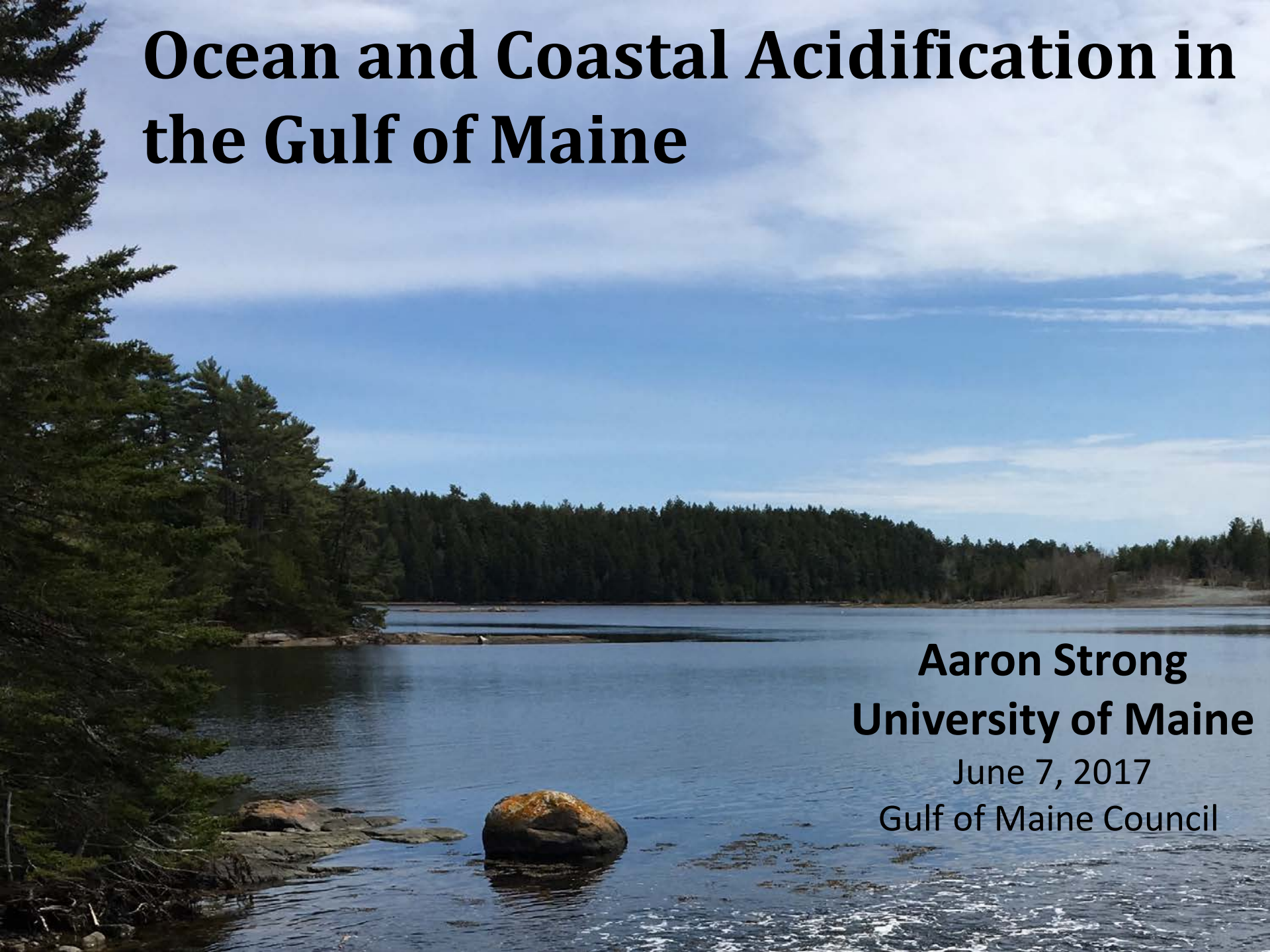
Ocean and Coastal Acidification in the Gulf of Maine



Aaron Strong
University of Maine
June 7, 2017
Gulf of Maine Council

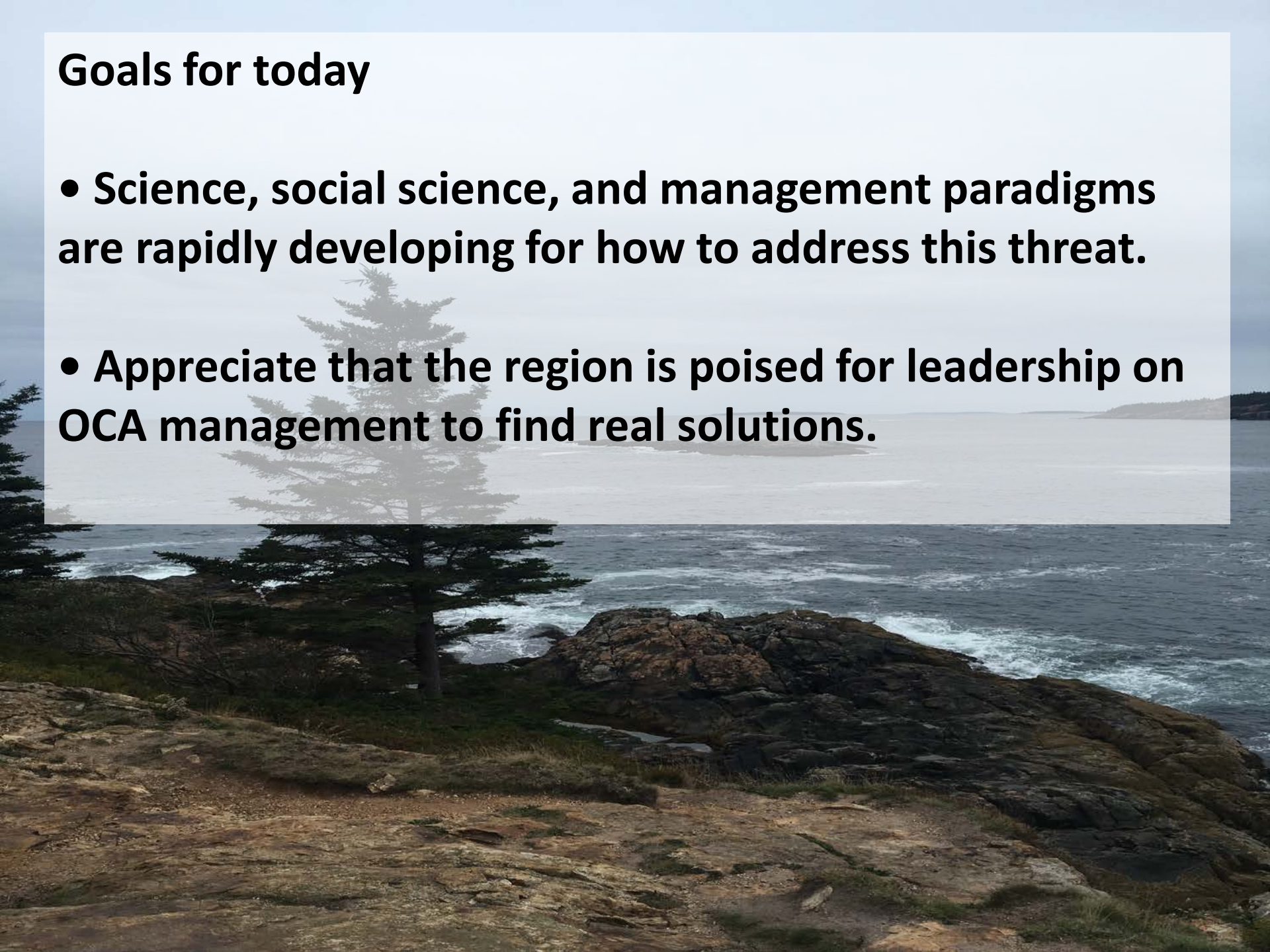
Outline of Talk

- **Ocean and coastal acidification and why we should care about it?**
- **What we have done, what we are doing, and we might do about it.**
- **Gaps and needs at the bioregional scale.**

Goals for today

- Science, social science, and management paradigms are rapidly developing for how to address this threat.

