

# Climate Change and Adaptation Solutions for the Coastal Ocean along the US Northeast

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[http://www.whoi.edu/sites/coastal\\_climate\\_change\\_solutions](http://www.whoi.edu/sites/coastal_climate_change_solutions)

MacArthur Foundation

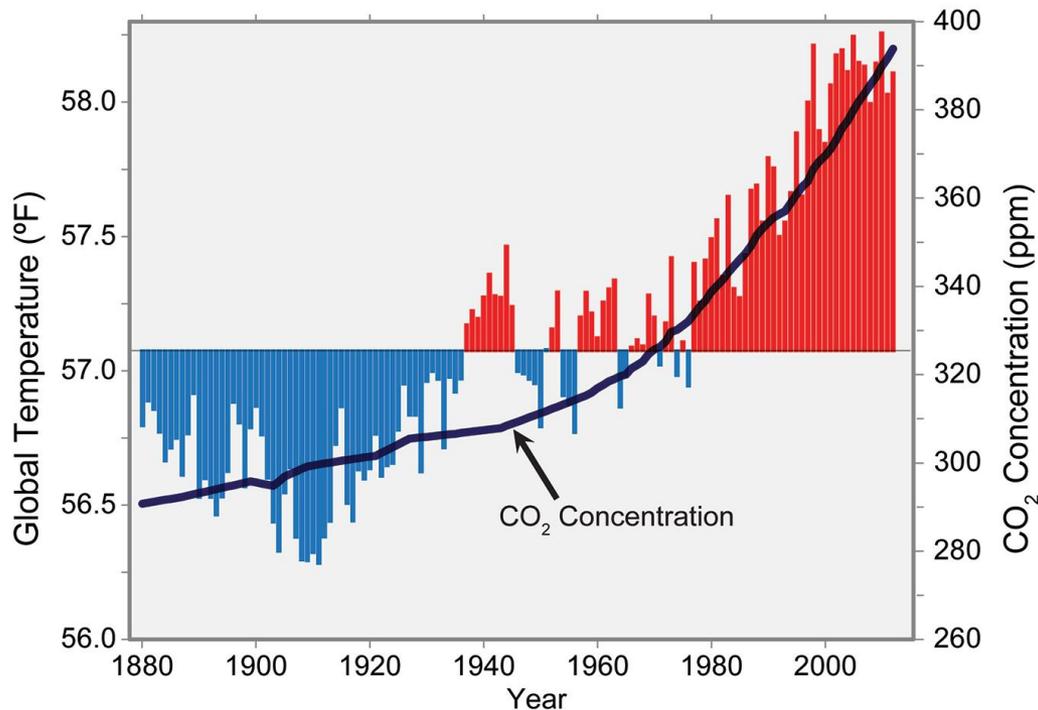


# Talk Outline

## Climate change & coastal impacts

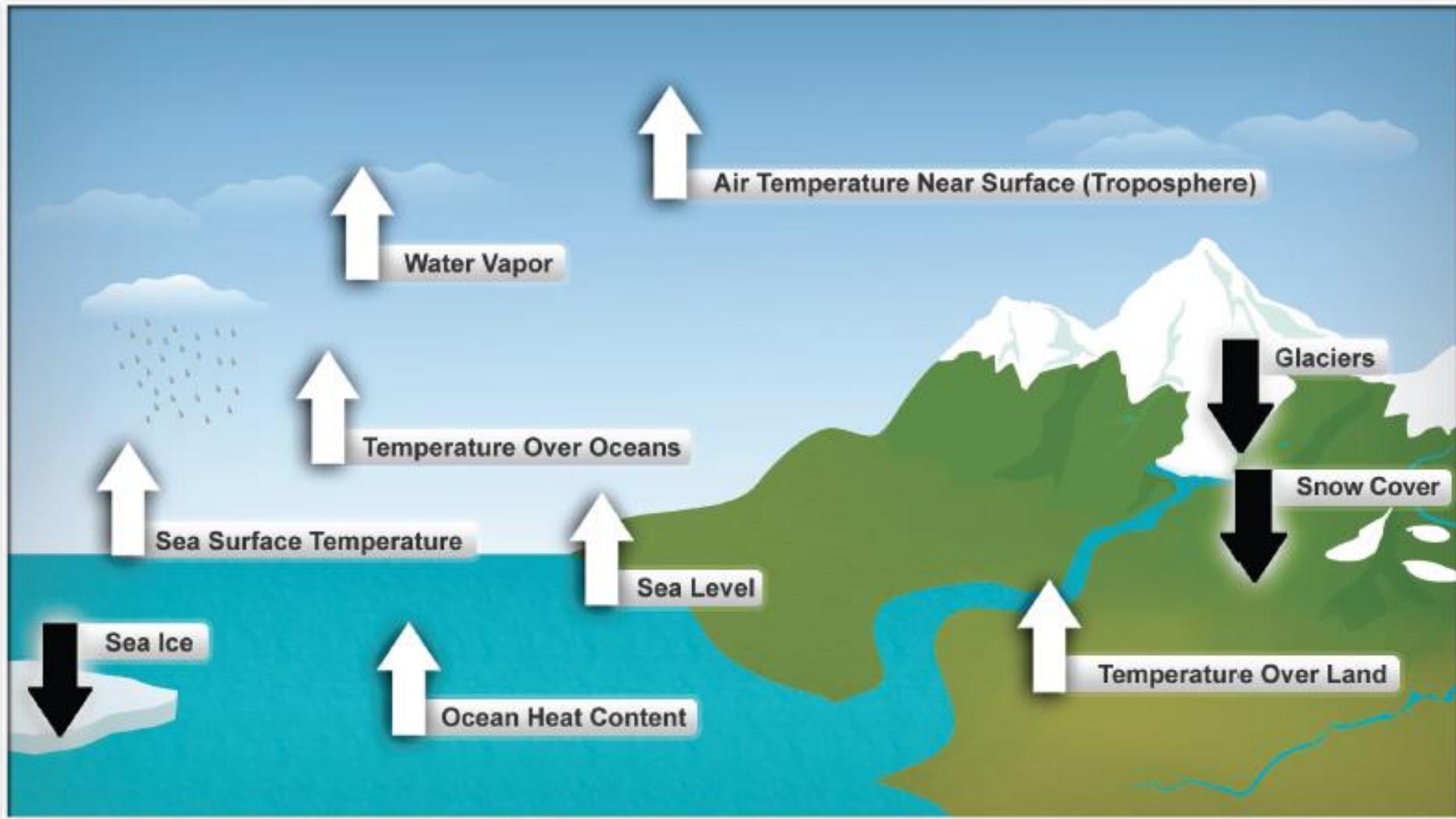
- Ocean warming & fisheries
- Sea-level rise & coastal flooding
- Water quality & ocean acidification

## Stakeholder engagement & adaptation solutions

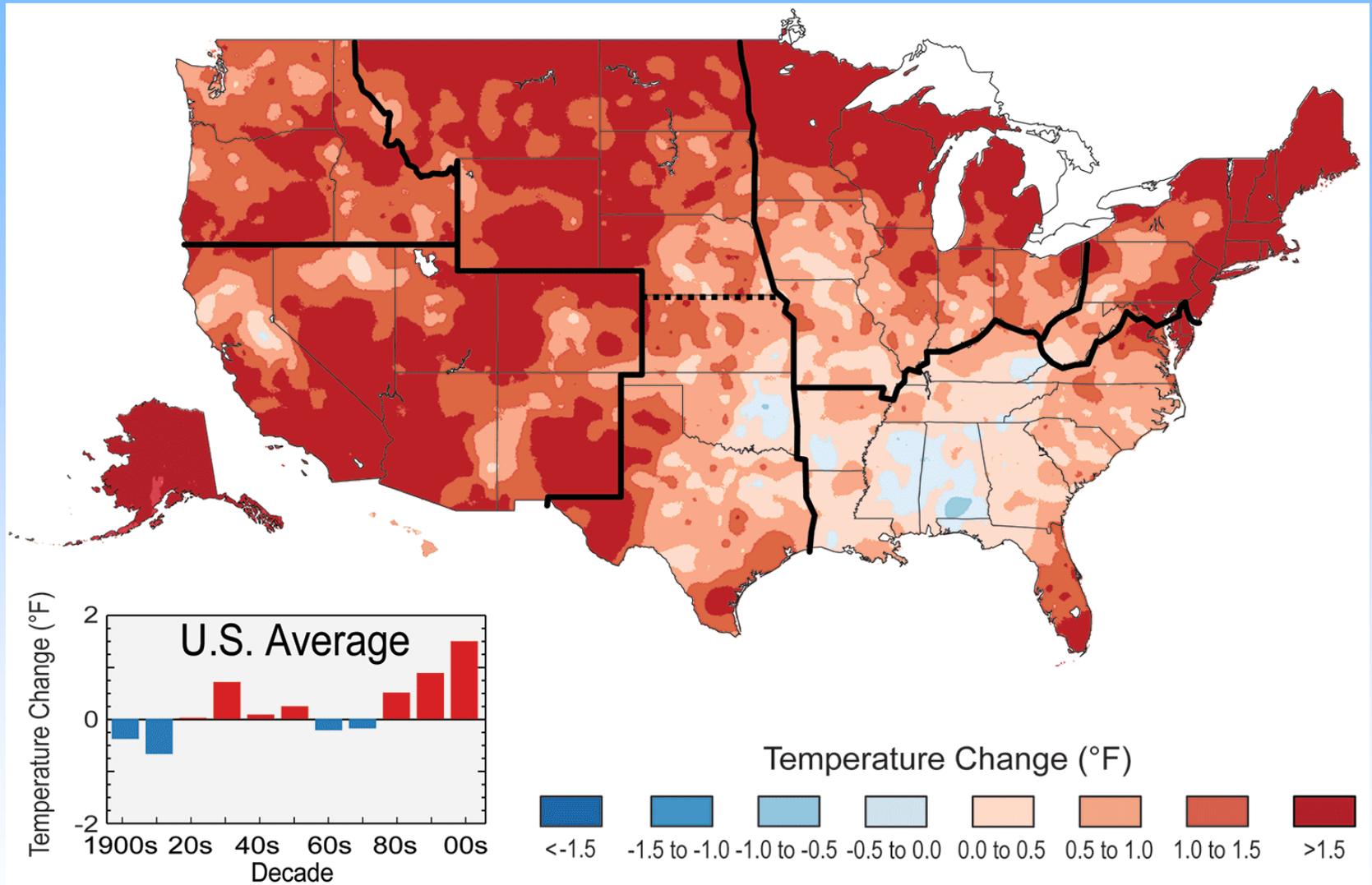


# Global Climate is Changing Now

## Ten Indicators of a Warming World

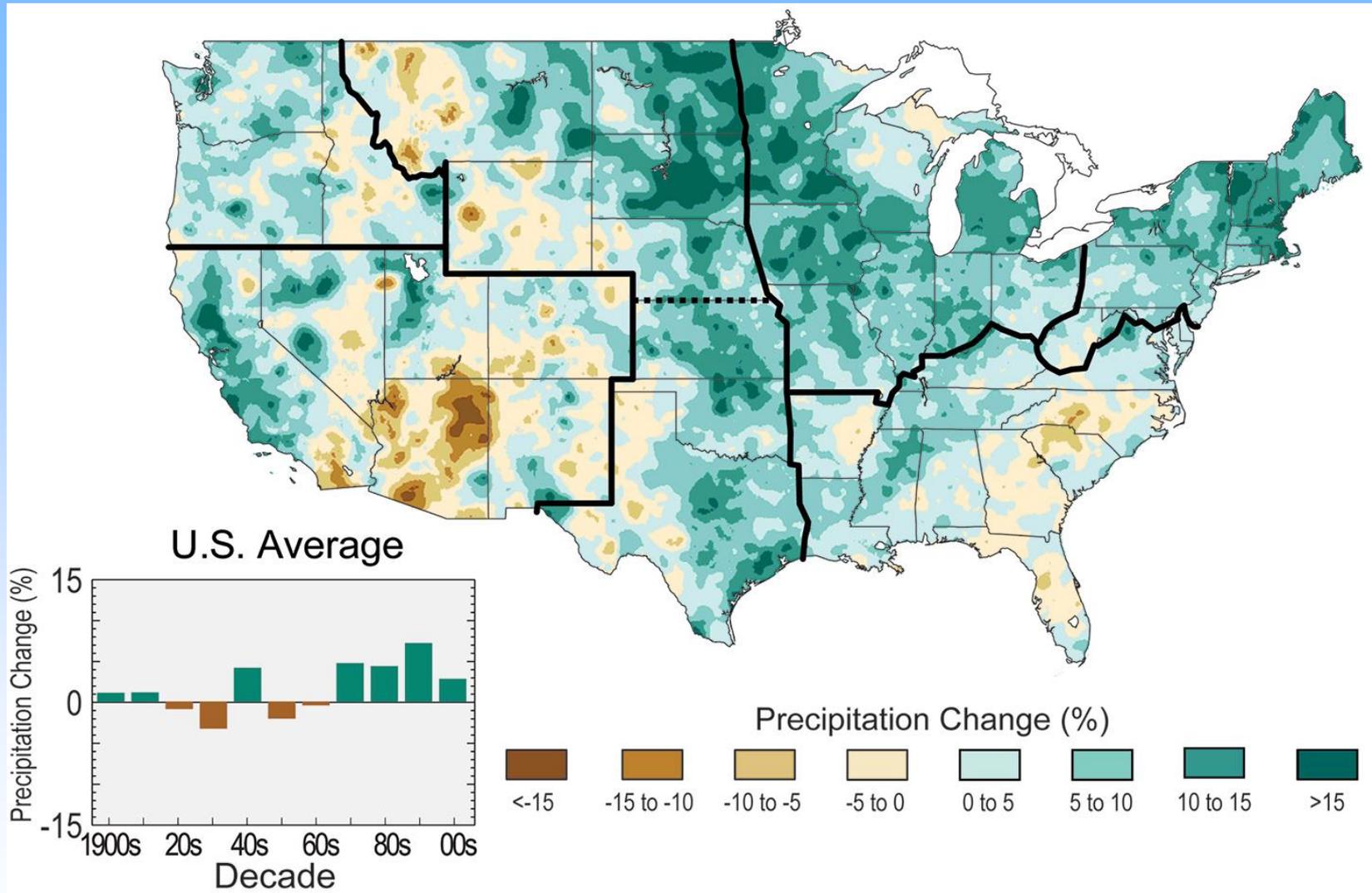


# Observed U.S. Temperature Change



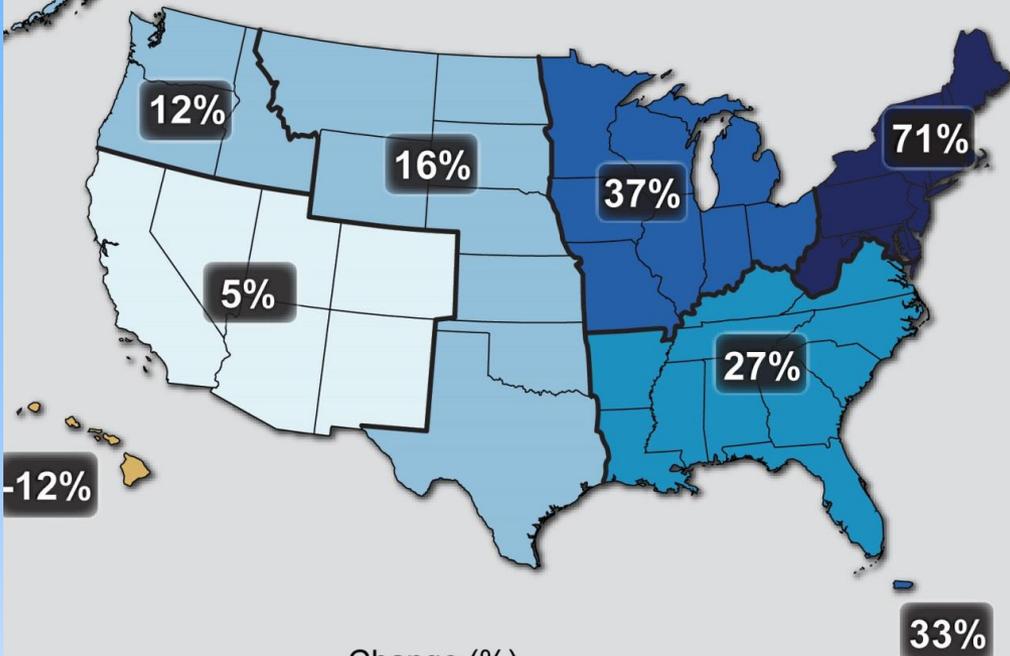
National Climate Assessment  
Walsh et al. 2014

