

The NECAN Story:

Linking Ocean and Coastal
Acidification science to managers,
policymakers, and coastal
communities in the northeast United
States and Canadian Maritimes

NECAN Steering Committee

Ru Morrison* (IOOS/NERACOOS)

Cassie Stymiest (NERACOOS)

Todd Capson (Independent Consultant)

Dwight Gledhill (NOAA OAP)

Bill Mook (Mook Sea Farm)

Joe Salisbury (UNH)

Elizabeth Turner (NOAA/NOS/NCCOS)

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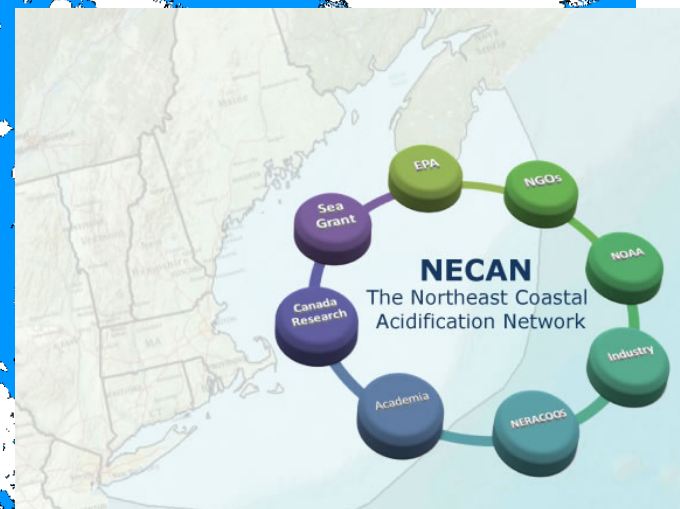
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Photo: University of Maine



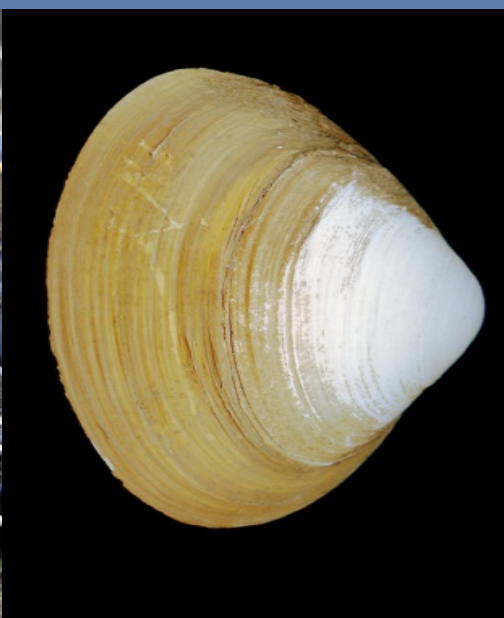
UNH, Coastal Marine Lab

SOCAN
Southeast Ocean and Coastal
Acidification Network



NECAN's role:

- **Review and assess** the most recent scientific, technical and socio-economic information relevant to the economically important marine organisms potentially impacted by ocean and coastal acidification;
- **Communicate** state of knowledge and critical knowledge gaps identified by stakeholders to relevant state and federal agencies;
- Help to **coordinate and set regional priorities** for monitoring and research designed to further our understanding of coastal acidification;
- Respond to **user and stakeholder needs**.



Review and assess

Communicate

Respond

Set priorities

Webinars



Synthesis



Translation



Stakeholder
Input



Implementation
Plan

Our Process



Webinars



State of the
Science
Workshop



Summary
Article



Stakeholder
Engagement
Workshops



Implementation
Plan

Review and assess

Webinars



Synthesis



Communicate

Translation



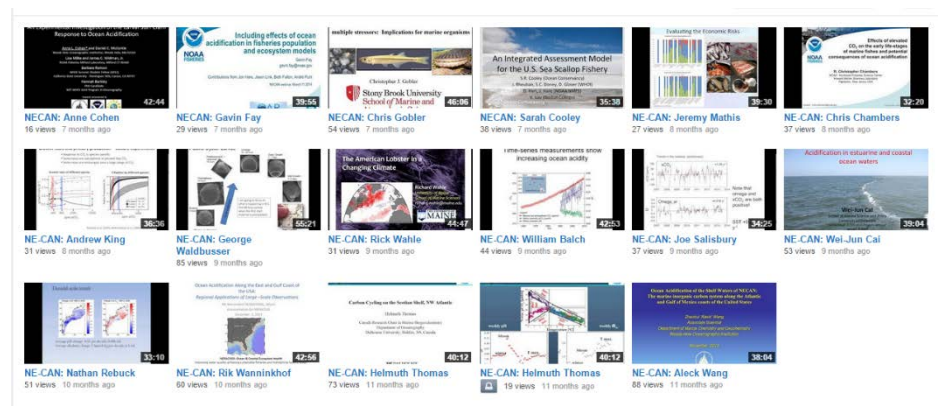
Respond

Stakeholder
Input



Set priorities

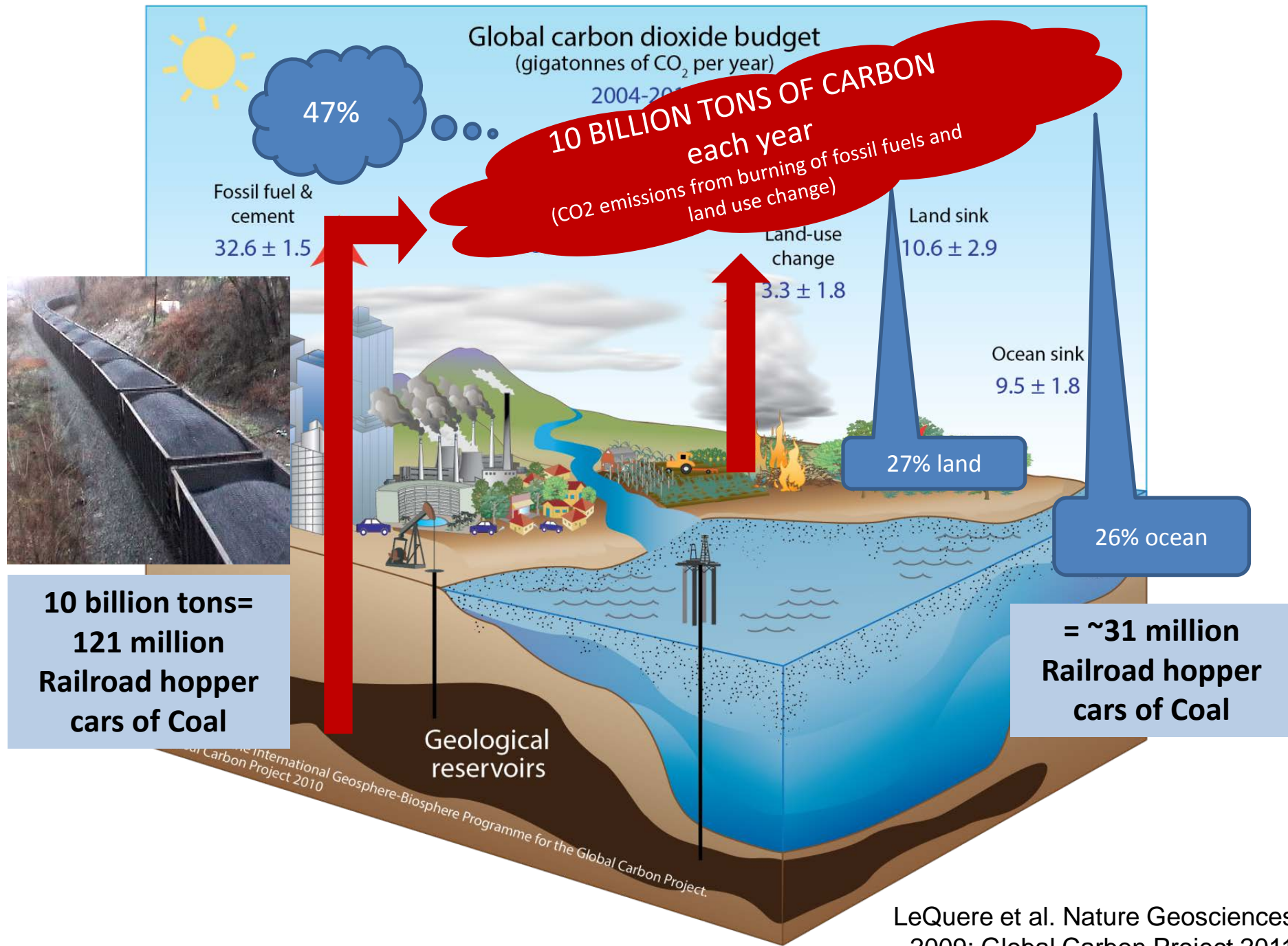
Implementation
Plan



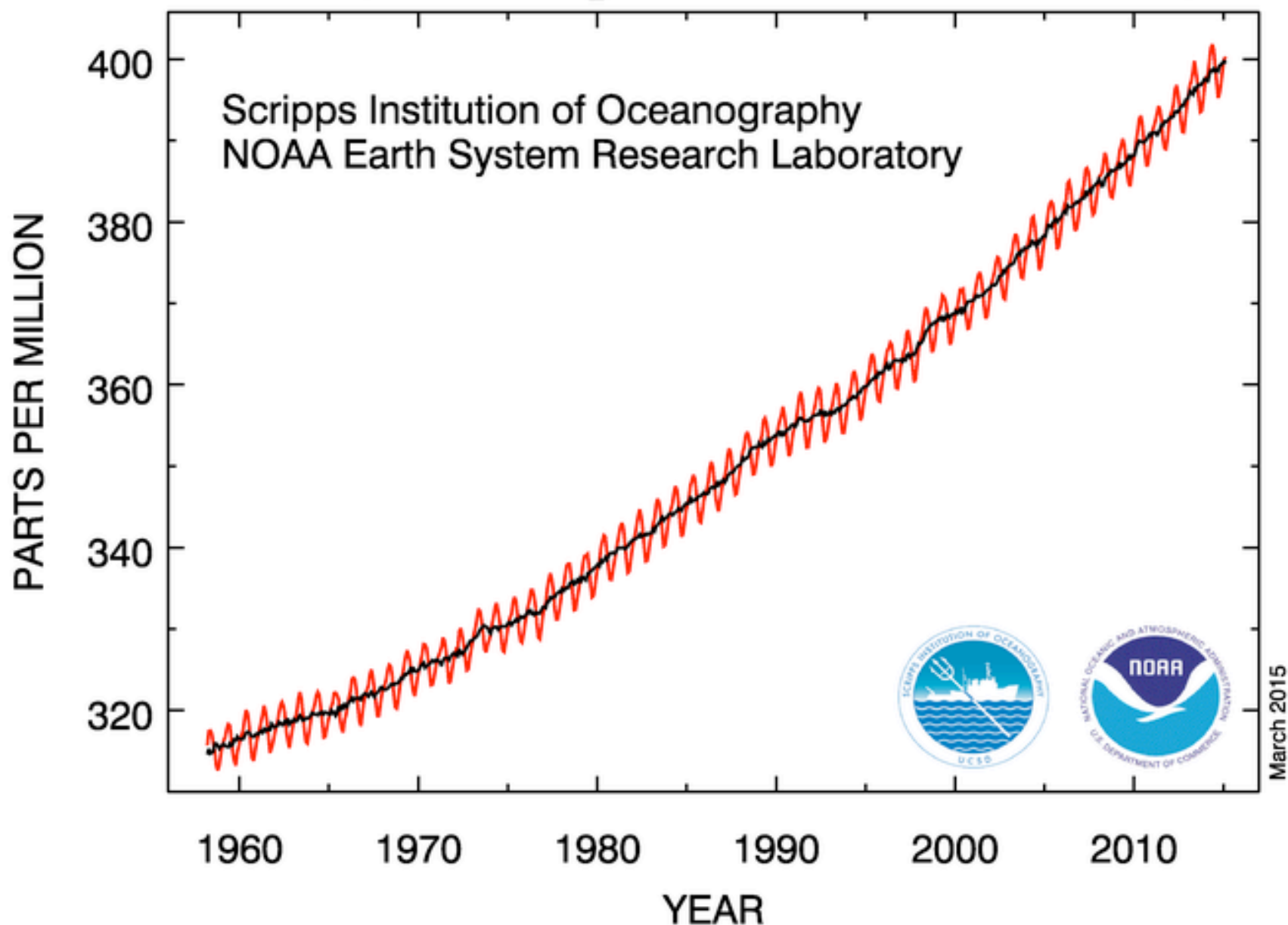
- ✓ 16 research presentations by webinar
- ✓ 1 state of the science workshop
- ✓ m.s. for special issue of Oceanography



