

5TH ANNUAL CAPE COASTAL CONFERENCE

The Value of Long-term Monitoring for Guiding Restoration Efforts – Warming Trends and Water Quality

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WAQUOIT BAY
NATIONAL
ESTUARINE
RESEARCH
RESERVE



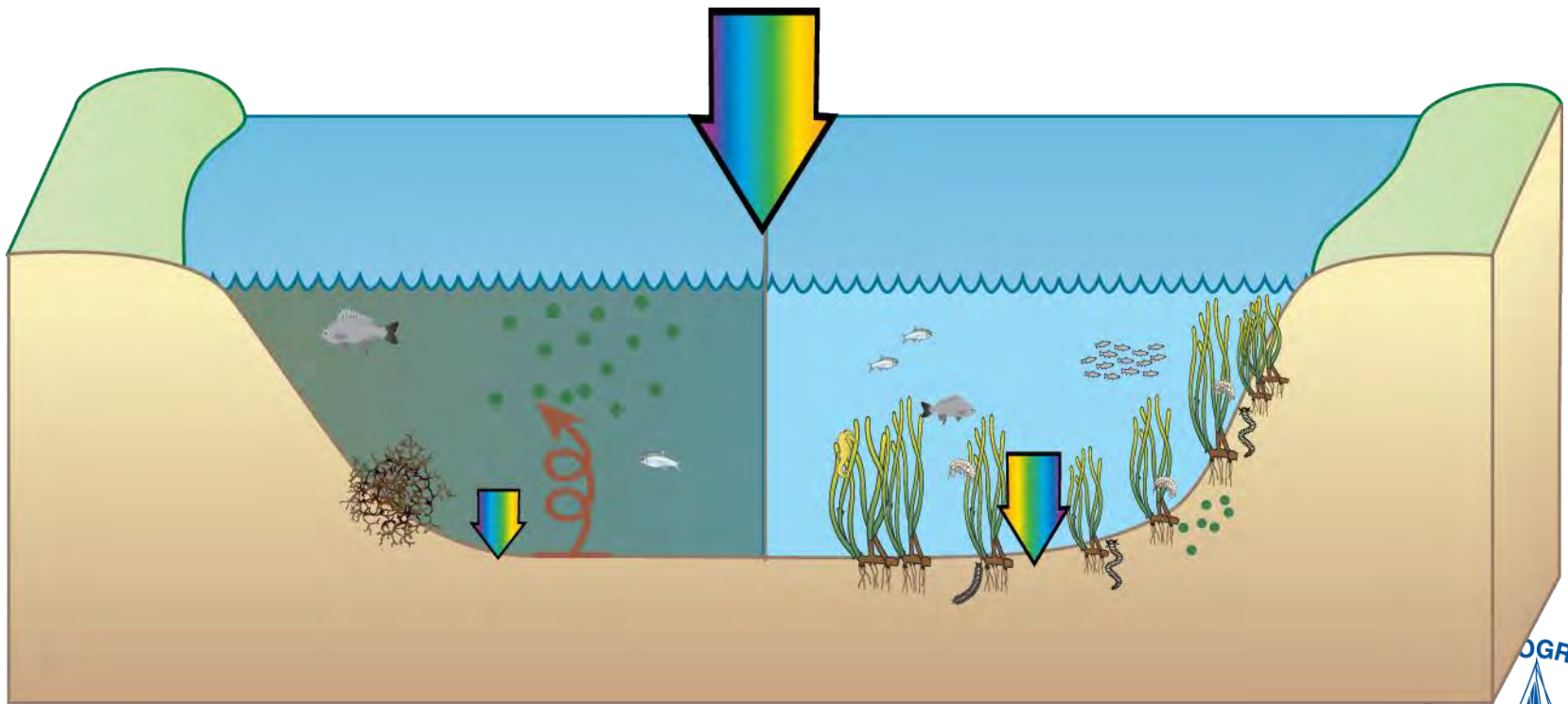
Outline

- Why do we care about water quality?
- What causes poor water quality?
- Stories from Waquoit Bay
- Stories from Buzzards Bay
- What does this mean for management?

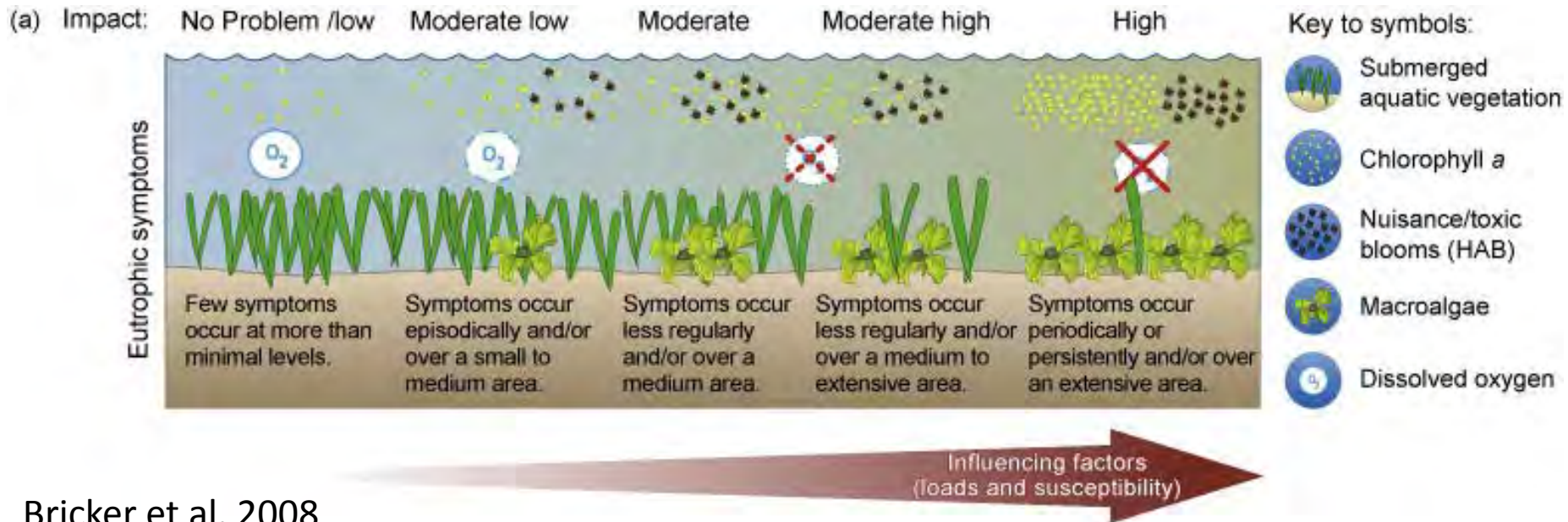


Why do we care about water quality?

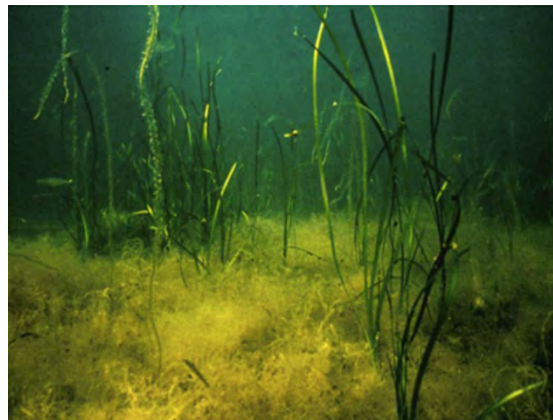
Good water quality provides us with benefits we enjoy, like clean and clear water and abundant fish and wildlife.



What causes poor water quality?



Bricker et al. 2008



How might global change impact water quality?

Waquoit Bay NERR Water Quality Monitoring Sites



Map by Jordan Mora, March 2016. Data provided by WBNERR and MassGIS.