# Observed U.S. Precipitation Change



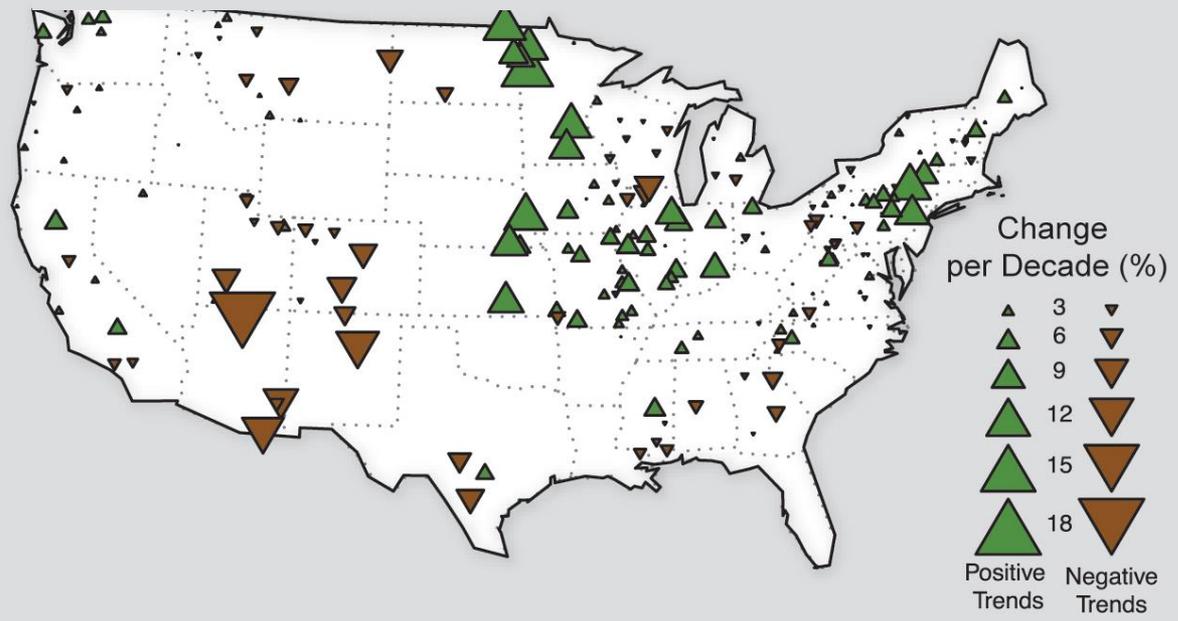
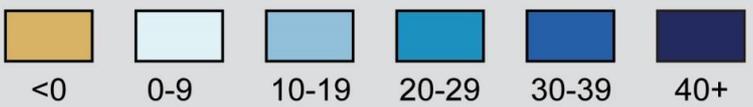
National Climate Assessment  
Walsh et al. 2014

# More Intense Precipitation Events & Flooding in Northeast



Observed Change in Very Heavy Precipitation

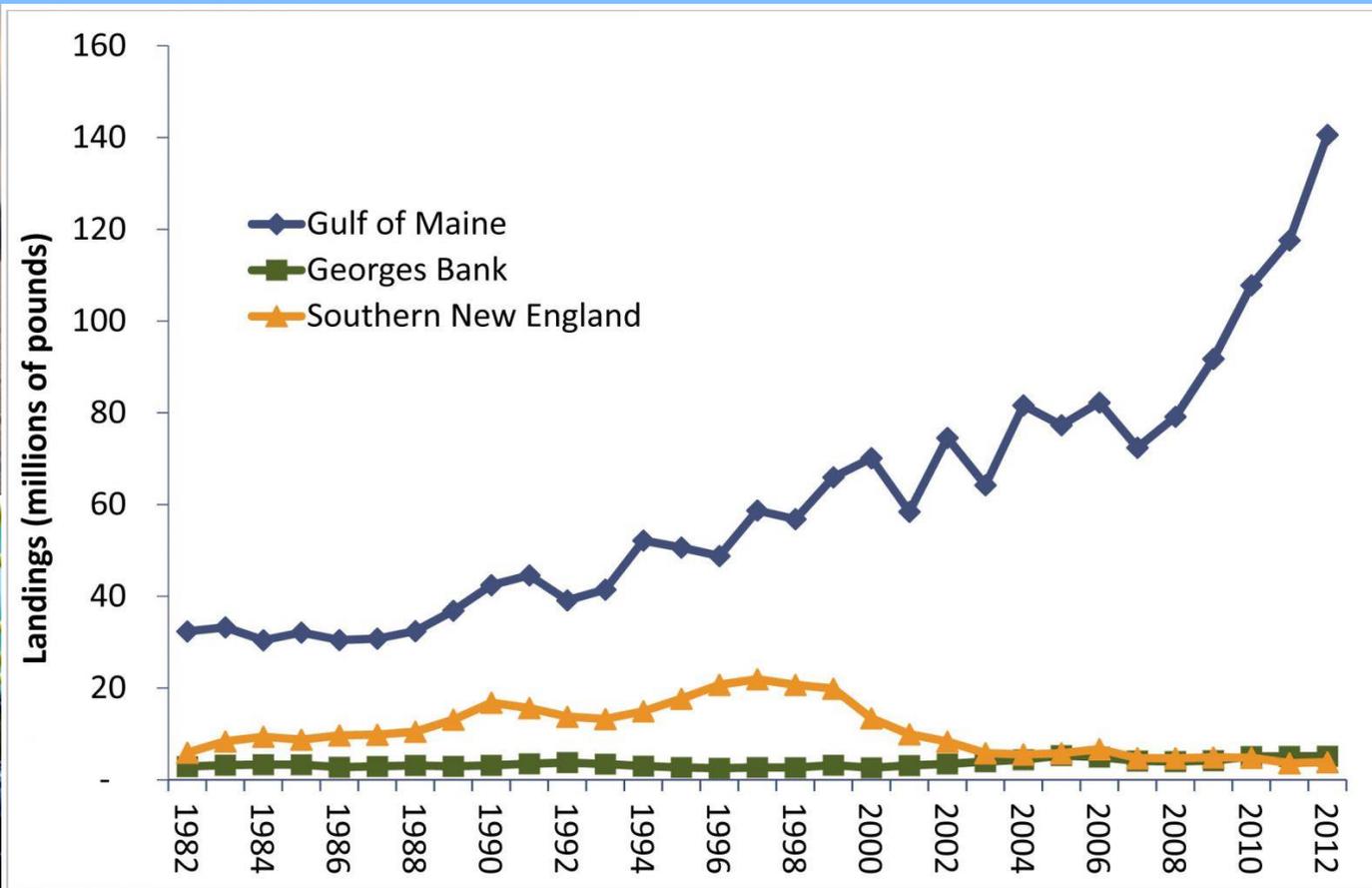
Change (%)



Observed U.S. Flooding

National Climate Assessment  
Walsh et al. 2014

# Ocean Warming & Fisheries



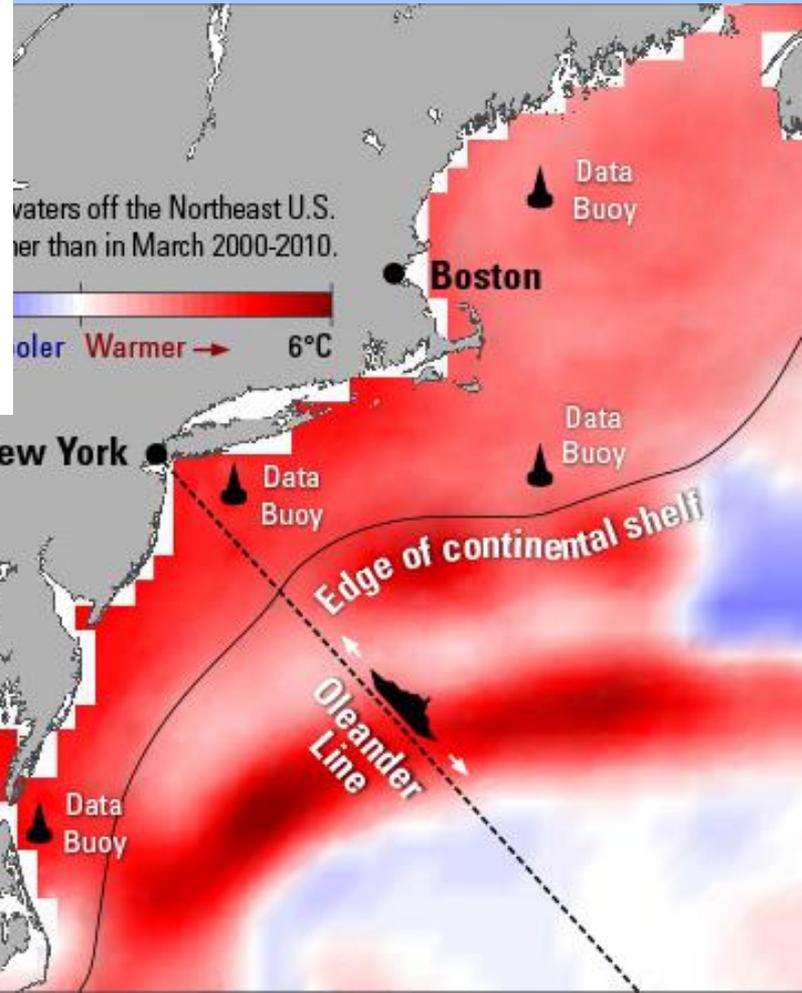
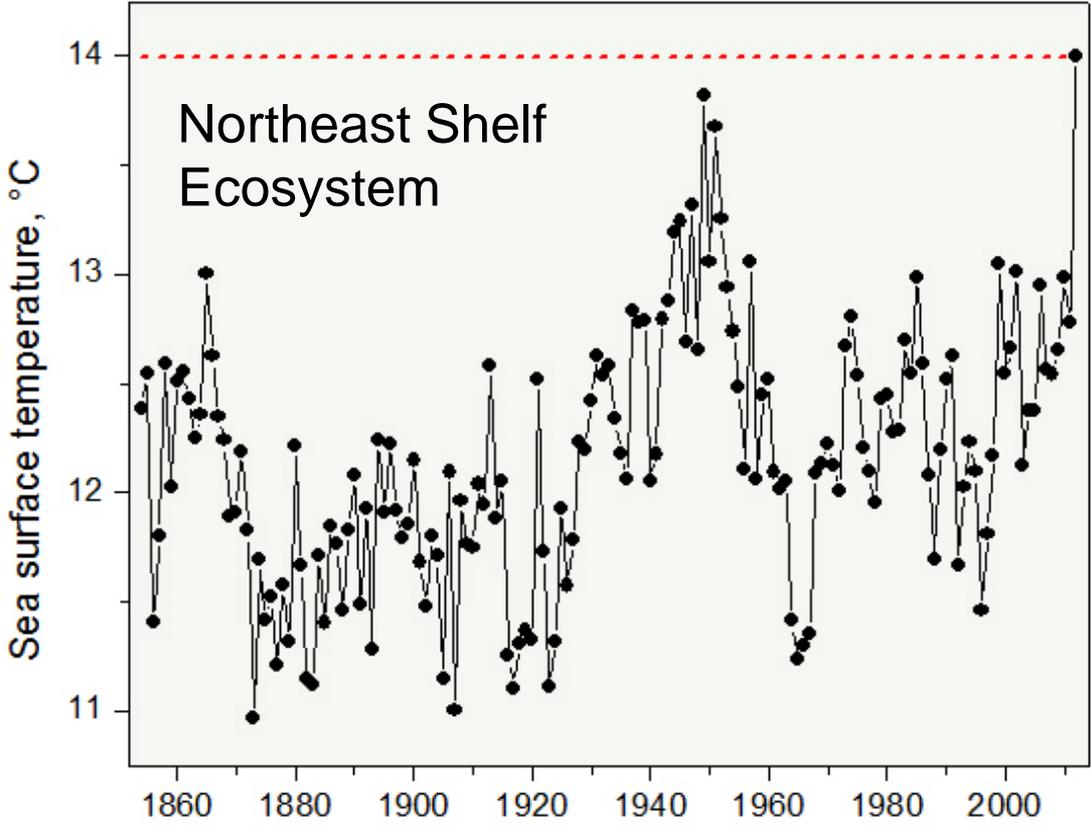
American Lobster Preliminary Landings by Stock Unit. Source: ACCSP Data Warehouse, 2013

