

# National Estuarine Research Reserve System

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Applying Science and Education to Improve  
the Management of Estuaries



# NATIONAL ESTUARINE RESEARCH RESERVES

A network of 27  
protected areas



- |                                   |                                            |                                |                                           |
|-----------------------------------|--------------------------------------------|--------------------------------|-------------------------------------------|
| 1. Wells, Maine                   | 8. Chesapeake Bay, Maryland                | 15. Rookery Bay, Florida       | 22. San Francisco Bay, California         |
| 2. Great Bay, New Hampshire       | 9. Chesapeake Bay, Virginia                | 16. Apalachicola, Florida      | 23. South Slough, Oregon                  |
| 3. Waquoit Bay, Massachusetts     | 10. North Carolina                         | 17. Weeks Bay, Alabama         | 24. Padilla Bay, Washington               |
| 4. Narragansett Bay, Rhode Island | 11. North Inlet-Winyah Bay, South Carolina | 18. Grand Bay, Mississippi     | 25. Old Woman Creek, Ohio                 |
| 5. Hudson River, New York         | 12. ACE Basin, South Carolina              | 19. Mission-Aransas, Texas     | 26. Proposed—St. Lawrence River, New York |
| 6. Jacques Cousteau, New Jersey   | 13. Sapelo Island, Georgia                 | 20. Tijuana River, California  | 27. Kachemak Bay, Alaska                  |
| 7. Delaware                       | 14. Guana Tolomato Matanzas, Florida       | 21. Elkhorn Slough, California | 28. Jobos Bay, Puerto Rico                |

# protected for:

- Long-term research and monitoring
- Education
- Resource stewardship





# state-federal partnership



## State role

- Land ownership and management
- Staff
- Program implementation

## Federal role

- Funding (70%)
- National coordination
- Technical assistance



# System-wide Monitoring Program

## Physical Monitoring

- Water quality
- Weather parameters

## Ecological Monitoring

- Habitat Change
- Sentinel Sites



# What's Up with the Water in Waquoit Bay?



Megan Tyrrell, Research Coordinator  
Waquoit Bay National Estuarine Research Reserve





# Waquoit Bay NERR Water Quality Monitoring Sites

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



# Who's collected this data?





# Where else can you find WBNERR's water quality information?

The screenshot shows a web browser window with the URL [www.waquoitbayreserve.org/education-training/education-programs/past-events-presentations/](http://www.waquoitbayreserve.org/education-training/education-programs/past-events-presentations/). The page content includes:

- Research at the Reserve: Spring 2016**  
(Please click on the title to view full presentation.)
- Nitrogen Removal A Shell (or Shellfish) Game: Insights into Nitrogen Loading in Coastal Waters & Potential Remediation Strategies**  
Nitrogen pollution of our coastal waters is a threat to the health of our ecosystems, public health and economy. For the residents of Cape Cod, nitrogen remediation is a multibillion dollar issue. This economic driver has spurred increased interest in alternative strategies to restore the health of our coastal waters. Oyster aquaculture is one such strategy that has benefitted from the increased interest but does it really remove nitrogen or just move it to another place within our estuaries?  
Dr. Daniel Rogers, Assistant Professor, Analytical Chemistry, Stonehill College in Easton, MA
- After Twenty Years, What Can the Waters in Waquoit Bay Tell Us?**  
The Waquoit BayWatchers volunteer citizen science program has over twenty years of temperature, salinity, depth, dissolved oxygen, and chlorophyll data for Waquoit Bay. The Reserve's Research Associate Jordan Mora has recently examined the data and detected dramatic changes in temperature and dissolved oxygen that provide compelling evidence that Waquoit Bay may be experiencing impacts from climate change as well as eutrophication from the addition of too much nitrogen to the waters stemming from wastewater, fertilizers, and the burning of fossil fuels. Join us to see what the data is revealing.  
Jordan Mora, Research Associate, Waquoit Bay Reserve
- Tracking the Movement Patterns of Seabirds and Shorebirds to Inform Siting and Monitoring of Off-Shore Wind Facilities**  
Ever wondered about the animals rising up from the sands at South Cape Beach in Mashpee? Researchers from UMASS Amherst are tracking the movements of Common Terns, Roseate Terns, and Piping Plovers in Southern New England by using light-weight transmitters which track the birds around the clock. Knowledge of offshore flight paths of birds is essential to inform effective conservation decisions in marine planning such as how to minimize impacts of offshore wind energy facilities on key bird populations. Hear about the work at South Cape Beach in Mashpee and how it connects to work in southern New England which is coordinated with automated radio telemetry stations throughout the Western Hemisphere. To learn more about wildlife tracking, visit [www.motus-wts.org](http://www.motus-wts.org).  
Pamela Loring, PhD candidate, Dept. of Environmental Conservation, University of Massachusetts, Amherst

On the right side of the page, there is a calendar view for April 2017 with the following events:

- Wonders up with the water in Waquoit Bay? - 04/10/2017
- Bats & Bunnies: Managing Habitat for Seldom Seen Mammals - 04/17/2017
- Chickens Aren't the Only Ones - 04/18/2017
- Where is Peter Cotton Tail? - 04/18/2017
- Return of the Osprey - 04/20/2017

Below the calendar is a search bar and a "view calendar" link. At the bottom right, there is a "Donate" button and logos for accepted payment methods: American Express, MasterCard, Visa, Discover, and PayPal.

# Where else can you find WBNERR's water quality information?

Secure | <https://www.youtube.com/watch?v=SHj1Y4bcJH8&index=2&list=PLulztFkHStHwBlmM2JsQQqSD6pUK3Ibhn>