BayWatcher (BW) Citizen Water Quality Monitoring Program

Site #1-5: 1993 - present
Site #6: 1995 - present
Site #7: 1996 - present
Site #8: 2003 - present
Site #9: 2008 - present

Parameters Collected:

- Water Temperature
- Turbidity
- Surface & Bottom Depth
- Salinity
- Dissolved Oxygen (mg/L and %)
- Nutrients (NH₄, NO₂/3, PO₄, SiO₄, DON)
- Chlorophyll - a

System-Wide Monitoring Program (SWMP)

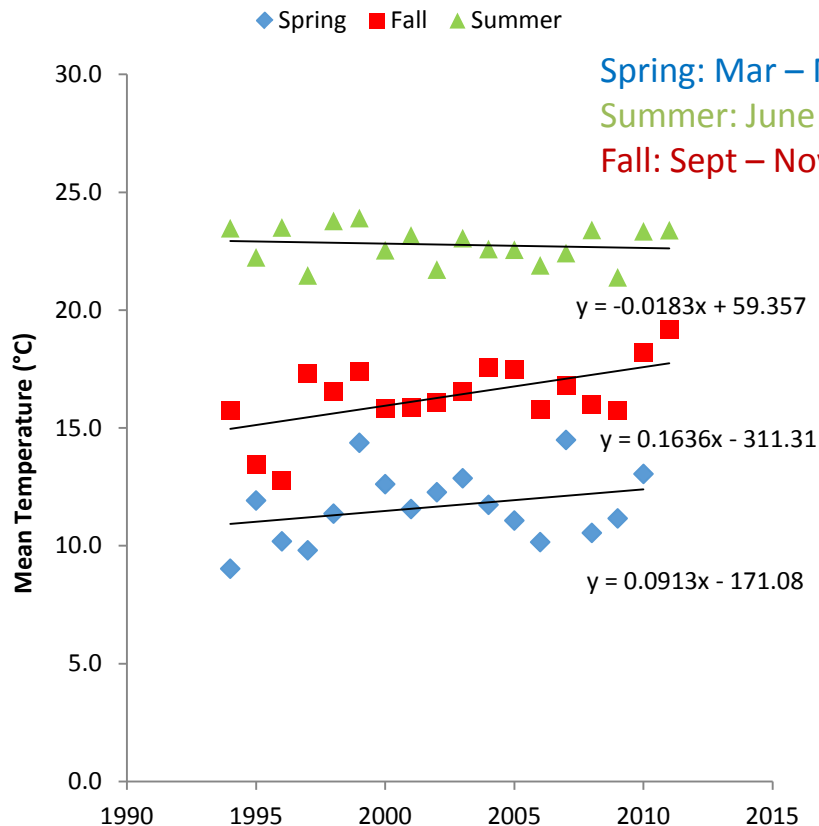
Site #1: Metoxit Point (1998 - present)
Site #2: Menauhant Yacht Club (2001 - present)
Site #3: Sage Lot (2002 - present)
Site #4: Childs River (2002 - present)

Parameters Collected:

- Water Temperature
- Turbidity
- pH
- Water Depth
- Specific Conductivity/Salinity
- Dissolved Oxygen (mg/L and %)
- Nutrients (NH₄, NO₂/3, PO₄, SiO₄, DON, TN)
- Chlorophyll - a

BayWatchers – Temperature

Sites 1-5, Years 1994-2011



Note: Did not include years 2012-2014 because of sampling frequency change in fall season

Linear Regression by season

Winter: $R^2 = 0.001$, $F = 0.267$, $p = 0.605$

Spring: $R^2 = 0.011$, $F = 6.081$, $p = 0.014$

Rate of change: 0.09°C/yr (4°F over 20 years)

Summer: $R^2 = 0.009$, $F = 9.903$, $p = 0.002$

Rate of change: -0.02°C/yr (-1°F over 20 years)

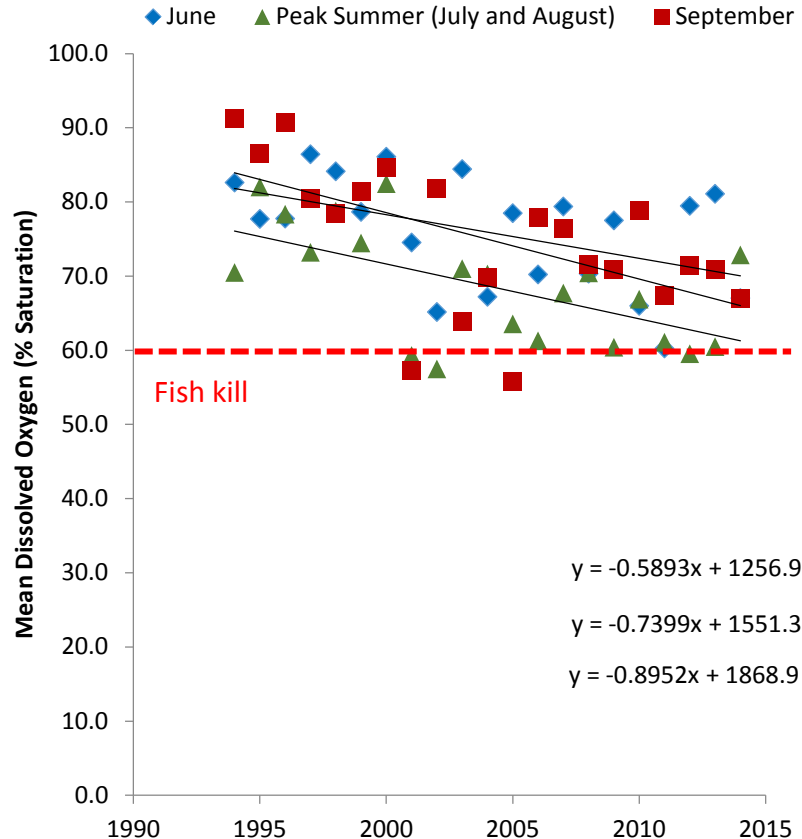
Fall: $R^2 = 0.015$, $F = 11.274$, $p = 0.001$

Rate of change: 0.16°C/yr (6°F over 20 years)



Baywatchers – Dissolved Oxygen

Sites 1-5, Years 1994-2014



Linear Regressions (growing season only)

June: $R^2 = 0.035$, $F = 13.870$, $p = 0.000$

Rate of change: -0.6% per year (12% over 20 years)

Jul/Aug: $R^2 = 0.039$, $F = 32.518$, $p = 0.000$

Rate of change: -0.7% per year (14% over 20 years)

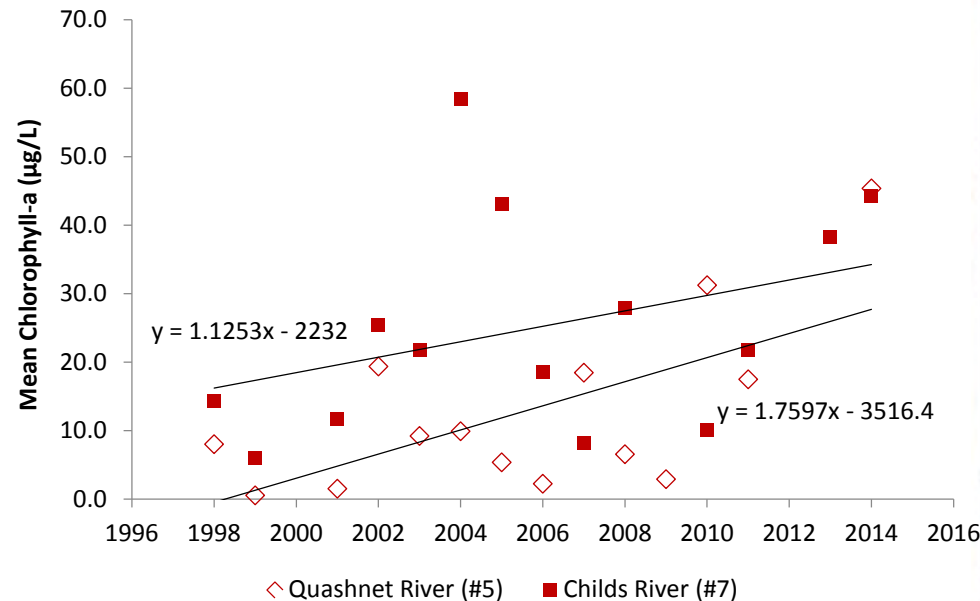
September: $R^2 = 0.054$, $F = 20.709$, $p = 0.000$