CFRF

COMMERCIAL FISHERIES  
RESEARCH FOUNDATION



# Coastal Ocean Warming

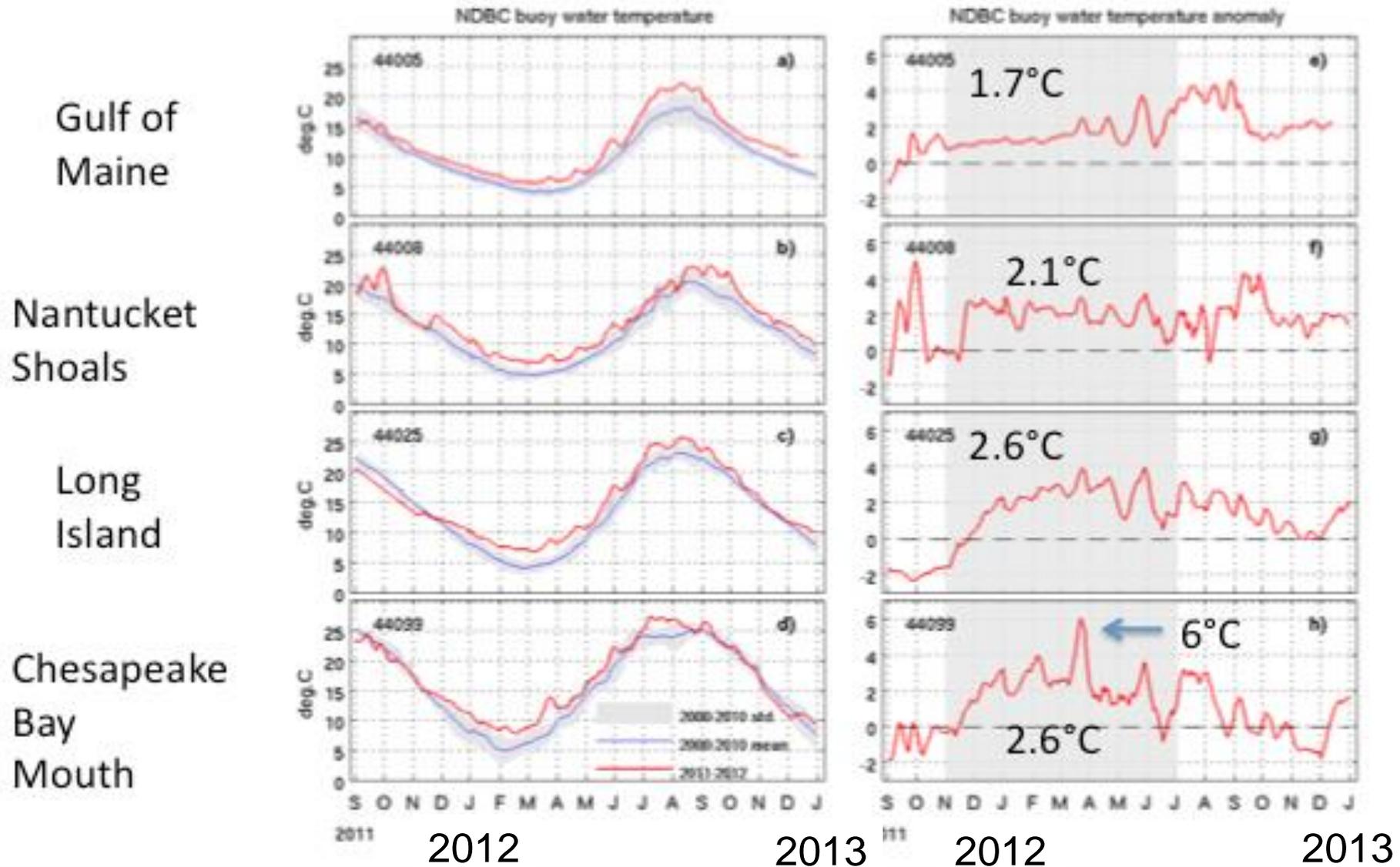


NOAA/NMFS

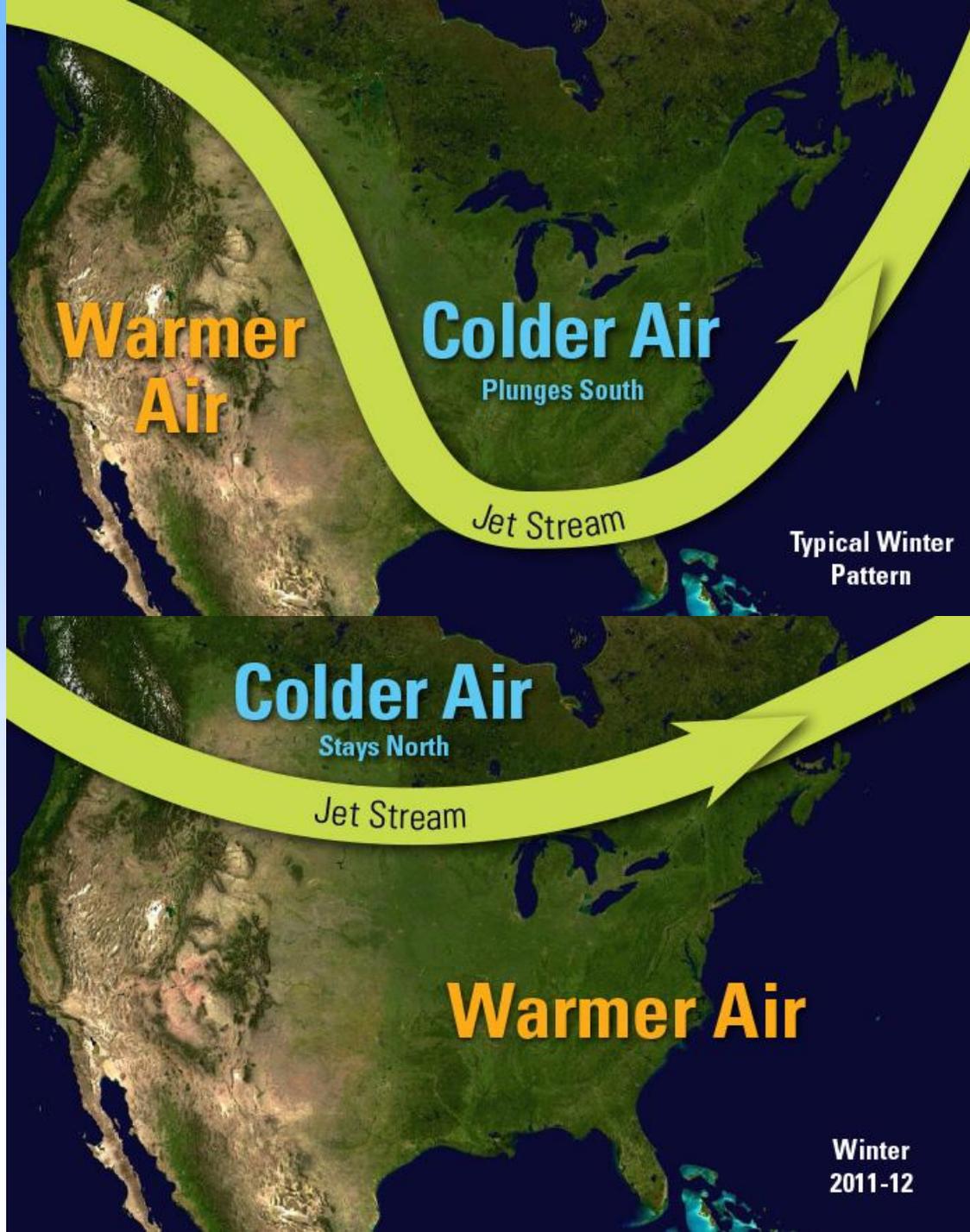
Chen et al.  
J. Geophys. Res. Oceans  
(2013)

# 2011-2012 Ocean Warming Event

Temperature Anomalies NDBC Buoys Relative to 2000-2010 mean



# Atmosphere Circulation & Jet Stream



Typical Winter  
Pattern

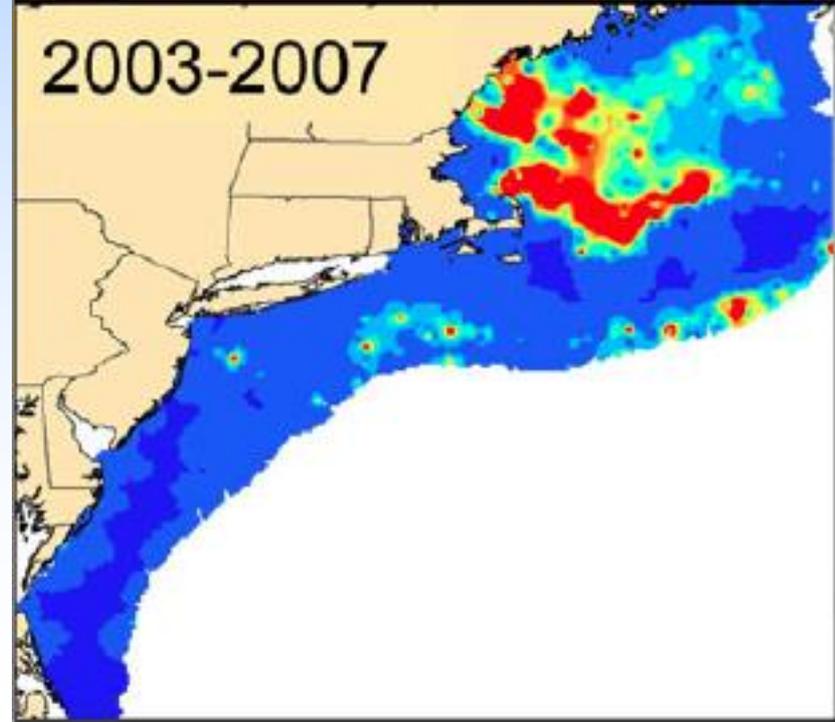
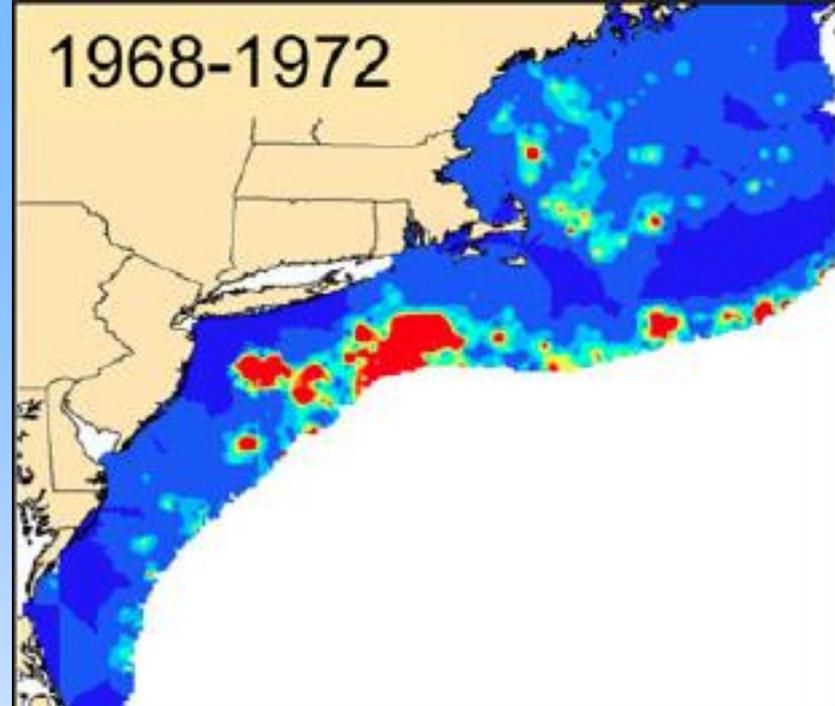
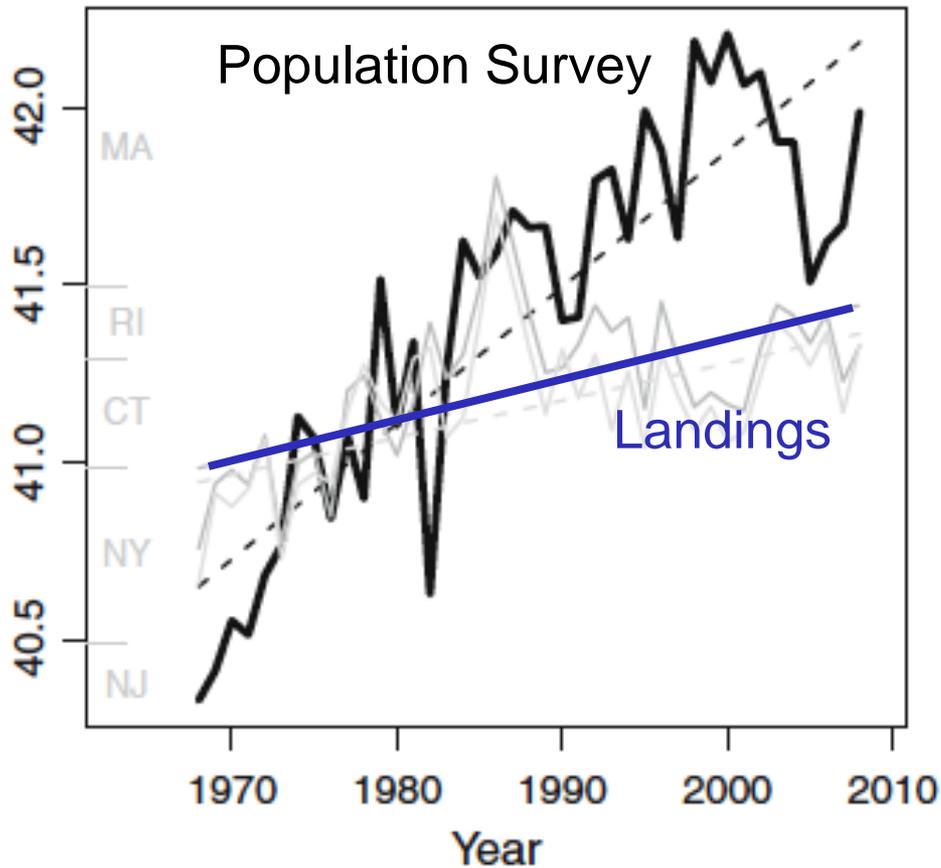
Winter  
2011-12