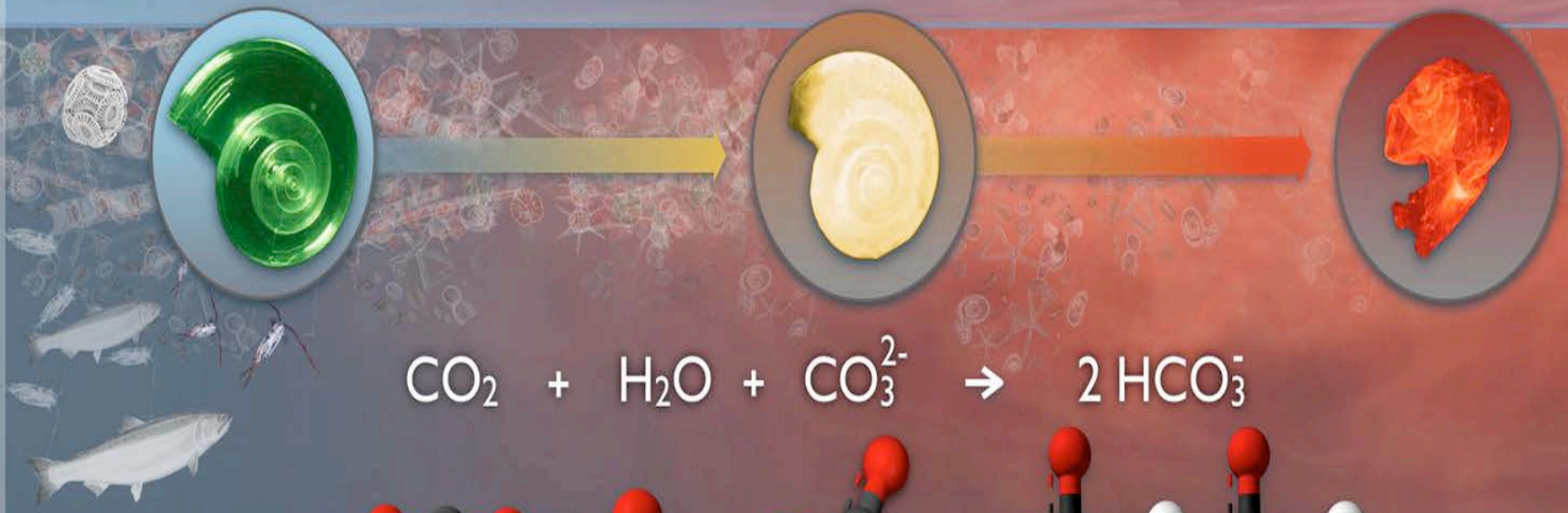
- Appreciate that the region is poised for leadership on OCA management to find real solutions.



OCEAN ACIDIFICATION

HOW WILL CHANGES IN OCEAN CHEMISTRY AFFECT MARINE LIFE?