Rate of change: -0.9% per year (18% over 20 years)

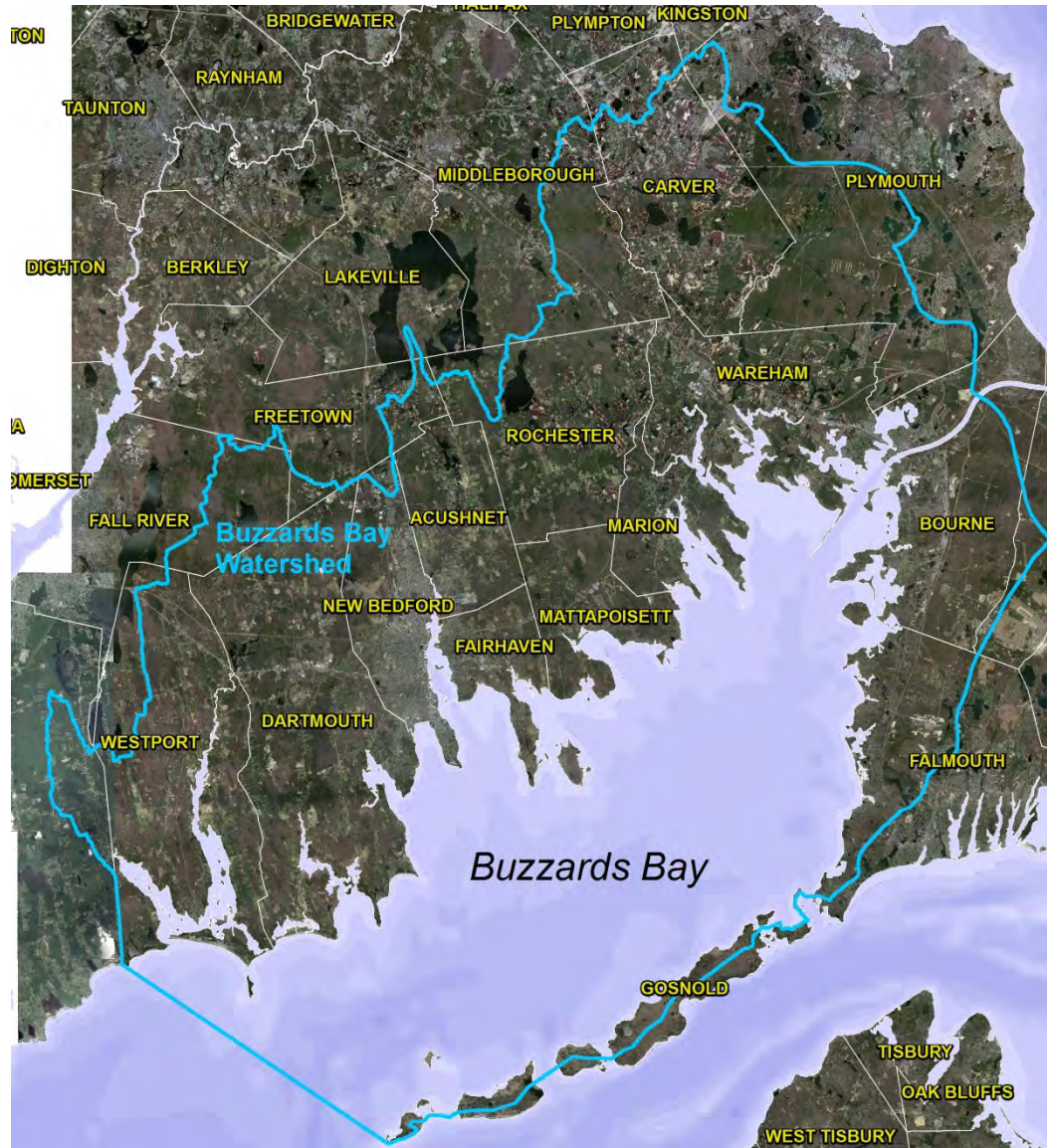


Baywatchers Chlorophyll-a (September Only)