Apps | Lenovo Recommended



waquoit bay water quality



## Water Quality Monitoring Program



WaquoitBayReserve



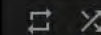
+ Add to | Share | ... More

78 views



### Research at the Reserve Series

WaquoitBayReserve • 2/5 videos



1 Waquoit Bay Reserve Eelgrass Video  
WaquoitBayReserve



2 Water Quality Monitoring Program  
WaquoitBayReserve



3 South Cape Beach Ancient Forest  
WaquoitBayReserve



4 Nitrogen Cycling with Scott Wankel and Cary Buchwald  
WaquoitBayReserve



5 P.I.T. Tagging in the Quashnet River  
WaquoitBayReserve



Marine Flight Program: Water Quality Monitoring  
PacificEDInstitute  
76 views

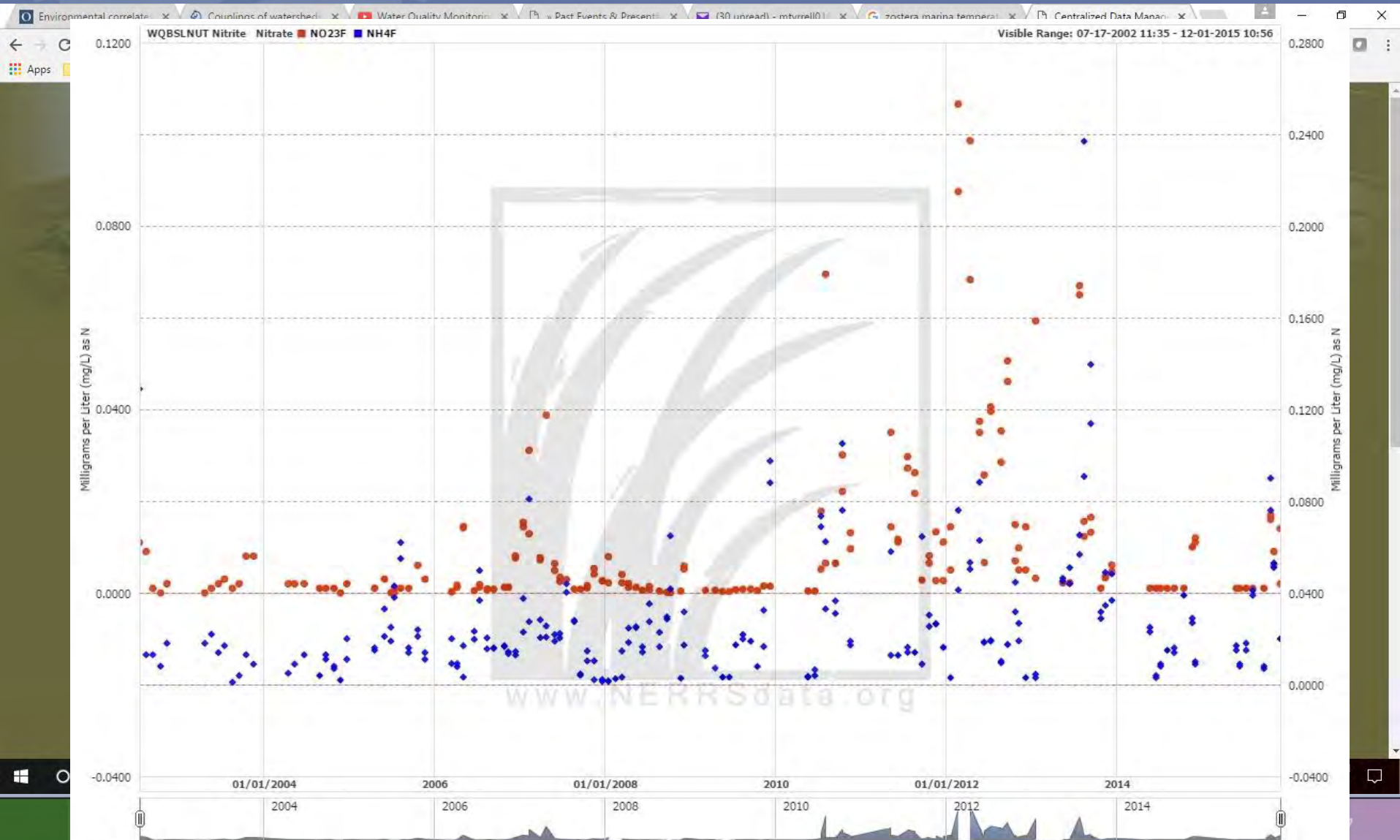


Volunteer Water Quality Monitoring  
MSUExtWaterQuality

*national estuarine research reserve system*



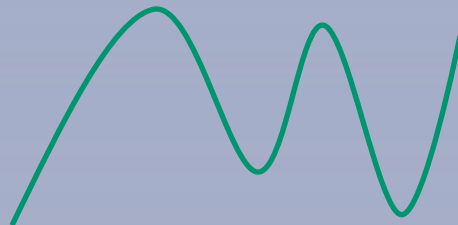
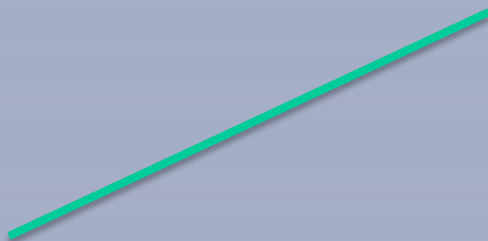
# Where else can you find WBNERR's water quality information?





# Timeframe

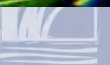
- 1998 Metoxit
- 2001 Menauhant
- 2002 Child's River and Sage Lot
- Fifteen to nineteen years of water quality data to infer trends



# What would it take to bring back Waquoit Bay's eelgrass?



Credit: Christoffer Bostrom\_Zosteramarina\_Finland



*national estuarine research reserve system*



# Nutrient enrichment in Waquoit Bay

■ E

Estuaries Vol. 15, No. 4, p. 443–457 December 1992

## Couplings of Watersheds and Coastal Waters: Sources and Consequences of Nutrient Enrichment in Waquoit Bay, Massachusetts<sup>1,2</sup>

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KENNETH FOREMAN  
MICHAEL LAMONTAGNE  
DOUGLAS HERSH  
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# Seagrass decline in Waquoit Bay