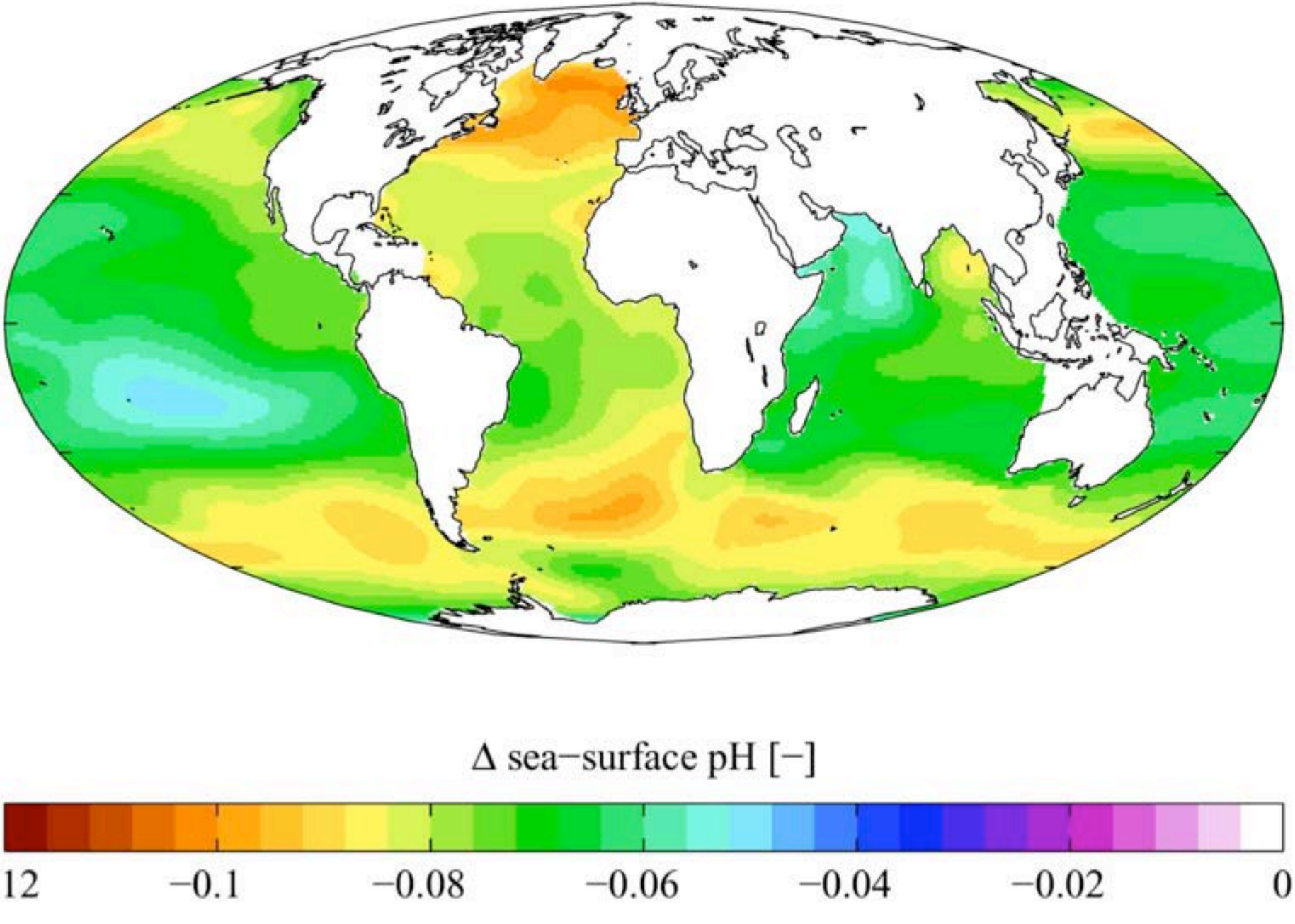
CO_2 absorbed from the atmosphere



$$CO_2 + H_2O + CO_3^{2-} \rightarrow 2\,HCO_3^-$$

carbon dioxide | water | carbonate ion | 2 bicarbonate ions

consumption of carbonate ions impedes calcification

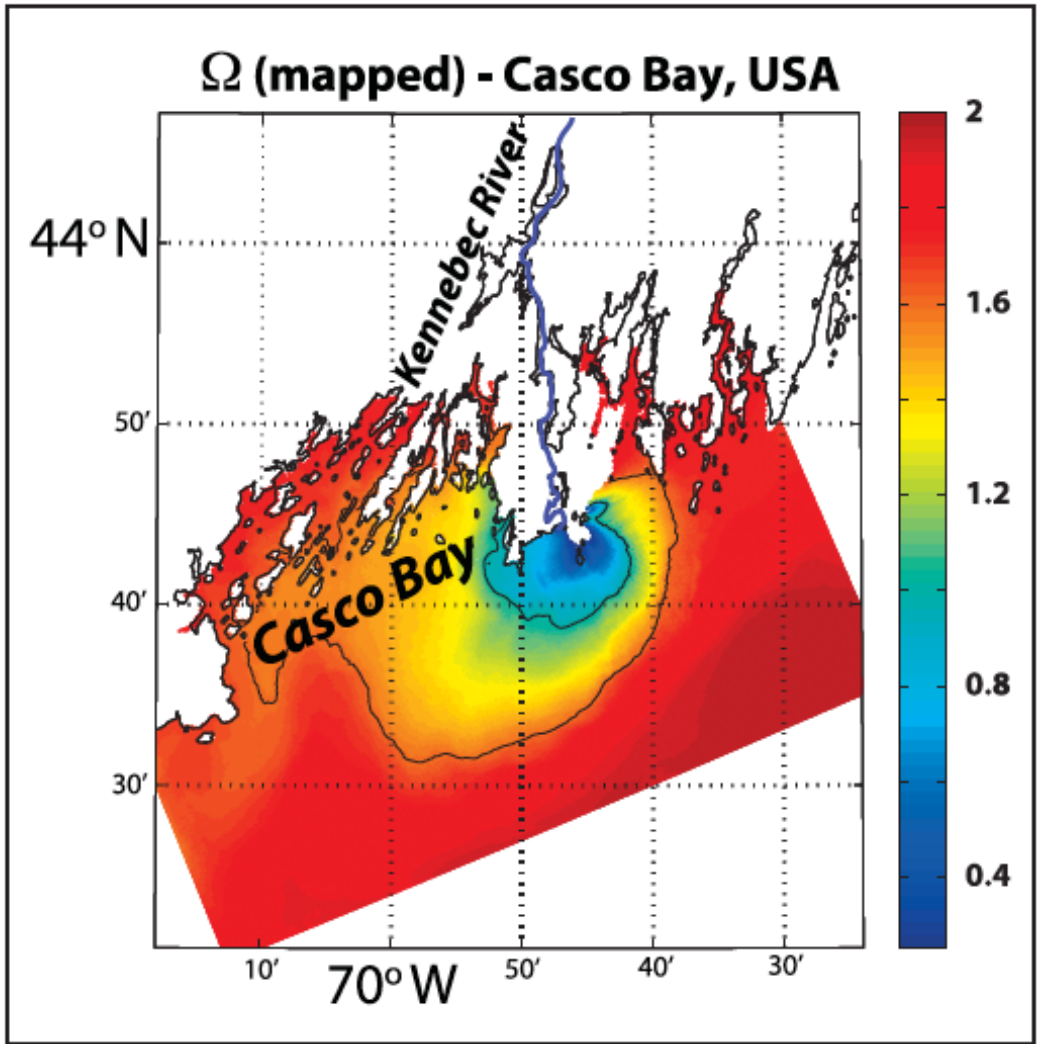

Δ sea−surface pH [−]
−0.12
−0.1
−0.08
−0.06
−0.04
−0.02
0

Drivers of Global Ocean Acidification: Carbon Dioxide Emissions

The "Other CO_2 Problem"

Ocean and Coastal Acidification 2.0

- Nutrient pollution and runoff
- Colder, fresher water
- Heavy storm events
- Changes in Gulf of Maine water



Salisbury et al. 2008; Strong et al. 2014

Impacts already occurring in hotspots

21 NOV 2011: **REPORT**

Northwest Oyster Die-offs Show Ocean Acidification Has Arrived

The acidification of the world's oceans from an excess of CO2 has already begun, as evidenced recently by the widespread mortality of oyster larvae in the Pacific Northwest. Scientists say this is just a harbinger of things to come if greenhouse gas emissions continue to soar.

BY ELIZABETH GROSSMAN

Standing on the shores of Netarts Bay in Oregon on a sunny fall morning, it's hard to imagine that the fate of the oysters being raised here at the Whiskey Creek Shellfish Hatchery is being determined by what came out of smokestacks and tailpipes in the 1960s and '70s. But this rural coastal spot and the shellfish it has nurtured for centuries are a bellwether of one of the most palpable changes being caused by global carbon dioxide emissions — ocean acidification.

It was here, from 2006 to 2008, that oyster larvae began dying dramatically, with hatchery owners Mark Wiegardt and his wife, Sue Cudd, experiencing larvae losses of 70 to 80 percent. "Historically we've had larvae mortalities," says Wiegardt, but those deaths were usually related to bacteria. After spending thousands of dollars to disinfect and filter out pathogens, the hatchery's oyster larvae were still dying.

Finally, the couple enlisted the help of Burke Hales, a biogeochemist and ocean ecologist at Oregon State University. He soon homed in on the carbon chemistry of the water. "My wife sent a few samples in and Hales said someone had screwed up the samples because the [dissolved CO2 gas] level was so ridiculously high," says Wiegardt, a fourth-generation oyster

BDN MAINE **Bangor Daily News**

Wednesday, Feb. 4, 2015 Last update: 3:27 p.m.

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Previous story:

« Big Apple store in South Portland robbed again

Next story:

Occupy Maine gets support from unions as demonstration nears one-week mark »

Shellfish harvesters plagued by acidic 'dead muds'