- The Northeast is unique
- At risk shell forming species are hugely important to the region's marine economy, including: lobsters, mussels, clams, oysters, scallops
- Larvae are most vulnerable to acidification
- Species response can vary: we know something (but not enough) about bivalves, and we are largely ignorant of OA impacts on lobsters

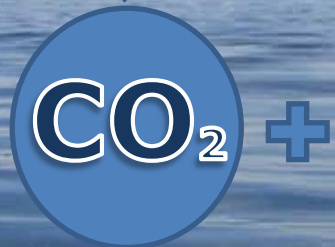


Atmospheric CO₂ at Mauna Loa Observatory





dissolves



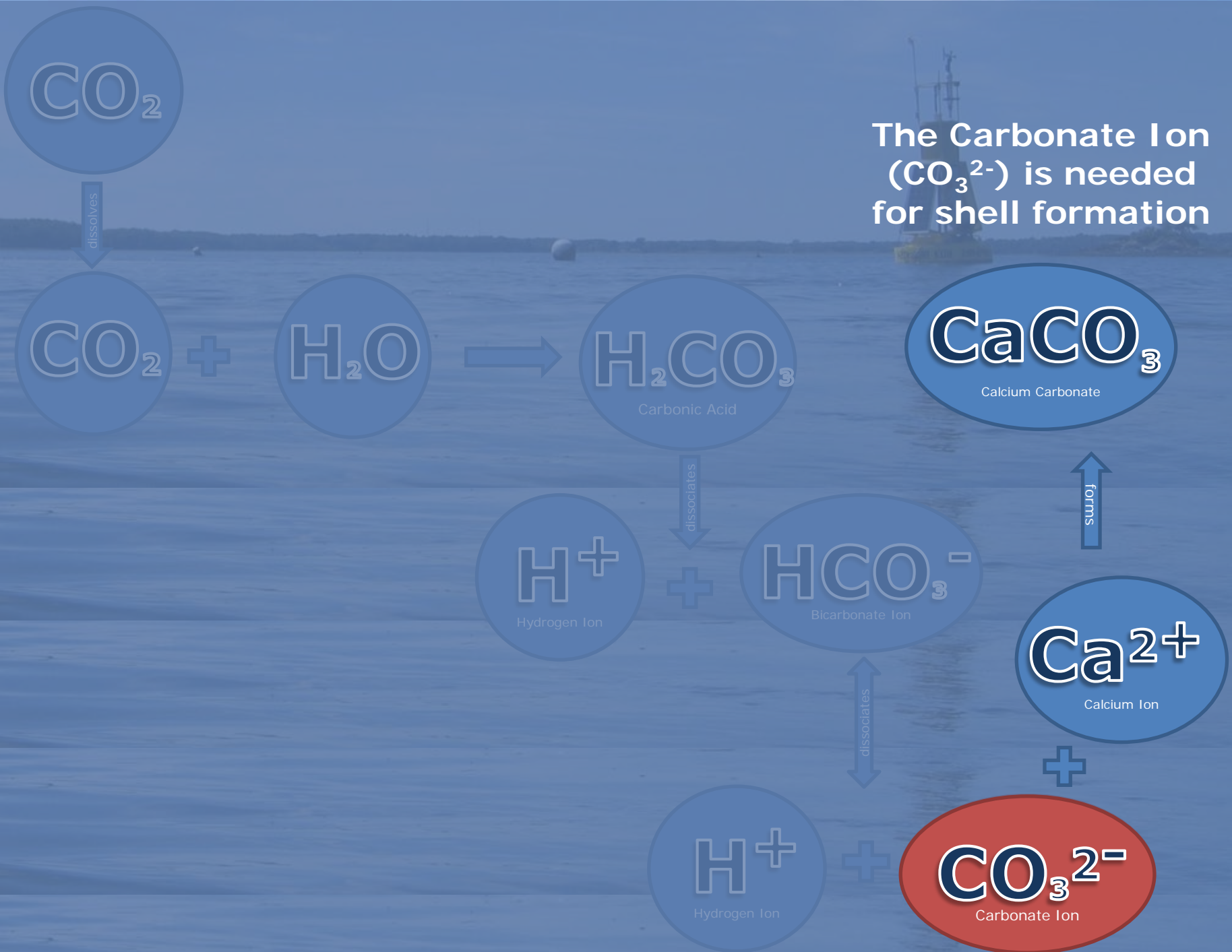
dissociates

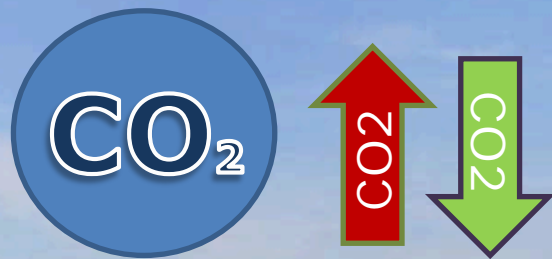


dissociates

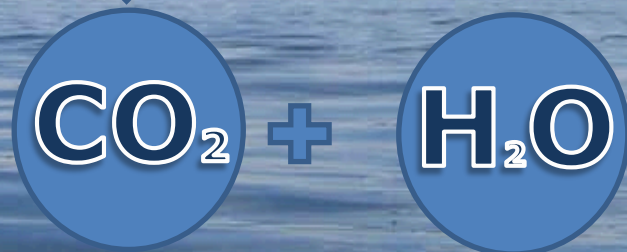


The Carbonate Ion (CO_3^{2-}) is needed for shell formation





dissolves



dissociates



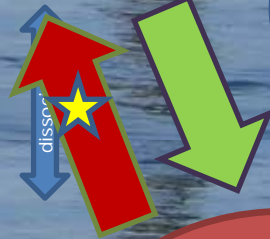
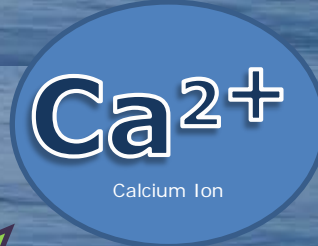
forms



Less shell formation



More shell formation



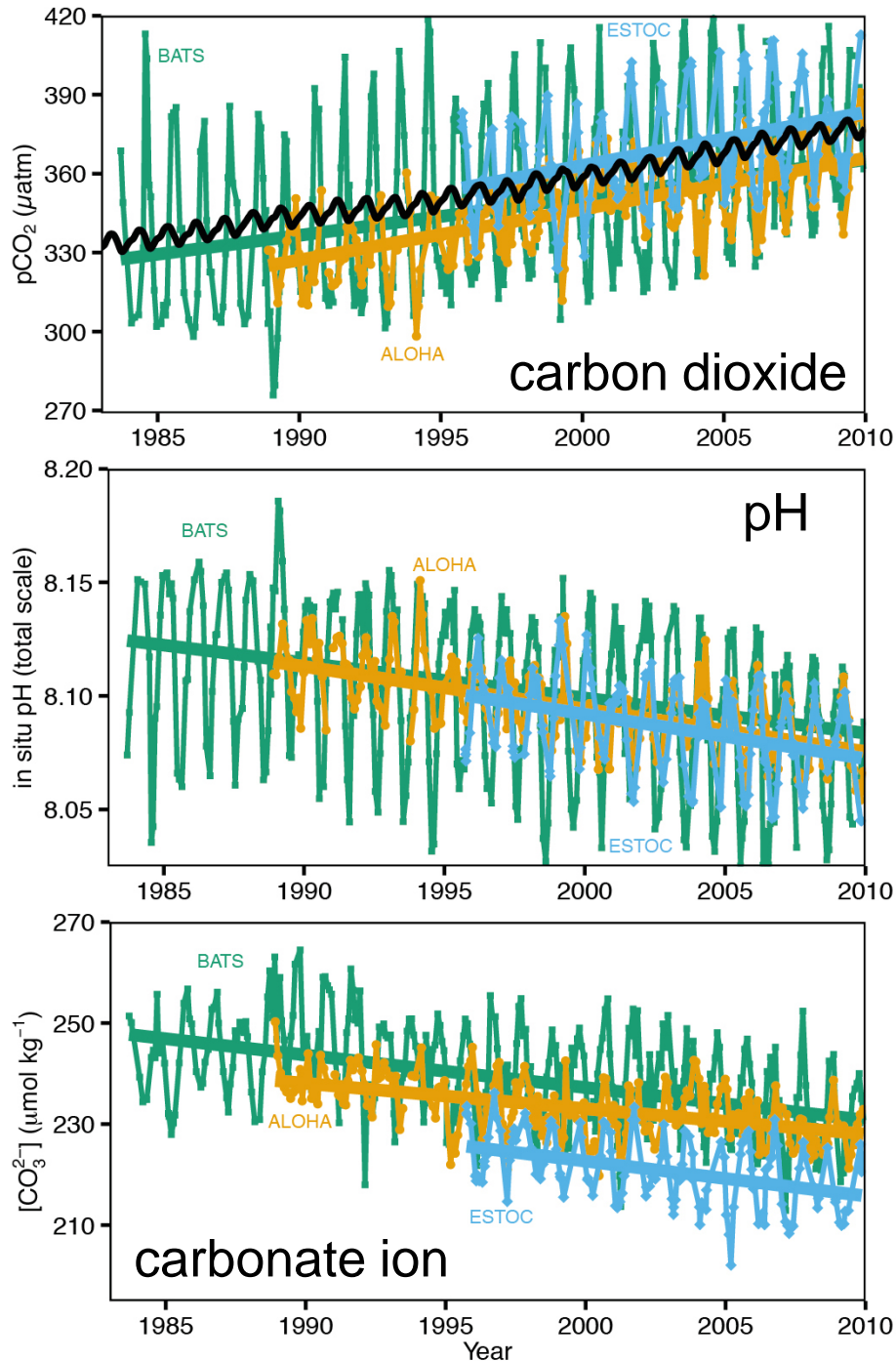
Less available CO_3^{2-}

More available CO_3^{2-}

★ *But... these reactions depend on initial chemical conditions and changes in:*

- Temperature
- Salinity
- Pressure

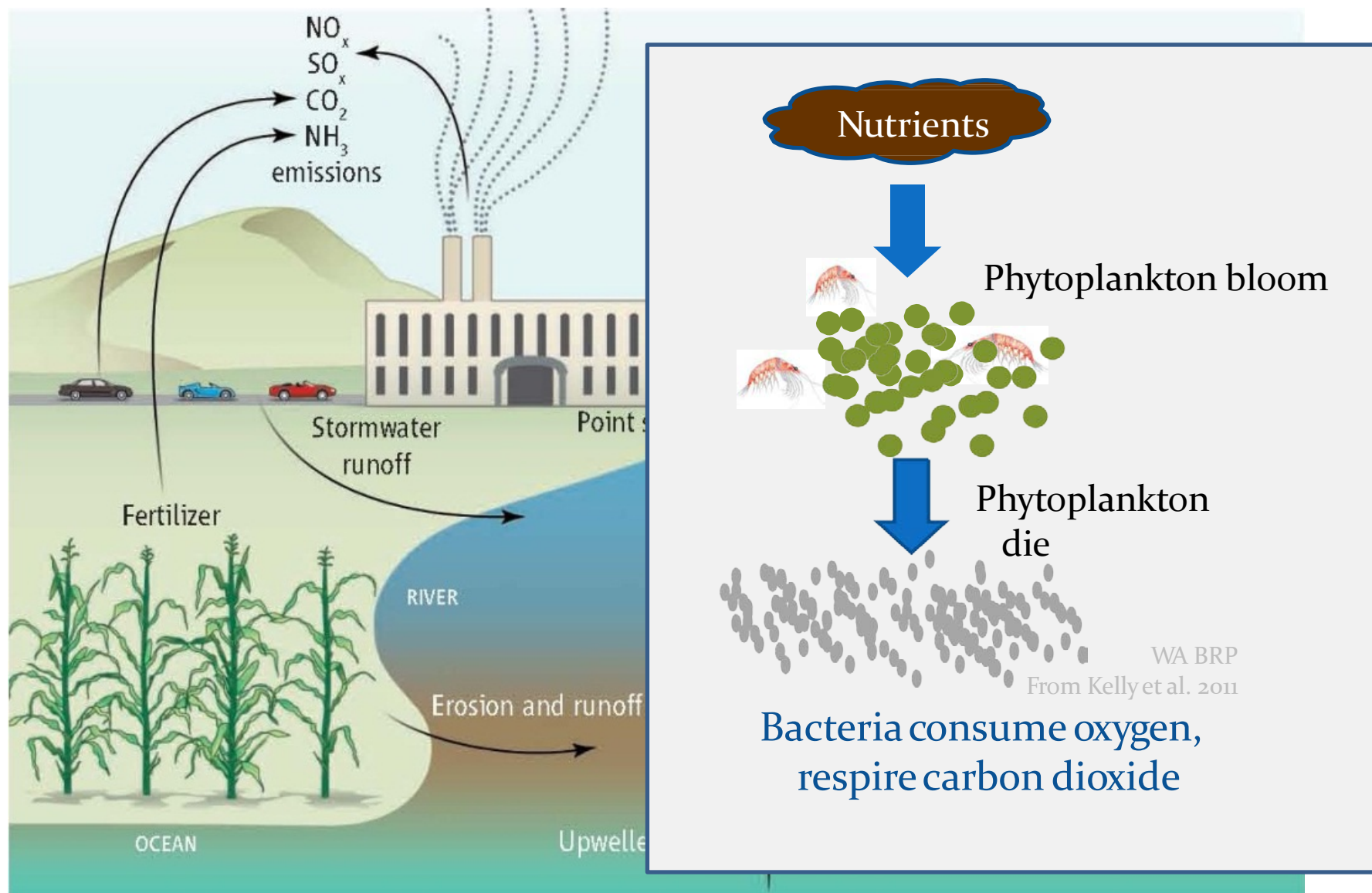
Changing Seawater Chemistry



IPCC 2014
WG1, Chapter 3
Doney et al. Ann. Rev. Mar. Sci. 2009
Dore et al. PNAS 2009