Years 1998-2014; Head of tide, riverine sites



Buzzards Bay, MA



buzzards
BAY
COALITION



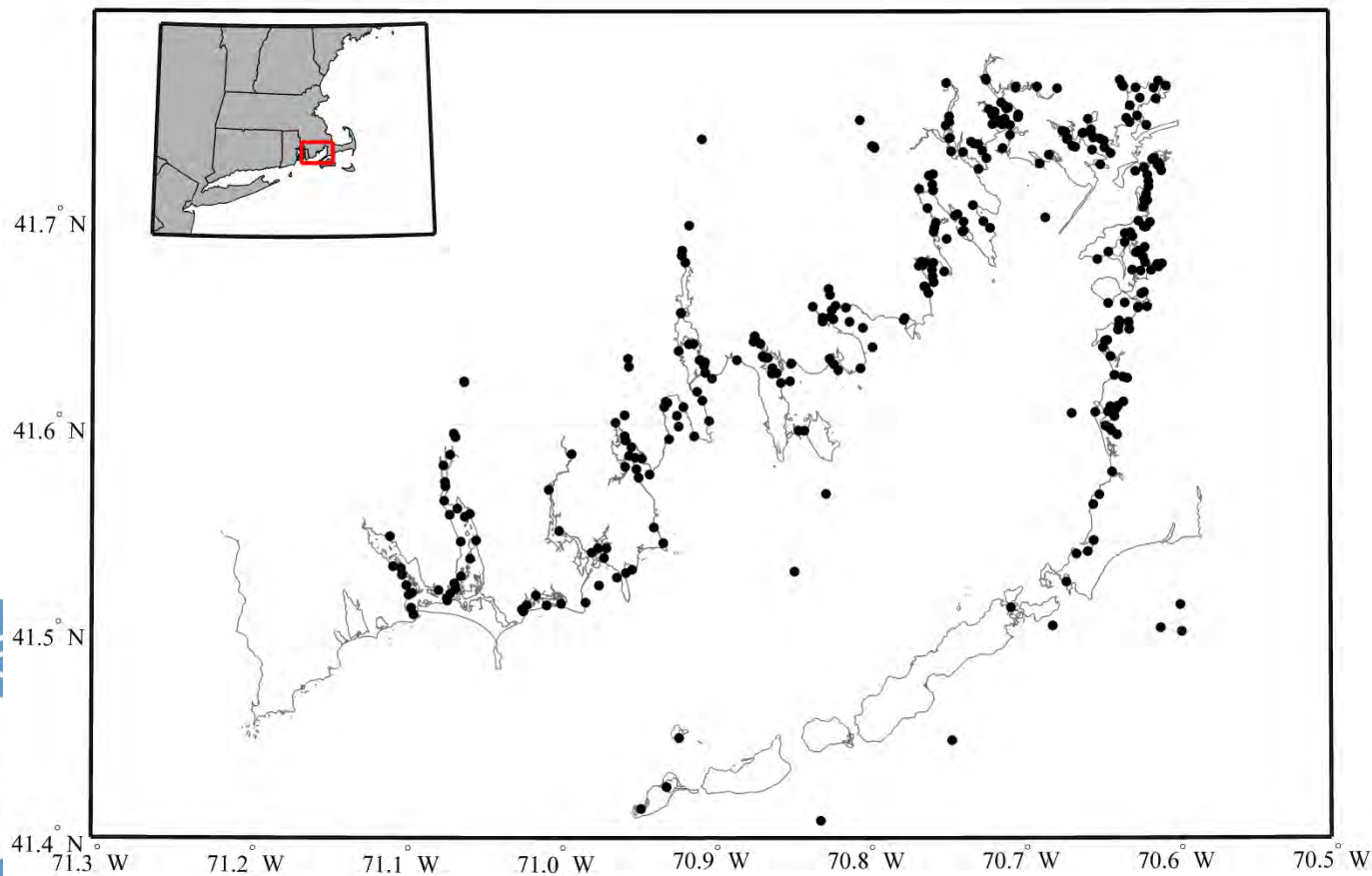
Buzzards Bay Coalition's Baywatchers

- The Baywatchers Program began in 1992.
- Volunteers measure water quality indicators from May to September.
- Over 1600 citizen-scientists!!
- Nutrients, temperature, salinity, dissolved oxygen



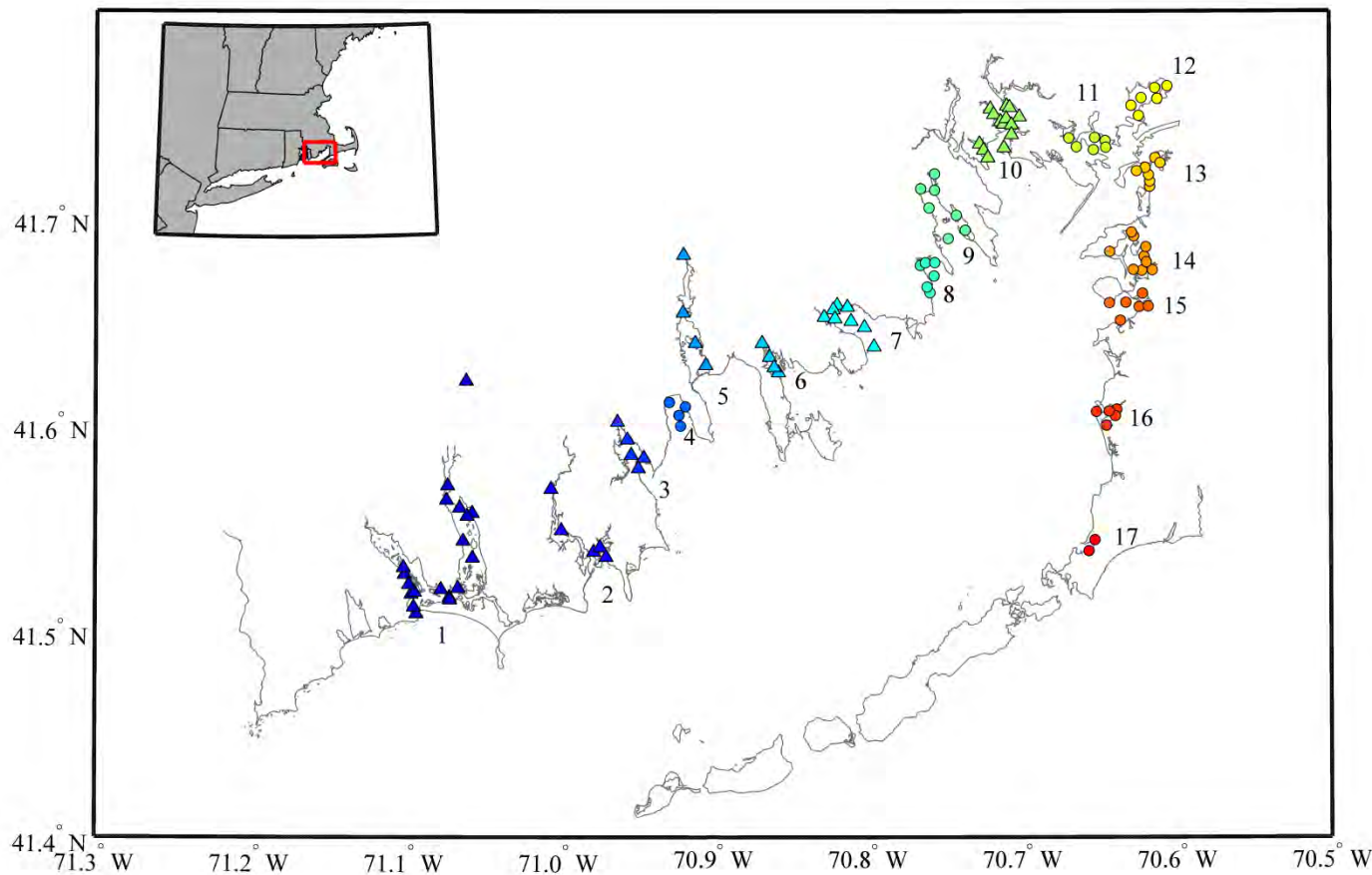
Where have the Baywatchers collected data?

- Over 330 places have been sampled!!!



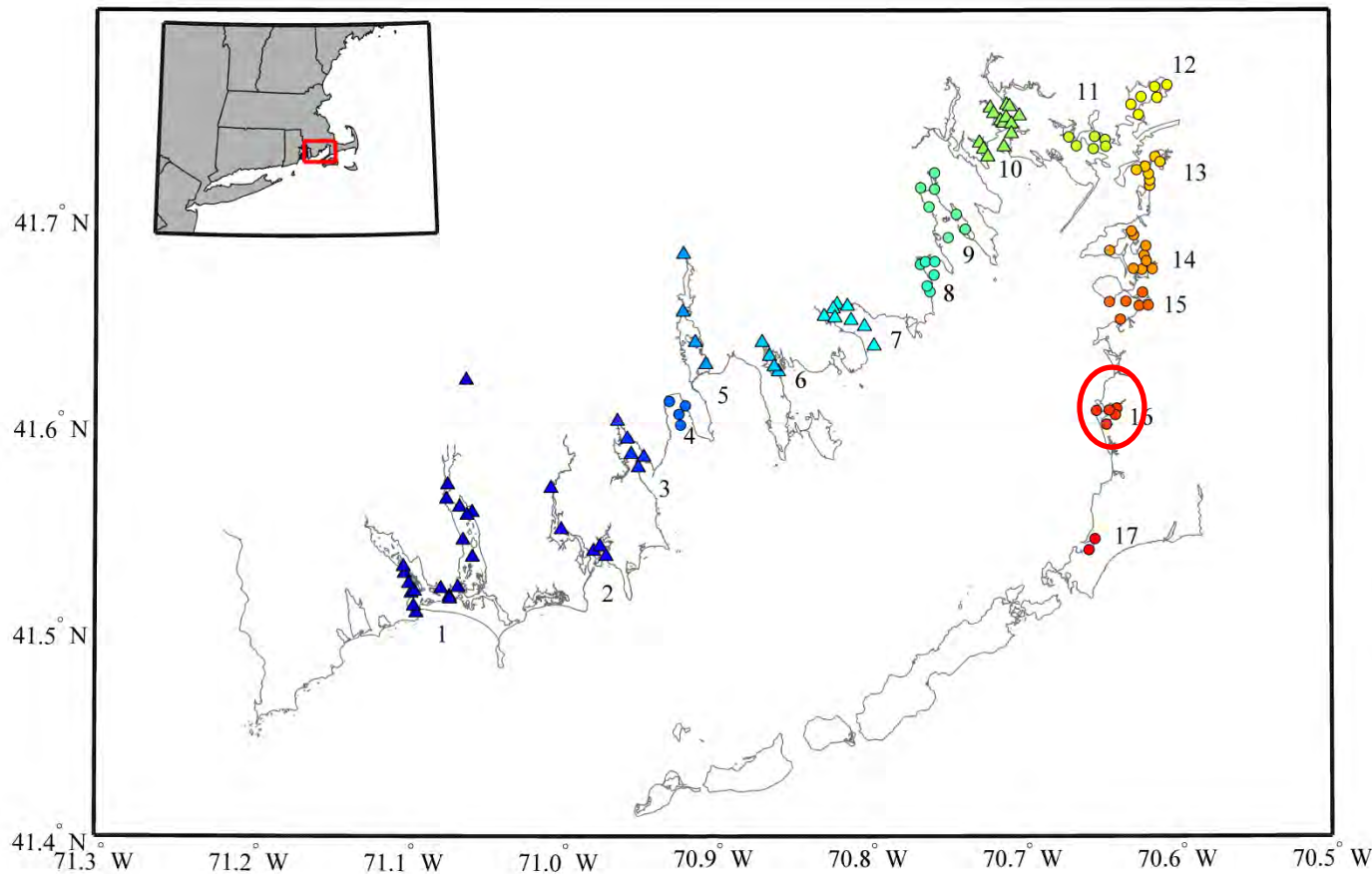
Where have the Baywatchers collected data?