454

I. Valiela et al.

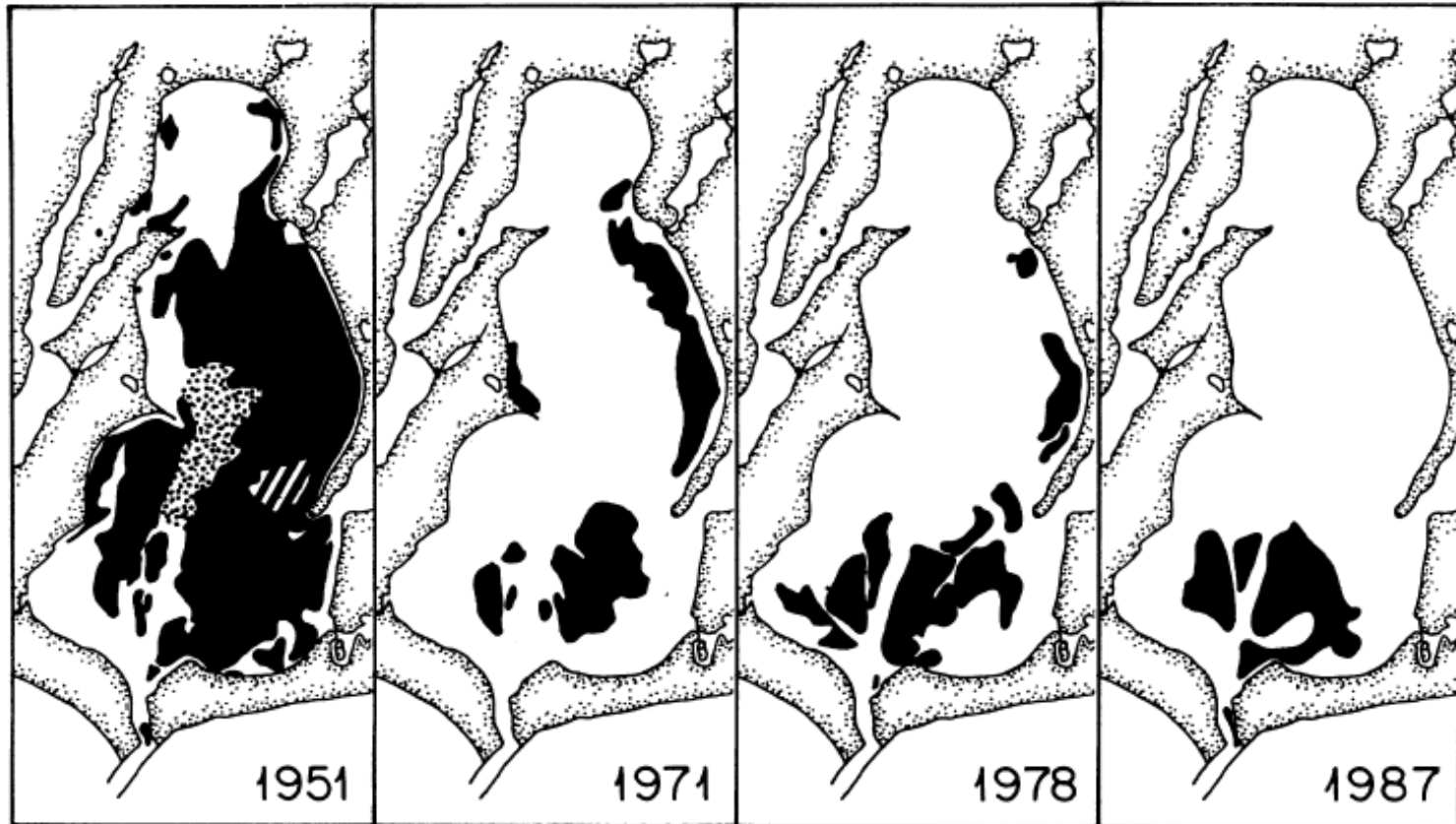


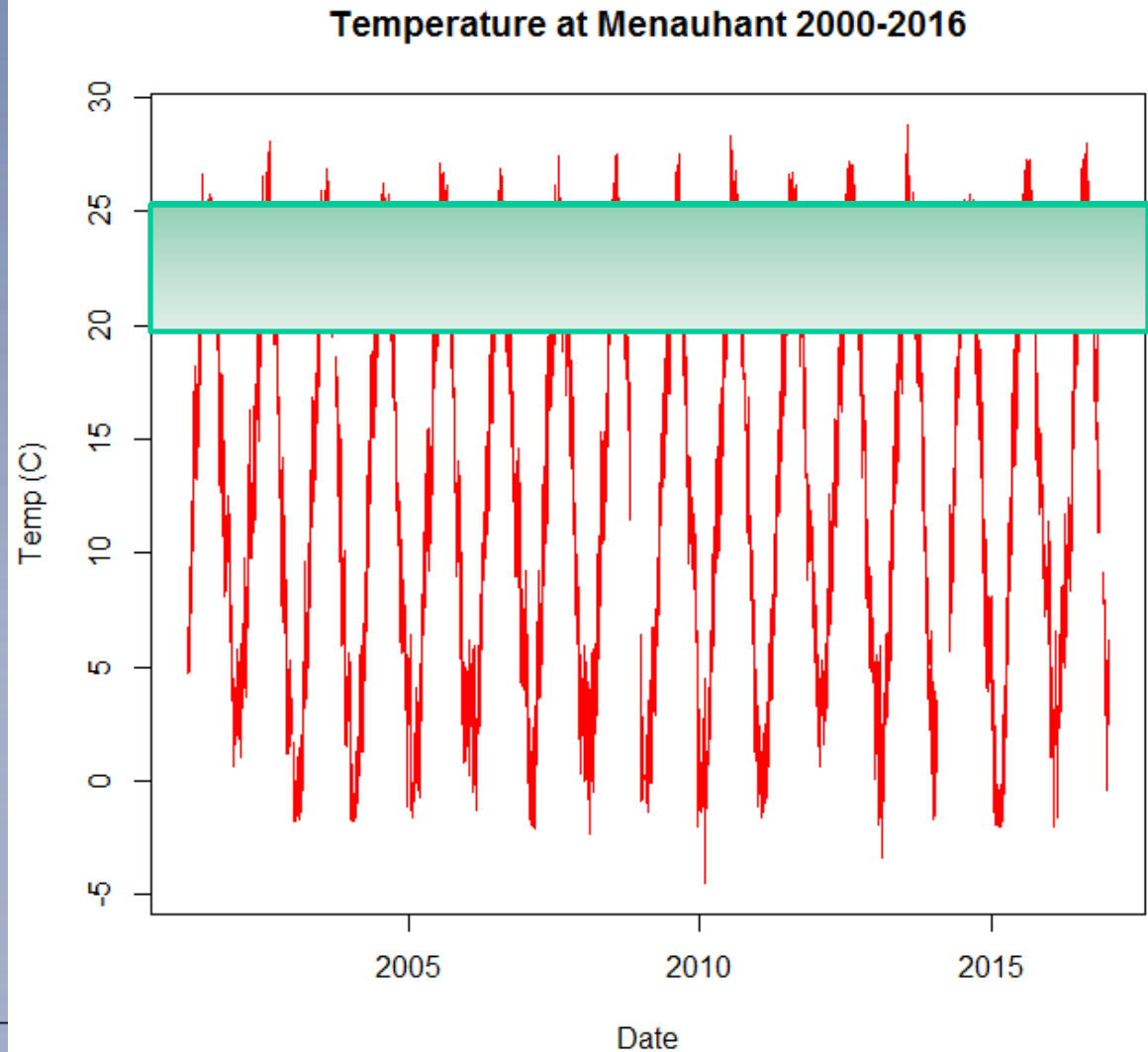
Fig. 12. Changes in eelgrass distribution in Waquoit Bay, 1951–1987. Black areas are eelgrass beds with cover near 100%. The diagonal stripes in 1951 map show an area of patchy eelgrass cover. The dotted ones in 1951 map refer to parts of photograph where it was impossible to interpret the information. From Costa et al. (in press).

Valiela et al. 1992 *Estuaries*



# Eelgrass temperature thresholds

- Mortality strongly increased  $>25^{\circ}\text{C}$
- Optimal growth  $10\text{--}20^{\circ}\text{C}$
- High temperatures + high nutrients = less eelgrass



# SWMP widget by Marcus Beck and Todd O'Brien

## Monthly and annual summary of SWMP parameters

Created by Marcus W. Beck, [beck.marcus@epa.gov](mailto:beck.marcus@epa.gov) Todd O'Brien, [todd.obrien@noaa.gov](mailto:todd.obrien@noaa.gov)

This interactive widget provides graphical summaries of water quality, weather, and nutrient station data from the System Wide Monitoring Program of the National Estuarine Research Reserve System (NERRS). The drop down menus can be used to select the station, date range, and parameter for plotting. The raw data used for plotting include all SWMP records from the earliest date at each station after processing to remove QA/QC flags. The data were downloaded from the CDMO on November 25th, 2014 and include observations up to that date. Plots are based on daily averages for each parameter. Cumulative precipitation data are based on the daily maximum. See the [GitHub repository](#) for source code.