Slide from Scott Doney 2015

Other Local Sources of Coastal Acidification



Shallow coastal ecosystems: multiple stressors

Pristine conditions

Anthropogenically impacted



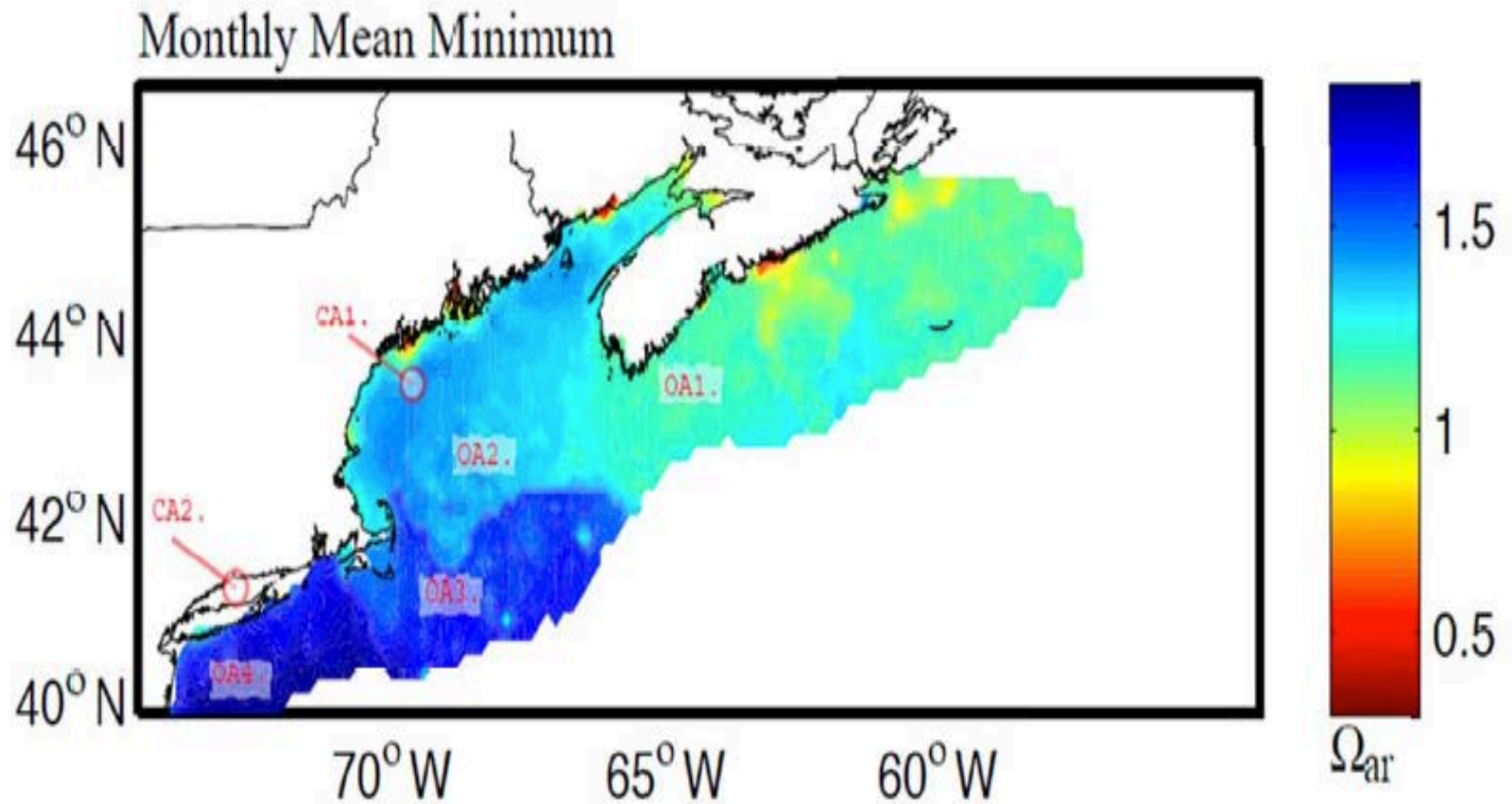
Factors in the NECAN region affective sensitivity to

- Freshwater input sources
- Currents into the GOM supply poorly buffered waters
- Its cold but... but with temperature fluctuations
- Strong seasonal productivity
- Mixed layer dynamics
- Nutrient loading



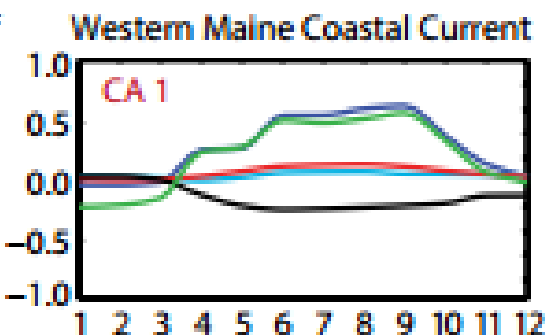
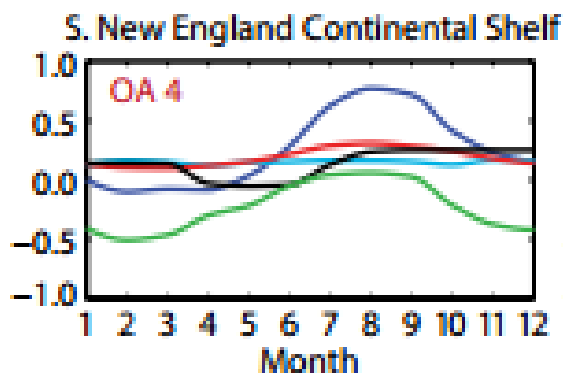
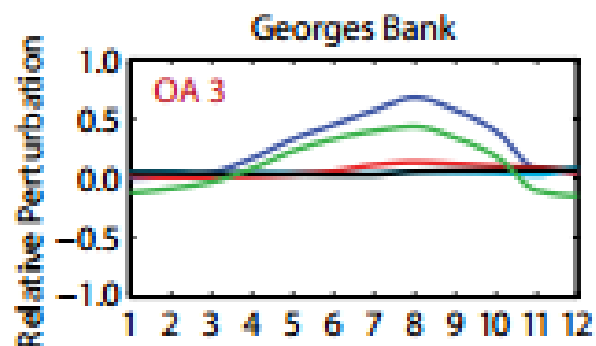
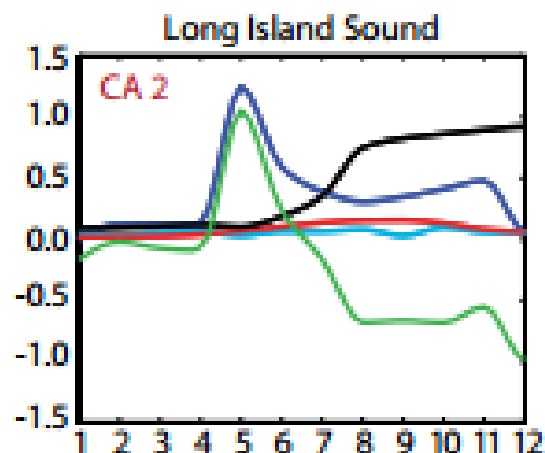
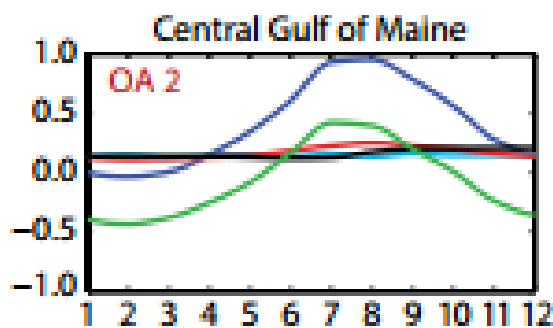
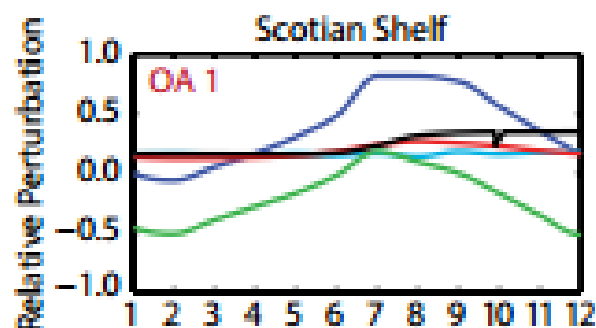
Sub-Regional Spatial Patterns