WHOI Oceanus



# Poleward Range Shifts in Marine Species

## Red Hake

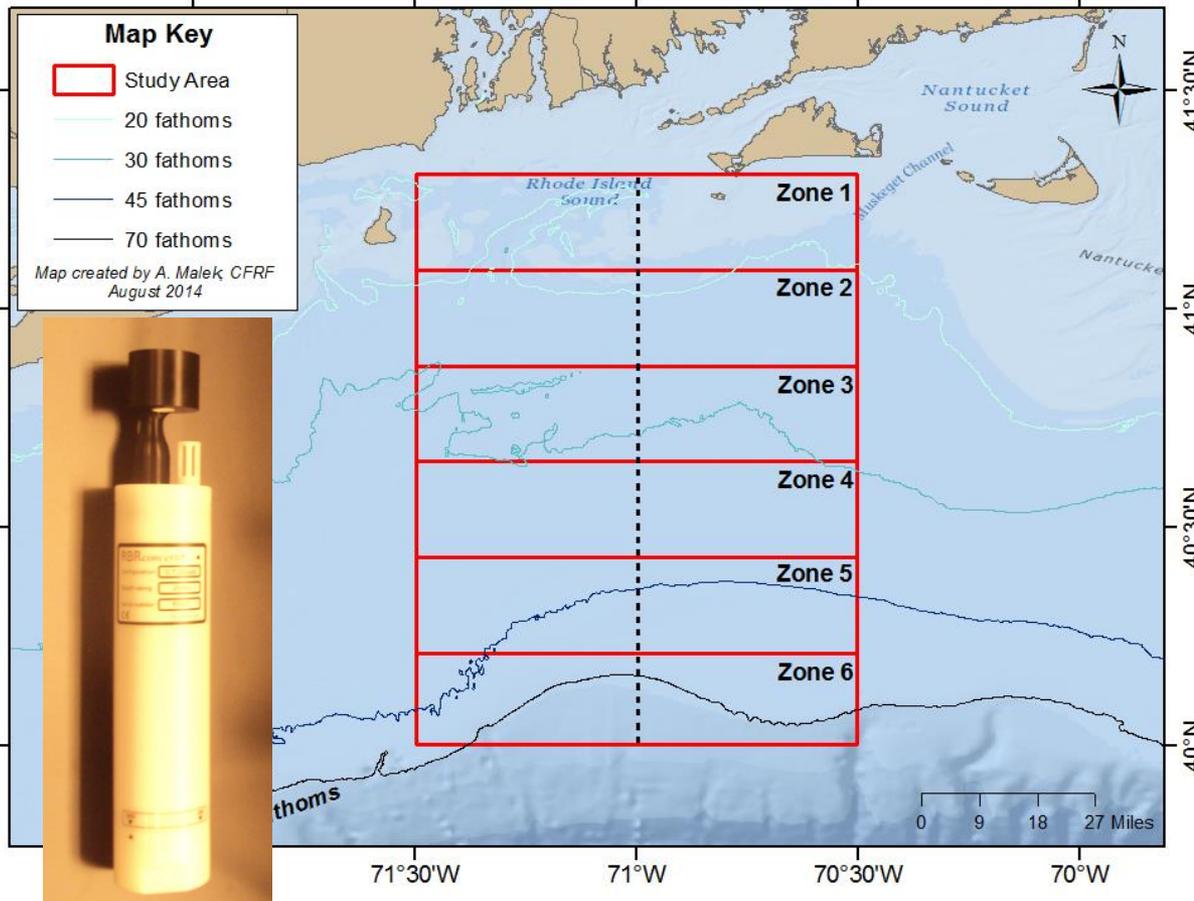


Nye et al. MEPS 2010

Pinsky & Fogarty Climatic Change 2012

# Partnership with Commercial Fishing Fleet

## MacArthur Fisheries & Climate Project - Study Area



Expand ocean climate data on shelf & slope

Commercial fisherman directly involved in data collection & analysis

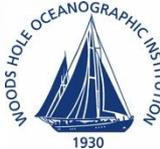
Empower fishing community in long-term stewardship

Concerto CTD

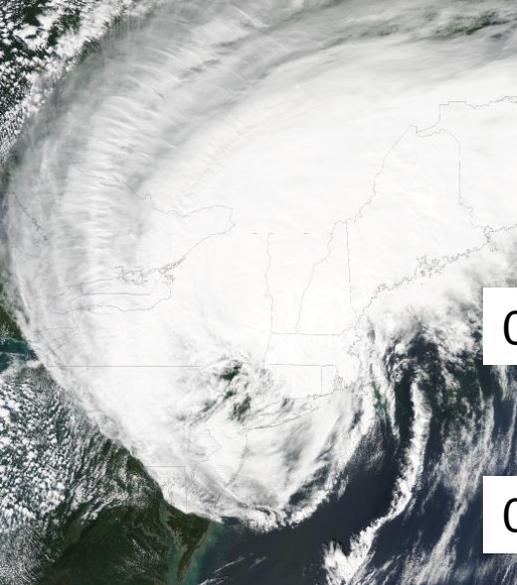


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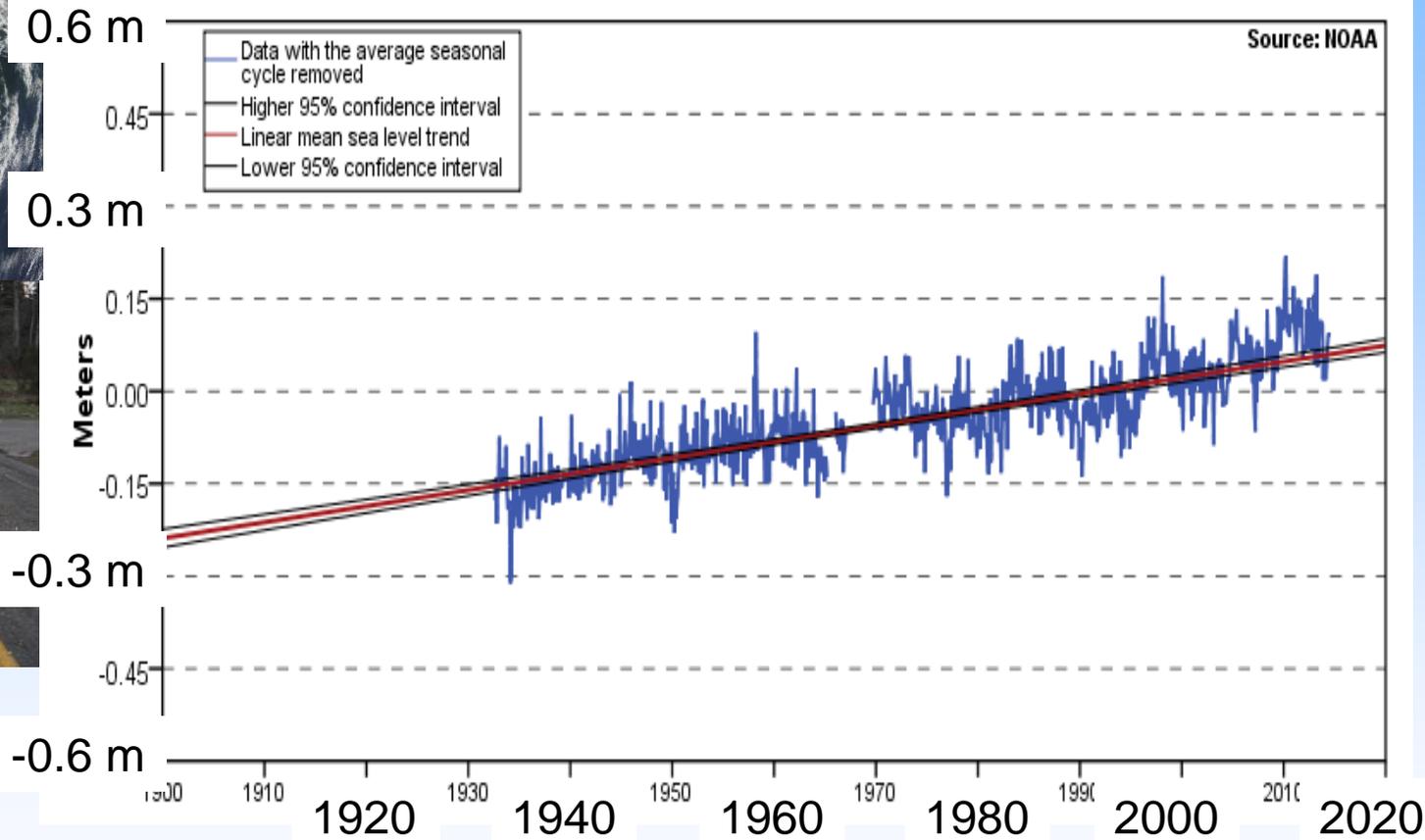


# Coastal Flooding & Sea-Level Rise



NOAA

Woods Hole, MA +0.26 m/century



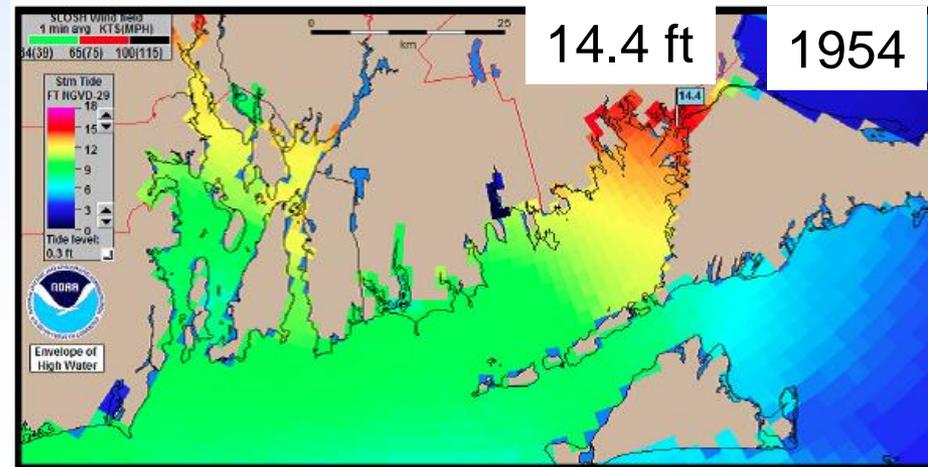
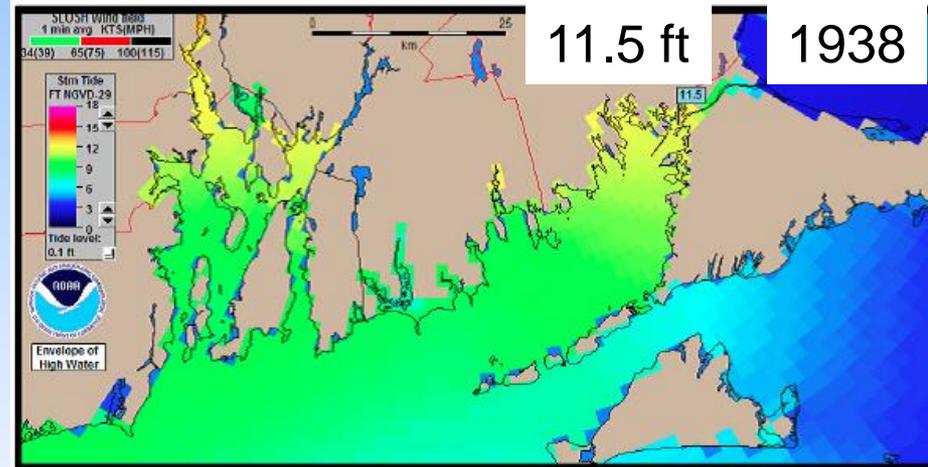
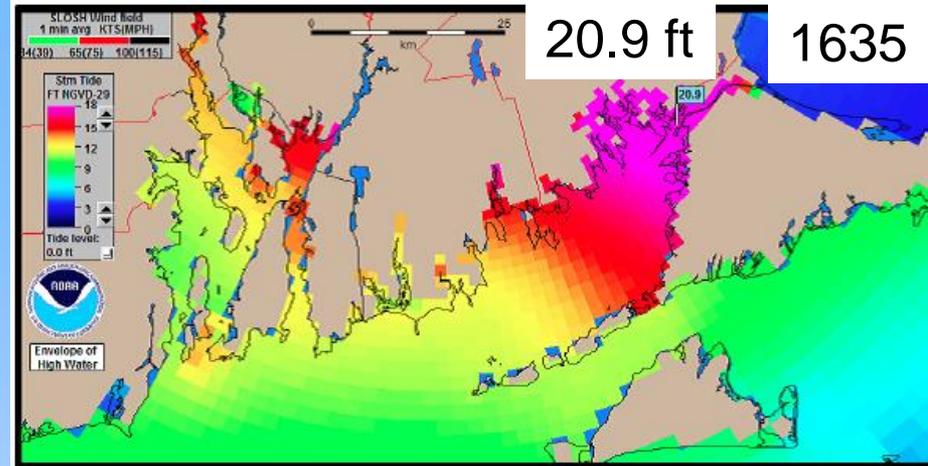
The Nature Conservancy