### Select station

acebbwq

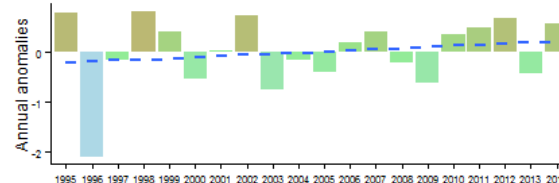
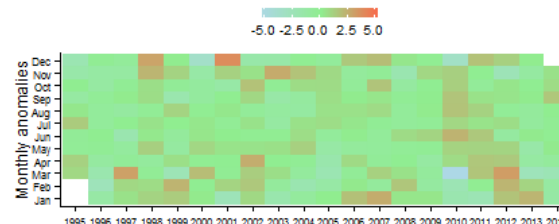
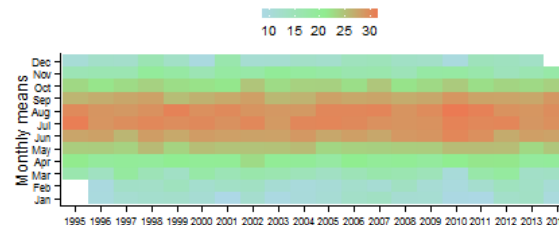
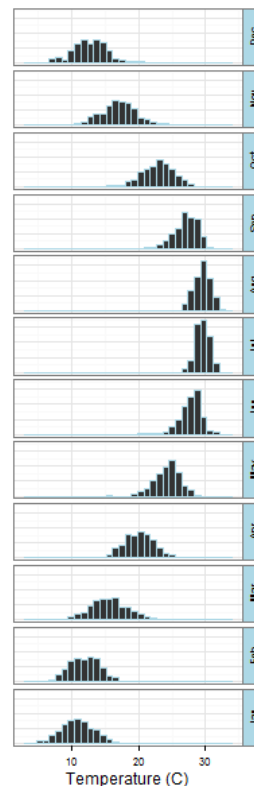
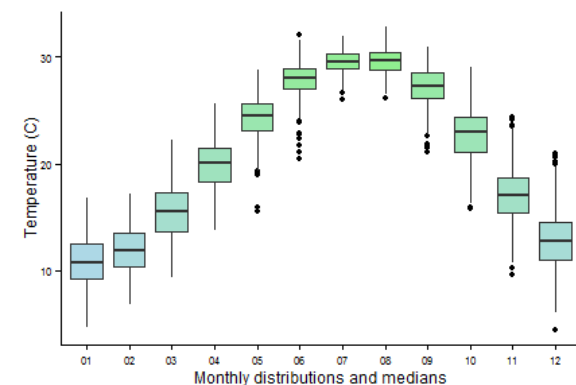
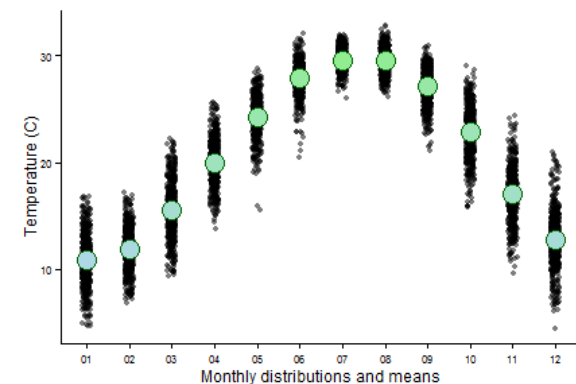
[Download plot](#)

### Select date range



### Select variable

Temperature (C)