Calcium carbonate saturation state

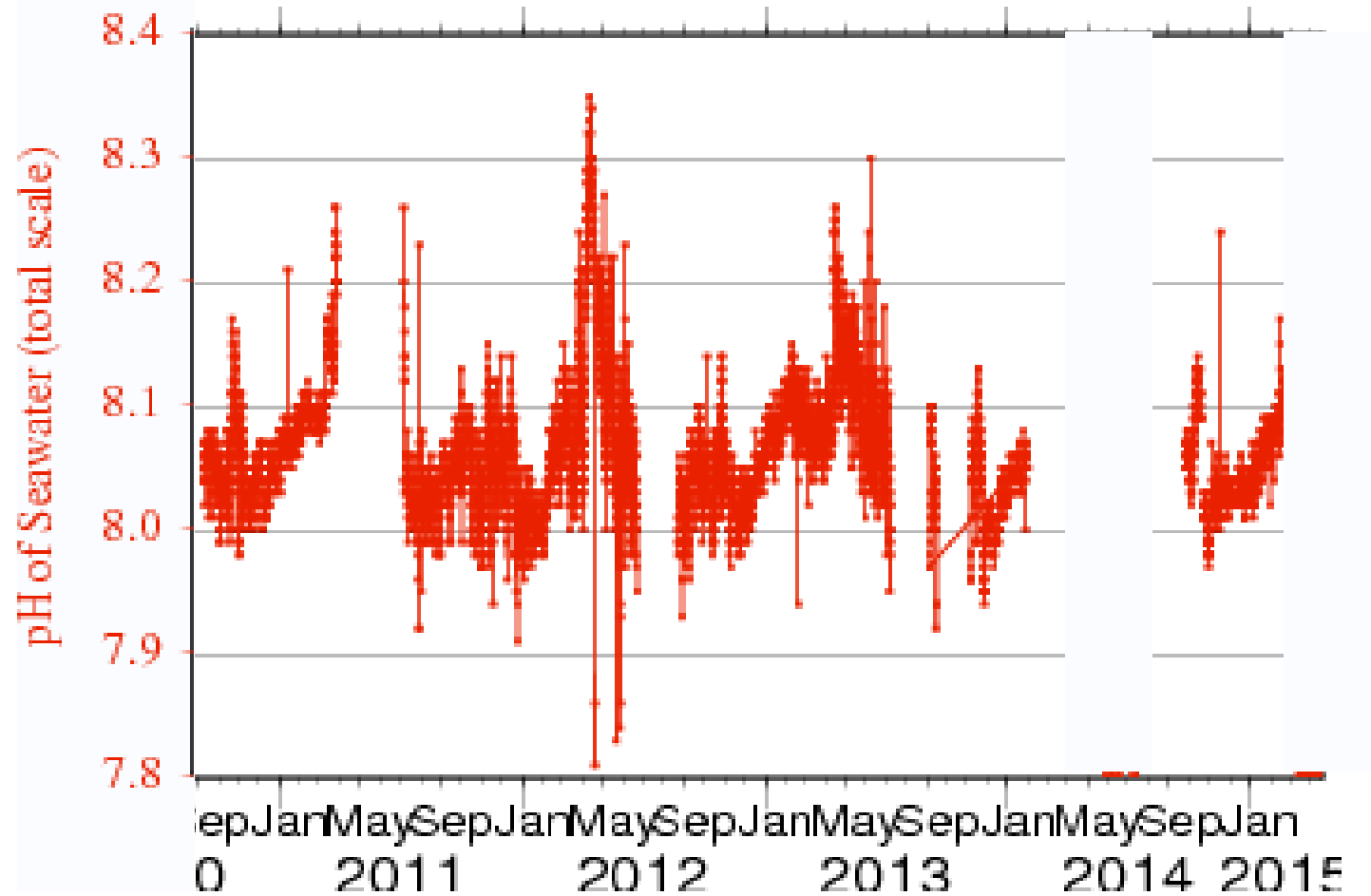


Sub-Regional Spatial Patterns With Seasonal Variability

- Total
- Mixing
- Solubility
- Air sea flux
- Biology



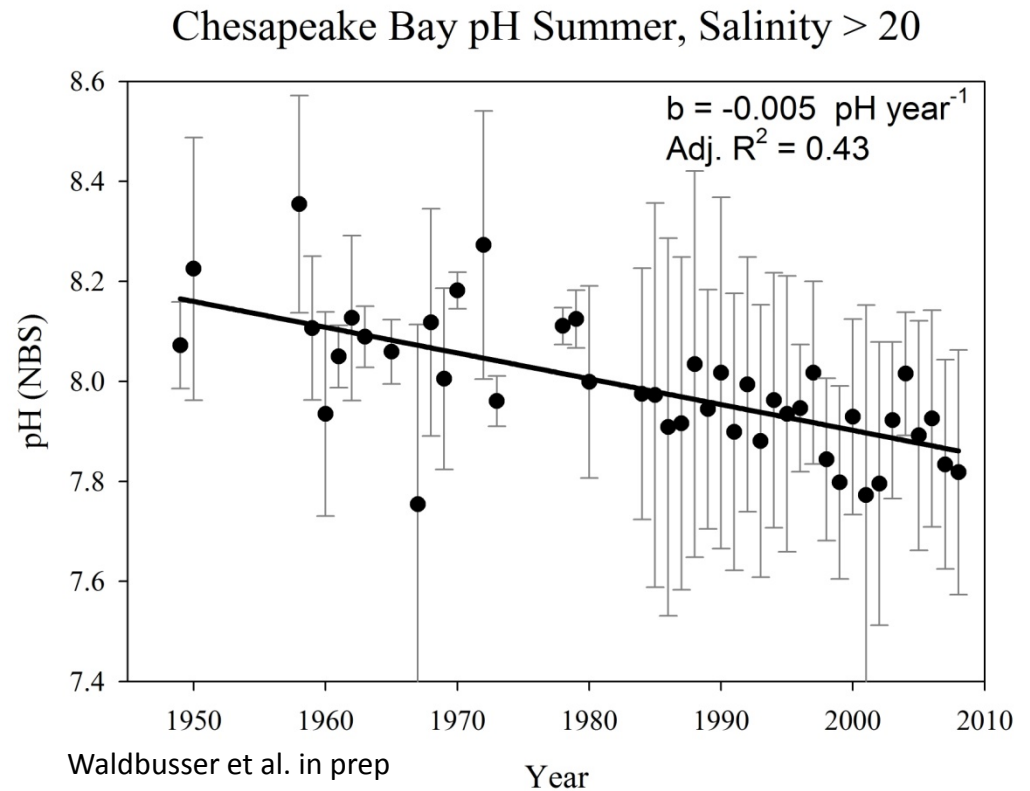
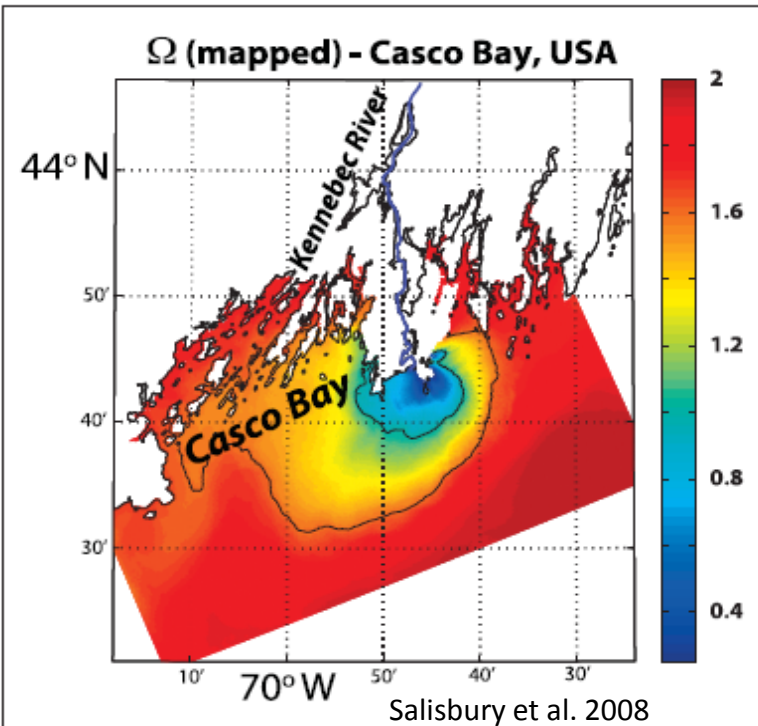
Seasonal Variability at the Isles of Shoals



Surface pH

<http://www.pmel.noaa.gov/co2/story/GOM>

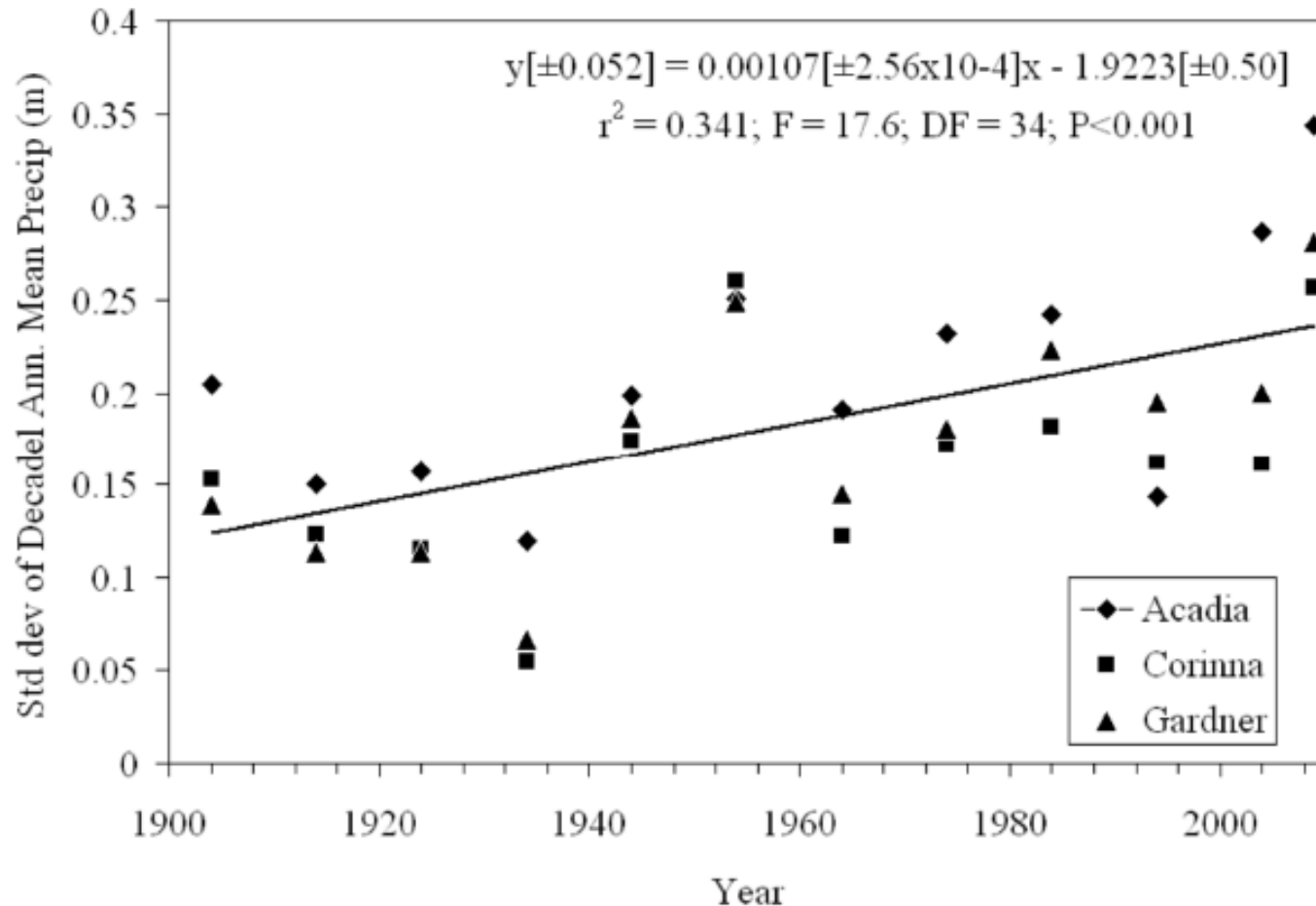
River and Estuary Contributions



Rivers lower available CaCO_3

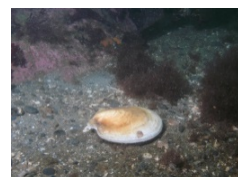
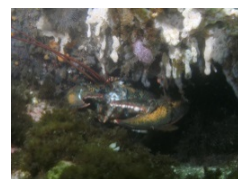
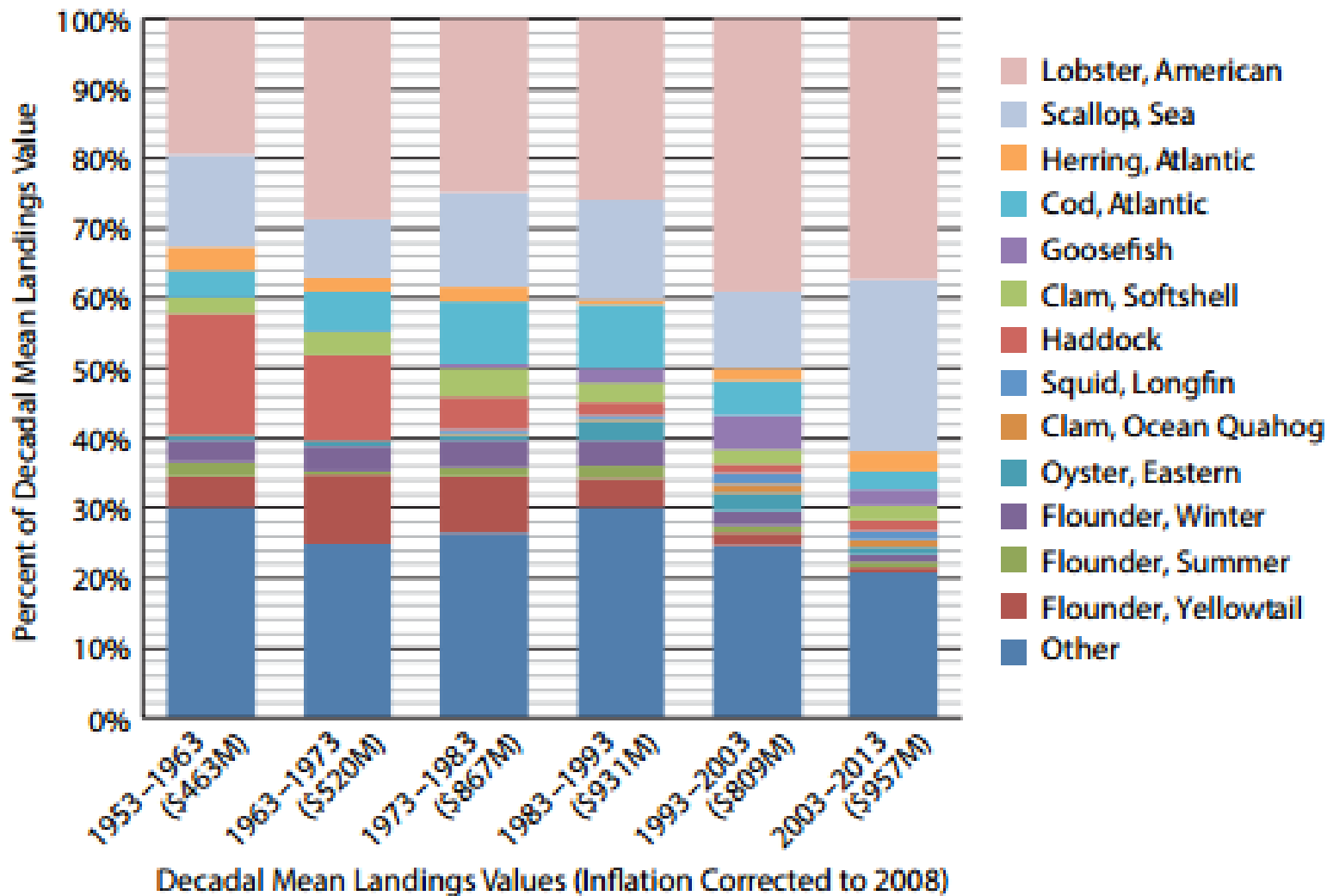
Estuaries also show evidence of acidification

Increased Precipitation



Four of eight wettest years in a century have been since 2005

We are dependent on our ocean resources!