Long-term trends, spatial patterns in water quality



Where have the Baywatchers collected data?

Long-term trends, spatial patterns in water quality



West Falmouth Harbor



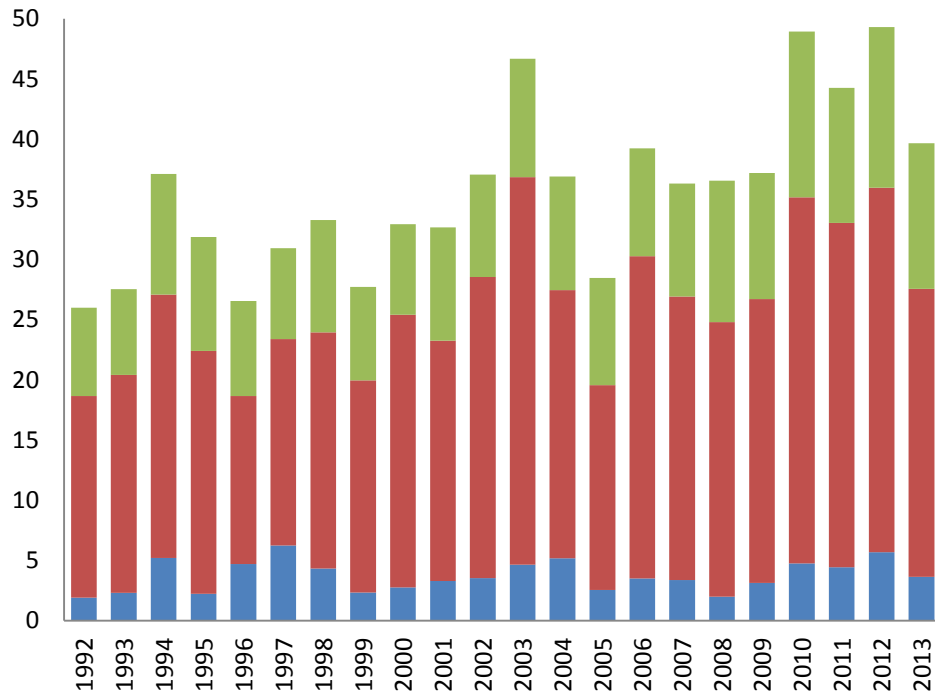
West Falmouth Harbor

Nutrient oops!!



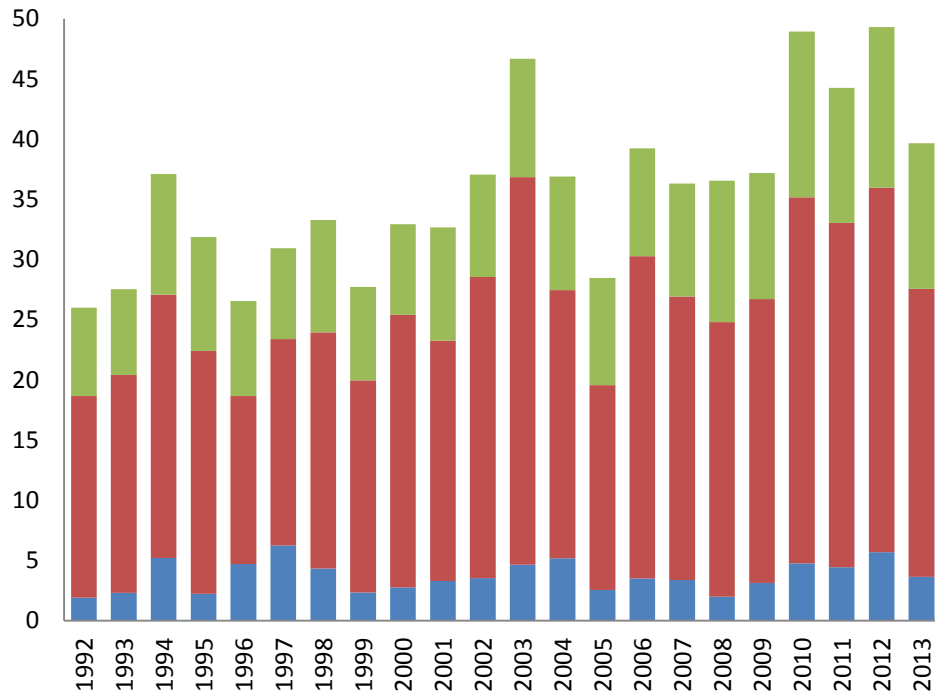
West Falmouth Harbor

Total Nitrogen (uM)

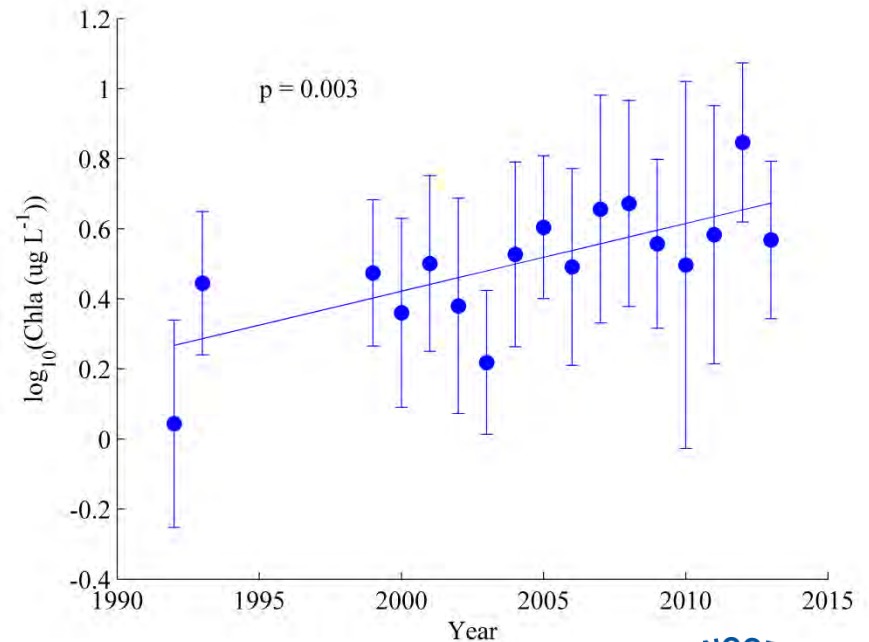


West Falmouth Harbor

Total Nitrogen (uM)