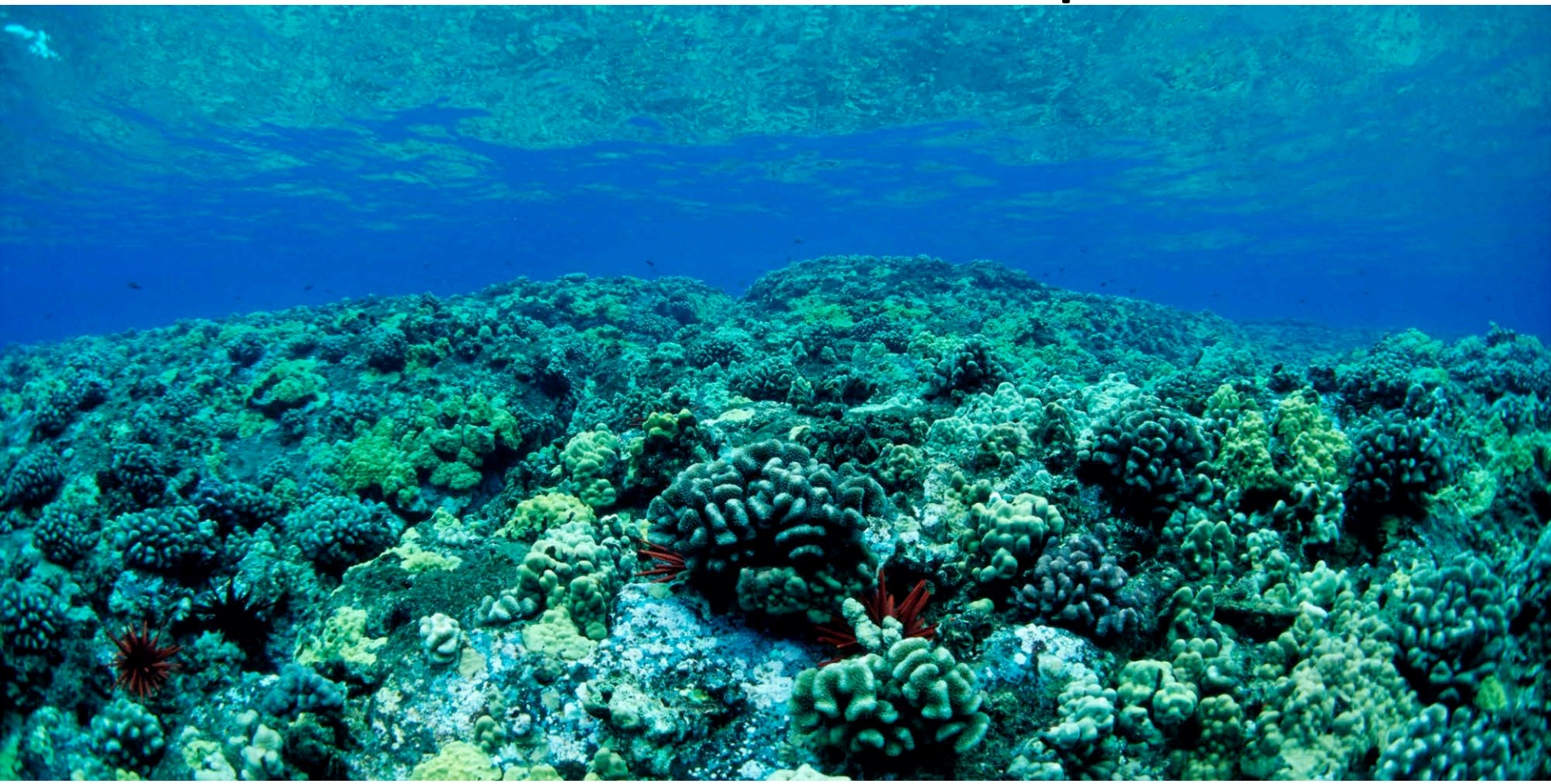
Prev | Next 1 of 2

Impacts are already occurring...

- Oyster farms in Maine have had to change operations to adjust to *undersaturation of calcium carbonate from acidification*.

- And west coast oyster growers have had to SHUT DOWN, MOVE, or completely change their growth operations.

Global economic impacts



$100s of billions per year by 2100

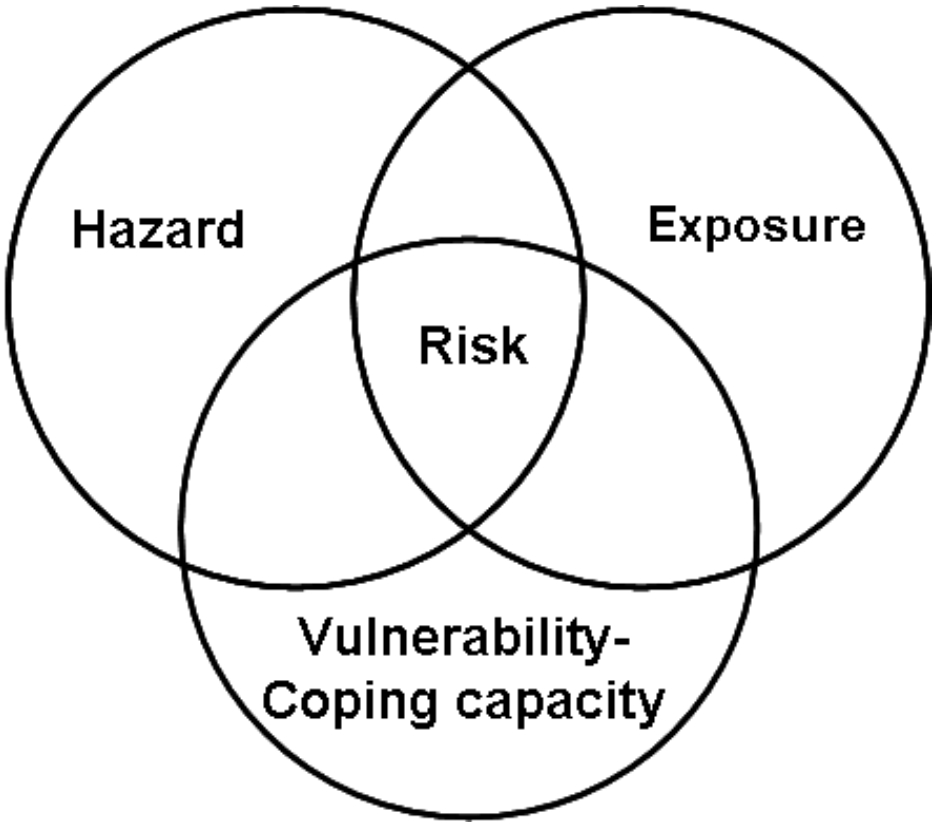
Narita et al. 2012

Projected economic impacts should raise alarms

- **$100s of millions in losses to regional economy**
- **1,000s of jobs at risk**