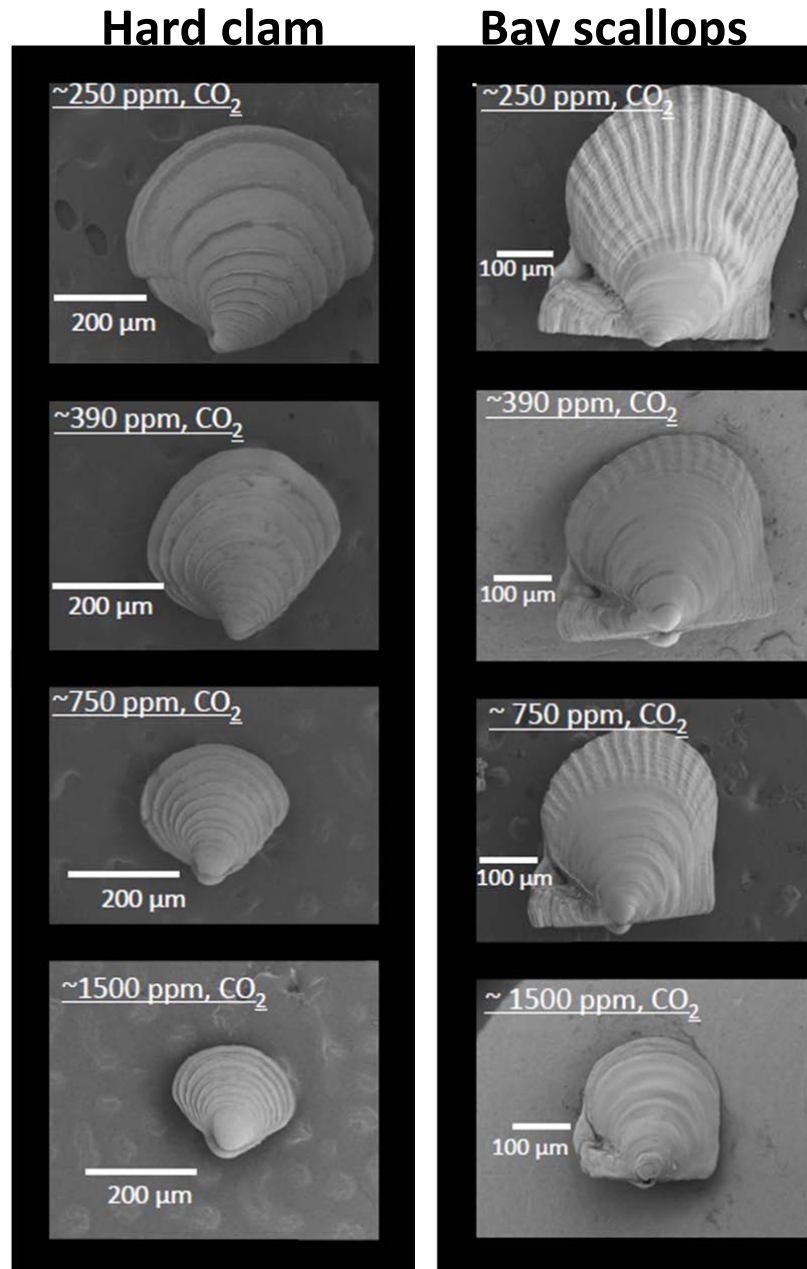
Valuable Fisheries

The Atlantic sea scallop supports the highest valued commercial fishery in New England > \$550 million /year fishery (Voorhees and Pritchard, 2014).



Impacts of OCA on Marine Life

- Reduced shell & skeleton formation (calcification)
- Growth
- Habitat loss
- Less available prey & smaller fisheries
- Behavior



Low CO₂

High CO₂

Some win, some lose



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Volume 28 | Number 2 | June 2015 Special Issue on Emerging Themes in Ocean Acidification Science

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SPECIAL ISSUE FEATURES

Introduction to this Special Issue on Ocean Acidification: The Pathway from Science to Policy
J.T. Mathis, S.R. Cooley, K.K. Yates, and P. Williamson. 2015. *Oceanography* 28(2):10–15, <http://dx.doi.org/10.5670/oceanog.2015.26>.

Understanding Ocean Acidification Impacts on Organismal to Ecological Scales

A.J. Andersson, D.I. Kline, P.J. Edmunds, S.D. Archer, N. Bednaršek, R.C. Carpenter, M. Chadsey, P. Goldstein, A.G. Grotoli, T.P. Hurst, A.L. King, J.E. Kübler, I.B. Kuffner, K.R.M. Mackey, B.A. Menge, A. Paytan, U. Riebesell, A. Schnetzer, M.E. Warner, and R.C. Zimmerman. 2015. *Oceanography* 28(2):16–27, <http://dx.doi.org/10.5670/oceanog.2015.27>.

Coupling Chemical and Biological Monitoring to Understand the Impact of Ocean Acidification on Coral Reef Ecosystems

A. Sutton, D. Manzello, and B. Gintert. 2015. *Oceanography* 28(2):28–29, <http://dx.doi.org/10.5670/oceanog.2015.28>.

Understanding, Characterizing, and Communicating Responses to Ocean Acidification: Challenges and Uncertainties

D.S. Busch, M.J. O'Donnell, C. Hauri, K.J. Mach, M. Poach, S.C. Doney, and S.R. Signorini. 2015. *Oceanography* 28(2):30–39, <http://dx.doi.org/10.5670/oceanog.2015.29>.

Technology for Ocean Acidification Research: Needs and Availability

T.R. Martz, K.L. Daly, R.H. Byrne, J.H. Stillman, and D. Turk. 2015. *Oceanography* 28(2):40–47, <http://dx.doi.org/10.5670/oceanog.2015.30>.

And on Top of All That... Coping with Ocean Acidification in the Midst of Many Stressors

D.I. Breitburg, J. Salisbury, J.M. Bernhard, W.-J. Cai, S. Dupont, S.C. Doney, K.J. Kroeker, I.A. Levin



Ocean and Coastal Acidification off New England and Nova Scotia

By Dwight K. Gledhill, Meredith M. White, Joseph Salisbury, Helmuth Thomas, Ivy Misna, Matthew Liebman, Bill Mook, Jason Grear, Allison C. Candelmo, R. Christopher Chambers, Christopher J. Gobler, Christopher W. Hunt, Andrew L. King, Nichole N. Price, Sergio R. Signorini, Esperanza Stancioff, Cassie Styliani, Richard A. Wahle, Jessica D. Waller, Nathan D. Rebuck, Zhaohui A. Wang, Todd L. Capson, J. Rualidh Morrison, Sarah R. Cooley, and Scott C. Doney

ABSTRACT. New England coastal and adjacent Nova Scotia shelf waters have a reduced buffering capacity because of significant freshwater input, making the region's waters potentially more vulnerable to coastal acidification. Nutrient loading and heavy precipitation events further acidify the region's poorly buffered coastal waters. Despite the apparent vulnerability of these waters, and fisheries' and mariculture's significant dependence on calcifying species, the community lacks the ability to confidently predict how the region's ecosystems will respond to continued ocean and coastal acidification. Here, we discuss ocean and coastal acidification processes specific to New England coastal and Nova Scotia shelf waters and review current understanding of the biological consequences most relevant to the region. We also identify key research and monitoring needs to be addressed and highlight existing capacities that should be leveraged to advance a regional understanding of ocean and coastal acidification.

This true-color image of the Northeast United States and Canada was captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on August 11, 2002. Credit: Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC

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SPECIAL ISSUE FEATURES

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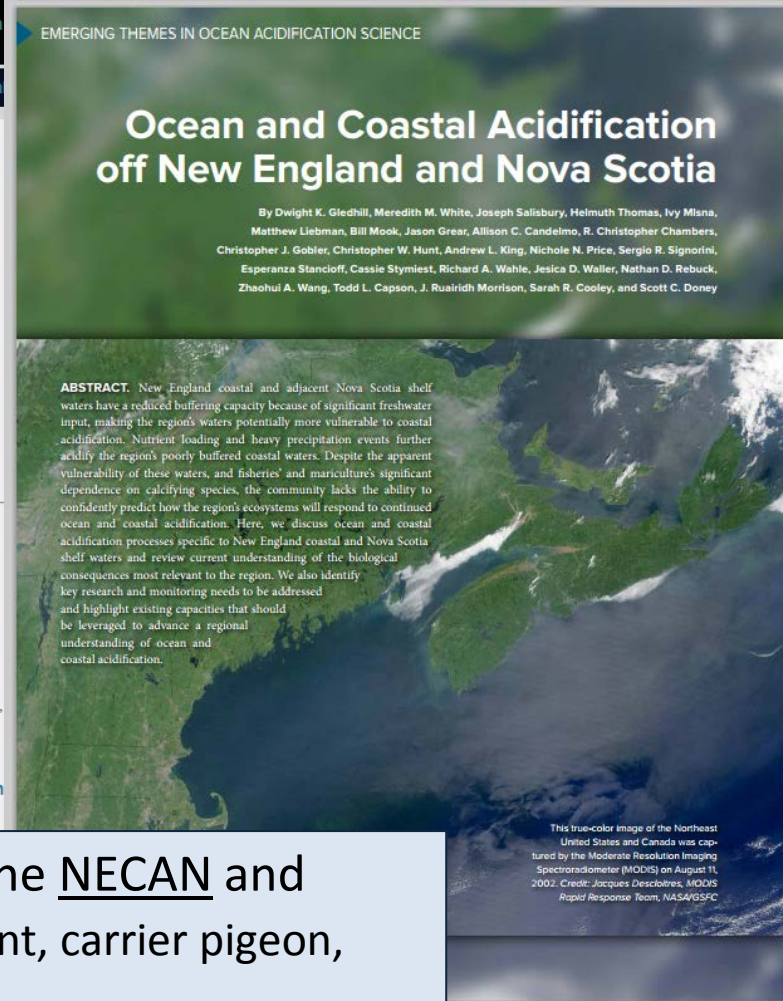
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Google some semblance of the title, also at the NECAN and NERACOOS website, or call an author for a reprint, carrier pigeon, telegraph, etc...