PRINCETON UNIVERSITY

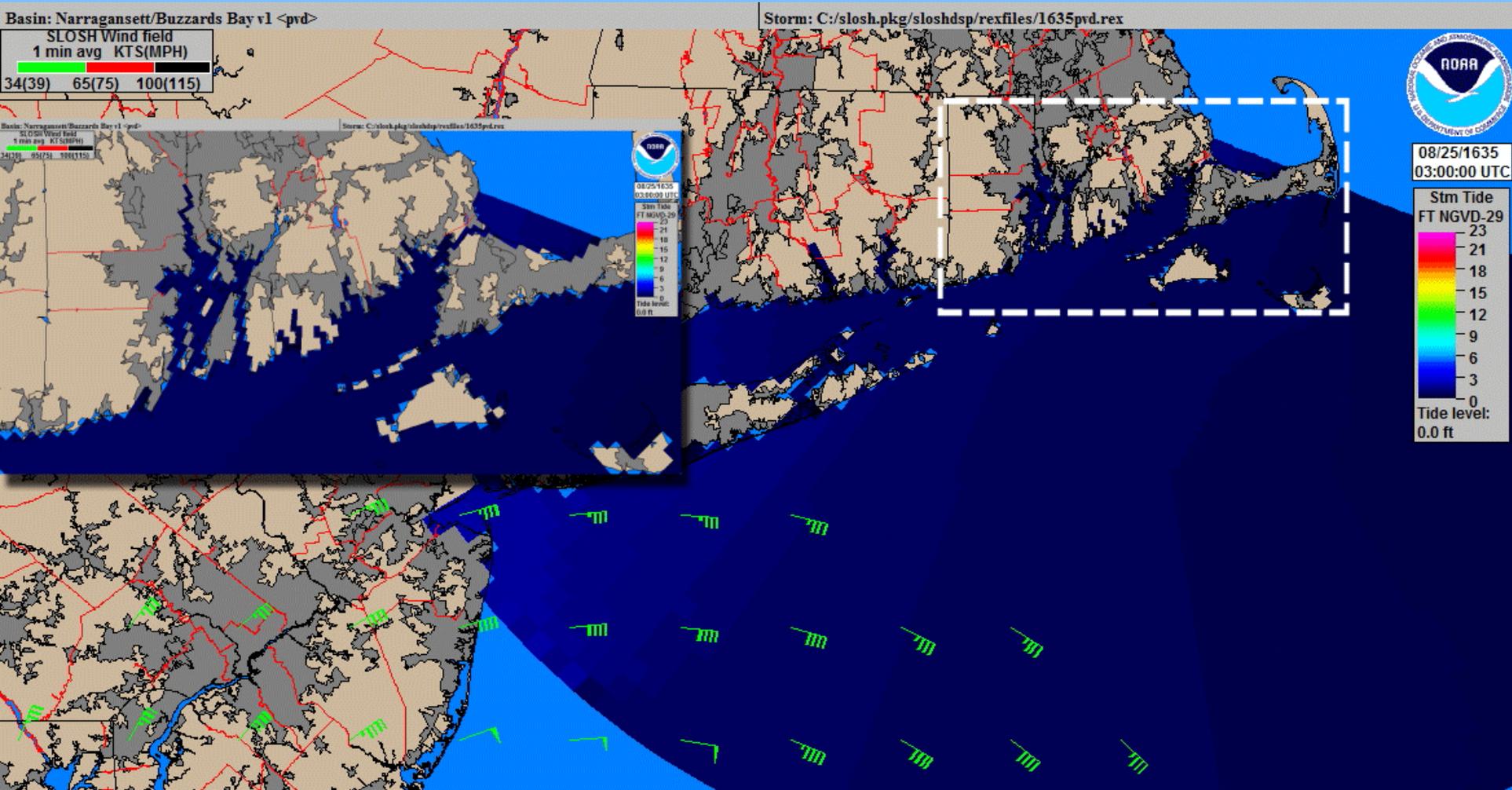


# Buzzards Bay, MA & Coastal Flooding



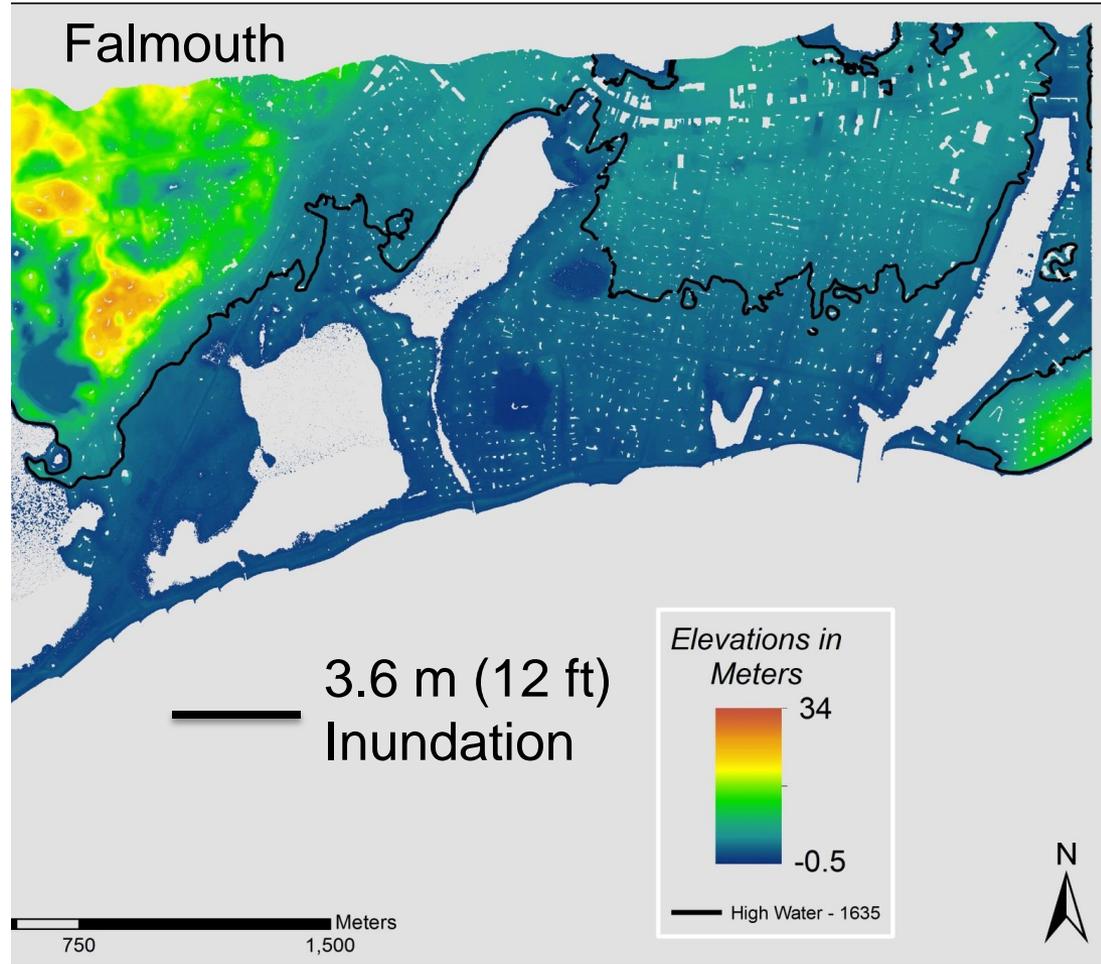
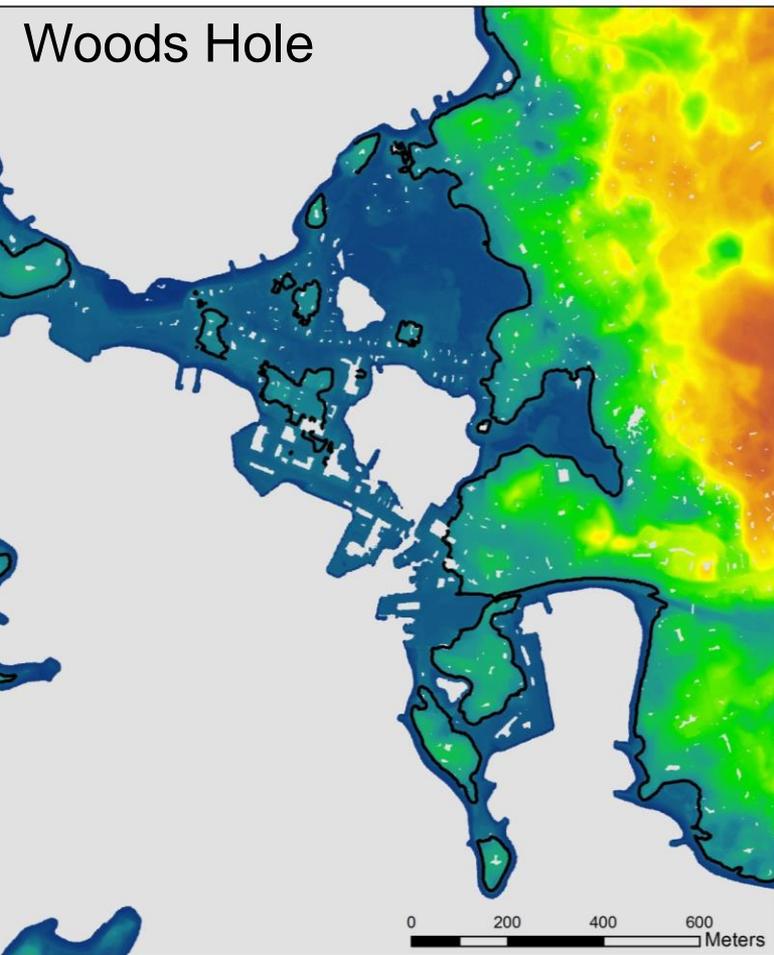
Boldt et al. 2010 Marine Geology

# 1635 Hurricane



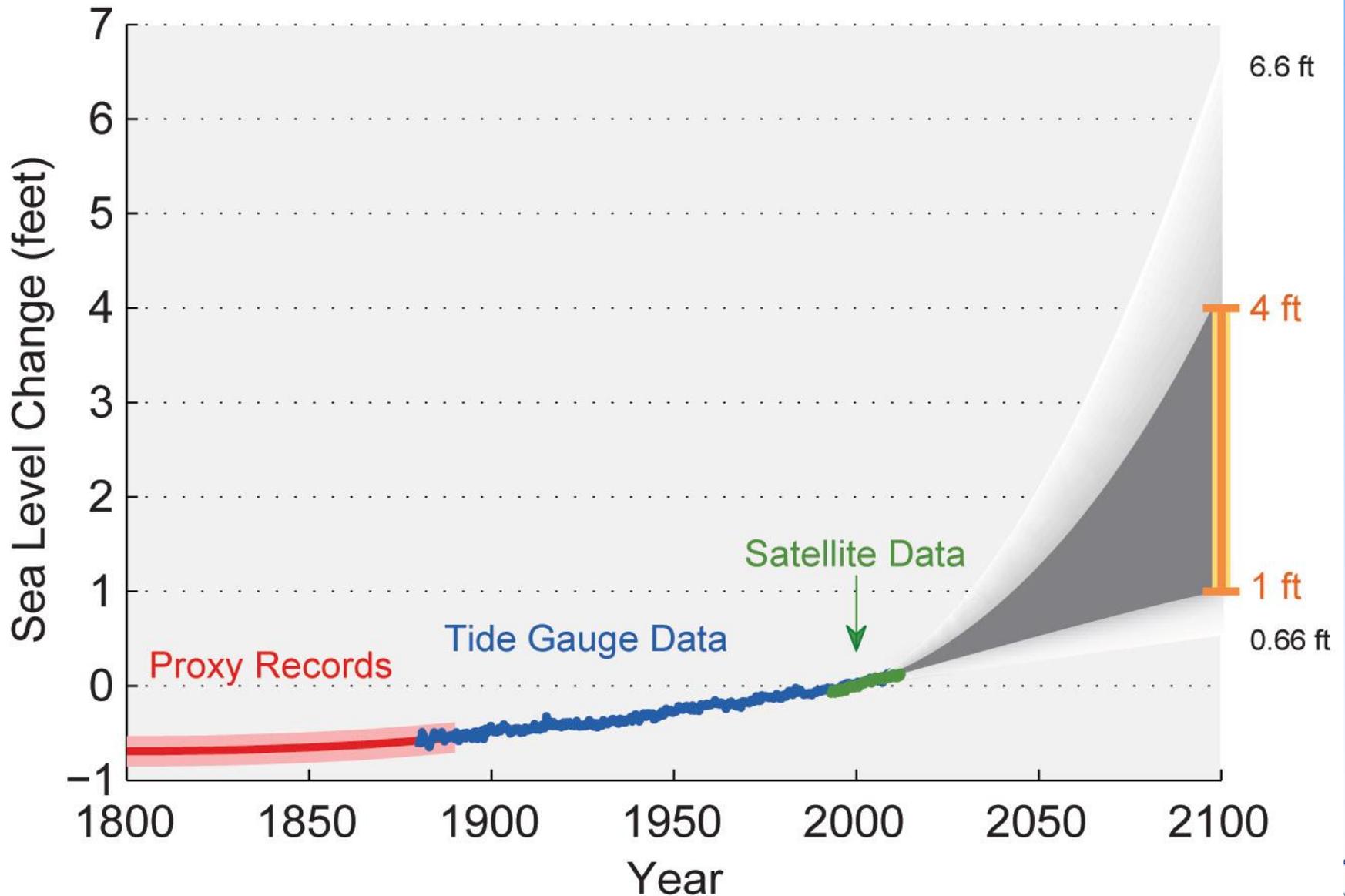
Boldt et al. 2010 Marine Geology

# What if the 1635 hurricane hit today?



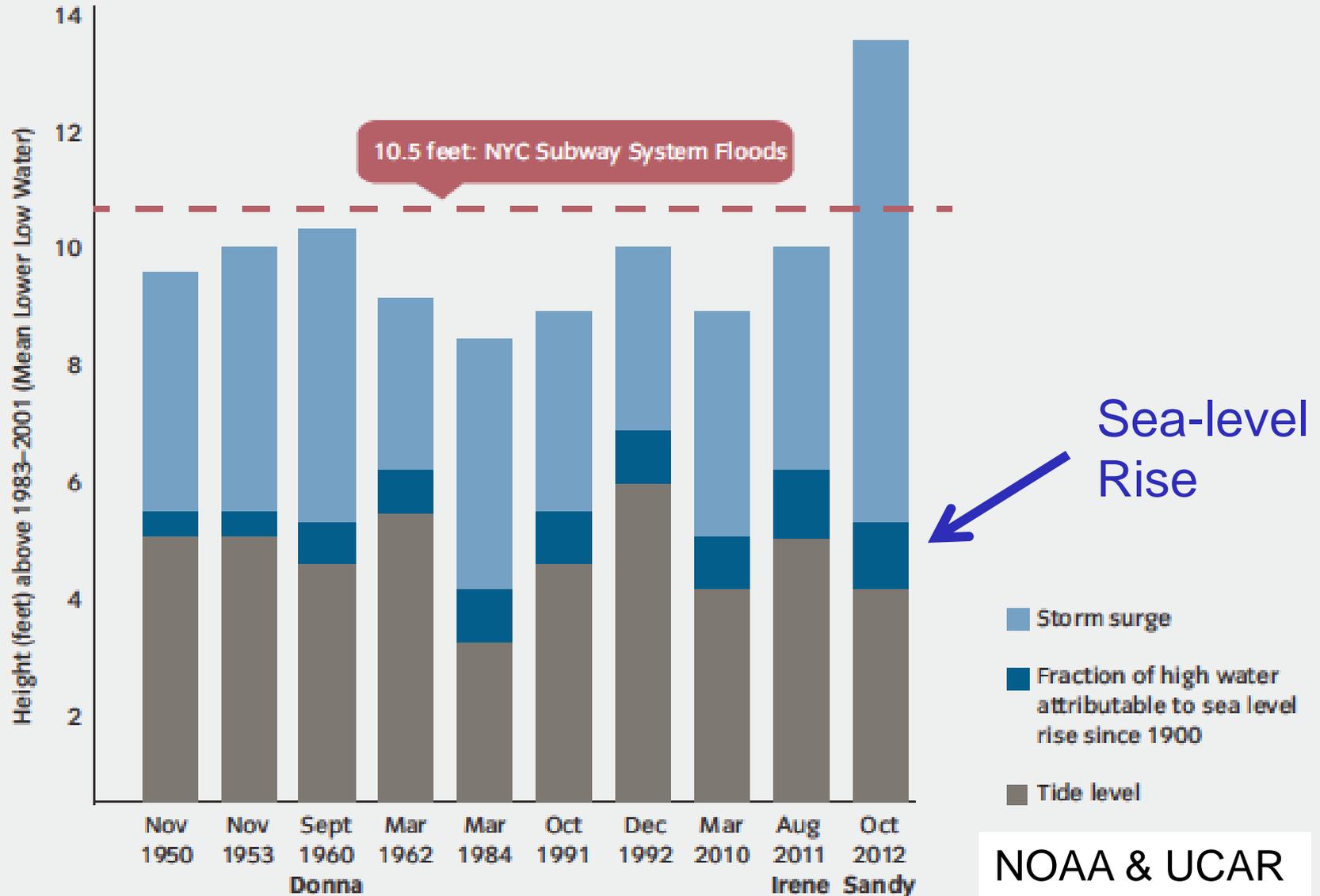
Donnelly et al.  
In prep.