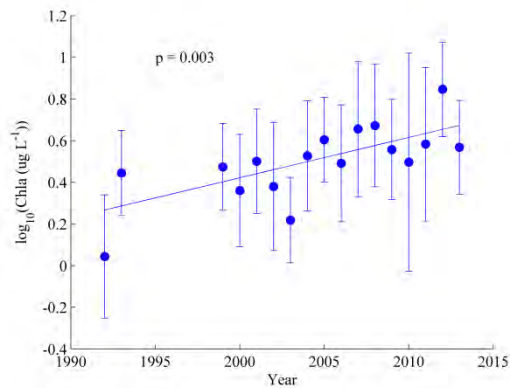


Chlorophyll

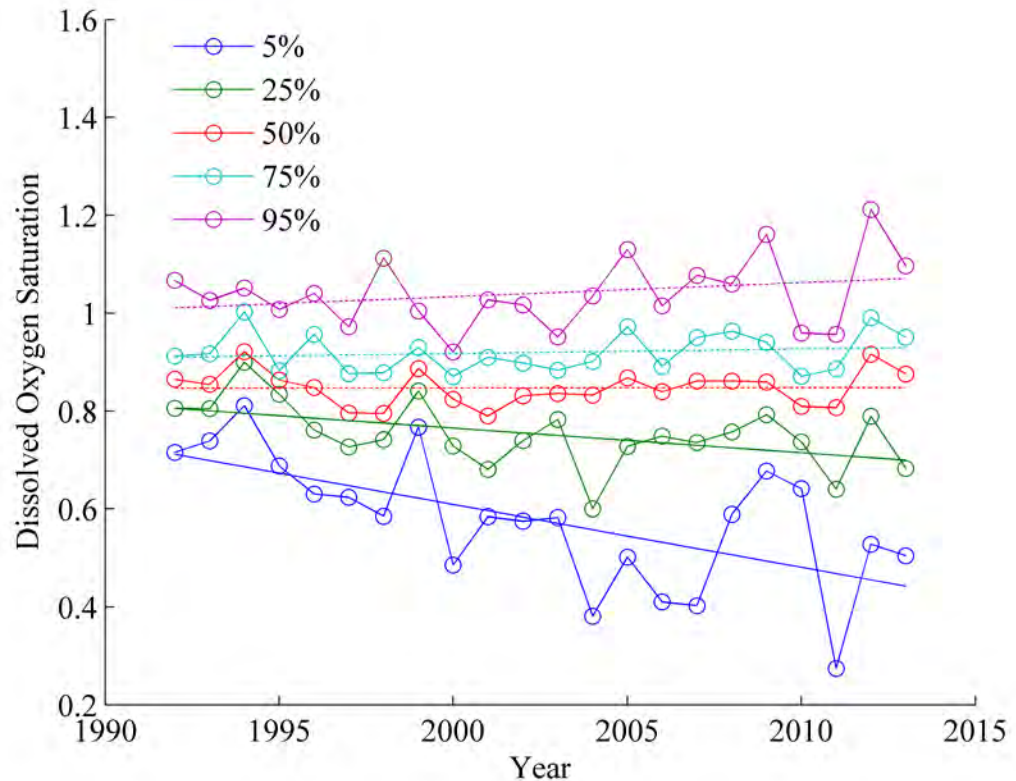


West Falmouth Harbor

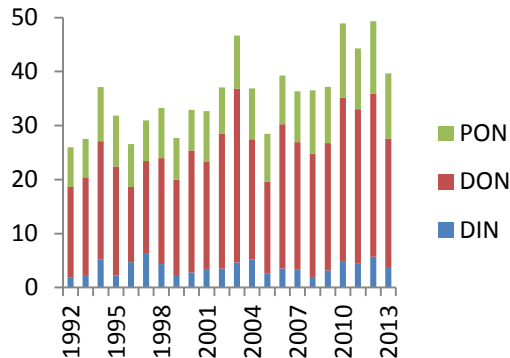
Chlorophyll



Dissolved Oxygen

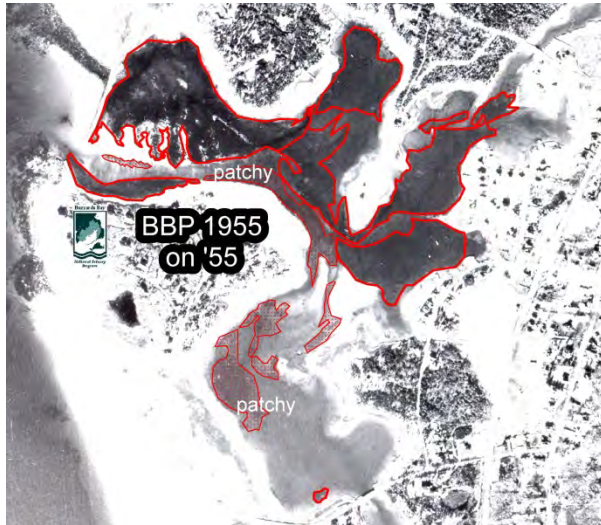


Nitrogen



West Falmouth Harbor

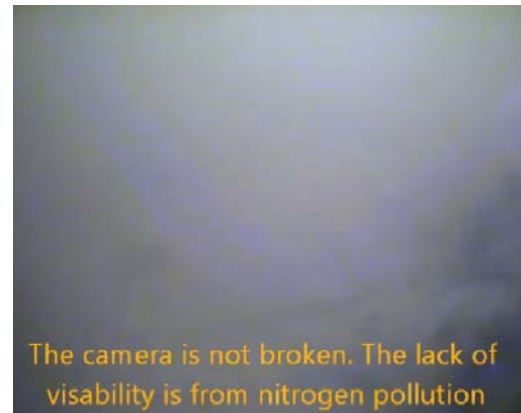
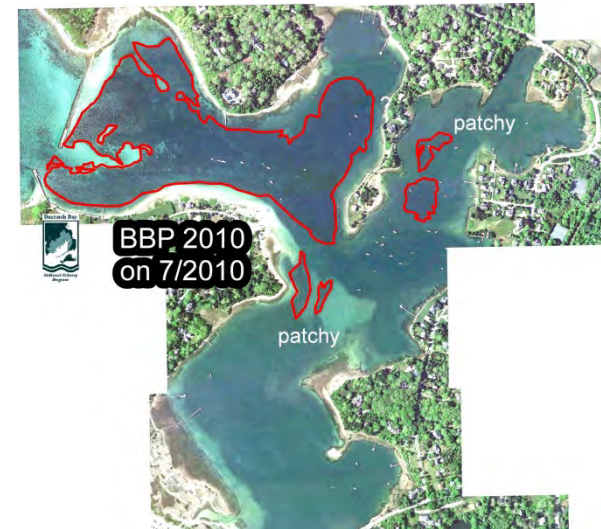
1955