Review and assess

Communicate

Respond

Set priorities

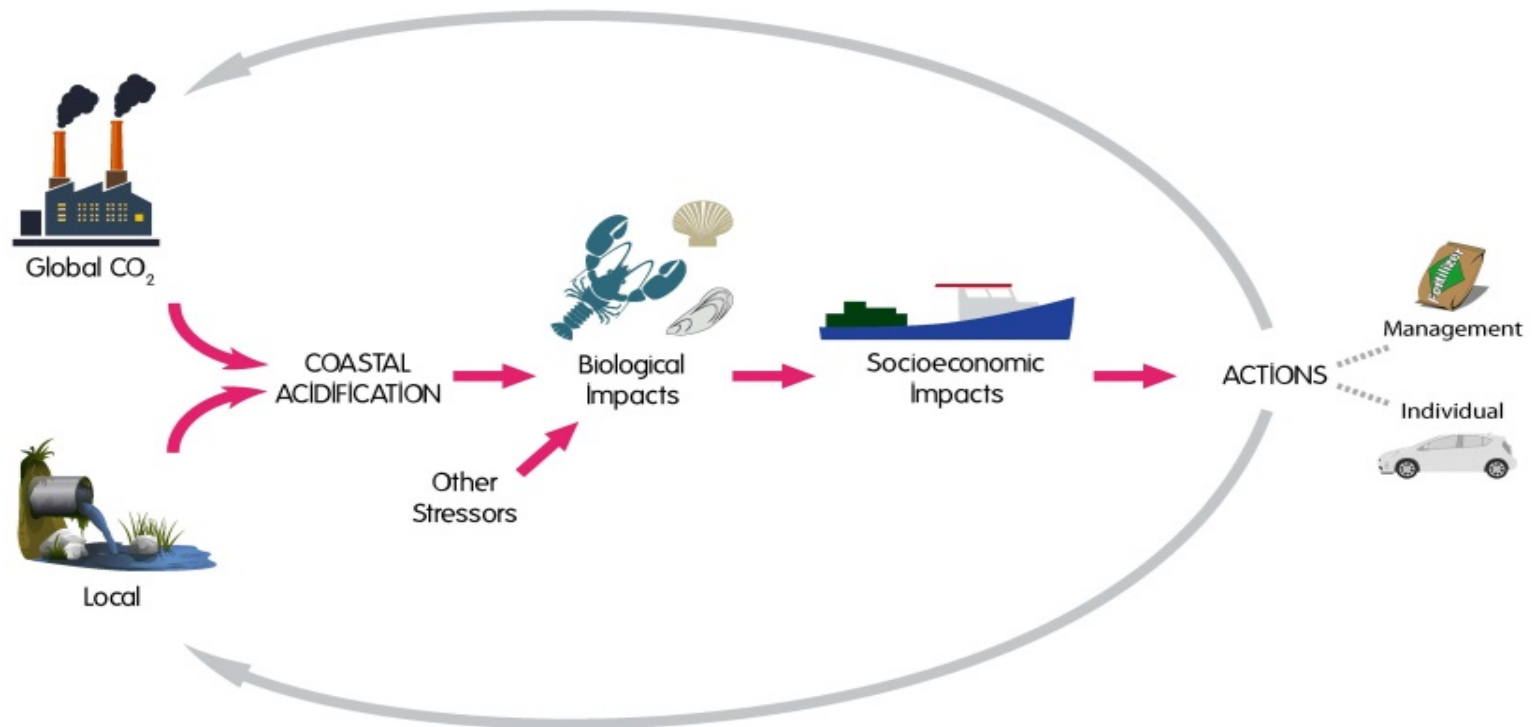
Webinars

Synthesis

Translation

Stakeholder
Input

Implementation
Plan



Review and assess

Communicate

Respond

Set priorities

Webinars



Synthesis



Translation



Stakeholder
Input



Implementation
Plan

Entrainment

Undersaturation

Biocalcification

Concentrations

Total Alkalinity

Marine Calcifiers

Acidification

Entrainment

Supersaturation

Carbonic Acid

Dissolved Inorganic Carbon

Discernible

Unprecedented

Review and assess

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Translation



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Implementation
Plan

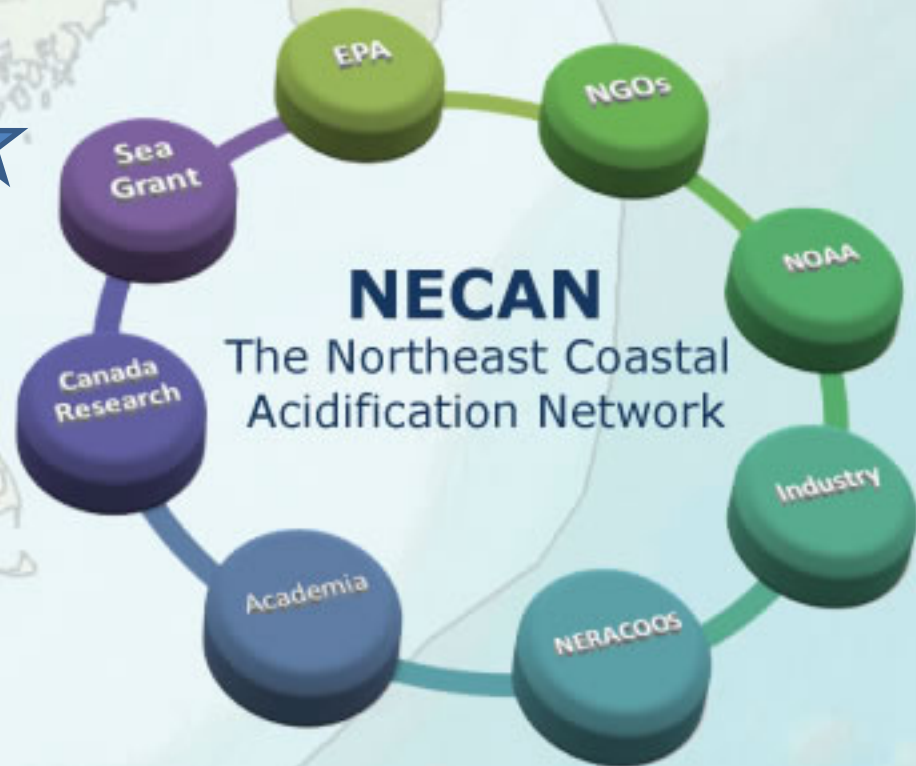
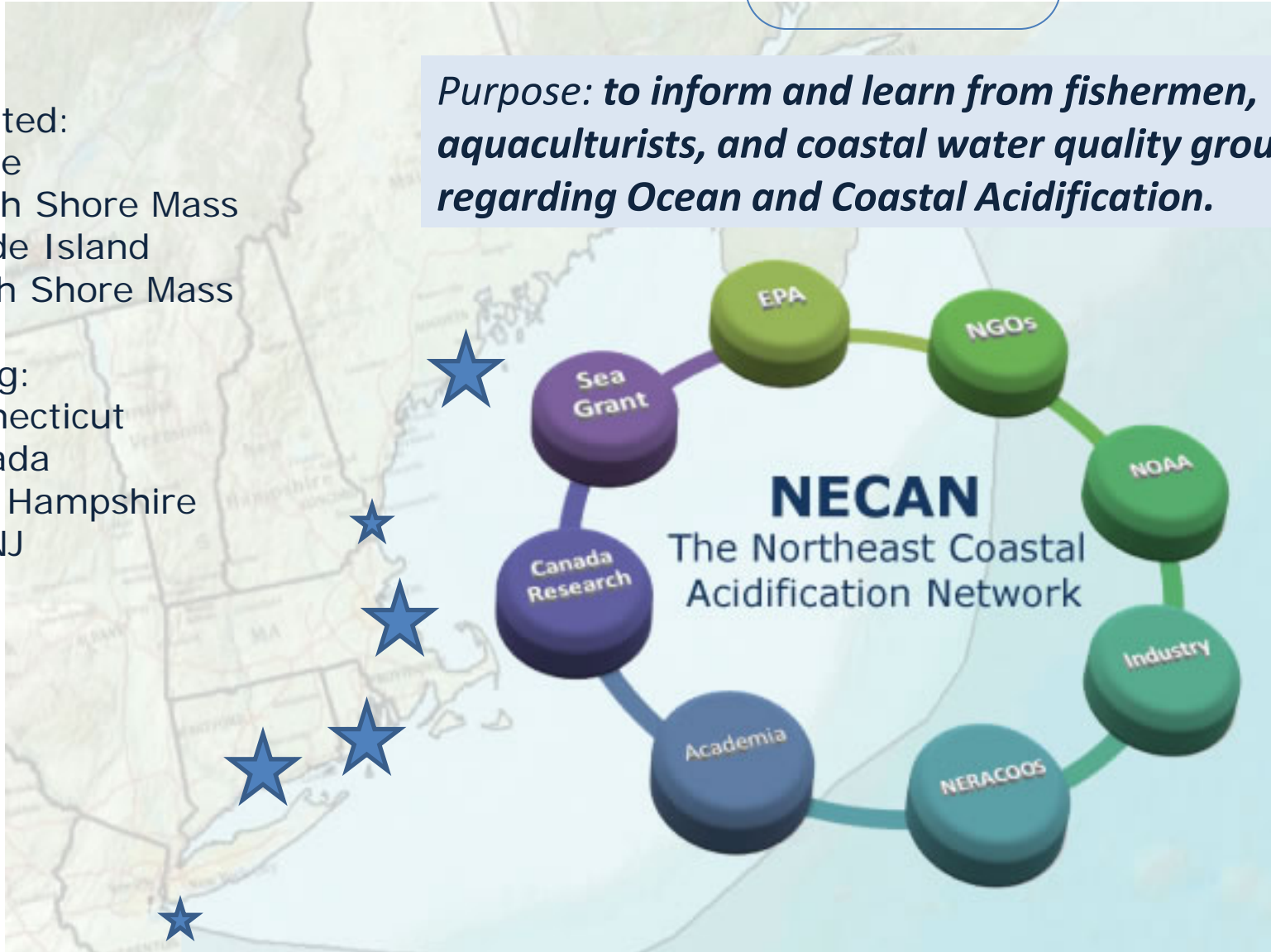
Completed:

- Maine
- South Shore Mass
- Rhode Island
- North Shore Mass

Planning:

- Connecticut
- Canada
- New Hampshire
- NY/NJ

Purpose: to inform and learn from fishermen, aquaculturists, and coastal water quality groups regarding Ocean and Coastal Acidification.



Review and assess

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Webinars



Synthesis



Translation



Stakeholder
Input



Implementation
Plan

Maine

- Popular wording: “a lack of awareness” and “many unknowns”
- The challenge of OCA is extremely complex – especially when adding storms and runoff to the conversation
- Concern that research efforts are disjointed
- Want practical solutions
- Great potential for partnerships for long term monitoring among many different researching groups and bodies.

January 2015 Volume 20, No. 1

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News and Comment for and by the Fishermen of Maine

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Ocean Acidification A Global Issue Gets Local

by Catherine Schmitt

The changing chemistry of the ocean threatens the state's most important fisheries. Yet ocean acidification seems diffuse and global, too overwhelming for any one person, or fisherman, to do much about. But, in fact, there's a lot of things people in Maine can do to address the problem, according to participants in a workshop hosted by the Northeast Coastal Acidification Network at the Darling Marine Center in December. Much of the carbon dioxide that gets emitted to the atmosphere ends up in the ocean, where it is transformed in a series of chemical reactions that cause an



Left to right: Mark Green, a shellfish grower and professor at St. Joseph's College who has studied the effects of acidic water.; Maine Lobstermen's Association President Dave Cousins; Bill Mook operates an oyster hatchery and sea farm on the

CONTENTS

“Possibility Open” That Habitat Closures Could Impact Lobster Gear

Scalp Bounties and Lovewell's War

Editorial – In These Last Hours

Maine and Massachusetts Rope Buybacks in January

Scallop Fishermen Can Harvest, But Early Season End Expected

Eastport Breakwater Collapse

Getting to the Water

Omnibus Habitat Amendment 2 to Bring Comprehensive Management

Review and assess

Communicate

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Webinars



Synthesis



Translation




Stakeholder
Input



Implementation
Plan

South Shore Massachusetts

- Popular wording: “do not fully understand” and “lack understanding of...”
- Multiple stressors: the link between them all
- Want more research on acidified mud
- Concern for lack of mitigation solutions
- Recognize the need for, and want to be part of collaborative research efforts
- Need funding
- “The goal should be to communicate with the public in a way that causes or inspires them to change behavior and spend money on solutions”






**Finding the local perspective
on ocean acidification**

Ocean acidification is not just a buzzword for the men and women who make their living harvesting shellfish off the coast of New England. The pH of coastal water directly affects the health of shellfish and that has a real and immediate impact on the livelihood of fishermen.

With the help of MIT Sea Grant and Woods Hole Sea Grant/Cape Cod Cooperative Extension, the Northeast Coastal Acidification Network coordinated an Ocean Acidification Stakeholder Workshop. The workshop brought together scientists, state and federal regulators, non-profit groups, and leaders in fishing communities across Cape Cod and The Islands to learn from one another about the local effects of coastal acidification.