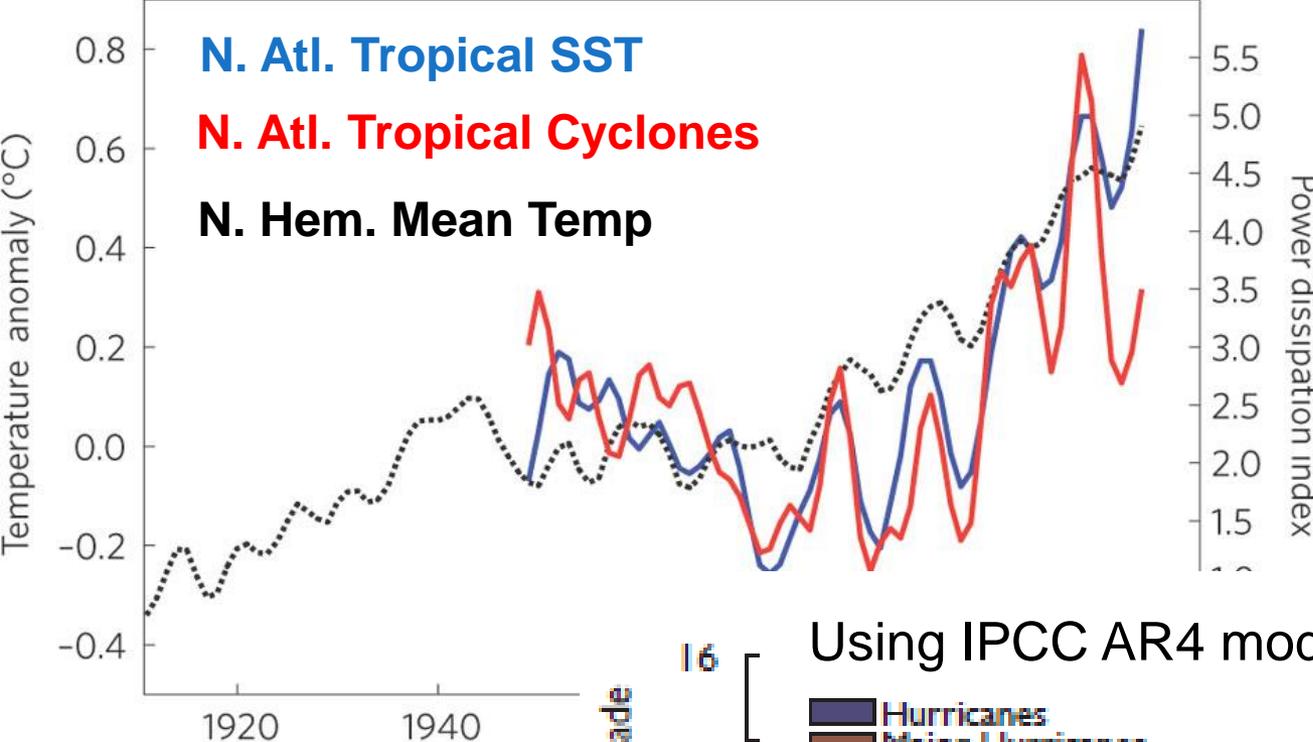
# Past and Projected Changes in Global Sea Level



# Sea-Level Rise Exacerbates Storm Surge

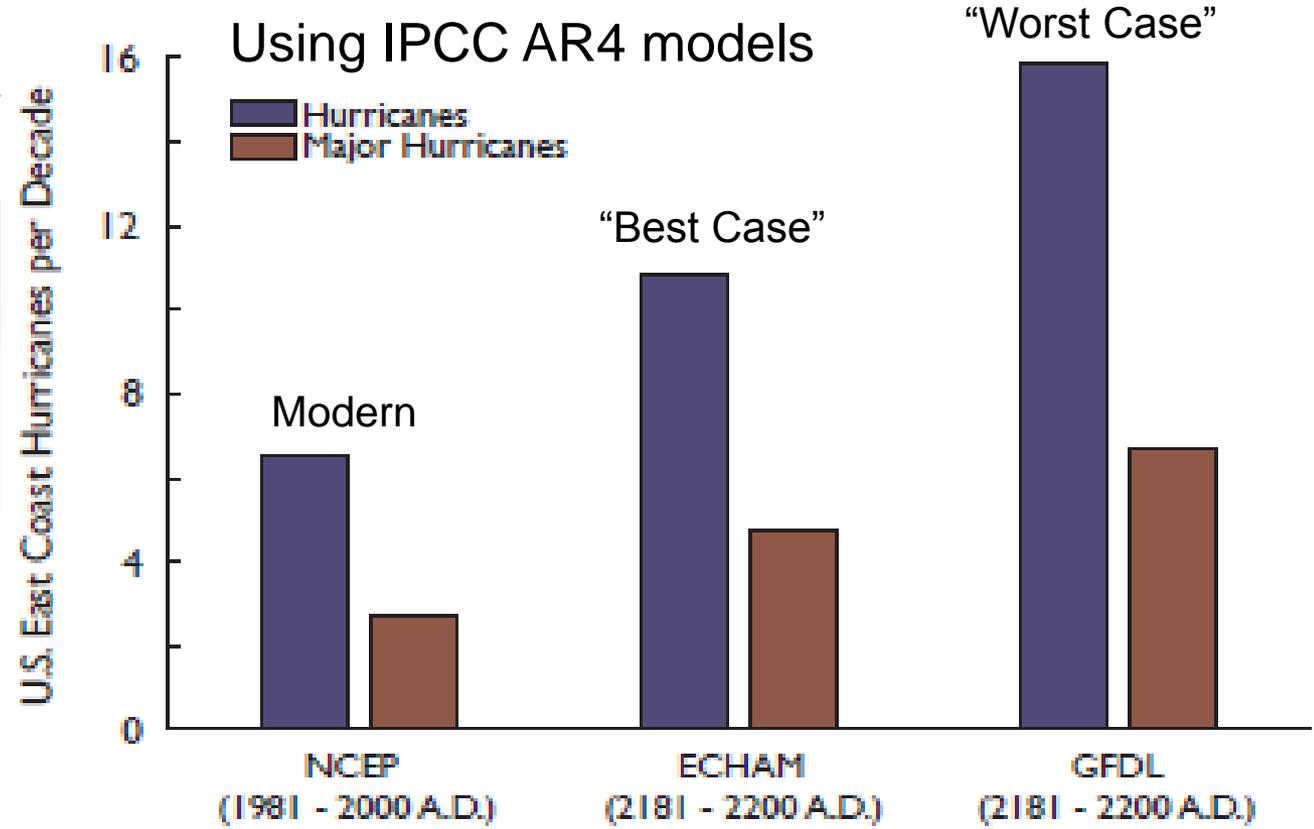
## High-Water Events in Lower Manhattan





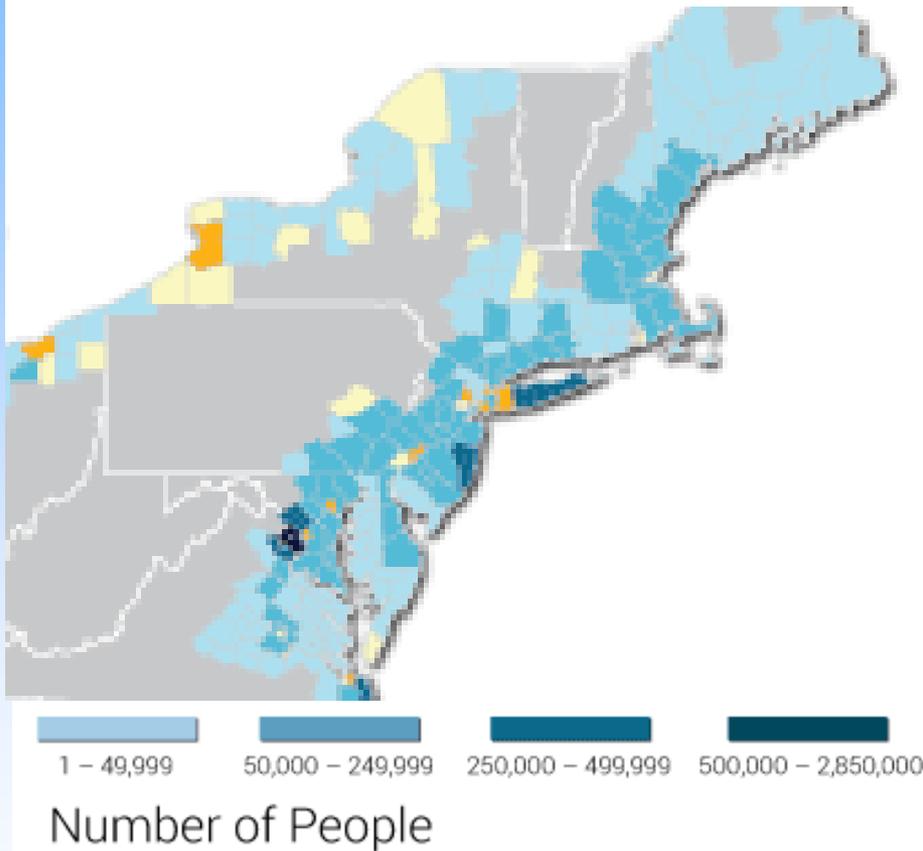
# Ocean Warming & Hurricane Frequency

Frequency of hurricanes may increase (particularly intense storms)



# Risks of Sea-Level Rise & Storm Impacts

Population Change in U.S. Coastal Watershed Counties (1970-2010)



Web-based tools to raise awareness & support better informed decision making for coastal inundation risk

Prehistoric & historical storm reconstructions with sea-level rise projections

Assessment of wetland and artificial reef flood protection

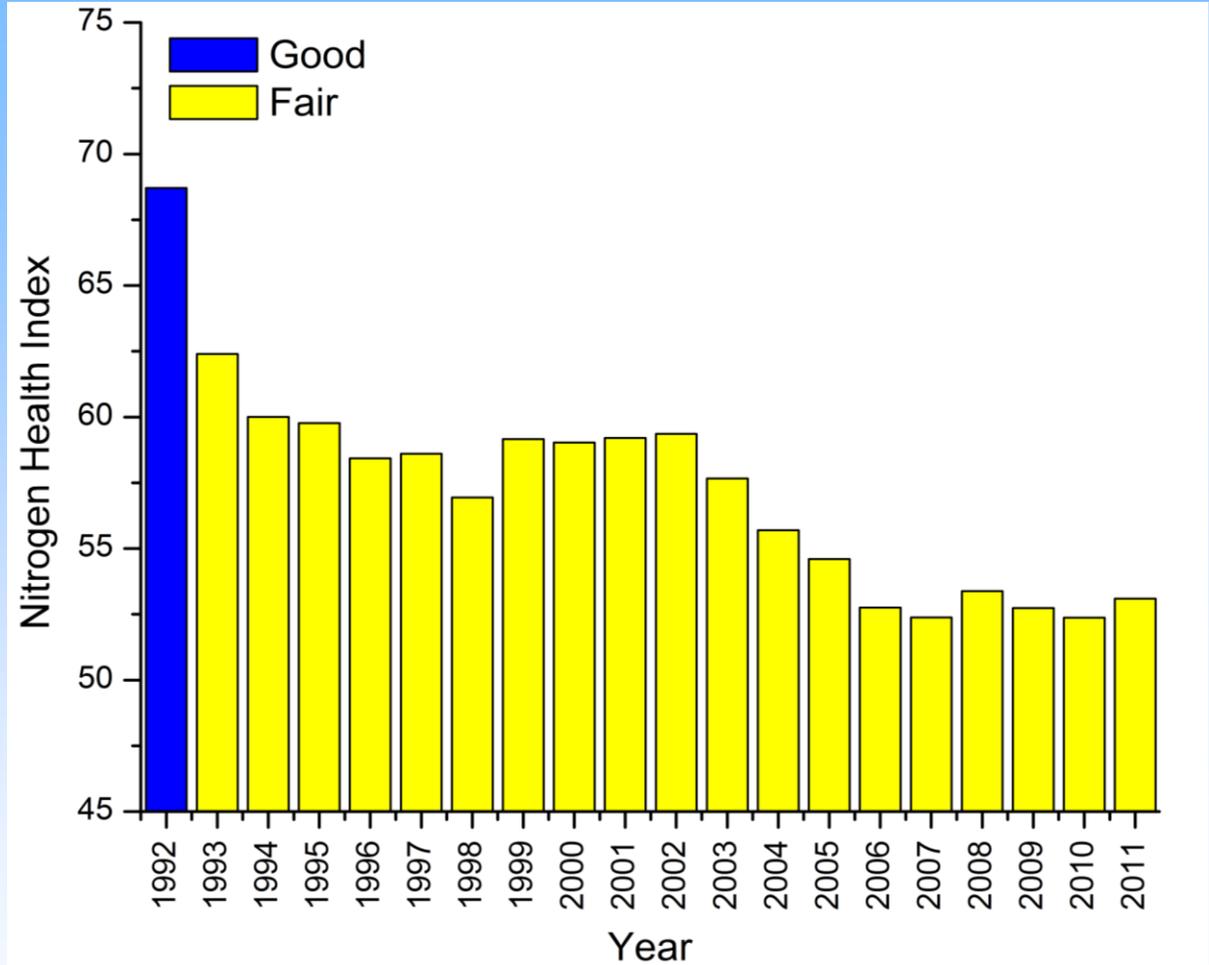
National Climate Assessment  
Moser et al. 2014