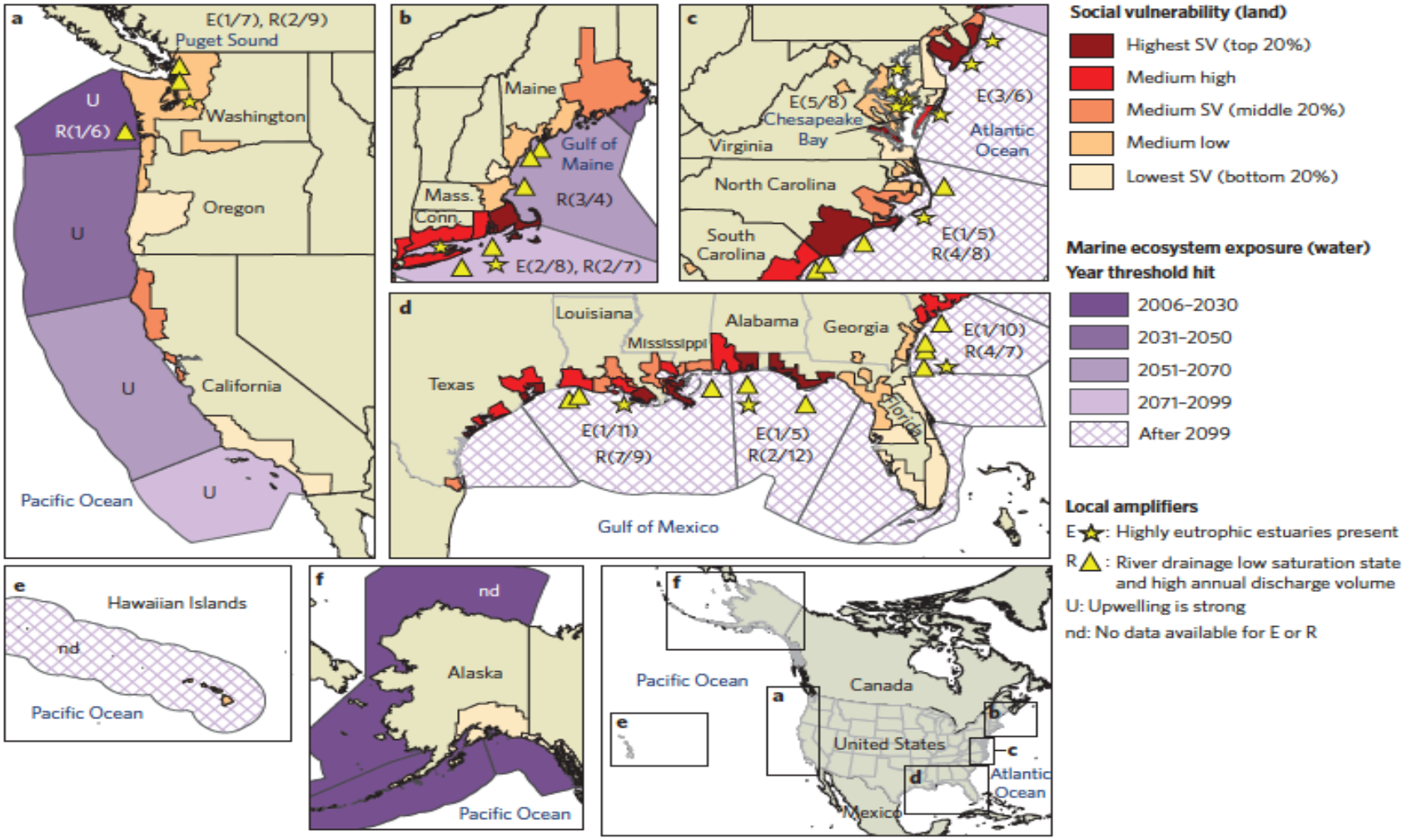
Cooley et al. 2015
Cooley et all 2009

What's the Risk in Gulf of Maine?

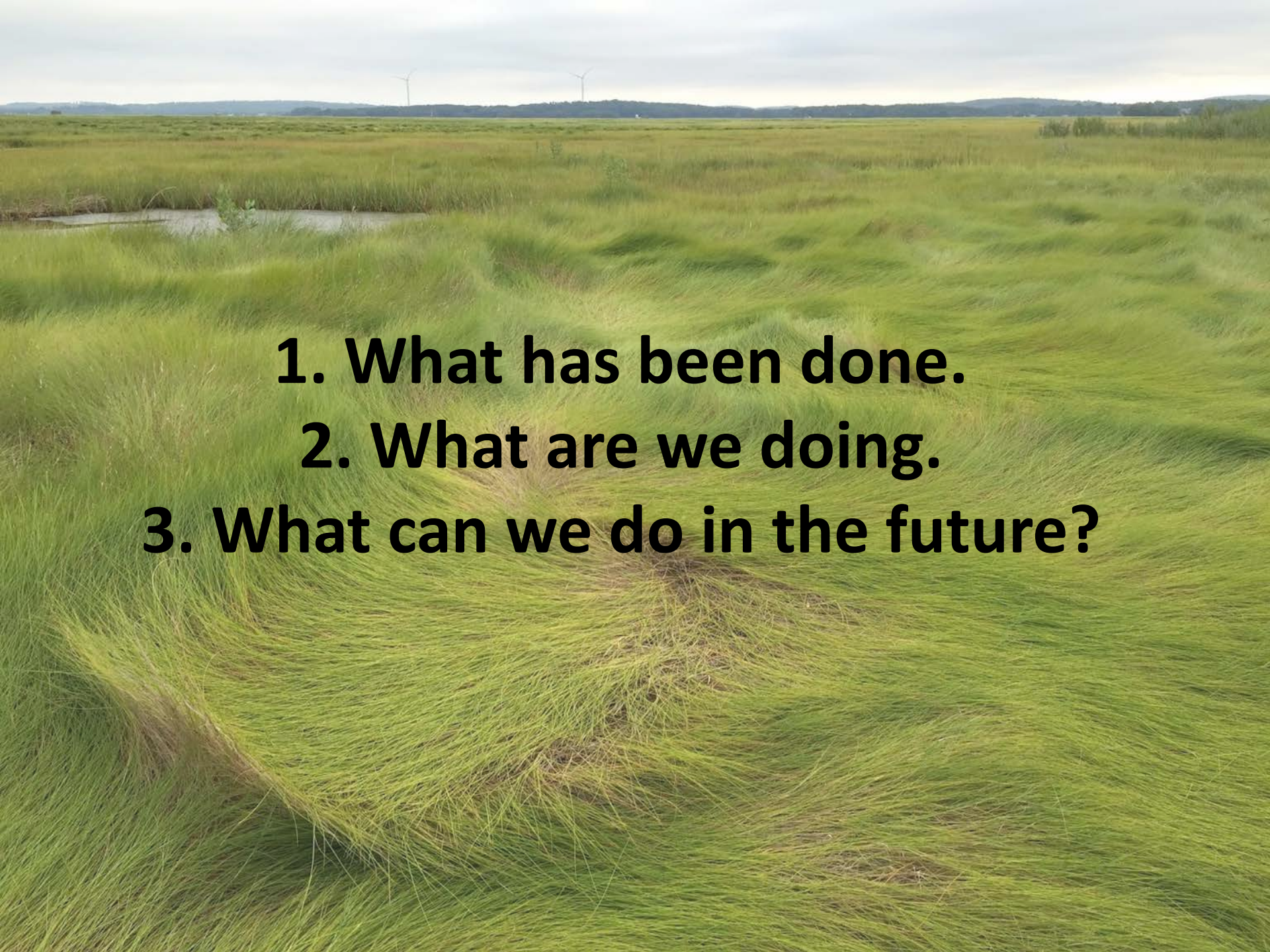


Cardona et al. 2012

High! But we lack details on species-specific impacts due to not enough monitoring and experimentation



Ekstrom et al. 2015


1. What has been done.
2. What are we doing.
3. What can we do in the future?

Washington State Blue Ribbon Panel on Ocean Acidification

Ocean Acidification: From Knowledge to Action

Washington State's Strategic Response

November 2012

Maine's 126th Legislature formed a study commission that met throughout 2014.

STATE OF MAINE
126th LEGISLATURE
SECOND REGULAR SESSION

Final Report
of the

COMMISSION TO STUDY THE EFFECTS OF COASTAL AND OCEAN ACIDIFICATION AND ITS EXISTING AND POTENTIAL EFFECTS ON SPECIES THAT ARE COMMERCIALLY HARVESTED AND GROWN ALONG THE MAINE COAST

January 2015

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Richard Nelson
Joe Payne
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Dr. Meredith M. White

Find Your State?

- **Maine** (Done 2015)
- **Washington** (Done 2012)
- **Oregon + California** (Done 2015)

- New York (Commission Formed Late 2016)
- Rhode Island (House Commission Formed 2017)
- New Hampshire (Coastal Hazard's Commission- First Topic: OA Formed 2017)
- Massachusetts (in Senate Committee 2017)

Results of Legislative Study Commission

1. Invest in Maine's Capacity to **Monitor** and Investigate Effects of Ocean Acidification and **Determine Impacts of Ocean Acidification on Commercially Important Species** and Mechanisms behind Impacts.