2001

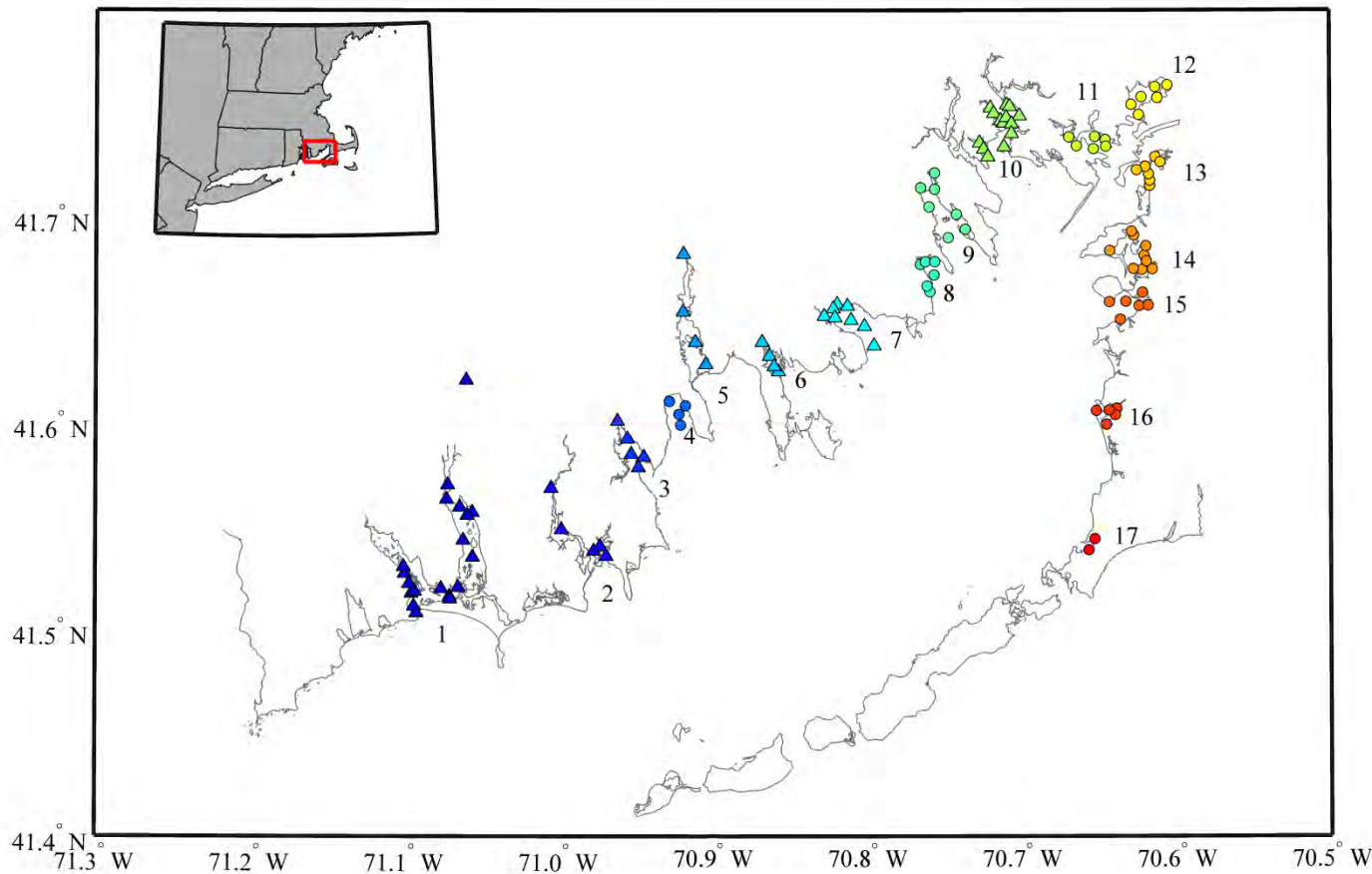


2010

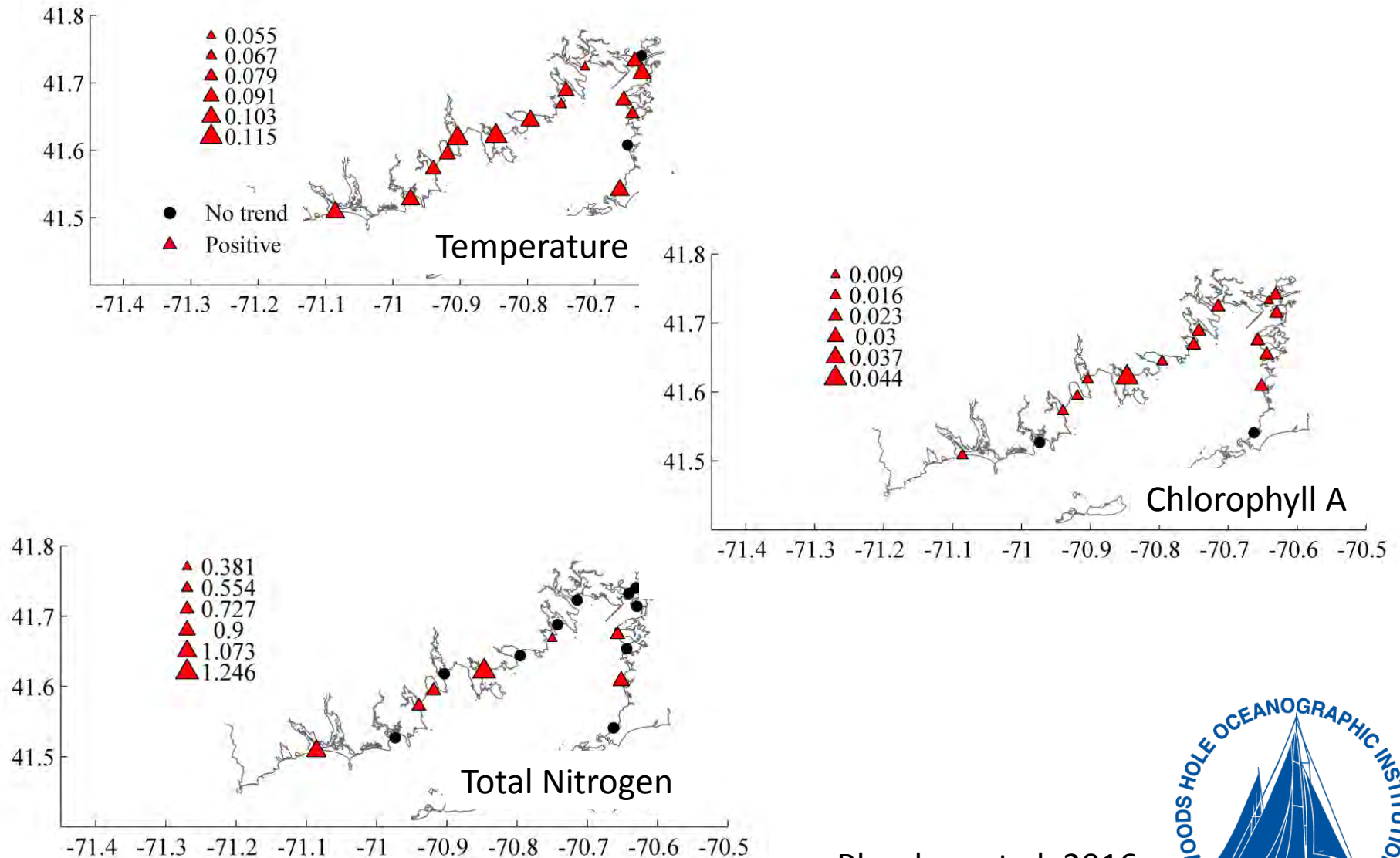


Where have the Baywatchers collected data?