The Nature  
Conservancy



# Water Quality & Acidification



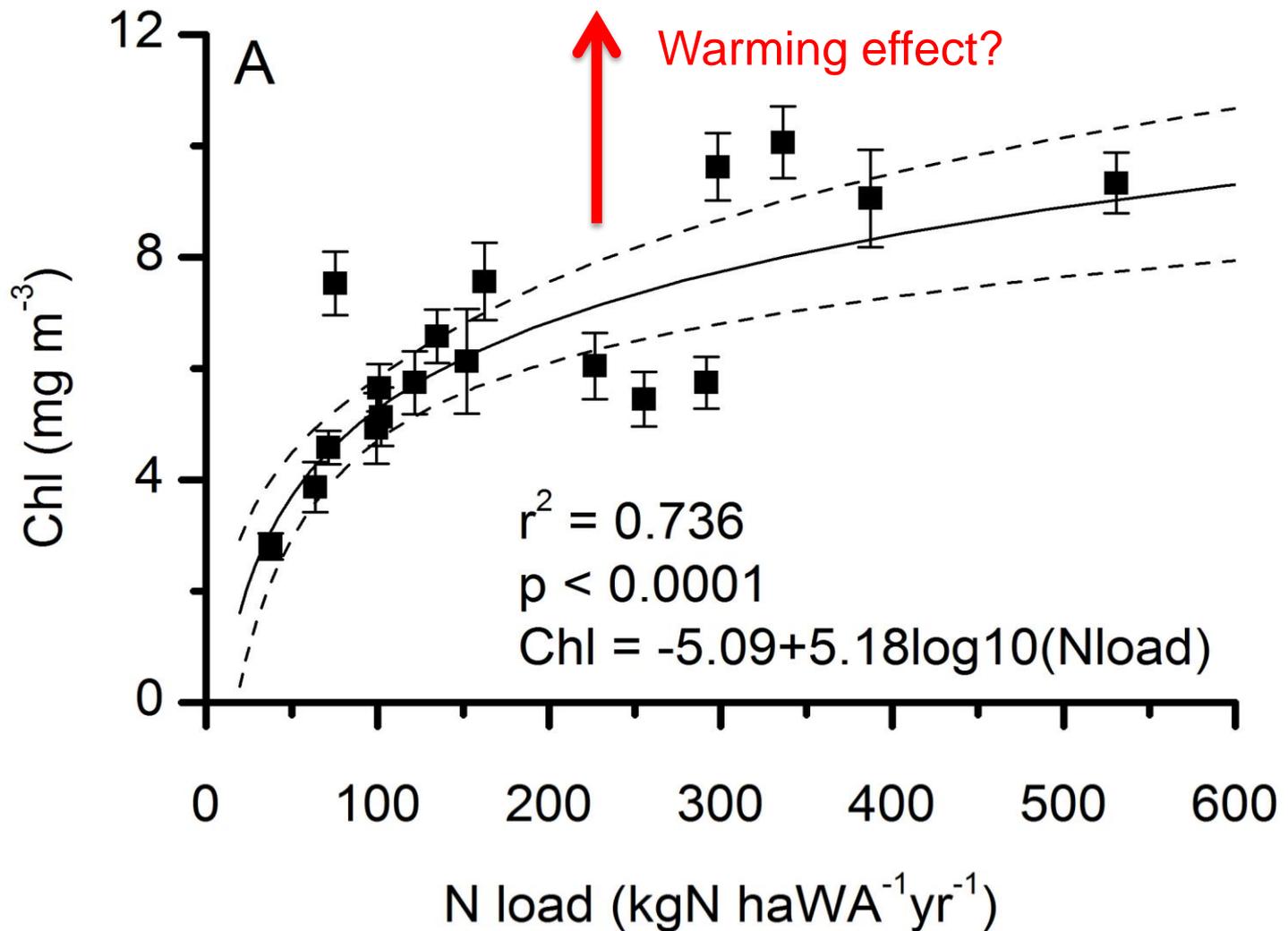
buzzards  
**BAY**  
COALITION



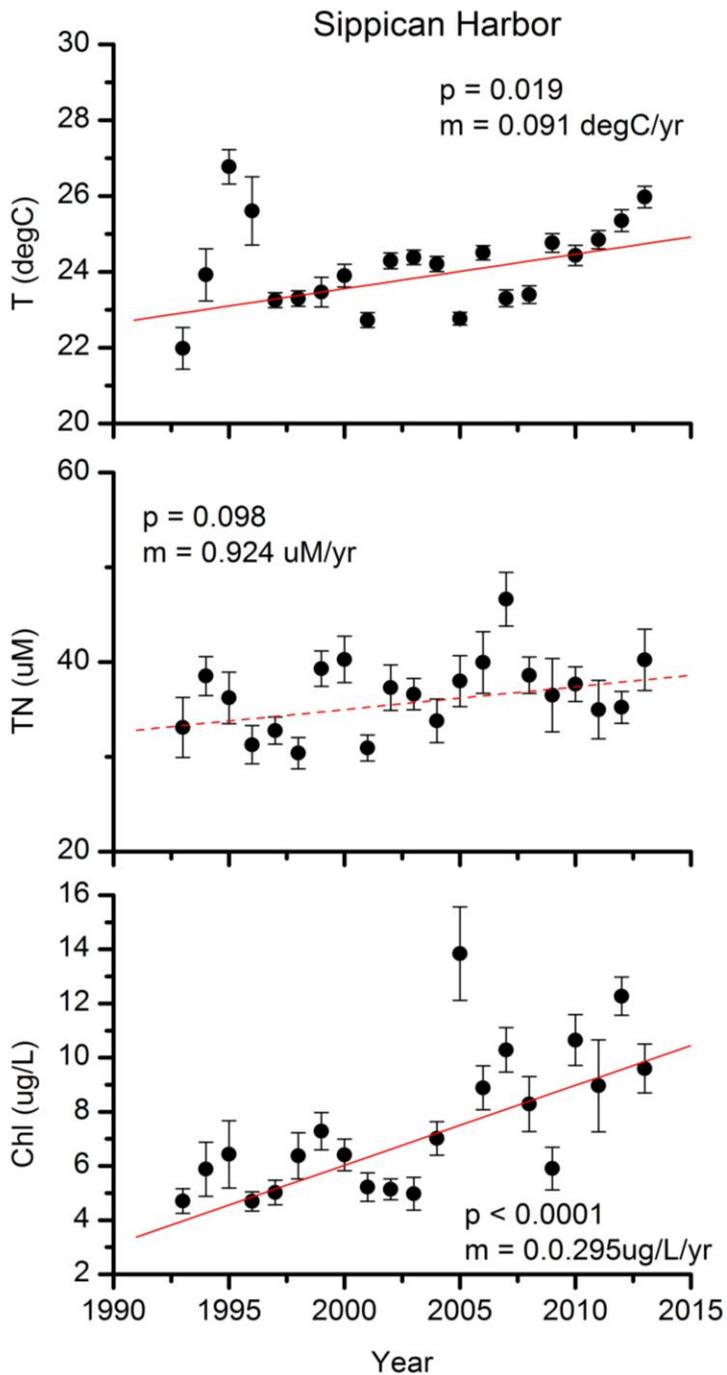
Buzzards Bay  
Coalition



# Nutrient Eutrophication



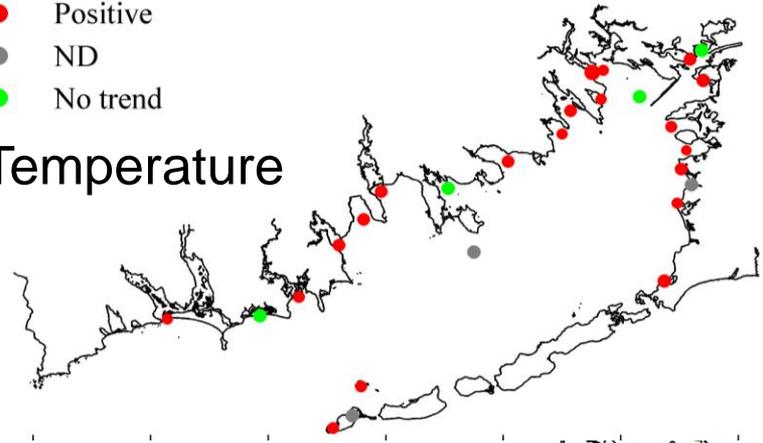
Rheuban et al., in prep.



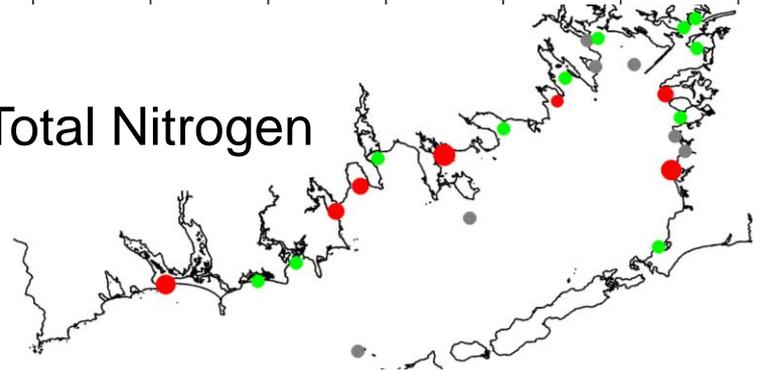
## Decadal Trends

- Positive
- ND
- No trend

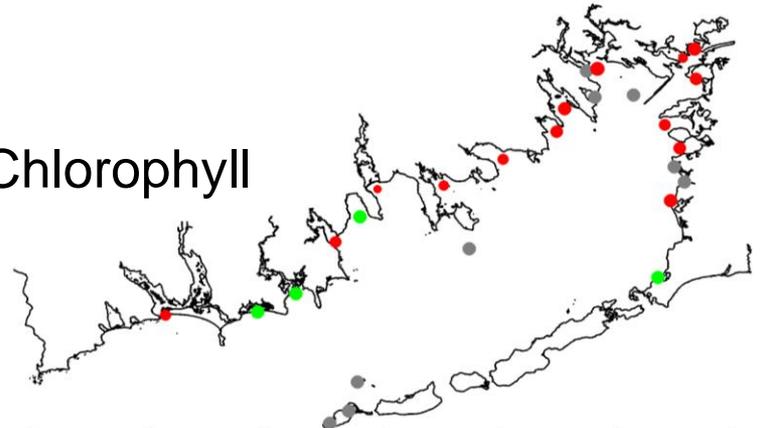
Temperature



Total Nitrogen



Chlorophyll

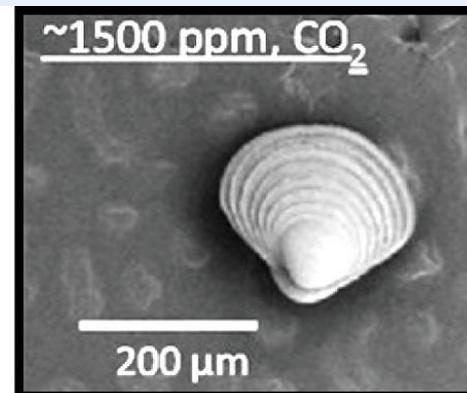
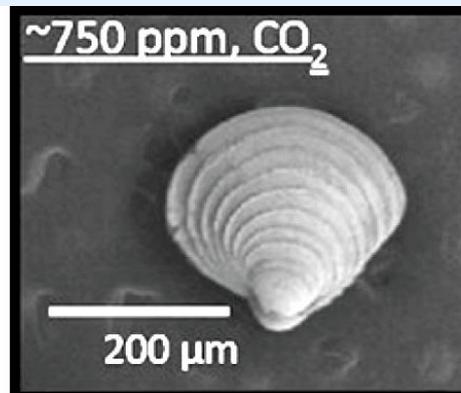
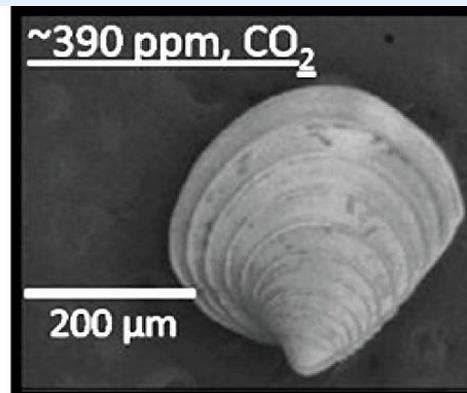
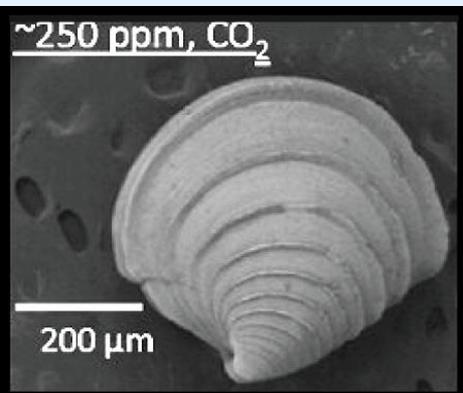
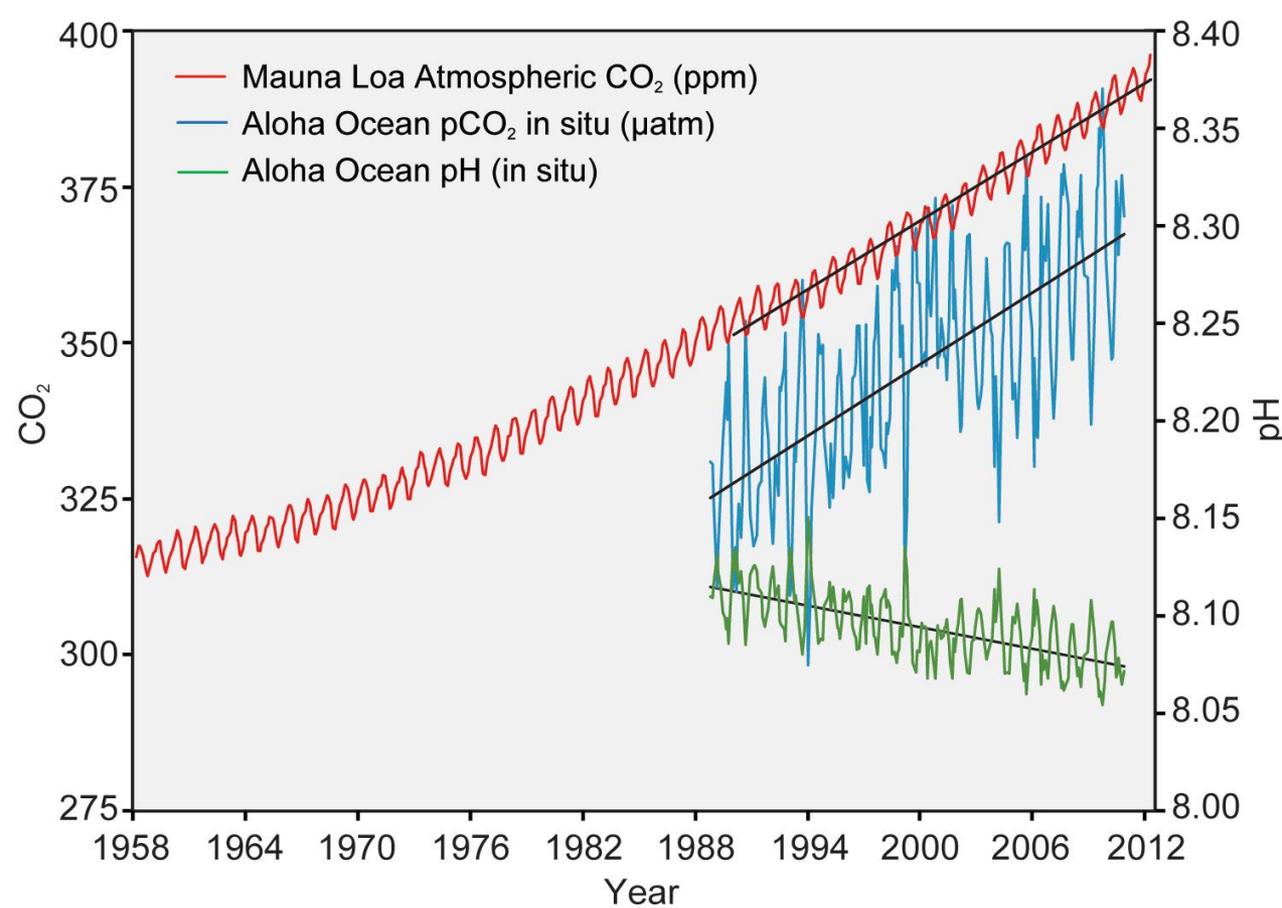


Rheuban et al., in prep.