re system



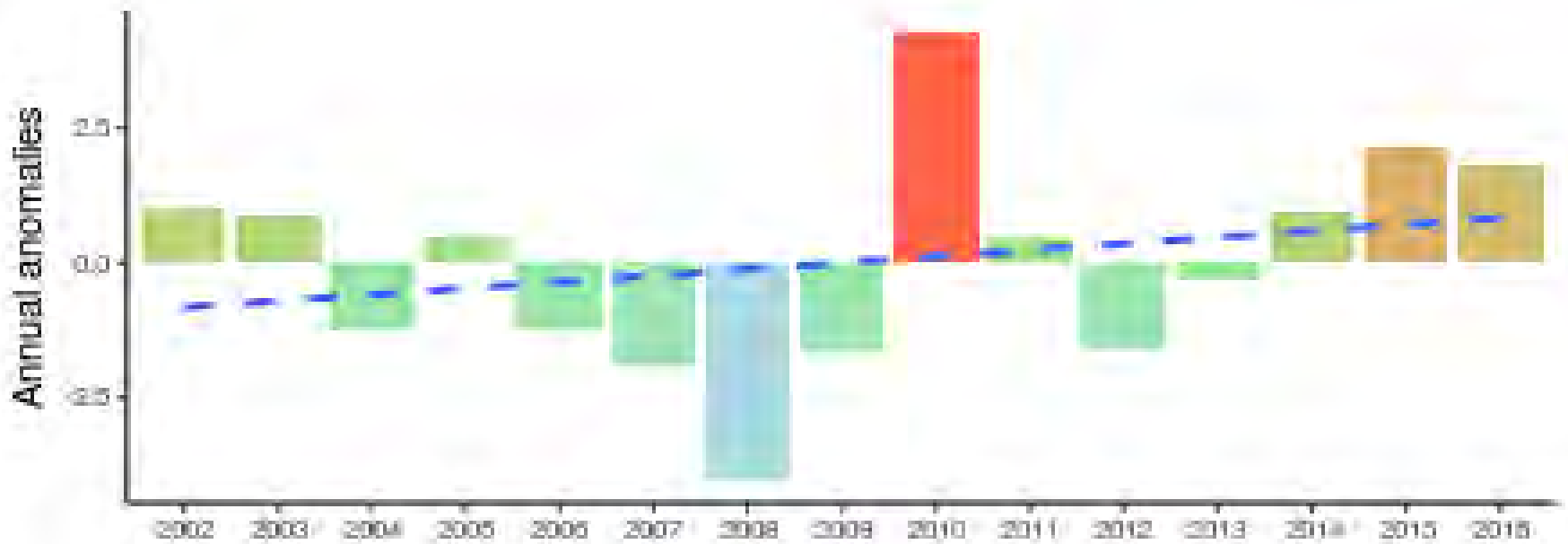
# Stinging jellies



*Gonionemus*, Image Credit: Annette Govindarajan, WHOI

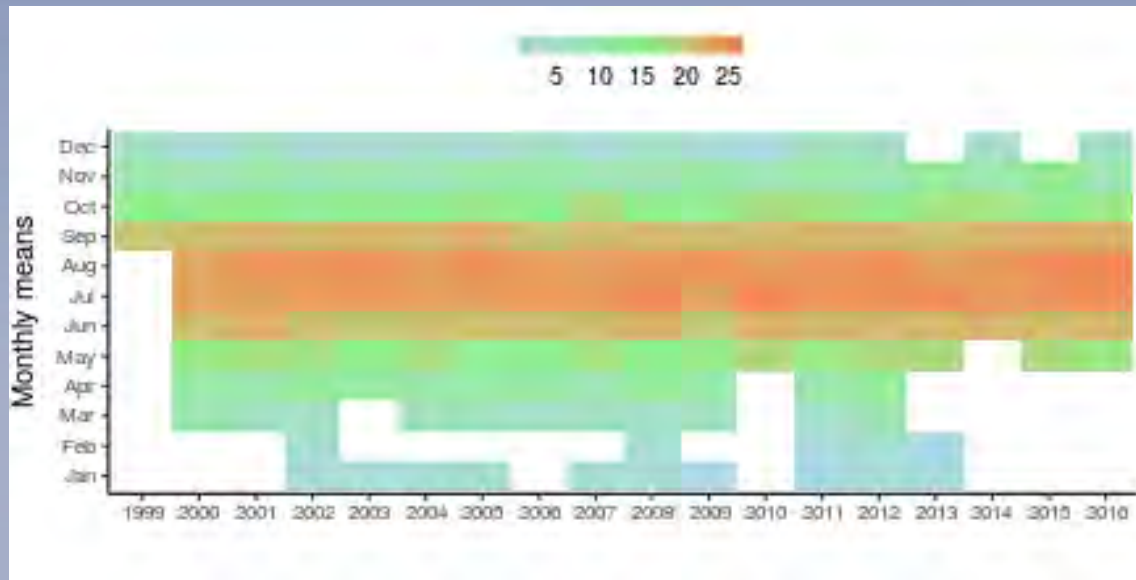


# Sage Lot Pond Water Temperatures

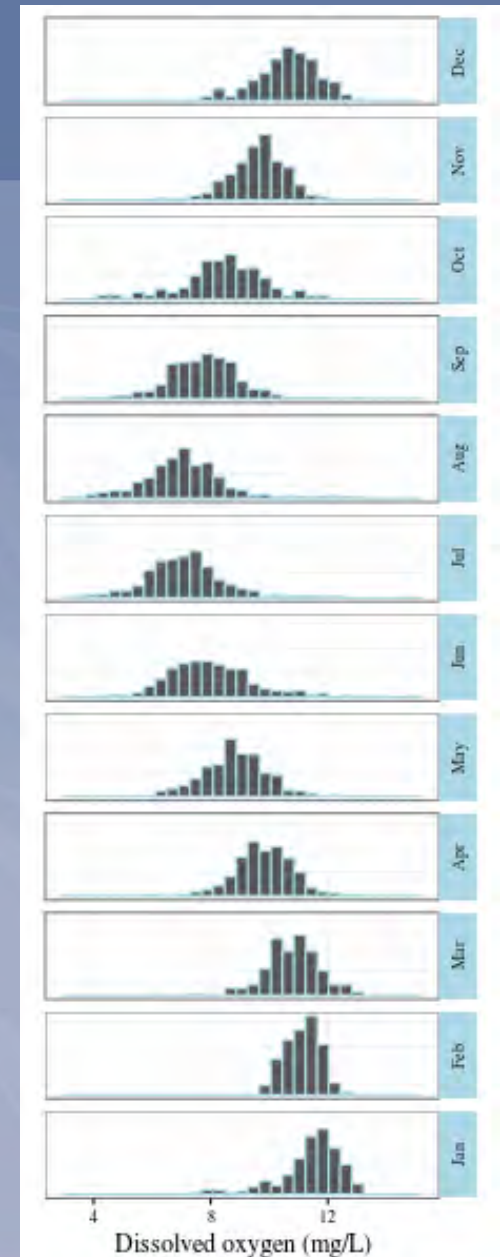


# Metoxit Point- Dissolved oxygen

- Cold temperatures, more dissolved oxygen

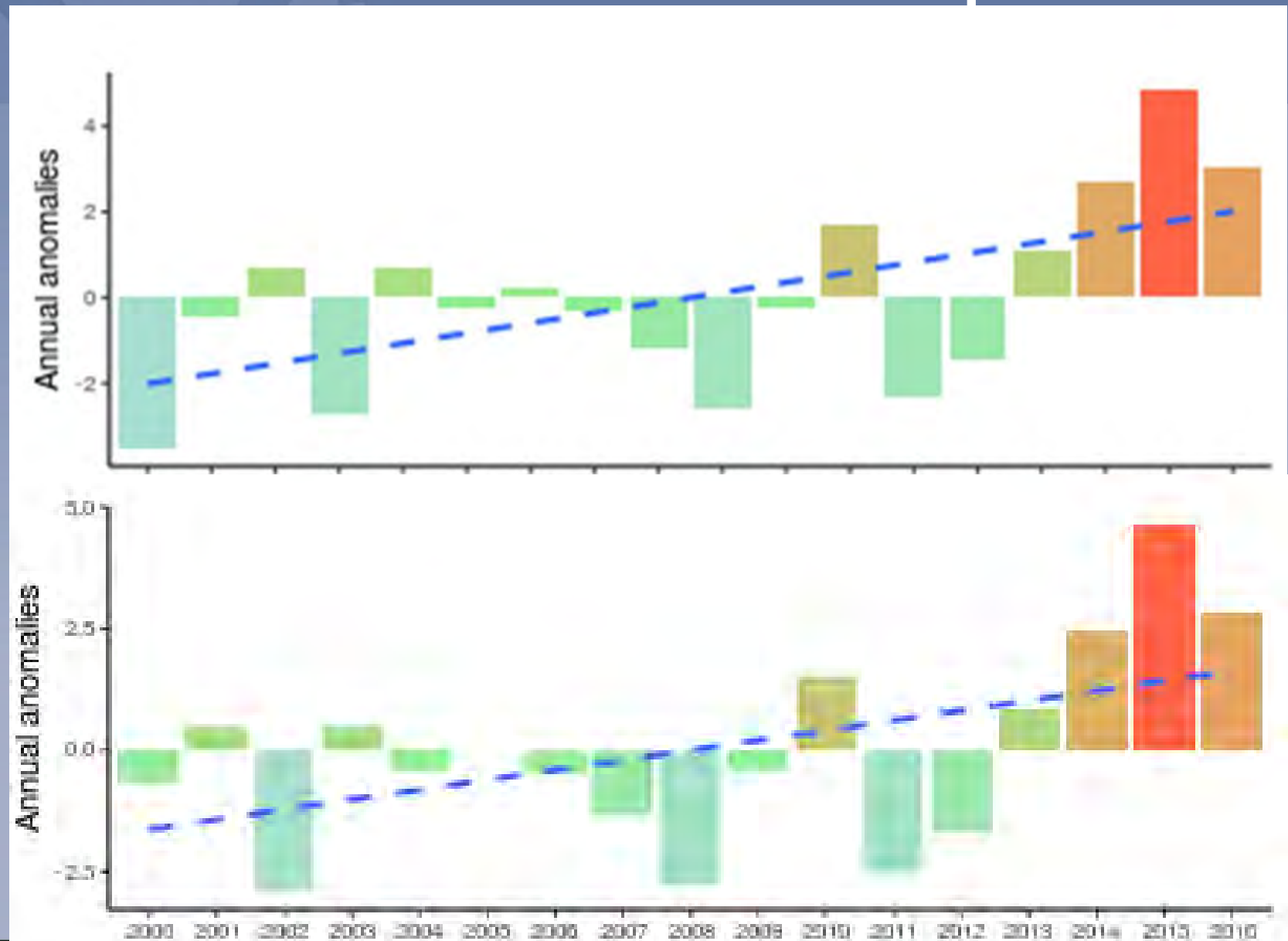


Metoxit Point water temperatures





# Metoxit Point water temperatures



# Fish/shrimp kills



2014 Waquoit Bay

Image credit:  
CapeCod.com

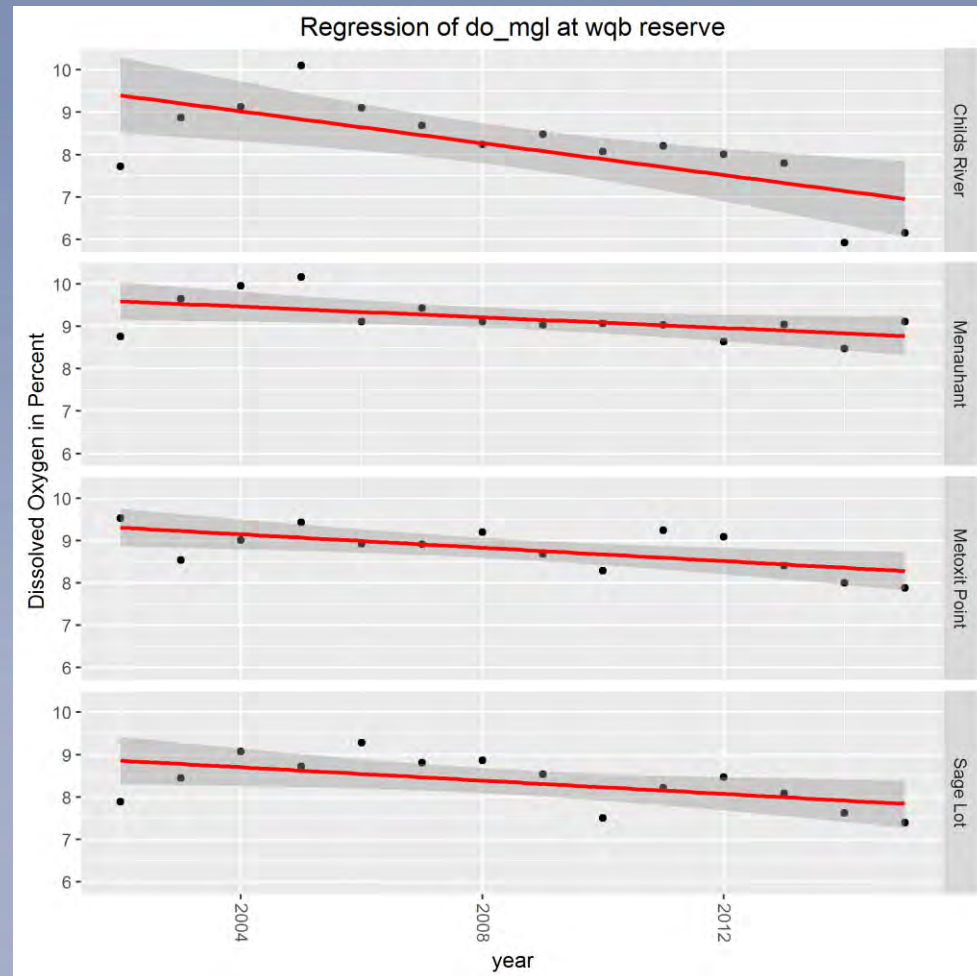


Image credit: Falmouth Enterprise



# Fish/shrimp kills

- Dissolved oxygen is significantly declining at all 4 water quality monitoring sites



Plots by Jordan Mora