Long-term trends, spatial patterns in water quality



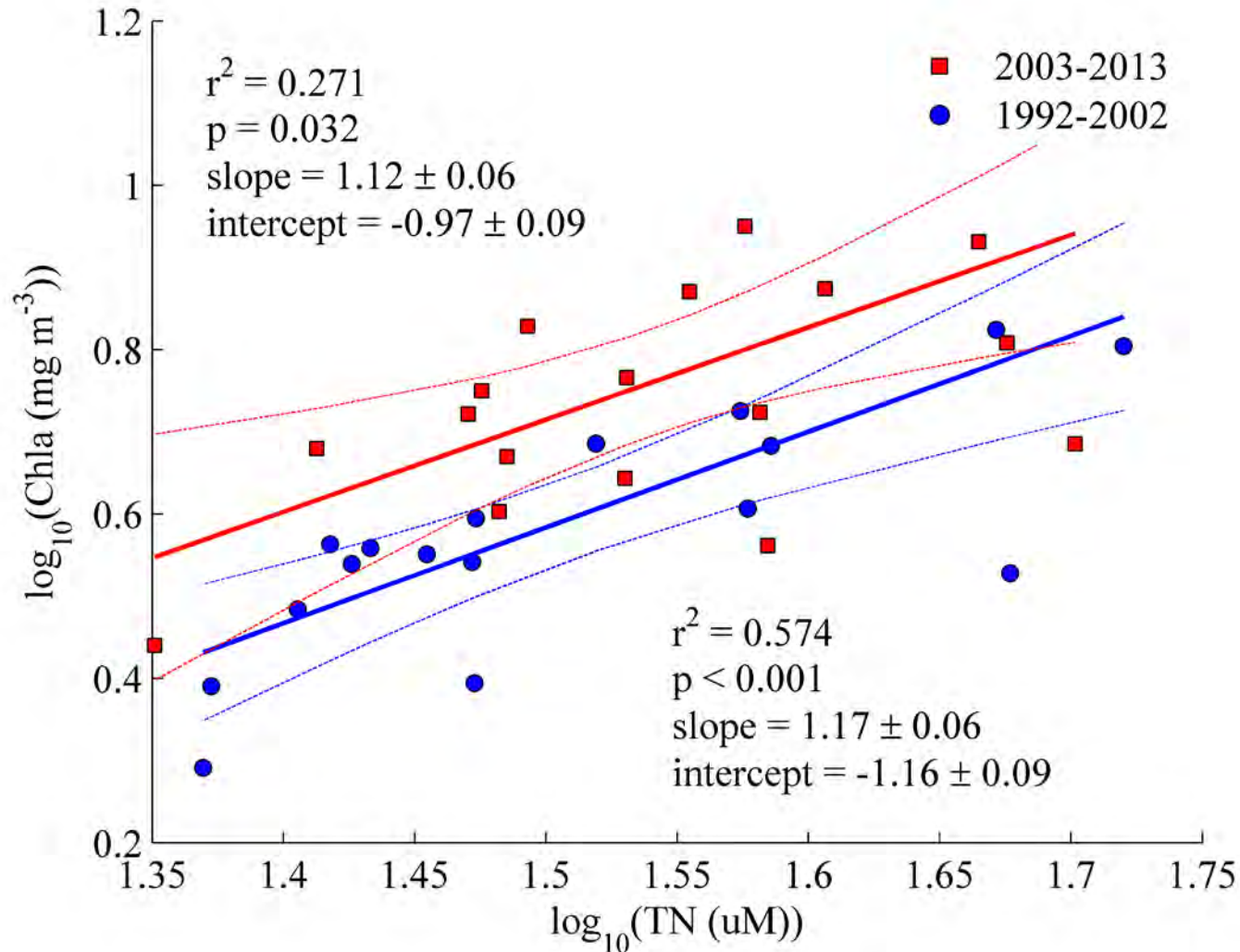
Decadal Trends



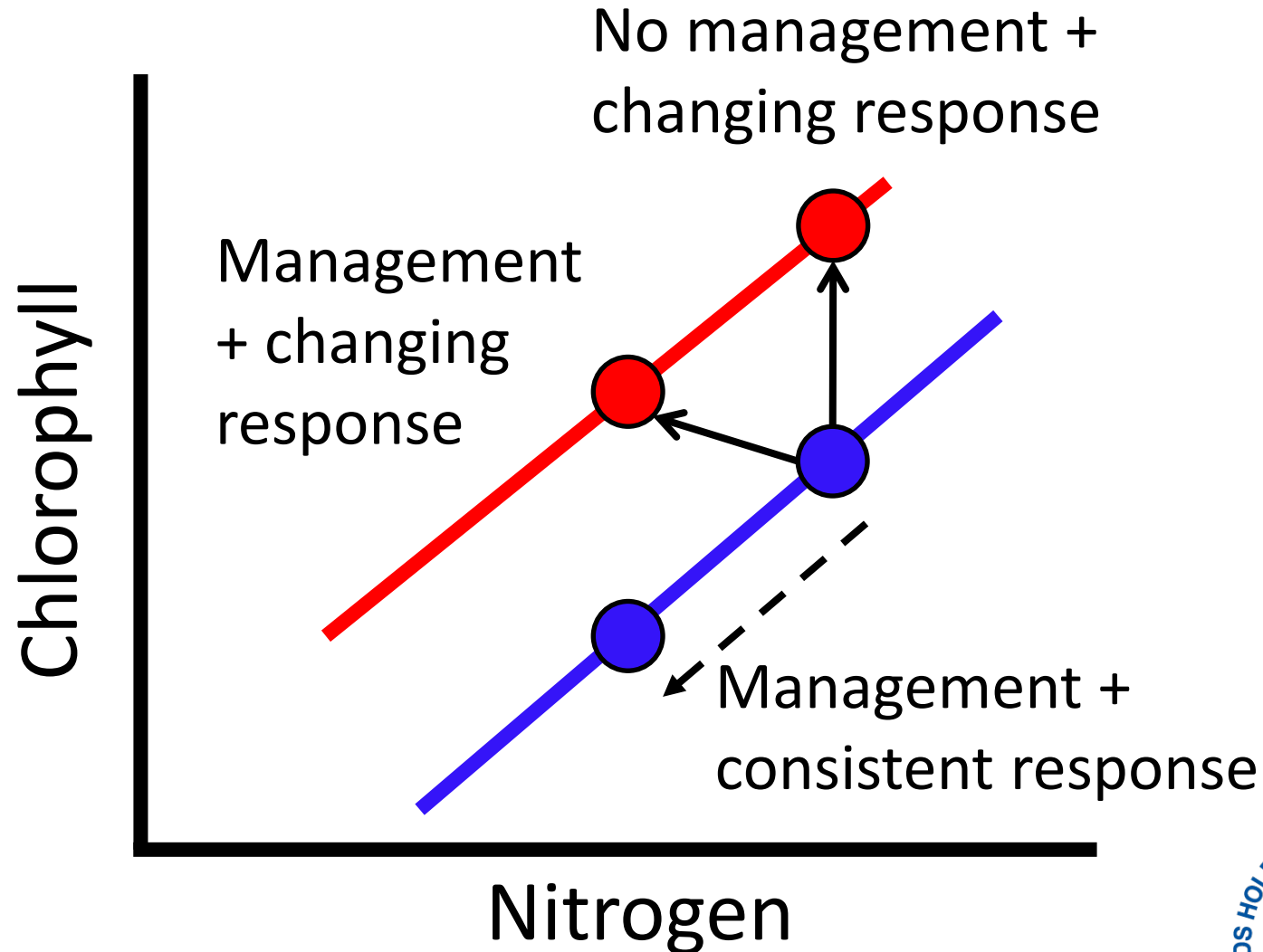
Rheuban et al. 2016



Yield of Chla higher in a warmer world



Yield of Chla higher in a warmer world



Yield of Chla higher in a warmer world

Management efforts to improve water quality may not look like they have produced positive results, but...

Without those efforts, things may have looked a LOT worse.



Conclusions

- We are seeing local impacts of climate change here - up to 2C (~4F!) warming over several decades
- Water quality indicators suggest declines in water quality in many places of Buzzards and Waquoit Bays
- In Buzzards Bay, Chlorophyll is increasing in more places than nutrients
- Higher yield of Chla/TN at present – Has substantial implications for management in the future



Thanks!

MacArthur Foundation



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http://www.whoi.edu/sites/coastal_climate_change_solutions