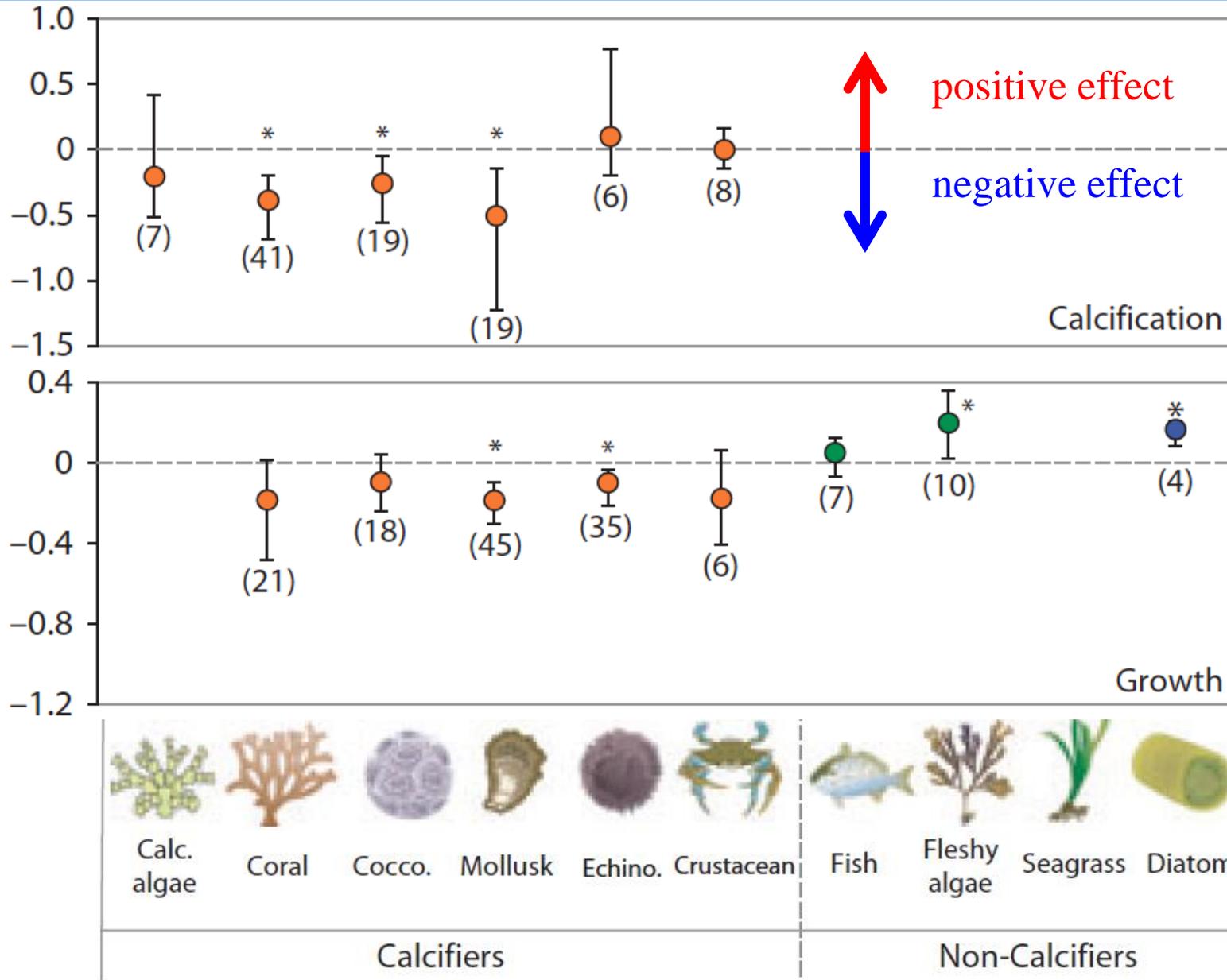
# Oceans Absorb CO<sub>2</sub> & Become More Acidic

Feely et al.  
Oceanography 2009  
National Climate  
Assessment  
Walsh et al. 2014

Ocean acidification  
reduces size of clams

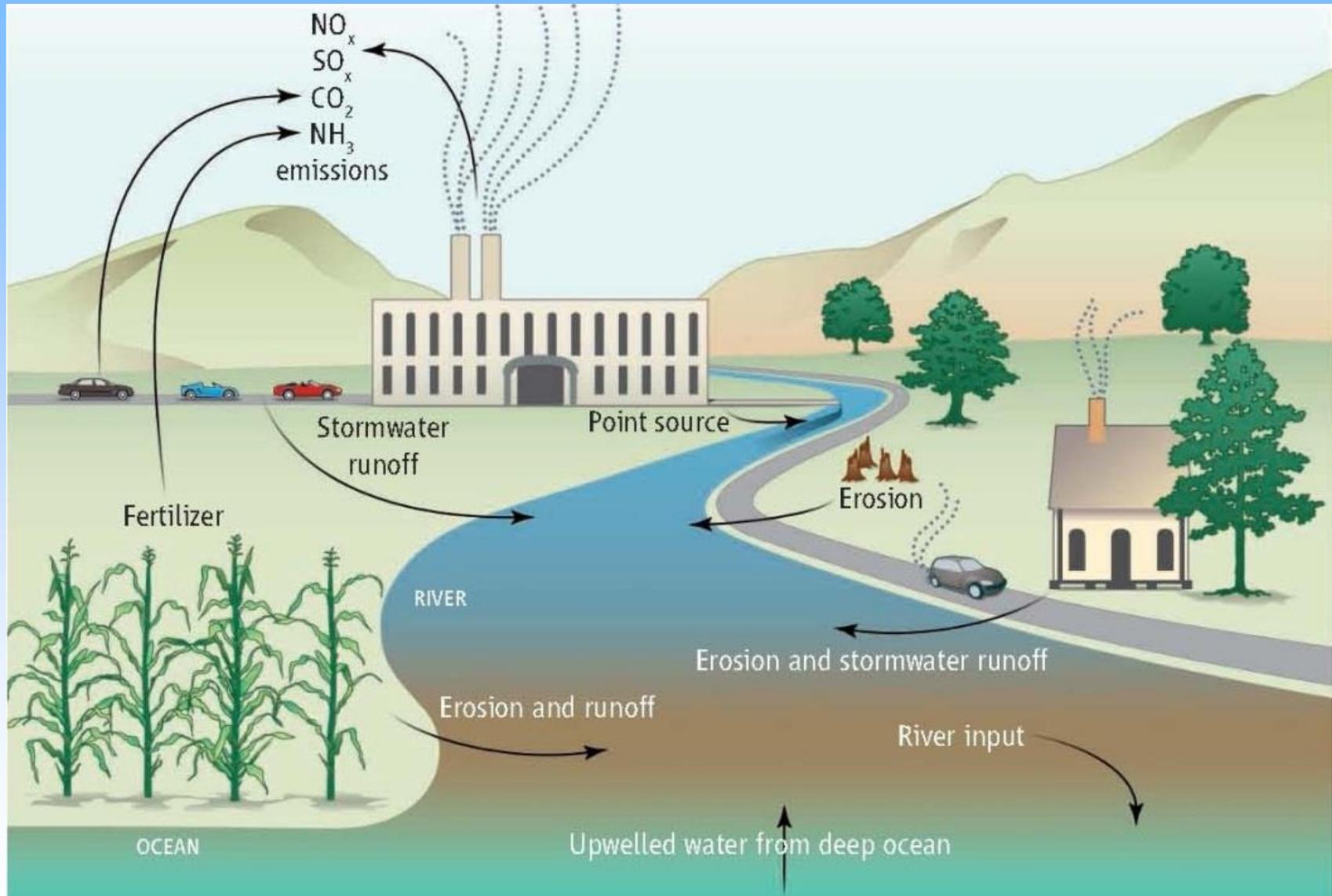


# Synthesis of Biological Impacts



Kroecker  
et al.  
Global  
Change  
Biology(2  
013)

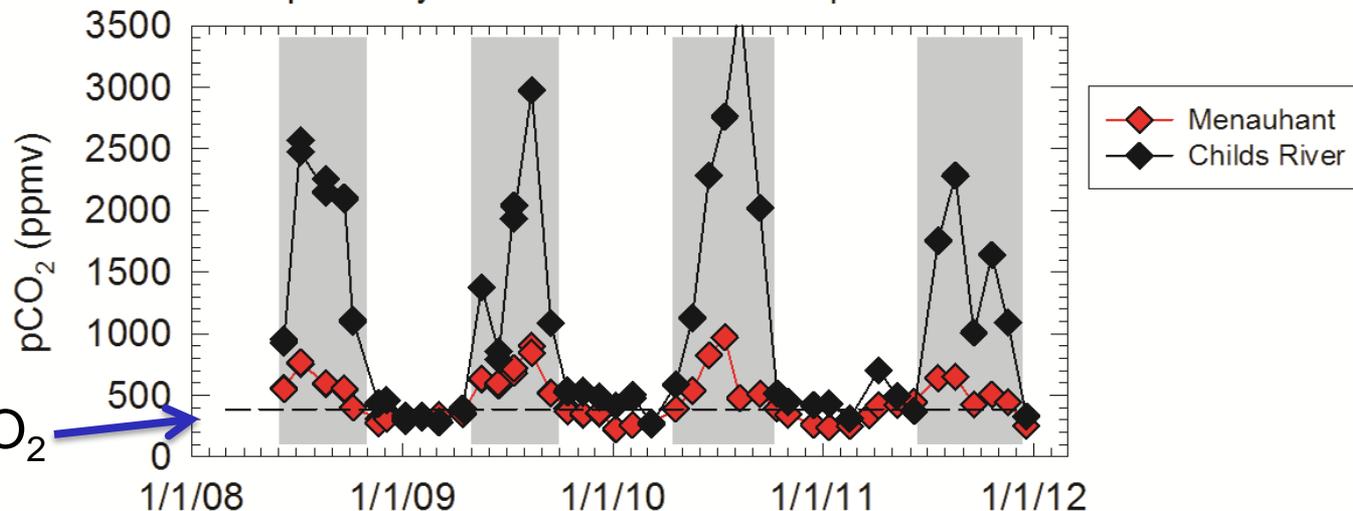
# Other Local Sources of Acidification



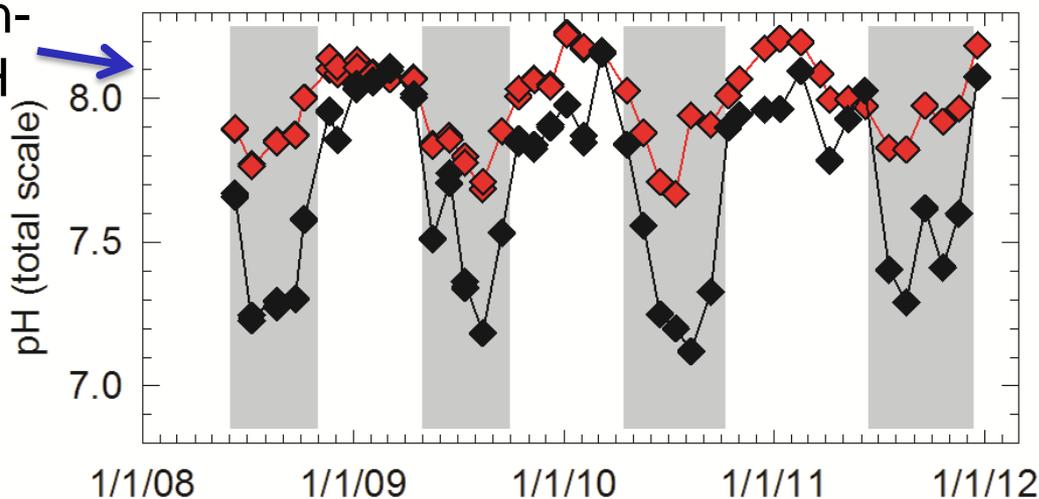
Doney et al. PNAS 2007; Doney Science 2010; Kelly et al. Science 2011

# Large Coastal Variability in CO<sub>2</sub> System & pH

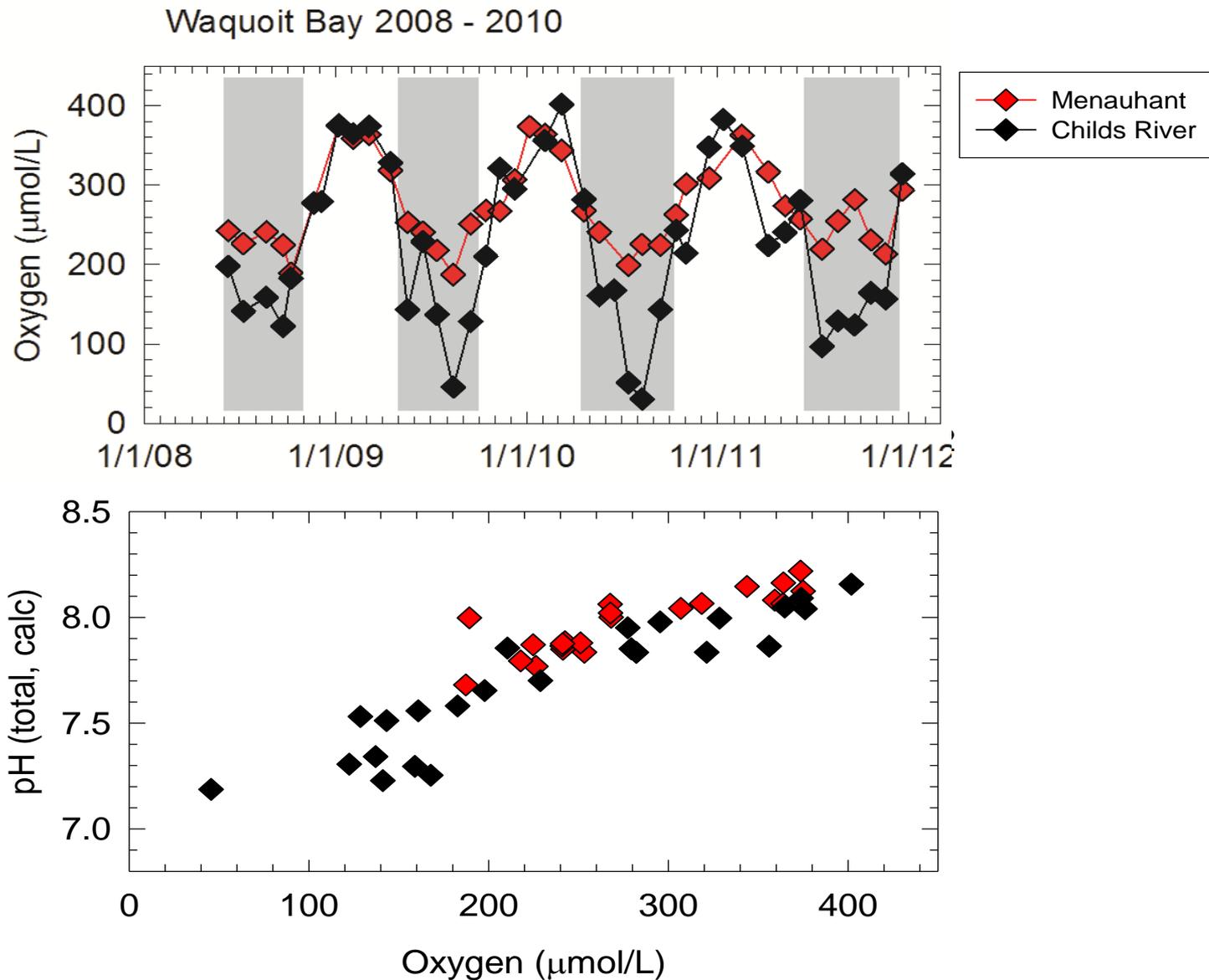
Waquoit Bay 2008-2011 calculated parameters



Present-day open-ocean surface pH (~8.1)



# Multiple Stressors



McCorkle et al., in prep.

# Water Quality & Ocean Acidification



Multiple stressors & impacts on coastal water quality

- warming
- nutrient loading
- ocean acidification

Historical data & new observations

Develop & test alternative management strategies

Science communication & outreach public & local municipalities

buzzards  
**BAY**  
COALITION

MBL<sup>®</sup>

The Ecosystems Center



# Talk Outline

## Climate change & coastal impacts

- Ocean warming & fisheries
- Sea-level rise & coastal flooding
- Coastal water quality & ocean acidification

Stakeholder engagement & adaptation solutions