# Warm waters

- Stressed eelgrass
- Increased stinging jellies?
- Reductions in dissolved oxygen
  - Fish/shrimp kills



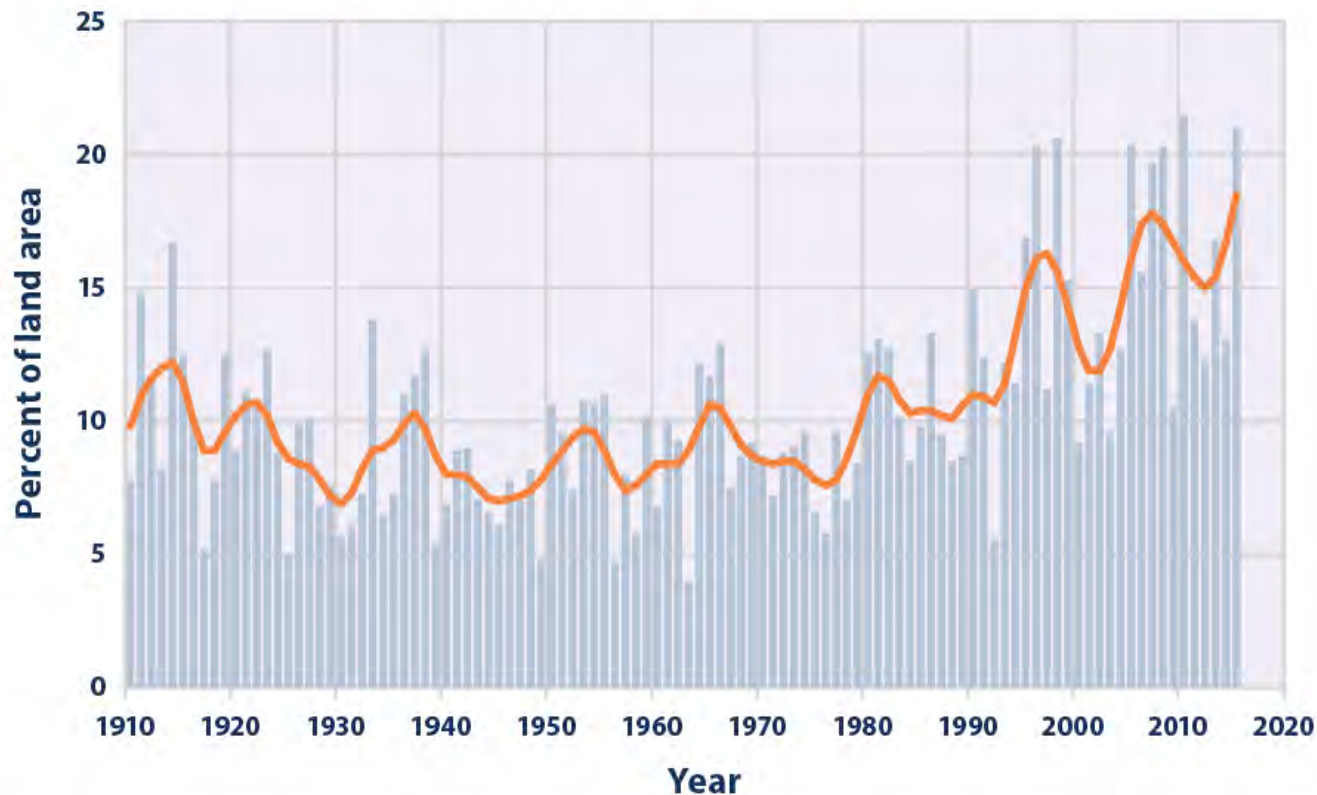
# Meteorological and water quality data

- Increased extreme precipitation events-  
can we see it in salinity drops or turbidity  
spikes?



# Increasing heavy precipitation events

**Extreme One-Day Precipitation Events in the Contiguous 48 States, 1910–2015**



Data source: NOAA (National Oceanic and Atmospheric Administration). 2016. U.S. Climate Extremes Index. Accessed January 2016. [www.ncdc.noaa.gov/extremes/cei](http://www.ncdc.noaa.gov/extremes/cei).

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at [www.epa.gov/climate-indicators](http://www.epa.gov/climate-indicators).