2. Reduce Emissions of **Carbon Dioxide**

3. Identify and Reduce **Local Land-Based Nutrient Loading** and Organic Carbon Contributions to Ocean Acidification and **Freshwater Runoff** by Strengthening and Augmenting **Existing Pollution Reduction Efforts** and Making Groundwater Recharge a Land Use Priority

Results of Legislative Study Commission

4. Increase Maine's Capacity to Mitigate, **Remediate and Adapt** to the Impacts of Ocean Acidification

5. **Inform Stakeholders, Public and Decision Makers** about Ocean Acidification in Maine and Empower Them to Take Action

6. Create an Ongoing **Ocean Acidification Council**

The Maine Ocean and Coastal Acidification Partnership

A volunteer partnership dedicated to implementing the recommendations of the Maine OCA Commission.

Steering Committee: Island Institute, Friends of Casco Bay, University of Maine, Rep. Mick Devin

1. Expanding Monitoring Capacity and Experimentation

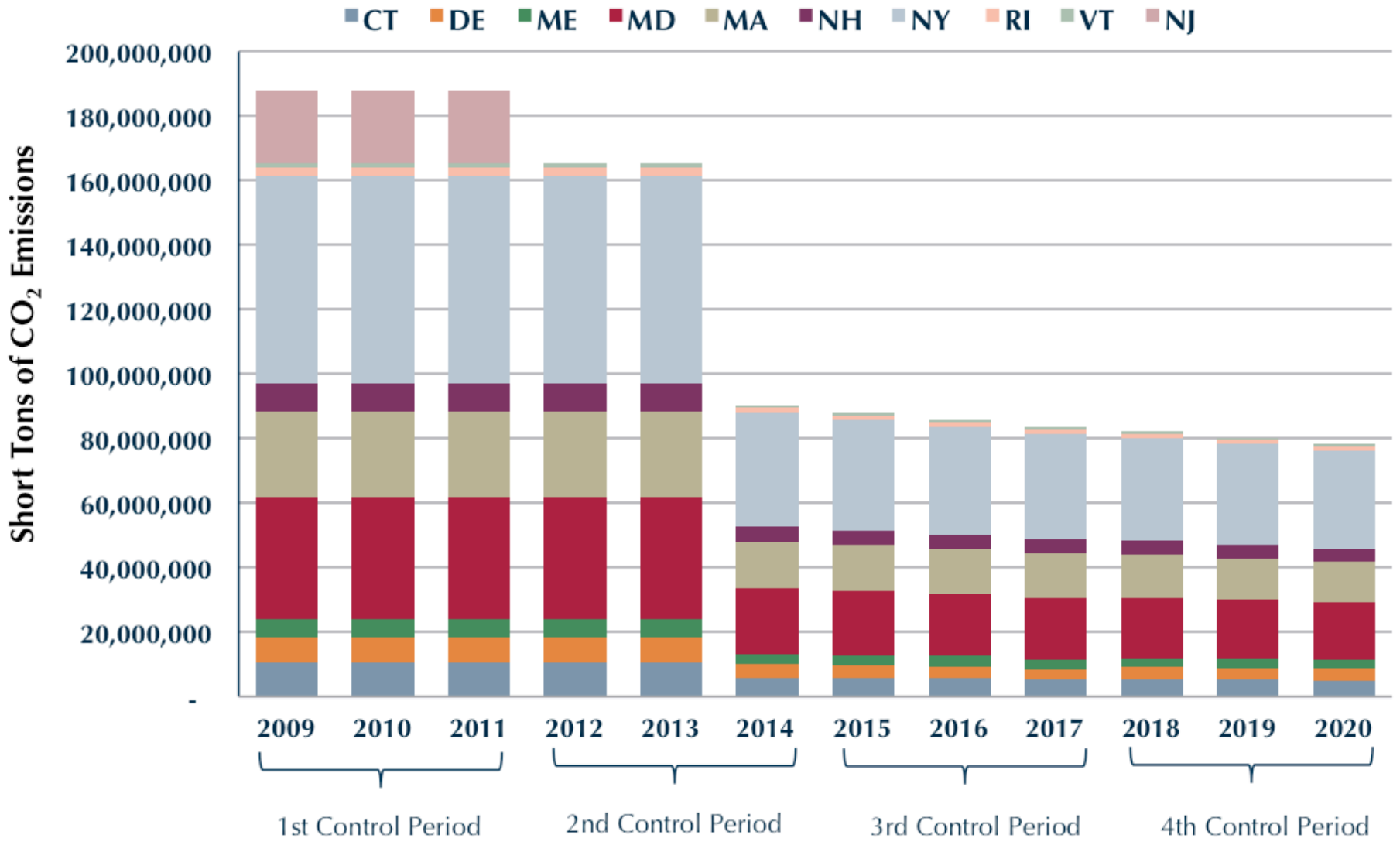
New monitoring capacity in Damariscotta, Bowdoin Peer, and other locations.

New research on lobster impacts.

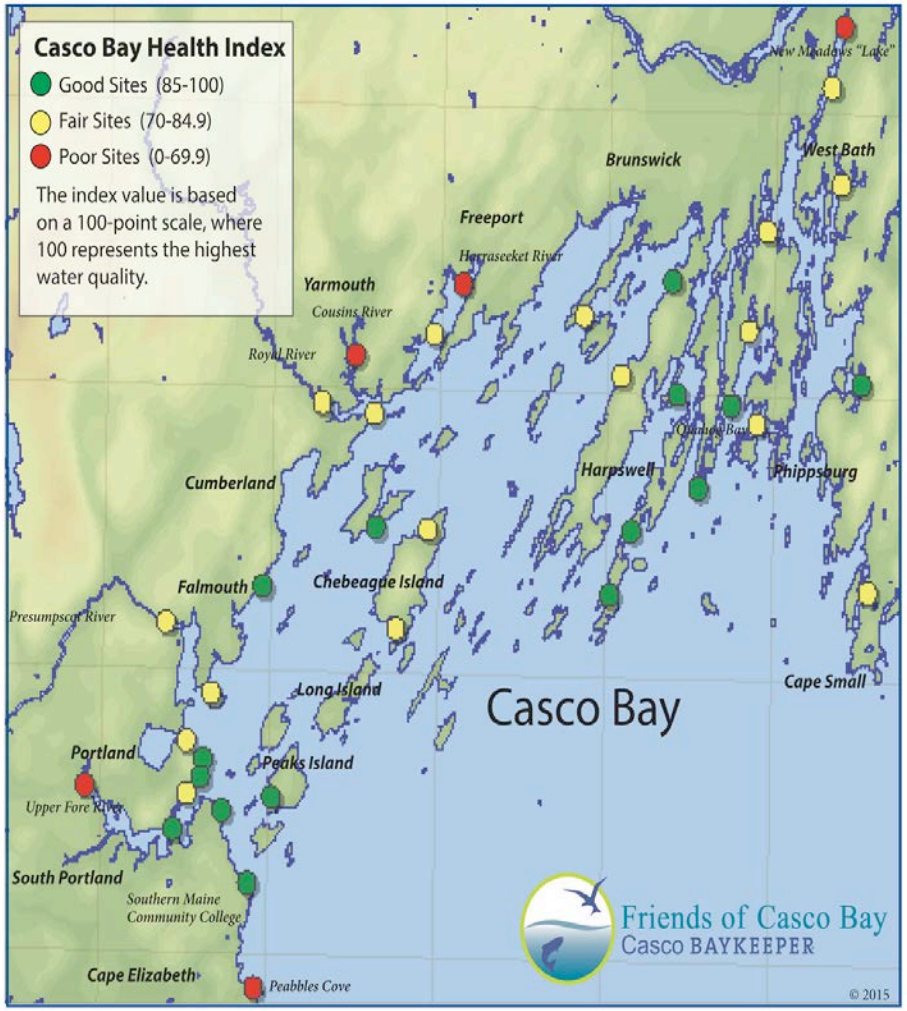
Monitoring in Maine

- Standardize protocols
- Citizen science training
- Data sharing and partnerships
- Intercalibration cruise

2. Reducing CO_2 Emissions



3. Nutrient Loading



Newly Formed
Casco Bay Nutrient Council

New High-Throughput Nutrient Sensors

Coordinated Monitoring

4. Remediation

Experiment by Nichole Price, Susie Arnold, Joe Salisbury et al.

