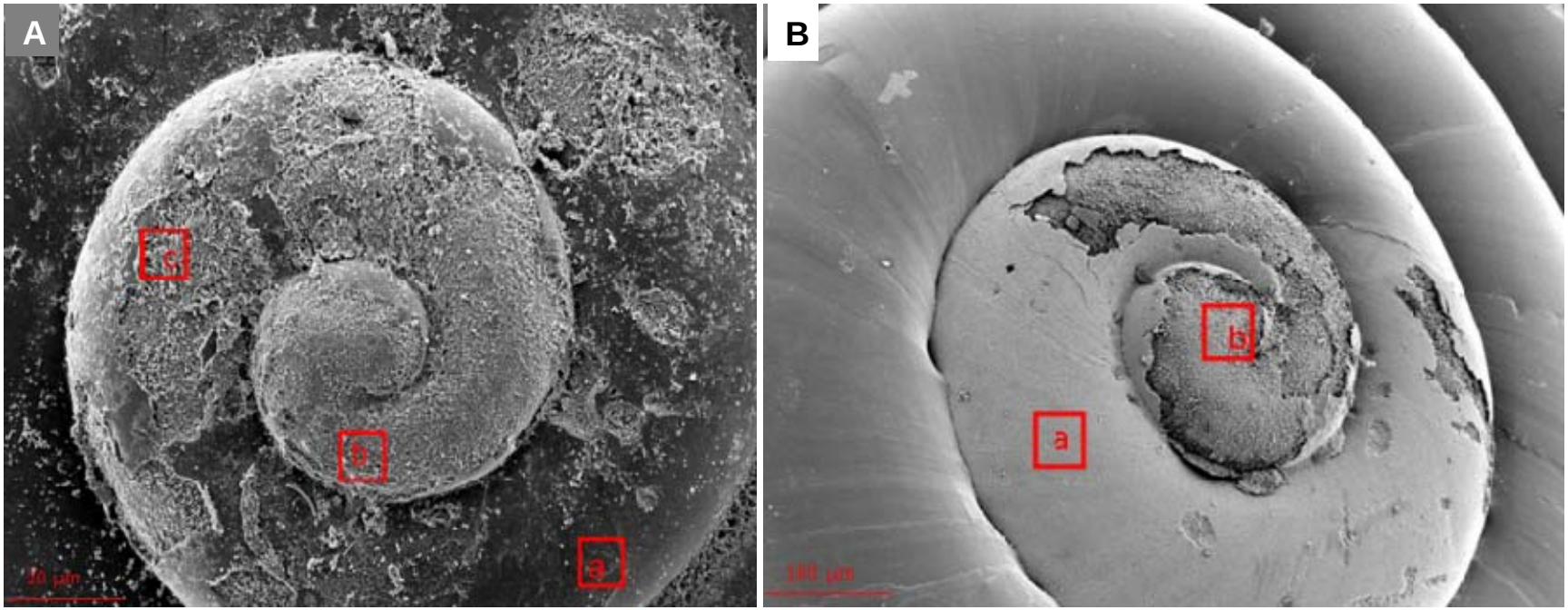
Barton et al 2012

Whisky Creek Hatchery, Oregon, US

Oyster hatcheries use data from observing system to inform their day to day management

NOAA OCEAN ACIDIFICATION PROGRAM

Pteropod shell dissolution in the California Current Ecosystem



SEM images of shells of the pteropod Limacina helicina sampled during the 2011 cruise showing signs of in situ dissolution from (A) an on-shore station, with the entire shell affected by dissolution, and (B) from the off-shore region, with only the protoconch (first whorl) affected. Indicated in the figure are: (**a**) intact surface, (**b**) mild dissolution, (**c**) severe dissolution.

Tips to Consider…

- 1. Have **scientists and policy maker/managers work together** on everything but technical science documents.
- 2. Be **careful of scope**, especially committing to too much from the science side. It will take a lot longer than a few months to write an accurate and peer-reviewed state of the science document.
- 3. Focus **on setting the ground-work for the future**. Likely this panel is the start of a process, not its end, so getting a good consensus on how to work on OA in the state for the years into the future is important. For WA state, this meant establishing separate bodies to carry on political agenda AND research.
- 4. **Healthy ecosystems and food webs** are vital for maintaining wild-harvested species and most aquaculture operations. Thus, impacts of OA on important members of the food web of commercial species must be considered (e.g., zooplankton, phytoplankton, forage fish).
- 5. There is a lot of activity around commercial species that can be **leveraged** to deal with OA, so, as much as possible, emphasize how to slot OA activities into existing efforts and management frameworks .

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