# Sheet flow off a salt marsh



Image from: <https://bu.digication.com/bartlettwoogmaster/Home/>

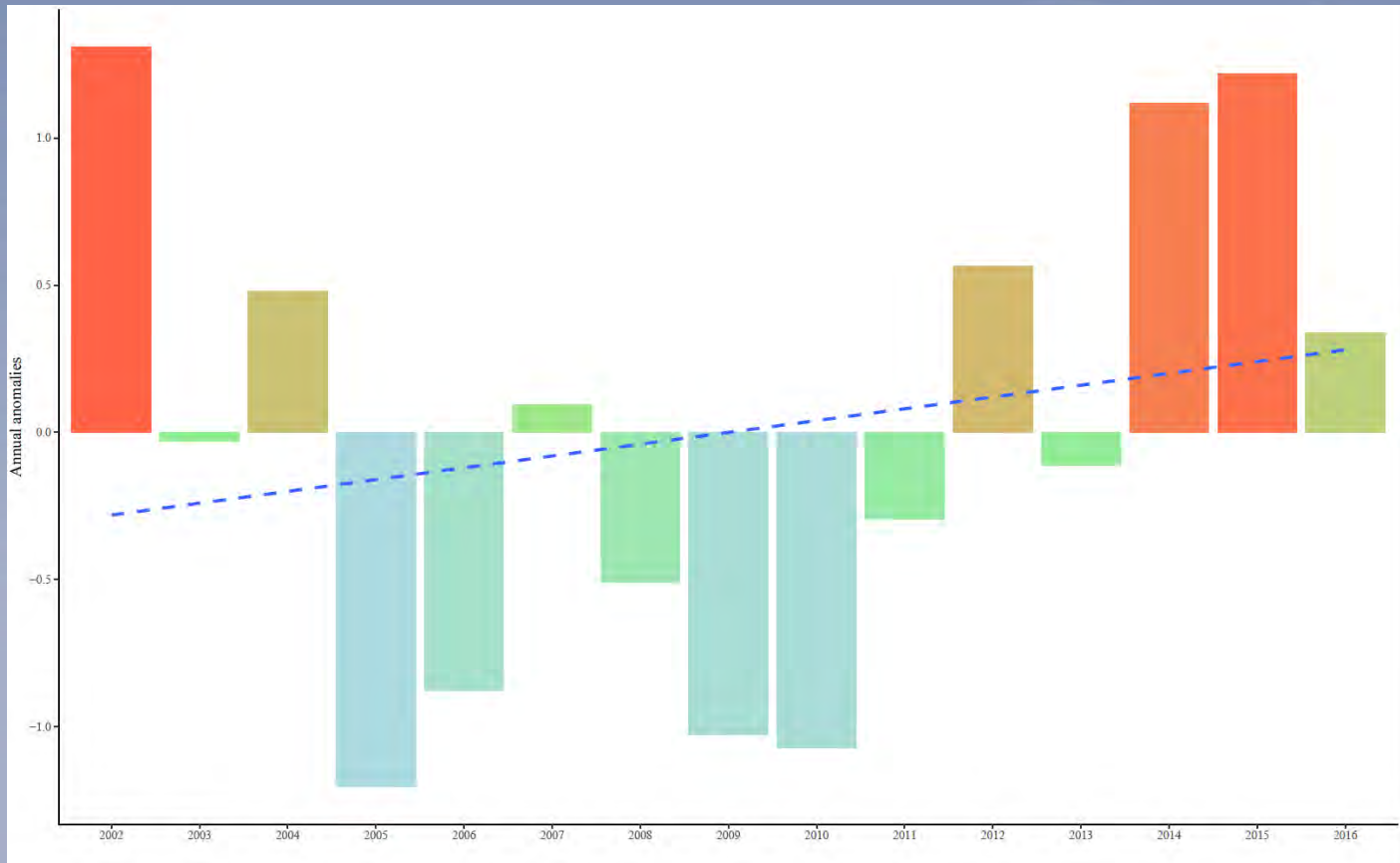


# Meteorological and water quality data

- Increased extreme precipitation events-  
can we see it in salinity drops or turbidity  
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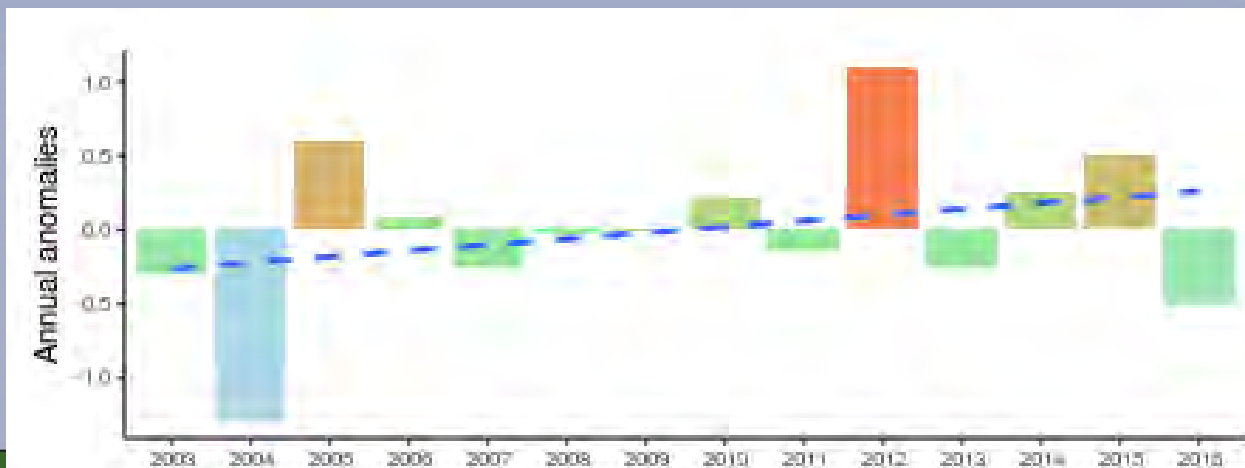
# Sage Lot Pond Salinity



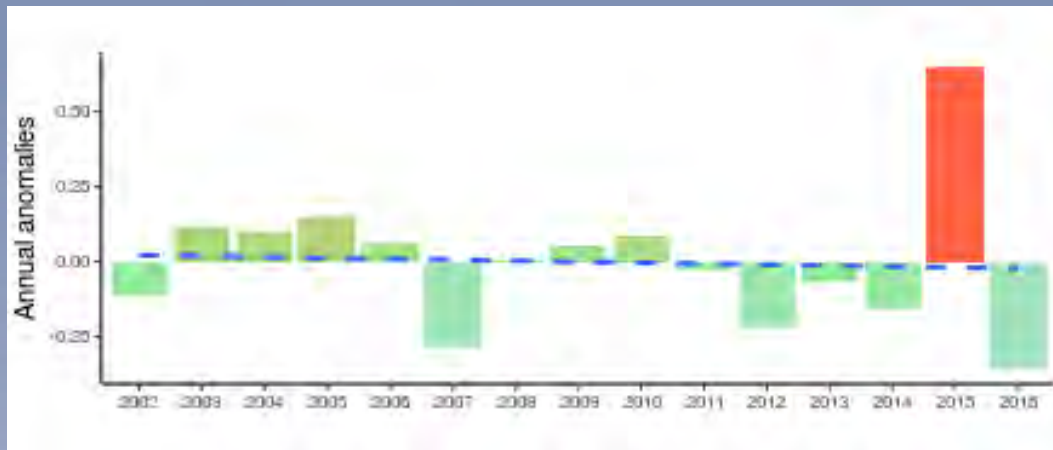


# Sage Lot Pond Turbidity

- Turbidity is generally low= clear water
- Little variation between months
- Slight trend of increasing average values through time