[continue reading](#)



Review and assess

Communicate

Respond

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Webinars



Synthesis



Translation



Stakeholder
Input



Implementation
Plan

Rhode Island

- Need more research on the impacts of biota, eventual/potential ecosystem impacts, and acidified mud.
- Questions raised about understanding coastal acidification and its role in the multiple stressors puzzle
- Translation of the science (good science), through outreach and education efforts.
- Future monitoring needs to be done in a targeted manner to cover gaps, and existing monitoring should be maintained; “Let’s not lose what we have”



Review and assess

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Webinars



Synthesis



Translation



Stakeholder
Input



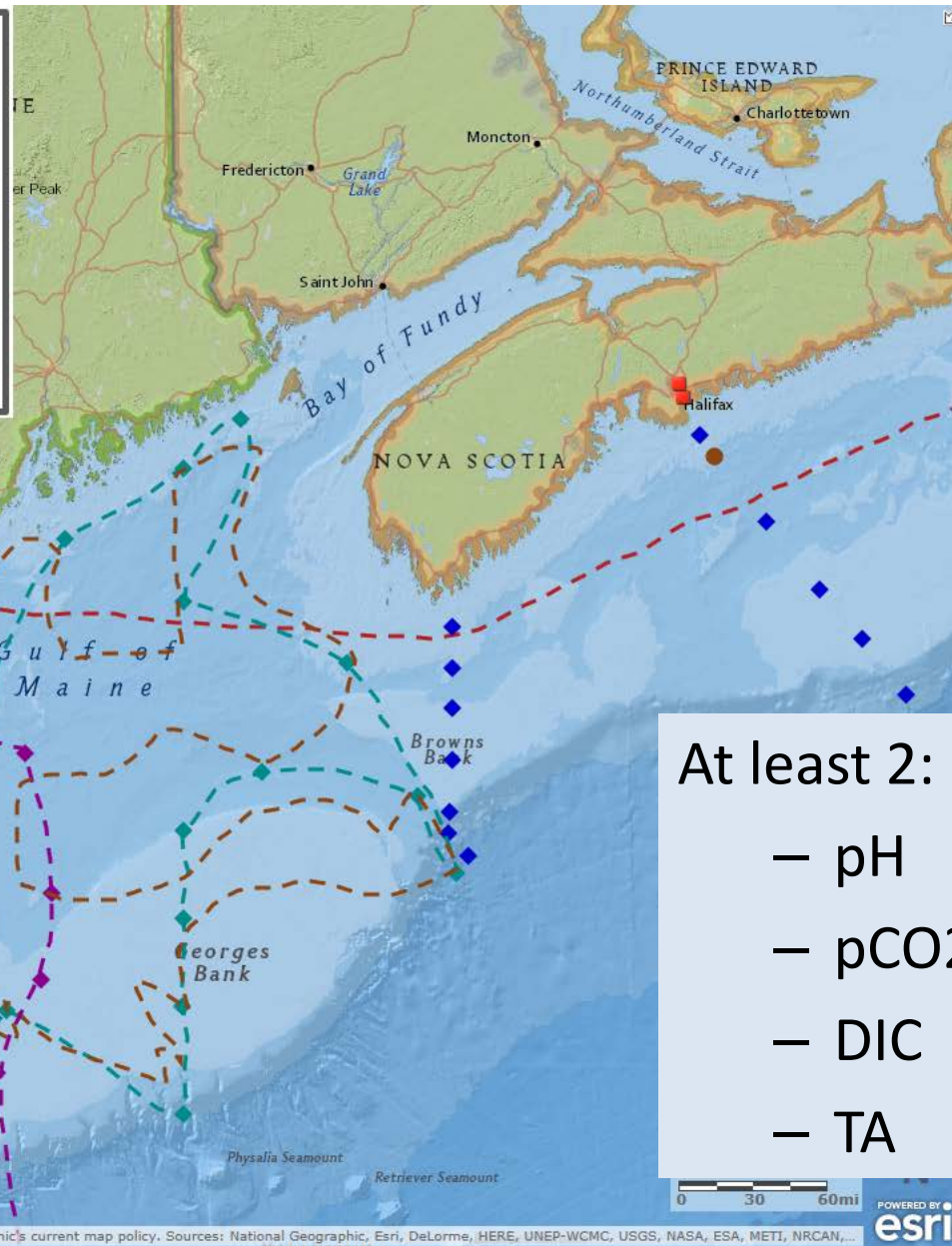
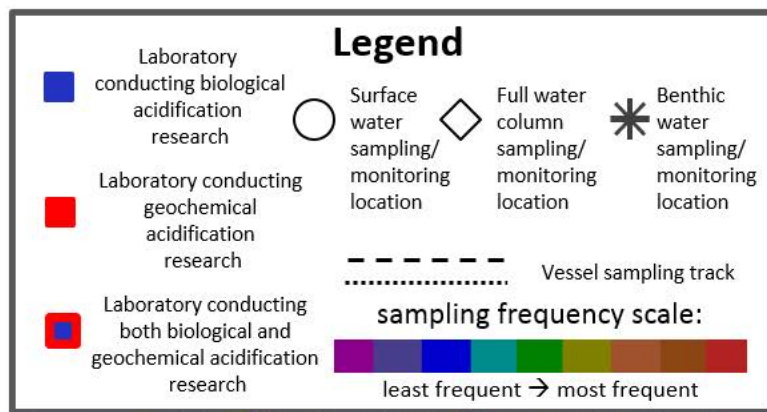
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Summary so far

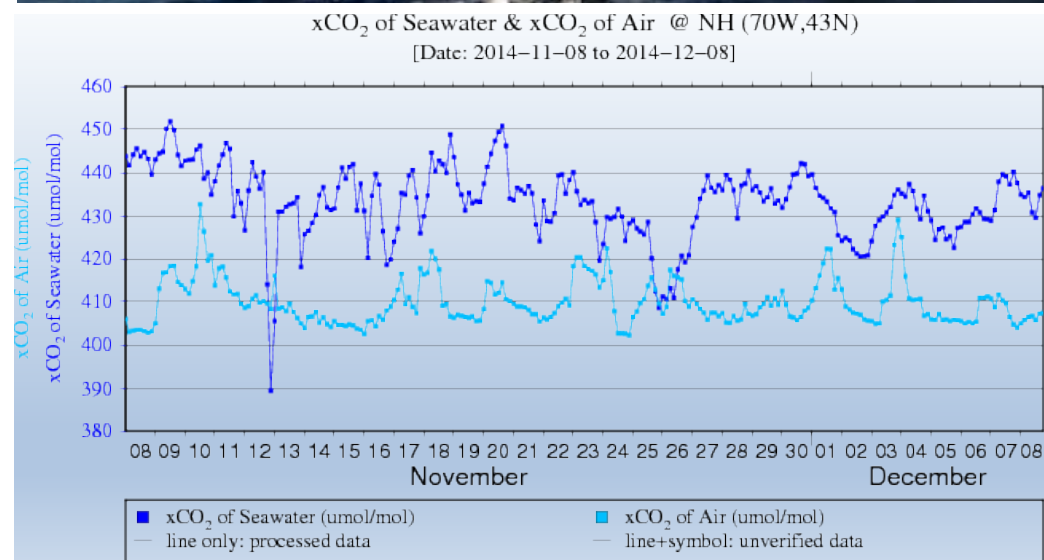
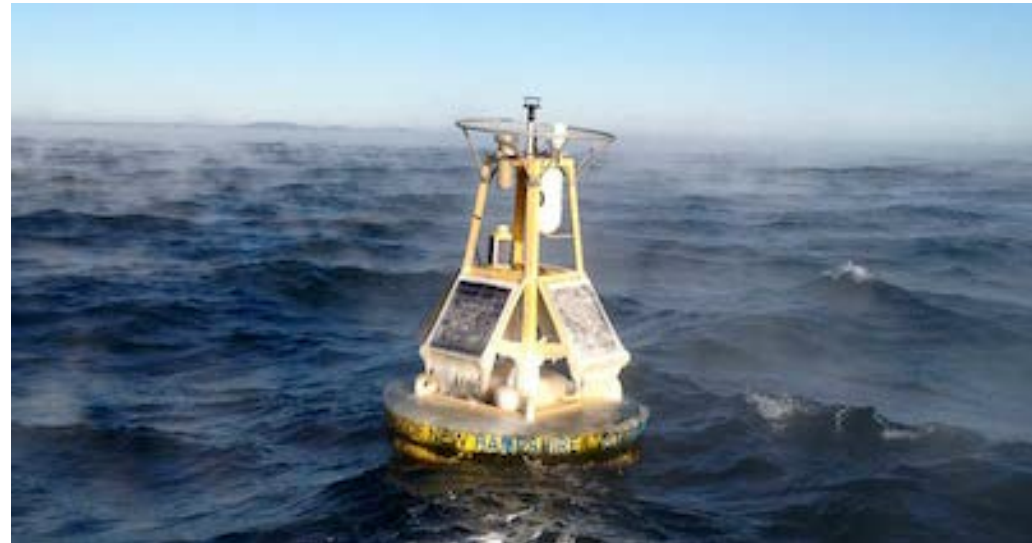
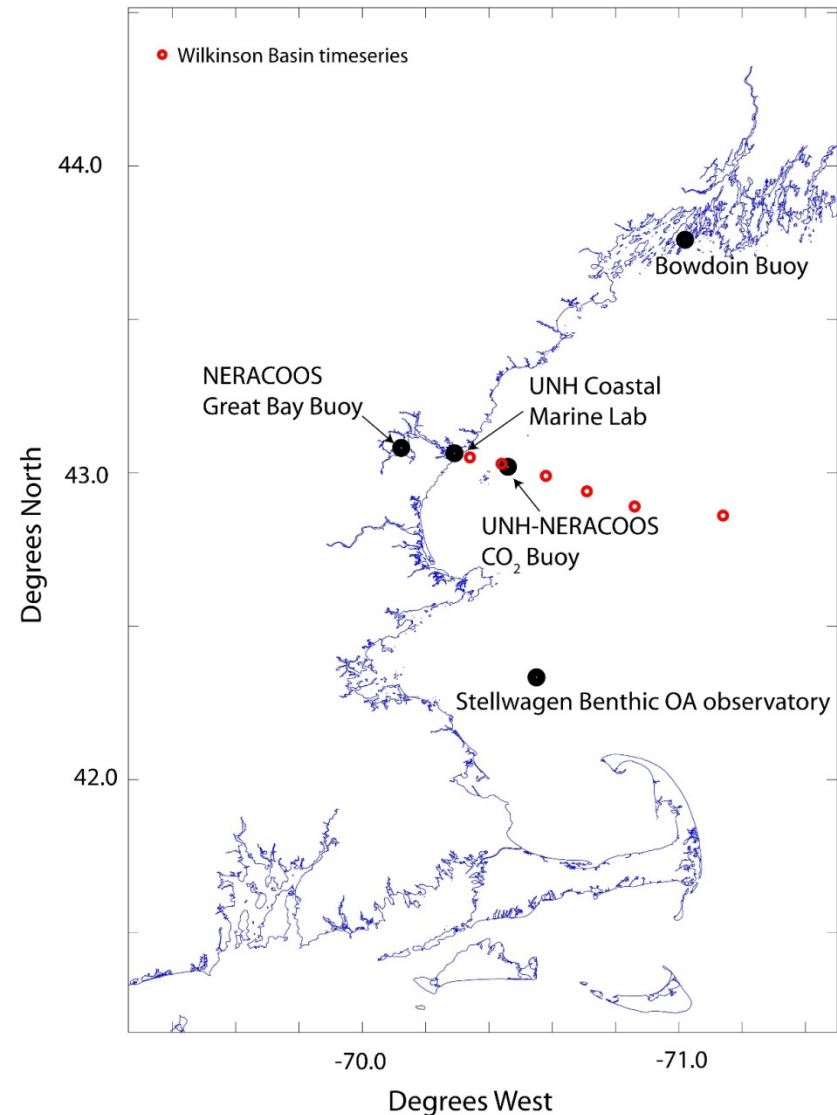
- *Need to translate the connections of OCA in the context of climate change and its role in a multiple stressor environment*
- *Need to identify risks and make recommendations for each industry group*
- *Need more monitoring and research*
- *Need Practical Guidance for monitoring efforts*
- *...which needs to be coordinated*
- *Need to improve and expand monitoring so we are collecting high quality (long term) data*