5/6. Education Outreach and Ongoing Focus

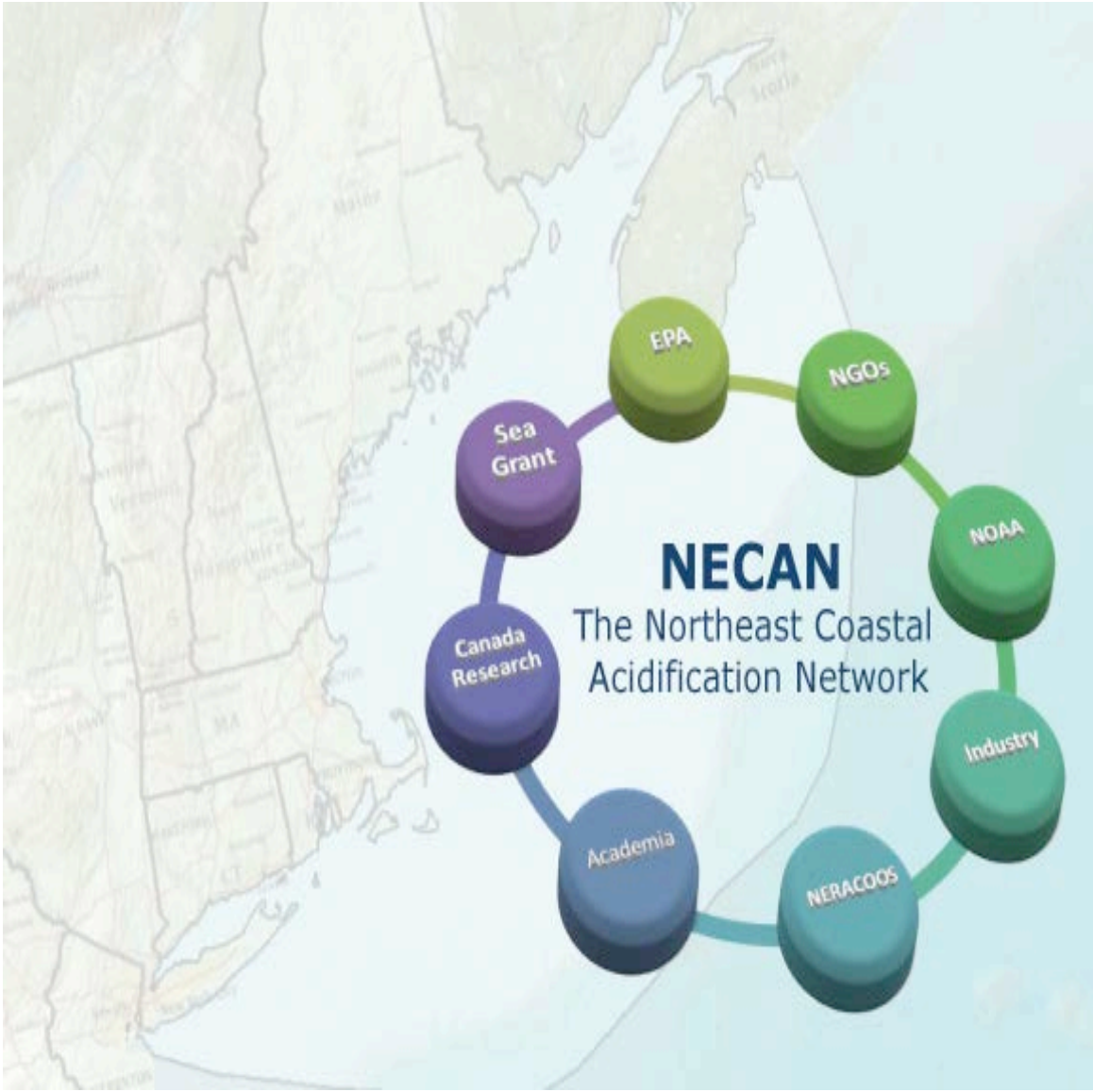
The Gaps in Maine

- Monitoring capacity is not adequate to address management potential
- Critical to use of Clean Water Act and critical to adaptive capacity of industry/stakeholders
- Need risk assessments
- More focus on solutions (remediation)
- Distributed funding is *ad hoc*