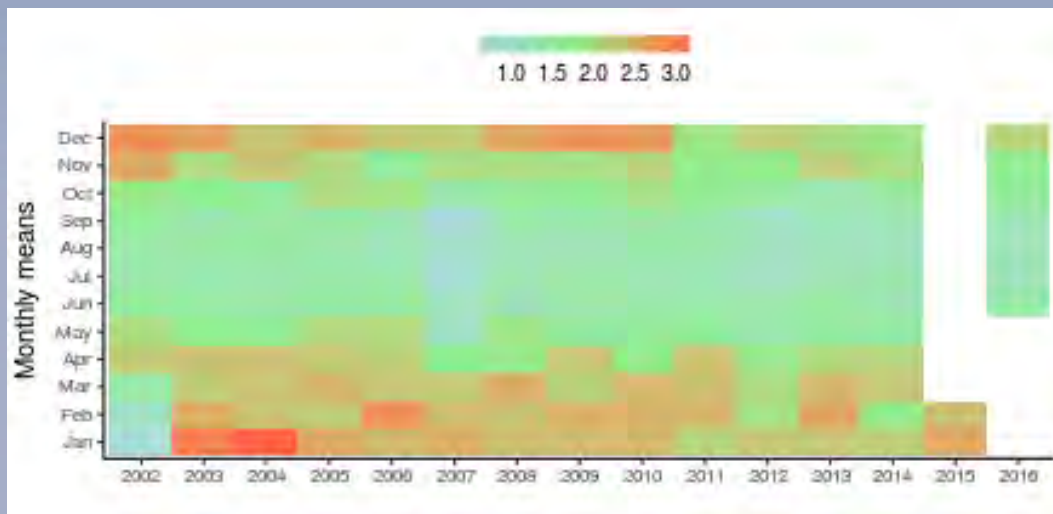
# Carriage house wind speed 2002-2016



Is it getting windier through time?

What about 2015?

Missing data belies 2015 as a strong anomaly



# What's Up with the Water in Waquoit Bay?

- Appears to be warmer (eelgrass, stinging jellies, effects on oxygen, metabolic rates)
- Oxygen is decreasing (\*declining at 4 sites- fish/shrimp kills)
- Salinity- variable (Sage Lot)
- Turbidity- correlations with heavy rain, strong winds TBD





# Widget quickly summarizes SWMP data for the NERRS

## Monthly and annual summary of SWMP parameters

Created by Marcus W. Beck, [beck.marcus@epa.gov](mailto:beck.marcus@epa.gov) Todd O'Brien, [todd.obrien@noaa.gov](mailto:todd.obrien@noaa.gov)

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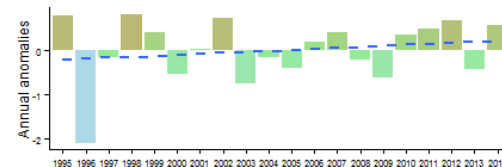
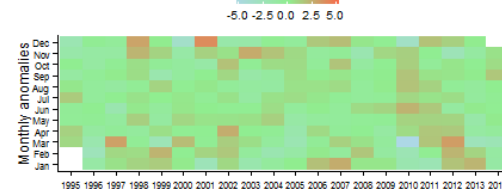
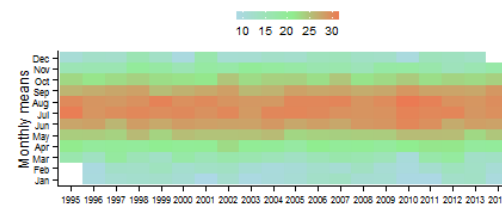
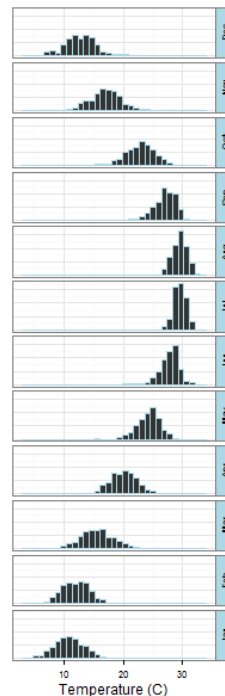
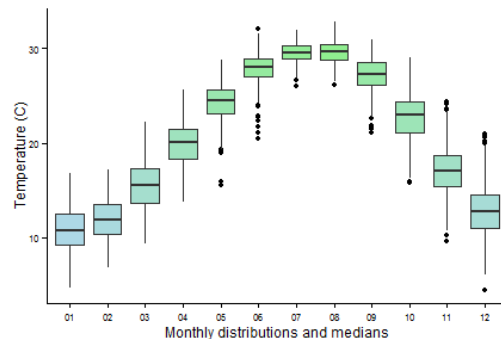
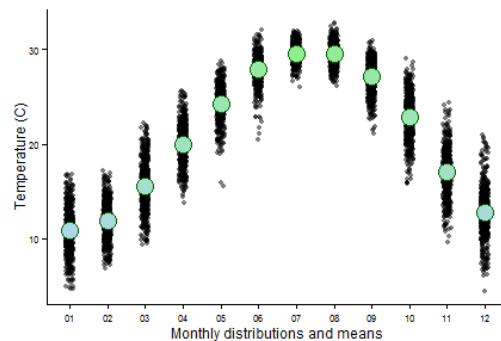
[Download plot](#)

### Select date range

1995 - 2014

### Select variable

Temperature (C)



# References

- Bondoni, M., S. Francalanci, L. Cappietti, and L. Solari (2014), On salt marshes retreat: Experiments and modeling toppling failures induced by wind waves, *J. Geophys. Res. Earth Surf.*, 119, 603–620, doi:[10.1002/2013JF002967](https://doi.org/10.1002/2013JF002967).
- Hugh L. Macintyre, Adrienne L. Stutes, William L. Smith, Carol P. Dorsey, Ann Abraham, Robert W. Dickey; Environmental correlates of community composition and toxicity during a bloom of *Pseudo-nitzschia* spp. in the northern Gulf of Mexico. *J Plankton Res* 2011; 33 (2): 273-295. doi: 10.1093/plankt/fbq146
- Kaldy, J.E. 2014. Effect of temperature and nutrient manipulations on eelgrass *Zostera marina* L. from the Pacific Northwest, USA. <http://doi.org/10.1016/j.jembe.2013.12.020>
- Nejrup, L.B. and M.F. Pederson 2007 Effects of salinity and water temperature on the ecological performance of *Zostera marina*. *Aquatic Botany*. <http://doi.org/10.1016/j.aquabot.2007.10.006>
- Valiela, I., Foreman, K., LaMontagne, M. et al. 1992 Couplings of watersheds and coastal waters: Sources and consequences of nutrient enrichment in Waquoit Bay, Massachusetts. *Estuaries* 15: 443-457. doi:10.2307/1352389