Inventory of Monitoring for OCA

Monitoring Program	pH	pCO2	DIC	TA	salinity	"nutrients"	nitrate	nitrite	phosphate	orthosilicic acid	DIN	silicate	POC	PIC	DOC	C14 primary productivity	C14 calcification	plankton	chl-a	DO	turbidity	TON	Phaeophytin	DON	E. coli	TDN		
Shelf-wide Plankton Surveys																												
OOI Maintenance/Deployment																												
Martha's Vinyard Coastal Observations	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Y	Y									
Waquoit Bay System-Wide Monitoring Program																												
Buzzards Bay Water Quality Monitoring Program																												
Bathing Beach Water Quality Monitoring Program	MA Dept of Health and Environment	MA	15 Cape-wide beaches	weekly sampling	http://www.barnstablecountyhealth.org/bathing-beach-water-quality	-	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	
National Coastal Assessment	multiple federal agencies	U.S.	multiple locations	assessment occurs about every 5 years, using many data sources collected at varying frequencies	http://water.epa.gov/type/oceb/assessment/monitor/ncca.cfm	-	Y	N	N	N	Y	Y	spec.	Y	Y	Y	N	N	N	N	N	N	N	Y	Y	N	N	N
Environmental Monitoring Program	MWRA	MA	50 locations around the coast and islands	monthly sampling	http://www.mwra.state.ma.us/harbor/html/bh_wq.htm		Y	N	N	N	Y	Y	spec.	N	N	N	N	Y	N	Y	N	N	N	N	Y	N	Y	
Cape Cod Bay Monitoring Program	Center for Coastal Studies	MA	Over 40 stations located along the shoreline	bi-weekly sampling April-October	http://coastalstudies.org/programs/cape-cod-bay-monitoring-program/		N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N
Environmental Monitors on Lobster Traps	NOAA NEFSC	Gulf of Maine and Southern New England Shelf	almost 100 stations throughout study area	continuous monitoring	http://www.emolt.org/		N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Plum Island Ecosystems Long Term Ecological Research	The Long Term Ecological Research Network	MA	Plum Island		http://pie-iter.ecosystems.mbl.edu/content/analytical-methods		N	N	Y	Y	N	N	spec.	Y	Y	Y	N	Y	N	N	N	Y	N	N	Y	Y	N	Y
Bay Watchers	Waquoit Bay National Estuarine Research Reserve	MA	Waquoit Bay (9 sites)		http://www.waquoitbayreserve.org/get-involved/volunteer-opportunities/		N	N	N	N	Y	Y	spec.	Y	N	Y	N	N	Y	N	N	N	N	Y	N	N	N	Y
Water Quality in Buzzards Bay	Coastal America Foundation	MA	Buzzards Bay (5 sites with dataloggers)		http://www.coastalamericafoundation.org/waterqualitydata.html		N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N
Salem Sound Water Quality Monitoring Project	Salem Sound Coastwatch	MA	Salem Sound (6 sites)	monthly sampling		Barbara Warren, barbara.warren@salessound.org	Y	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N

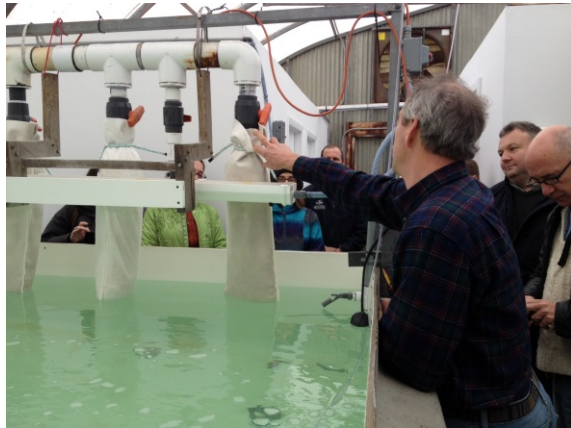


Observations in the Northeast



Shore Stations

Mook Sea Farm & Casco Bay



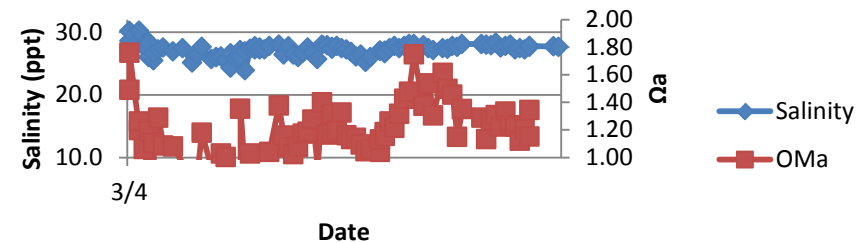
**The JBB
(Joe's Black Box)**



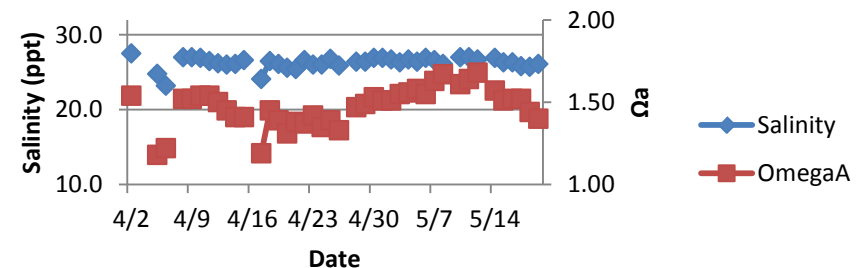
Measures:
Temperature
Salinity
Dissolved O₂
pCO₂

Calculates:
pH
Omega_{a&c}

Salinity and Ω_a , March to June 2011



Salinity and Ω_a , April/May 2014



Review and assess

Communicate

Respond

Set priorities

Webinars



Synthesis



Translation



Stakeholder
Input



Implementation
Plan



Review and assess

Communicate

Respond

Set priorities

Webinars



Synthesis



Translation



Stakeholder
Input



Implementation
Plan

NECAN Working Groups

NECAN Steering
Committee

Science

Obs. and research
prioritization and
coordination
Inventory of obs. &
research/scientists
Develop citizen science
Integrate new findings
into outreach materials

Industry

Develop targeted tools
and mitigation
approaches
Workshops to assess
industry needs

Policy

Develop information
products for policy
makers
Serve on local and
regional commissions
and task forces as
appropriate

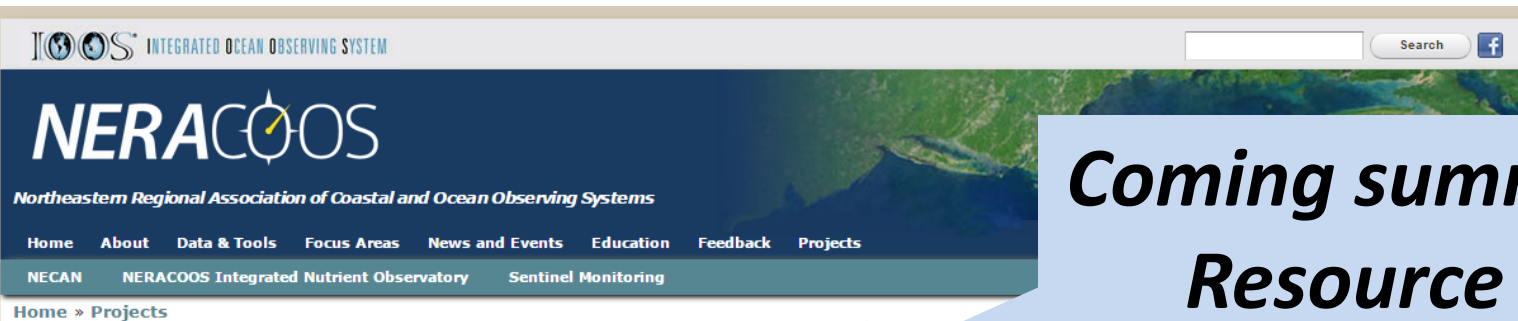
Outreach &
Education

Maintain wiki-cartoon
and other web
materials
Develop lesson plans
and other educational
materials for K-12
Provide outreach to
citizen scientists,
industry, policymakers

Where can I go for more info?

www.neracoos.org/necan

**Coming summer 2015:
Resource portal**



NECAN: The Northeast Coastal Acidification Network

[Home](#) [About us](#) [Listserv](#) [Resources](#) [Webinars](#)

NECAN Updates

NECAN is currently hosting stakeholder engagement workshops to inform and learn from fishermen, clam harvesters, aquaculturists, and coastal water quality programs regarding ocean and coastal acidification. The first workshop was held in Maine on December 10 and the meeting summary can be found [here](#). The second workshop was held on April 27 and was for the South Shore of Massachusetts and the third on June 5 for Rhode Island. We are still drafting the meeting summaries.

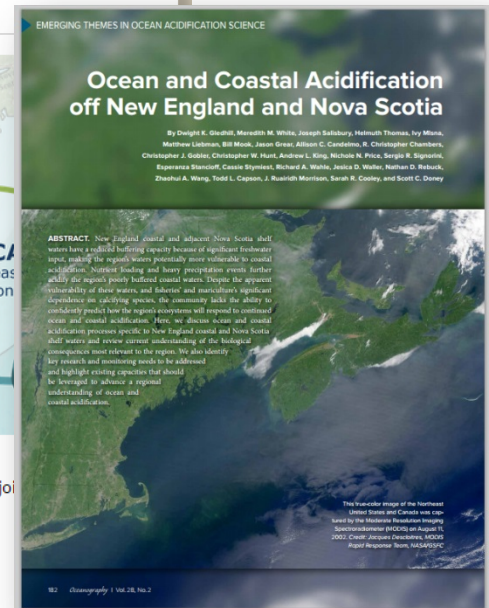
The North Shore Massachusetts workshop will be June 23. If you are interested in attending, or have any questions regarding these workshops, please contact Cassie Stymiest (cassie@neracoos.org). Subsequent workshops are being planned to occur in the next few months for Connecticut, Maritime Canada, and the New York Bight area.

New! NECAN's publication "[Ocean and Coastal Acidification off New England and Nova Scotia](#)" is now available in the new special issue of *Oceanography* magazine. This is the result of the state of the science webinars and workshops that NECAN conducted last year.

[Click here](#) or the registration tab above to register for the NECAN Listserv for webinars and other important information.

[Click here](#) to download "What is NECAN," a document that describes what the network is, what the functions are, and our structure. If you're interested in joining working groups, please fill out this [survey](#) to let us know.

Questions? Contact Ru Morrison, ru@neracoos.org



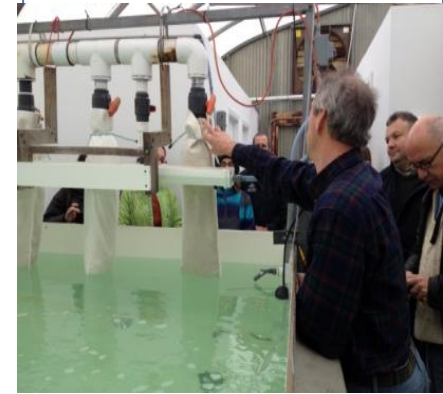
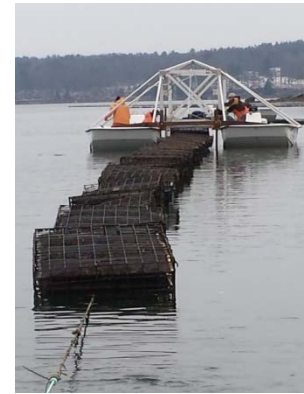
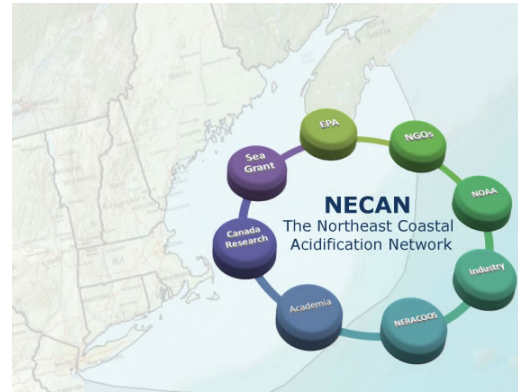
Regional Coastal Observing Systems: Alaska • Pacific Northwest • Central and Northern California • Southern California • Pacific Islands • Great Lakes • Atlantic-Northeast • Mid-Atlantic • Atlantic-Southeast • Gulf of Mexico • Caribbean • IOOS Association

National Observing System Partners: Alliance for Coastal Technologies (ACT) • Southeastern Universities Research Association (SURA)

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Yes, NE-CAN!



NECAN will:

- provide guidance and direction on research and observations
- generate information products
- organize workshops and outreach activities
- provide resources for stakeholders

NECAN is not:

- An agency or institution that undertakes monitoring or research (although its members do)
- A source of research funding (although it helps to prioritize regional research)

SUCCESS!

- 388 members
- 41-61% open rate on monthly updates
- 16 science based webinars
- 3 stakeholder workshops
- Over 850 Youtube views
- Over 4,000 Pageviews
- A model for other regions – SOCAN
- Legislation and action – ME Commission, other states following

Thank you!

www.neracoos.org/necan

cassie@neracoos.org

The NECAN Story continues...

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