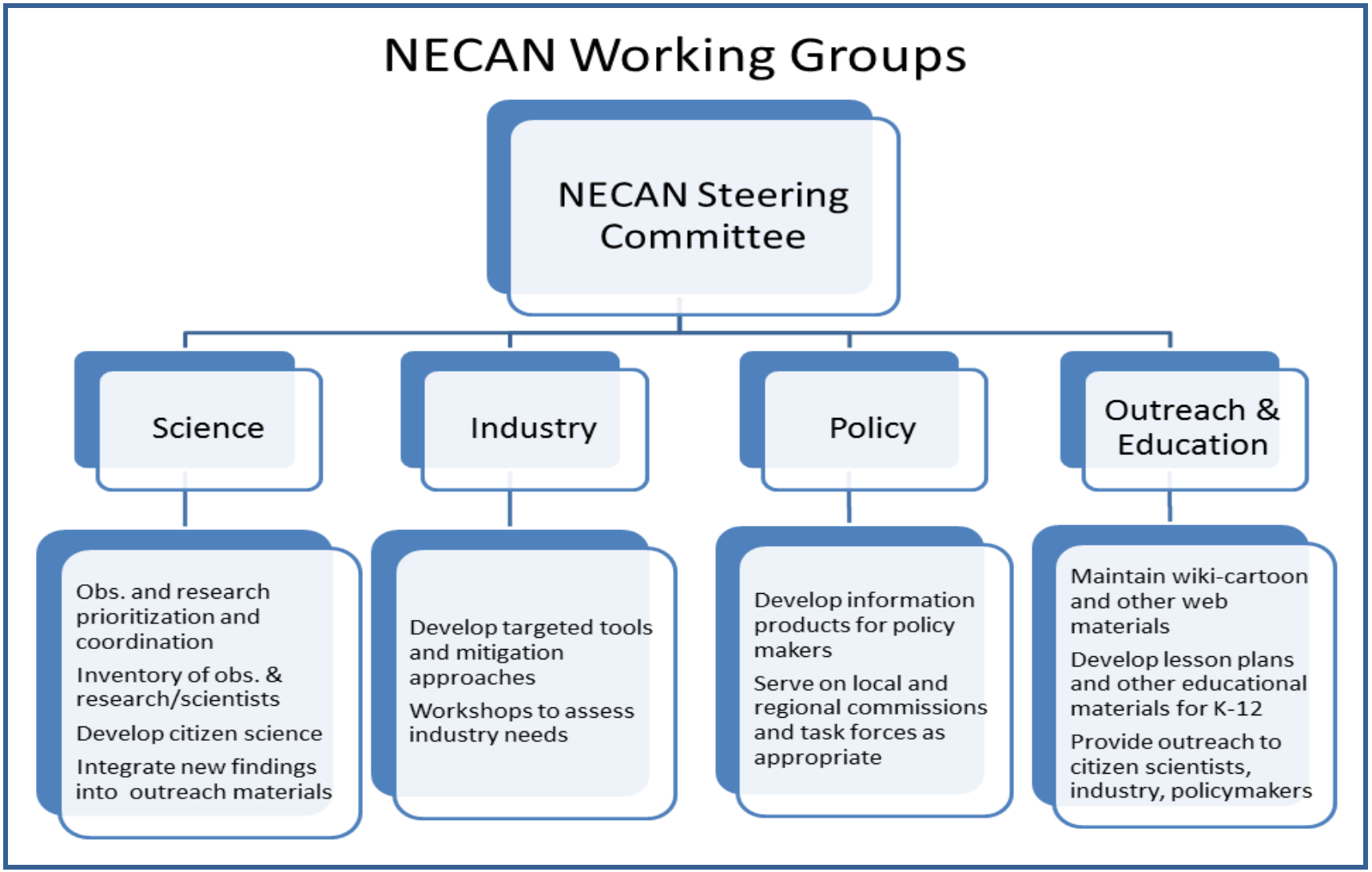
Northeast Coastal Acidification Network

- A nexus of
  - –Scientists,
  - –Federal and state agency reps.,
  - –Resource managers,
  - –Affected industry partners

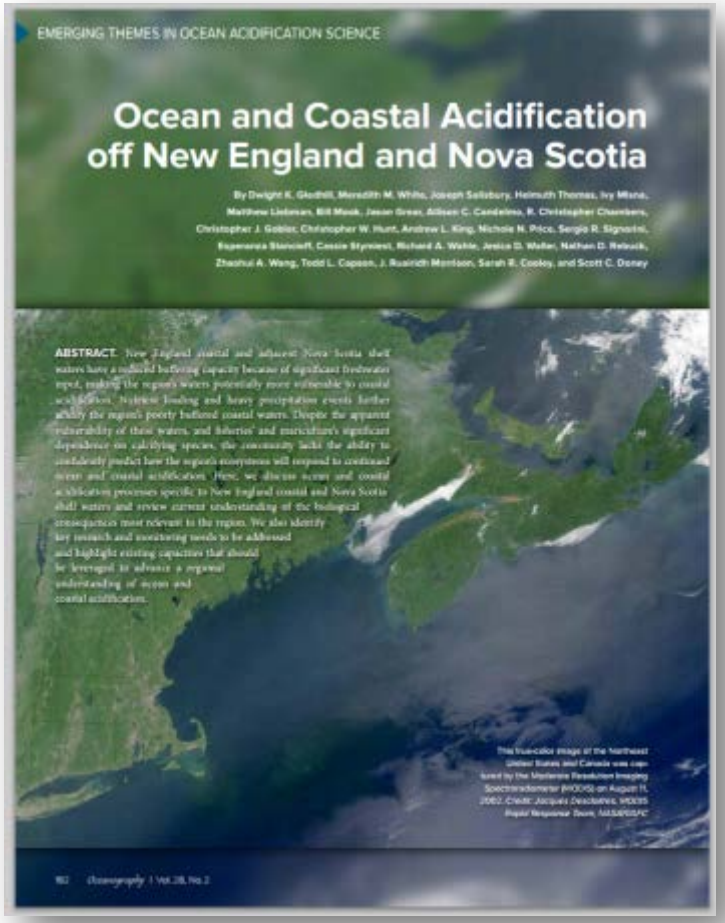
- Dedicated towards coordinating and guiding regional observing, research, and modeling endeavors



NECAN Structure



State of the Science



http://dx.doi.org/10.5670/oceanog.2015.41

Stakeholder Engagement

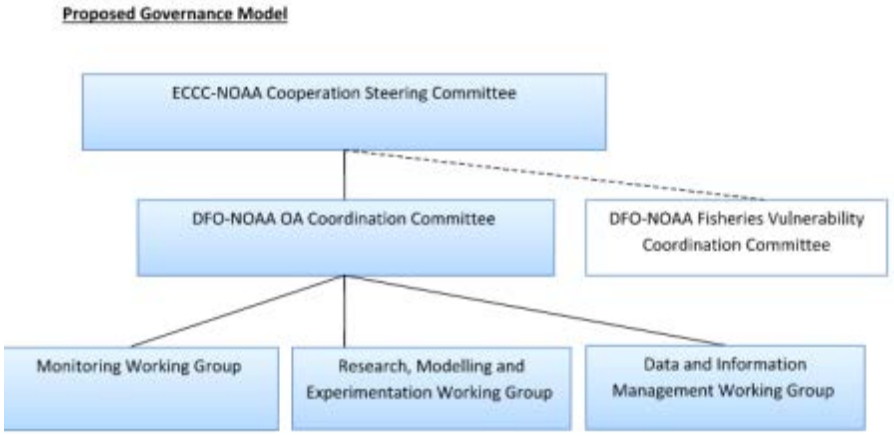
On the Horizon

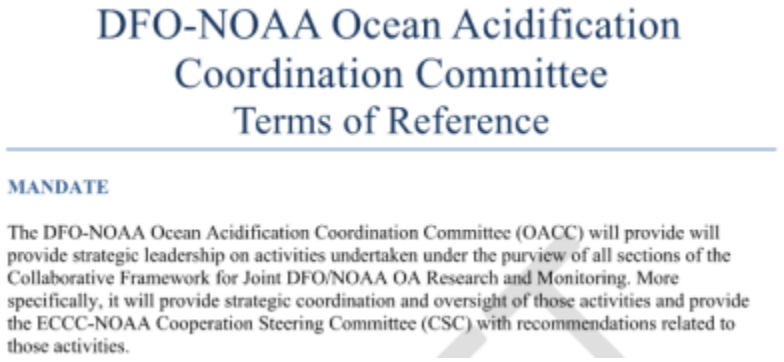
- Implementation Plan Finalized!
- NOAA Ocean Acidification Program Mini-Grant for Citizen Science Monitoring Training workshops in MA/CT/ME in Fall 2017
- Regional Workshop on November 29th, 2017 with Northeast Regional Ocean Council on monitoring coordination for action.

Joint NOAA-DFO Ocean Acidification Collaboration Meeting 2017

Wednesday, May 24th, 2017

Venue: NOAA Headquarters, Silver Spring, MD




DFO-NOAA Ocean Acidification Coordination Committee
Terms of Reference

MANDATE

The DFO-NOAA Ocean Acidification Coordination Committee (OACC) will provide will provide strategic leadership on activities undertaken under the purview of all sections of the Collaborative Framework for Joint DFO/NOAA OA Research and Monitoring. More specifically, it will provide strategic coordination and oversight of those activities and provide the ECCC-NOAA Cooperation Steering Committee (CSC) with recommendations related to those activities.

- Committee endorsed the draft collaborative framework for joint DFO/NOAA Ocean Acidification Research and Monitoring
- Committee reviewed regional activities in the north Atlantic, Arctic, and north Pacific which may offer mutual interest and potential for further collaboration

International Opportunities

What solutions?

- Mitigate nutrient drivers through WQ laws
- Explore remediation opportunities
- Provide information to stakeholders to enable adaptation of industries
- Conduct risk assessments and build international partnerships

- Strong regional capacity that is growing and evolving
- Opportunities for research/action/assessment/outreach
- Cross-border collaboration only at federal/national level
- **What should Gulf of Maine Council do?**